Univerza v Ljubljani
Filozofska Fakulteta
Oddelek za Arheologijo

Documenta Praehistorica XXVIII

Neolithic studies

Univerza v Ljubljani
Filozofska Fakulteta
Oddelek za Arheologijo

Documenta Praehistorica XXVIII

Editor
Mihael Budja

8th Neolithic studies

ISSN 1408-967X

Ljubljana 2001

DOCUMENTA PRAEHISTORICA XXVIII

8th NEOLITHIC STUDIES / NEOLITSKE ŠTUDIJE 8

Editor/Urednik:
Mihael Budja, miha.budja@uni-lj.si

English advisor/Jezikovni pregled angleškega besedila:
Philip James Burt

Published by/Založila:
Filozofska fakulteta, Oddelek za arheologijo

Technical editor and DTP/Tehnično urejanje in DTP:
CAMBIO d.o.o., Ljubljana

Printed by/Tisk:
Tiskarna Hren, Ljubljana

Number printed/Naklada:
1000 izvodov

Natisnjeno s podporo Ministrstva za šolstvo, znanost in šport ter Ministrstva za kulturo Republike Slovenije in Znanstvenega inštituta Filozofske fakultete.

Documenta Praehistorica je vključena v naslednje izbrane indekse:
SACHKATALOG DER PUBLIKATIONEN ZUR ALTERTUMSKUNDE - DAI- Germania ISBN 3-8053-1660-7; DYABOLA, Sachkatalog der Bibliothek der Röm.-germ. Kommission Mainz - http://www.db.dyabola.de/; COPAC http://www.copac.ac.uk/; OPAC http://www-opac.bib-bvb.de/; GBV http://www.gbv.de/; http://www.brzn.de/cgi-bin/nph-wwwobnmenu

CONTENTS

Mihael Budja
V Preface

Marek Zvelebil
1 The agricultural transition and the origins of Neolithic society in Europe

Mihael Budja
27 The transition to farming in Southeast Europe: perspectives from pottery

Avi Gopher, Shahal Abbo and Simcha Lev-Yadun
49 The "when", the "where" and the "why" of the Neolithic revolution in the Levant

Kostas Kotsakis
63 Mesolithic to Neolithic in Greece. Continuity, discontinuity or change of course?

Luiz Oosterbeek
75 Re-thinking the Mesolithic-Neolithic transition in the Iberian peninsula: a view from the West

Peter Bogucki
85 Recent research on early farming in central Europe

Eva Lenneis
99 The beginning of the Neolithic in Austria – a report about recent and current investigations

Helena Knutsson
117 Technology, mythology and the travels of the agricultural package in Europe

Maja Andrič
133 The Holocene vegetation dynamics and the formation of Neolithic and present-day Slovenian landscape

Preston Miracle
177 Feast or famine? Epipalaeolithic subsistence in the northern Adriatic basin

Kornelija Minichreiter
199 The architecture of Early and Middle Neolithic settlements of the Starčevo culture in Northern Croatia

Aleksandar Durman
215 Celestial symbolism in the Vučedol culture

"Vučedol calendar – pot", see A. Durman in this volume and, star chart from Zvezdni atlas za epoho 2000,0 (2001).

Preface

The overtures to this Neolithic Studies anthology, were the seventh and eighth Neolithic Seminars held at the Department of Archaeology, University of Ljubljana in May 2000 and November 2001. As far as content is concerned, we have maintained to contemplate the neolithisation processes and the transition to farming in Eurasia as well concepts and models such as “agricultural frontier”, “demic diffusion” and related genetic palimpsest, “wave of advance”, “availability model”, “secondary centres of neolithisation” and, to “when” and “where” questions of plant domestication. Special attention was paid to “the analyses of transition to farming and human impact on the landscape” that has been completed under the tenure of a research project at the Department of Archaeology, University of Ljubljana (J6-8598-0581) and with the financial assistance of Slovenian Ministry for Science and Technology.

There are papers address the gap between theory and method in the identification of prehistoric feasts and, the conception as shown on the vessels that had more of a ritual than a practical role. Particular attention is drawn to the pot with the calendar image.

Ljubljana, December 2001

UDK 903'12/'15(4)"634"
Documenta Praehistorica XXVIII

The agricultural transition and the origins of Neolithic society in Europe

Marek Zvelebil
Department of Archaeology, University of Sheffield, UK
M.Zvelebil@sheffield.ac.uk

ABSTRACT – *The origin of Neolithic societies and the agricultural transition have been a subject of concentrated attention and a subject of debate and controversy among archaeologist, geneticists and linguists. In my contribution I review and evaluate different archaeological interpretations of the transition to farming. I will also discuss the archaeogenetic evidence and its integration with archaeological data.*

IZVLEČEK – *Izvor neolitskih skupnosti in prehod h kmetovanju vzbujata veliko pozornost in sprožata razprave ter nasprotovanja med arheologi, genetiki in lingvisti. V članku podajam pregled in oceno različnih arheoloških razlag prehoda h kmetovanju. Pretresem tudi arheogenetske dokaze in njihovo vključevanje v arheološke podatke.*

KEY WORDS – *transition to farming; archaeogenetic*

INTRODUCTION

In my contribution, I address the dispersal of farming and the origin of Neolithic societies in Europe, with particular attention paid to the meaning and role of the genetic evidence in this process. My point of departure is that neither the introduction of farming through contact, nor by migration can alone explain the establishment of Neolithic societies. More sophisticated processes, which include both movement and contact must have been responsible for the regional variation characteristic of the Neolithic.

The basic premise of my argument is that the dispersal of farming and the process of neolithisation were embedded in the existing, pre-Neolithic social and historical conditions of each region, in the history of contacts with communities which had already adopted farming (beginning in the Levant or Anatolia), and in the inter-generational transmission of knowledge. In this sense, the social context of the agricultural transition in Europe had its structure and agency. The structure was set by the network of social relationships and contacts, and by tradition: the socially and culturally defined normative rules for the transmission of knowledge and practical skill from one generation to another. People, through contact and colonisation, provided the agency such transmissions, for the incorporation of innovations such as cultigens and domesticates, and for changing the structural framework of the social context.

AGRO-PASTORAL DISPERSALS

There can be little doubt that agro-pastoral (Neolithic) farming originated in the Levant and Anatolia some 10 000 years ago. But how was it introduced to Europe?

This question is most commonly debated in terms of deceptively simple dichotomy: introduction through contact or population movement. However, the situation is not so simple. Considered more thought-fully, the following mechanisms of diffusion can be suggested:

❶ *Folk migration* – is a directional and major population movement to a previously identified region (causing sudden gene replacement).

❷ *Demic diffusion* – is a sequential colonisation of a region by small groups or households. It occurs over many generations and involves slowly expanding farming populations, colonising new areas by the 'budding off' of daughter hamlets from the old agricultural settlements in a non-directional pattern (causing gradual gene replacement)

❸ *Elite dominance* – involves the penetration of an area by social elite and subsequent imposition of control over the native population (causing gene mixing, genetic continuity with genetic ad-stratum, and the retention of genetic markers of intrusive population).

❹ *Infiltration* – involves a gradual penetration by small, usually specialist groups of a region, who fill a specific economic or social niche (i.e. itinerant smiths, tinkers, leather workers, livestock herders). This may be genetically undetectable if there is no inter-group gene flow, if gene flow occurs, then small-scale genetic signature as in (3) can be expected.

❺ *Leapfrog colonisation:* denotes selective colonisation of an area by small groups, who target optimal areas for exploitation, thus forming an enclave settlement among native inhabitants (causing gene replacement which is regionally variable, genetic 'islands' which may be diffused in time through gene mixing with local population).

❻ *Frontier mobility* – denotes small-scale movement of population within contact zones between foragers and farmers, occurring along the established social networks, such as trading partnerships, kinship lines, marriage alliances and so on (causing gene mixing marked by graded or discontinuous patterning in gene frequencies between genetically distinct populations, but if population were genetically similar, this would be undetectable).

❼ *Contact* – through trade, exchange, within the framework of regional, or extra-regional trading networks which served as channels of communication through which innovations, including domesticated plants and animals, spread (there is no gene replacement due to migration, genetic continuity prevails).

AGRICULTURAL TRANSITION: INTERPRETATIONS OF THE ARCHAEOLOGICAL EVIDENCE

From the archaeological position, which is based on the treatment and interpretation of the archaeological evidence, we can identify three major points of view:

The migrationist position

Ever since Childe (*1925; 1957*), it has become an established view to regard the adoption of farming in Europe as a case of replacement of indigenous hunter-gatherers by farmers immigrating from the Near East and, over the generations, colonising hitherto unfarmed areas of Europe. These new people laid the foundations of the Neolithic settlement in Europe. This process was driven by a rapid population growth experienced by the Neolithic farming populations (*Piggott 1965; Case 1969; Lichardus and Lichardus-Itten 1985; Vencl 1986; Aurenche and Cauvin 1989; Cauvin 1994; van Andel and Runnells 1995; Cavalli-Sforza and Cavalli-Sforza 1995; etc*). These events are thought to have shaped the genetic map of Europe (*Ammerman and Cavalli-Sforza 1984; Cavalli-Sforza, Menozzi and Piazza 1994 with references; Cavalli-Sforza and Cavalli-Sforza 1995; Cavalli-Sforza 1997*), and to have been responsible for the introduction of Indo-European languages to the continent (*Renfrew 1987; but see Renfrew 1996; 2000 for recent modifications*).

This school of thought holds dispersal processes 1–5 exclusively or primarily responsible for the introduction of farming into Europe, although the relative contribution of each is a matter of debate. Earlier scholars (*i.e. Childe 1957; Piggott 1965*) tended to favour migration, but more recent workers favour demic diffusion (*i.e. Ammerman and Cavalli-Sforza 1984; Renfrew 1987*). Elite dominance is discounted by some (*i.e. Renfrew 1987*), while others accept infiltration as a part of the neolithisation process (*Neustupný 1982*). Leapfrog colonisation has recently been introduced as a more realistic alternative to other forms of movement (*Arnaud 1982; Zilhão 1993; Renfrew 1996; 2000*). The migrationist view is most readily accepted among the public, among non-archaeological scholars, and commands a favoured position among archaeologist on the continent.

The indigenist position

This school of thought believes that the adoption of farming into Europe and the origins of the Neolithic came about exclusively through frontier contact and cultural diffusion (processes 6 and 7). Migration from the Near East had little or no role to play. Genetically, then, populations of Near Eastern origin had little or no contribution to make. This view is based on strict interpretation of archaeological evidence, where the burden of proof is placed on the presence of clear archaeological markers of migration.

'Indigenists' fall into two groups, depending on their perceived importance of innovations which were spreading with cultural diffusion. Dennell (*1983; 1992*) and Barker (*1985*) regard the spread of agro-pastoral farming and Neolithic technology as the defining features of the Neolithic. Tilley (*1994*) and Thomas (*1988; 1996*) perceive the eventual shift from hunting-gathering to farming communities as internal social and ideological restructuring of Mesolithic communities that also – almost incidentally involved farming. Whittle (*1996*) and Pluciennik (*1998*) adopt an intermediate position. The indigenist position has almost no support outside Britain and Scandinavia.

The integrationist position

This group regards processes of leapfrog colonisation, frontier mobility and contact responsible for the agricultural transition (*Zvelebil 1986a; 1986b; 1989; 1995; 1996; Chapman 1994; Thorpe 1996; Price 1987; 1991; 1996; Zilhão 1993; 1997; Auban 1997; Renfrew 1996*), although the relative contribution of each differs from author to author. A good number of archaeologists in Britain as well as in North America and continental Europe adhere to this view, although it is less popular outside the profession (*but see Willis and Bennett 1994; Richards et al. 1996*). Although the differences of interpretation between the three groups are of a degree rather than categorical, the implications for the population history and genetic patterning at the agricultural transition are quite major.

Discussion of the archaeological evidence

The indigenist scenario places emphases on archaeological evidence, which shows lack of support for any kind of population movement. The problem here is the resolution of archaeological data: we cannot expect clear and unequivocal signatures for human behaviour, including migration. Past human behaviour is merely one among many factors, which structure the archaeological record (see below). Bearing this in mind, archaeological cultures seem best regarded as cultural traditions of multivariate origin, including most recent variables of taphonomy and modern hermeneutics. The specific relationship between archaeological cultures and human migration has also been much discussed recently, without resolution (*Renfrew 1986; Mallory 1989; Anthony 1990; Chapman and Dolukhanov 1992; Bellwood 1996; Renfrew and Boyle 2000*). The problem lies in specifying the relationship between population movement, normative (ethnically-identified, see below) concept of culture and archaeological signatures of these phenomena. Despite the fuzziness between past human identities, behaviour and its archaeological signatures, there are four developments, which, if coeval, are likely to indicate population movement:

- the introduction of new cultural traits into a region in more than one cultural 'subsystem' (or aspects of culture)
- their discrete and coeval distribution,
- the lack of earlier traditions for such traits within the region;
- and the existence of an adjacent donor culture where such trait occur.

Gordon Childe has already drawn attention to such signifiers of population movement in the material culture (*1957*). In here, they are accepted as indicators of population movements (processes 1–5) without the corresponding ethnic connotations of a 'folk' or 'people'. The more precise form of population movement than has to be identified on the basis of other historical observations.

Bearing in mind this argument, and taking into the account archaeological evidence for continuity and discontinuity at the time of the agricultural transition, the indigenist explanation throughout Europe seems untenable. Too many new traits are introduced coevally in parts of the east and west Mediterranean, south-east Europe and Central Europe (Fig. 1).

Equally, the migrationist hypothesis does not find unequivocal support in either the archaeological, ecological, or demographic evidence. For the demic diffusion of farming populations, the rationale most often cited for the immigration of Neolithic farmers from the Near East to Europe is the rapid population growth brought about by the emergence and development of farming (*i.e. Renfrew 1987; 1996*), regarded by some as 'demographic explosion' (*Cavalli-Sforza and Cavalli-Sforza 1995.133–134*). The shift to agriculture brought about increasingly sedentary existence, improved diet, and rise in the economic value of child labour. This in turn reduced the need for population controls and made having more children both possible and desirable. In consequence, farming populations grew rapidly, colonised adjacent regions, and replaced hunter-gatherer communities, whose population growth was negligible or nil.

Archaeologically, there is no evidence for sustained and wide-ranging immigration that would support either the demic diffusion hypothesis or a major continent-wide migration (*Dolukhanov 1979; Dennell 1983; 1992; Barker 1985; Zvelebil 1986a; 1986b; 1989; 1995; Thomas 1996; Midgley 1992; Larsson 1990*): there is simply too much cultural continuity in most regions of Europe to warrant such an interpretation.

Demographically, there is no evidence for population pressure which would encourage first farmers to migrate, nor is there evidence for rapid population growth (*i.e. van Andel and Runnels 1995*). Archaeological evidence does not record any evidence for rapid saturation of areas colonised by Neolithic farmers, or for demographic expansion, with the single possible exception of the Linear Pottery Culture in central Europe. Even in the presumed core area for such expansion, south-east Europe, the saturation process was slow and incomplete. This is shown, for example, through the work of van Andel and Runnels in Thessaly. Even though they argue in favour of the demic diffusion for the spread of farming (*1995.494–498*), their own calculations fail to substantiate the population growth rates necessary for such model to operate. They conclude that the Early and Middle Neolithic periods "seemed to have been a time of steady but not very rapid population growth" so that "even the Larisa basin, region of major growth, required some 1500 years, from about 9000 to 7500 BP to reach saturation" (*1995.497*). This is a far cry from "demographic explosion" of Cavalli-Sforza, but in complete agreement with the recent palynological work carried out by Willis and Bennett (*1994*) showing that even in south-east Europe (including Greece) the impact of agriculture is not evidence until ca 6000 BP, suggesting that the introduction of farming 'was not of sufficient intensity to be detected upon a landscape scale' (*1994. 327*).

Archaeological evidence for the Mesolithic in much of Europe (except central and south-east Europe) records stable, relatively affluent, often semi-sedentary communities which would have maintained relatively high population densities see *Rowley-Conwy 1983; 1999; Price 1987; Price and Brown 1986; Zvelebil 1986; 1996; Tilley 1996; Finlayson and Edwards 1997; Voytek and Tringham 1989; Price 2000; etc.*). Archaeological evidence for the early Neolithic in much of Europe records partly mobile communities which relied on a mixture of farming, hunting, gathering and animal husbandry (*except for south-east and central Europe: Barker 1985; Bogucki 1988; Tilley 1994; 1996; Thomas 1991; Whittle 1996; Thorpe 1996; Barclay 1997; etc.*). Consequently, the differences in economy and sedentism between hunters and farmers, which are held responsible for differences in population growth of the two types of communities, were much reduced during the time in question, removing the rationale for 'demographic explosion' and 'the growth-migration cycle' (*Cavalli-Sforza 1997. 386*).

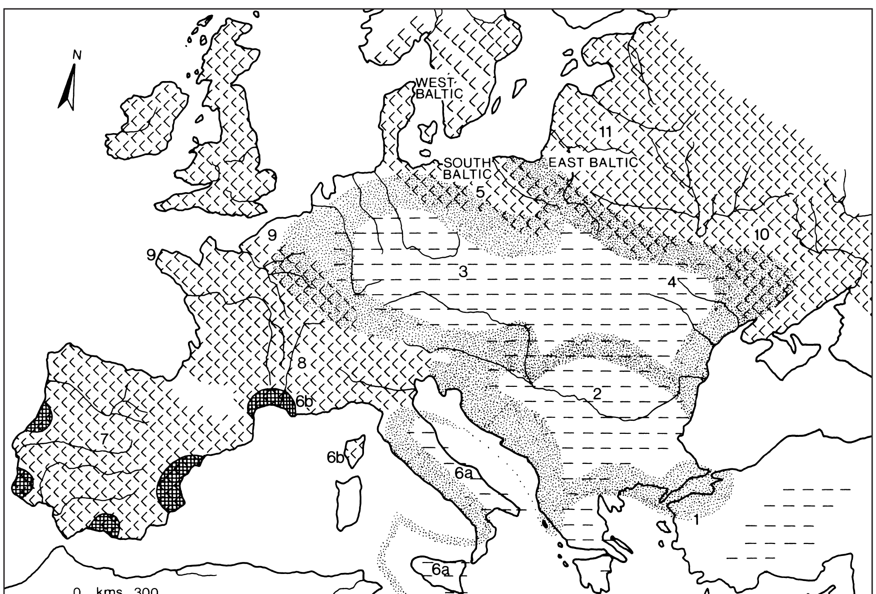


Fig. 1. 'Colonist' and 'indigenous' regions of Europe at the agricultural transition according to one (integrationist) interpretation of the archaeological evidence. Base map after Renfrew (*1986*) with additional information from Zvelebil and Zvelebil (*1988*) and Zilhão (*1993*).

Ecologically, there is no evidence for sustained woodland clearances after the initial phase and for environmental degradation that would indicate extensive agriculture on one hand, and provide a rationale for relocation on the other before the *late* Neolithic (*Willis and Bennett 199; Willis et al. 1998; Smith 1981; Whittington and Edwards 1997; Berglund 1990*). At the same time, the ecology of Europe was favourable to supporting greater-than-average densities of hunter-gatherer populations, especially in coastal and lacustrine regions and along major rivers (*Clarke 1976; Price 1987; Zvelebil 1986a; 1996*).

Ethnographically, the choice by the migrationist school of examples as analogues for the historical situation at the Mesolithic-Neolithic transition is inappropriate (*i.e. Piggott 1965; Ammerman and Cavalli-Sforza 1984; Cavalli-Sforza and Cavalli-Sforza 1995*). In fact, pertinent ethno-historical evidence shows that there is a wide overlap in population densities between hunter-gatherers and subsistence farmers, further eroding the demographic basis of the farming colonisation hypothesis. The ethnographic sample shows that hunter-gatherer population densities range from 0.02 to about 100 per square kilometre (*Hassan 1975*) with coastal, more sedentary foragers having the greater population densities. For example, hunter-gatherer population densities in river basins of south-east Australia are thought to have been 20–40 times higher than in non-riverine regions (*Birdsell 1953; Pardoe 1990*). Given their economic and mobility patterns, Mesolithic communities were likely to approximate the higher population densities found among the Californian and north-west coast Native Americans. By comparison, the population densities of subsistence farmers engaged in swidden agriculture ranged from 3 per km. sq. in Laos and Zimbabwe, to 30 in the Philippines and to 300 in New Guinea, while the rural population of Lorraine and of Belgium in mid-15th century was 10–25 and 30–70 people per km. sq. respectively, and the population of England in 1086 was calculated as 78 per km. sq. (*Hassan 1978*). Hammel (*1996.228*) notes that the current evidence suggests no major change in mortality rates between the Palaeolithic and the eighteenth century AD, and that rapid population growth took off only 300 years ago 'when doubling times generally dropped below a millennium' (*Hammel 1996.221*). Finally, recent genetic studies in Africa also show the lack of any great differences in population dynamics between hunter-gatherers and subsistence farmers (*Bandelt and Foster 1997*). Even though one cannot make much of these figures, they suggest in aggregate a more even demographic playing field between foragers and farmers in prehistoric Europe. These considerations remove a central plank from arguments in favour of the migrationist hypothesis. Although population growth rates for farmers were likely to be greater than for hunter-gatherers, the difference must have been considerably smaller than originally postulated. The population densities of prehistoric foragers and farmers in Europe may have partly overlapped as they do in the ethnographic sample.

In summary, then, the assumption of marked population differences between prehistoric hunter-gatherers and Neolithic farmers is based on a misunderstanding of hunter-gatherers as always mobile and organisationally simple, yet in Mesolithic Europe they tended toward socio-economic complexity and sedentism. Neolithic farmers are always sedentary and super-productive, yet in Neolithic Europe they were often transhumant or mobile, with mixed hunting-farming economy.

With this in mind, I would argue that the agricultural transition in Europe was, in the main, accomplished by the local hunter-gatherer communities, with varying degrees of gene flow between the hunter-gatherer communities and the settlements of Neolithic farmers. Enduring contact and exchange between the foraging and farming communities led to the development of agricultural frontier zones, manifested in the archaeological record by enduring cultural boundaries, for example between the Balkan Neolithic cultures and the Mesolithic/LBK of Central Europe, or the LBK and derived communities in Central Europe and the Mesolithic/TRB cultures of north temperate Europe (Figs. 1, 2 and 4). From an integrationist perspective, two patterns can be discerned:

Within south-east and central Europe, colonisation by farmers occurred through 'leapfrog colonisation', which I find a more convincing process of population movement than the demic diffusion model. Even though the idea of leapfrog colonisation was originally applied by Arnaud (*1982*) and Zilhão (*1993*) to explain seaborne colonisation of the west Mediterranean from the east, a similar process could be used to explain the rapid spread of farming communities through the fertile lowland basing and river valleys in the Balkans and Central Europe.

Within such a scenario, the farming groups would target patches of fertile soil – for example loess in Central Europe – for 'enclave-forming' settlement. At the same time, local adoption of farming occurred though contact in the frontier zones around the initial farming settlement. Such a combination of colonisation and contact can perhaps explain the origins of the Neolithic in the Balkans and in Central Europe. Here, the genesis of the LBK culture can be explained as the adoption and the adaption of the First Balkan Neolithic farming by the local hunter-gatherers at the periphery of the Köros culture (Fig. 2). With the adaption of farming practices to local conditions, hunter-gatherers turned farmers were in a position to expand quite rapidly within their own ecological region or culture area, in a 'star-burst' pattern of local adoption of farming, integration with local hunter-gatherer communities and regional demographic expansion. This did not require any major population explosion, only a shift in settlement pattern and moderate population growth associated with the initial opening of a new economic niche. Genetically, then, the people who were colonising these habitats mainly originated from the area of present-day Hungary, rather than from south-east Europe.

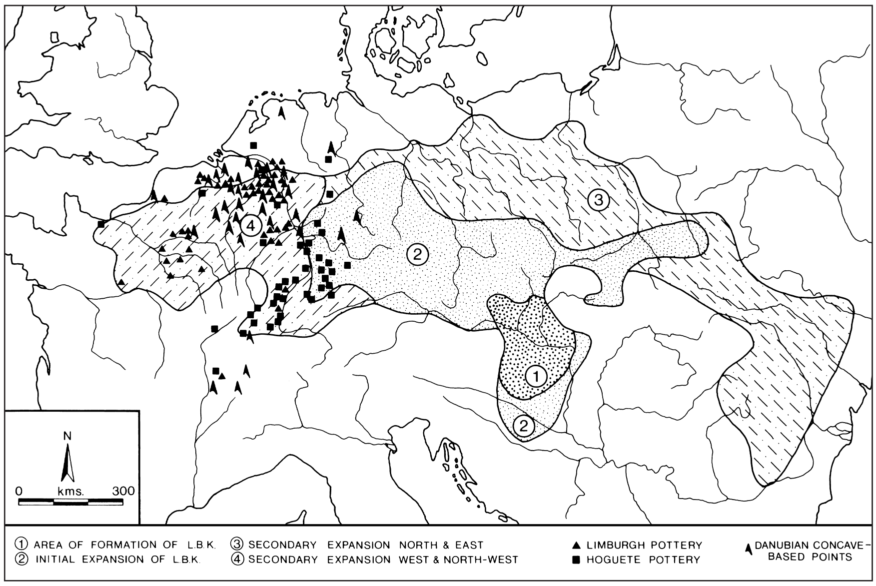


Fig. 2. The origin and dispersal of the Linear Pottery Ware culture. Base map after Lünning, Kloos and Albert (**1989**) and Bogucki (**1995**), with additional information from Guillaine and Manen (**1995**), Verhart and Vansleeben (**1997**), Gronenborn (**1998**).

Similar processes of contact and colonisation may have been responsible for the origins of the Neolithic in south-east Europe and parts of the Mediterranean: Greece, Istria and Dalmatia, Danube Gorges, southern Italy and the Iberian peninsula, for example (*Radovanović 1996; Budja 1991; Chapman and Müller 1990; Auban 1997; Zilhao 1993; 1997*). Although in some regions of the west Mediterranean, as in modern Languedoc or Tuscany, local cultural continuity and staggered introduction of farming practices and technology would argue in favour of a local adoption through contact and frontier mobility, rather than any form of colonisation (*Guillaine 1976; Lewthwaite 1986; Vaquer 1990; Barnett 1995; see Fig. 3*).

In other parts of Europe, I see the transition to farming occurring through contact and frontier mobility. In either case, such exchanges were socially contextualised: they happened within an established framework of social networks, such as kinship ties, marriage alliances, trading/exchange partnerships and other social ties of reciprocity and obligation between the hunter-gatherers and the first farming settlements in a region. Within this scenario, the direction and the pace of the adoption of farming reflected a much the existing Mesolithic social context and routes of communication, as it did the conditions of the Neolithic communities and the regional ecological circumstances. The outcomes of such contacts between the foragers and farmers, documented ethnographically, are listed in the Table 1. Although such information can only serve as a rough guide to prehistoric situations, it is this form of contact, of socially embedded mobility unfolding between the two kinds of communities – foragers and farmers – which in my view was mostly responsible for the formation of the Neolithic in most regions of Europe.

FORAGER-FARMER CONTACTS AND THE SOCIAL CONTEXT OF THE AGRICULTURAL TRANSITION

From my review so far, it is clear that contacts between foraging and farming communities, and the social context of such contacts are fundamental to our understanding of the cultural, genetic and linguistic history of communities undergoing the transition to farming. How can we recognise the operation of social networks, with all its genetic and linguistic implications, in the archaeological record?

At the Mesolithic-Neolithic transition, the social context for such networks would have been provided by the agricultural frontier zones. Such frontier zones can be either static or mobile, and open to contact or closed (*Alexander 1978; Dennell 1983; 1992*). The role of contact between foragers and farmers across this frontier could have been both supportive (*Gregg 1988; Bogucki 1988*), and disruptive for the foragers (*Moore 1985; Keeley 1992*). I suggest that in the early phase of forager-farmer contact, cooperation would prevail. At this stage, the effect of the frontier would have been largely supportive: the exchange of raw materials, foodstuffs, tools and prestige items across the frontier would reduce unpredictable variation in food supply and the risk of failure for both the hunting and farming communities (Fig. 6).

Outcomes of contacts between foragers and farmers	
Replacement	**Integration (continued)**
Annihilation. Hunter-gatherer communities are annihinlated by farming communities in a violent conflict or through disease	***Absorption of farmers by foragers***. Hunter-gatherer communities absorb farming households by force or peacefully within their communities and way of life, whilst at the same time adopting some aspects of farming existence
Assimilation. Hunter-gatherer communities disintegrate and their members join farming communities, introducing some aspects of (material) culture into farming communities	**Survival**
Adoption. Hunter-gatherer communities adopt farming way of life in the main, and accept farming ideology and a farming sense of identity, whilst retaining some aspects of traditional hunter-gatherer existence	***Isolation***. Hunter-gatherer communities remove themselves from contact with farming communities, usually by moving away and imposing "no man's land" between foragers and farmers; this results in a "closed static frontier"
Acquisition. Hunter-gatherer communities adopt farming practices selectively, whilst retaining significant elements of traditional hunter-gatherer existence, thereby producing new, or mixed (hybrid) cultural traditions	***Encapsulation***. Foragers are forced by farmers to move into suboptimal areas where they survive in relative isolation and impoverishment
Integration	***Commercialisation***. Hunter-gatherers reorganise their economy in response to demands by farming communities and commercial interests further afield (e.g. fur trade)
Infiltration. Gradual penetration by small, usually specialist groups of a region, who fill a specific economic or social niche (i.e. hunters, fishermen, honey collectors, leather workers, livestock herders)	**Reversion**
	Reversion. Farmers return to hunting, fishing and gathering as the principal means of subsistence

Tab. 1. Outcomes of contact between foragers and farmers.

Contacts between foragers and farmers may have also occurred in terms of client-patron relationships, in which foragers acted as providers of specialist services or as rented herders of livestock for farming communities (*Fewster 1996*). Typically, foragers derive economic benefit from livestock or its products, while farmers are able to extend the grazing area and increase the size of their herds through renting out to client foragers. Such a system has been in operation as a part of forager-farmer relationships in Africa. The movement of livestock may also have been of major importance in regional exchange systems. Such exchange in cattle would pass, as Sherratt (*1982.23*) suggested, 'as transactions between acephalous groups linked by alliances and as symbols of competitive prestige'.

There is a growing body of evidence for such exchange between foragers and farmers, which evidence comes from all parts of Europe (Figs. 2, 4 and 5). Let us take the frontier zone between foragers and farmers across the north European Plain as an example (Fig. 4). The date is fifth and fourth millennium bc. The imports from farming societies include the technology of pottery making and the pots themselves, such as the Baalberg and Michelsberg pottery at Rosenhof (*Schwabedissen 1981*). They also include shoe-last adzes and other stone axe imports, while t-shaped antler axes, bone combs, and rings appear to be Ertebølle imitations of neolithic artefacts (*Solberg 1989; Price and Gebauer 1992*). Bones of cattle which are found in small quantities on late Mesolithic sites in Denmark, Scania and northern Poland are also probably the results of trade, traded perhaps as prestige items as well as food. These products may have been exchanged for furs, seal fat, and forest products such as honey. The evidence for the specialized exploitation of fur animals, and their use for fur rather than meat, at such sites as Tybrind Vig and Ringkloster (*Andersen 1975; 1987; 2000; Rowley-Conwy 1999*) offers at least some support to this suggestion.

A similar exchange system existed within the frontier zone in the Central and east Baltic, where we have clear evidence for trade in amber (*Vankina 1970*) and other prestige items (axes, pots), and possibly also agricultural imports (*Dolukhanov 1979; 1993*) and trade in seal fat (Fig. 5), (*Zvelebil 1981;*

Rowley-Conwy and Zvelebil 1989). Local pottery shows the influence of ornamental motifs from early Neolithic sites in the Dnieper basin (*Zvelebil and Dolukhanov 1991*) and from the western Baltic (*Dolukhanov 1979; Timofeev 1987; 1990*), giving rise to hybrid ceramic traditions in northeast Poland and Lithuania (*Timofeev 1987*). Such a network of contact and exchange reached out over a wide area of the Baltic and eastern Europe, creating a pathway for new ideas and cultural innovations, which, in the later stages, may have been manifested archaeologically in the Corded Ware/Boat Axe horizon (*Zvelebil 1993; Zvelebil and Lillie 2000*).

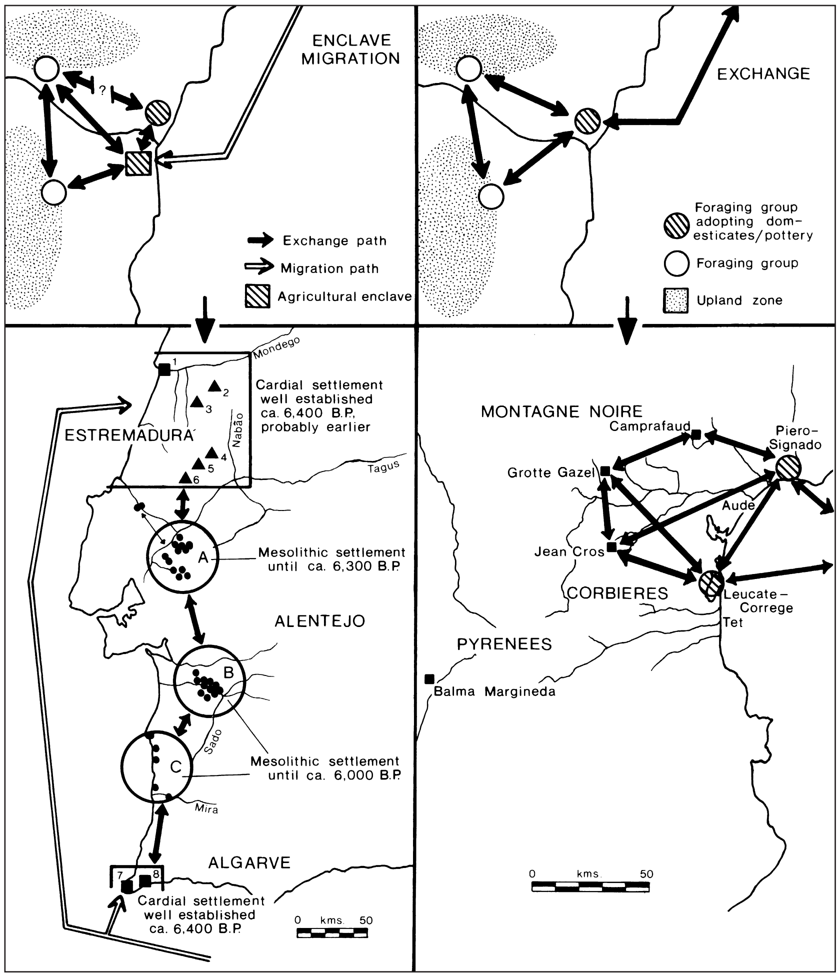


Fig. 3. Origins of the Neolithic communities in Iberian peninsula: Different views for different regions. Redrawn after Barnett (*1995*), Zilhão (*1997*), Auban (*1997*).

With the increasing stability of the agricultural frontier, disruptive effects gained the upper hand (Fig. 6). This would have been marked by the following developments:

❶ Internal disruption of the social fabric among hunter-gatherers arising from increased circulation of prestige items and increased social competition.

❷ Opportunistic use of hunter-gatherer lands by farmers, which, as Moore has shown, can cause serious interference in hunter-gatherer foraging strategies and information exchange (*Moore 1985*) and initiate an ecological change disruptive for foraging strategies.

❸ Direct procurement of raw materials and wild foods by farmers establishing their own 'hunting lands' in hunter-gatherer territories as part of a secondary agricultural expansion.

❹ Ecological change and over-exploitation consequent upon the development of commercially-oriented hunting and gathering

❺ Hypergyny: loss of women through marriage, voluntary departure or appropriation from hunting-gathering to farming communities, thereby generating an excess of women among farmers (hypergyny), and a shortage among hunter-gatherers (hypogyny). This is an ideologically conditioned practice, occurring in situations where among women farming is perceived as being of greater advantage than a hunting-gathering existence.

❻ Transmission of disease between the two communities

There are several indicators of conflict and competition within the agricultural frontier zone in northern Europe. These include marks of increased social competition, territoriality, and violence among the late Mesolithic hunter-gatherers around the perimeter of the agricultural frontier on the north European plain (*Whittle 1996; Keeley 1992*) and southern Scandinavia (*Persson and Persson 1984; Bennike 1985; Meiklejohn and Zvelebil 1991; Price and Gebauer 1992*), the presence of fortified farming villages on the farming side of the frontier and, in some areas such as in Limburgh and Brabant, the existence of a 'no man's land' (*Keeley 1992*). Similar areas of apparently unoccupied land around 20–40 km in width can be detected between the agricultural Bronze Age and forager inland Neolithic sites during the first millennium bc in Finland, again suggesting antagonistic relations prior to the transformation of the hunter-gatherer communities there (*Zvelebil 1981*). Similarly, the presence of Mesolithic armatures for arrows in Neolithic assemblages in Poland, Germany and the Low Countries could be explained as a manifestation of conflict between foragers and farmers, while Neolithic artefacts could be seen as loot rather than imports (*Tomaszewski 1988; Keeley 1992; Gronenborn 1990*)

Some regional examples

It is my belief that contacts and exchanges such as those outlined here were principally responsible for the emergence of Neolithic communities in Europe through cultural transformations of the kind illustrated in Table 1. We are now beginning to reconstruct regional histories of the emergence of the Neolithic communities in various parts of Europe. This includes social and ideological, not just economic contexts. For example, Radovanović (*1996*) argues convincingly that ideological integration and a shift from individual to collective identity in the Iron Gates region extended the existence of hunter-gatherer communities there and enabled their eventual assimilation into the surrounding world of farmers. Similar arguments were used to explain the constitution of Neolithic societies in north-west Europe (*Armit and Finlayson 1992; Tilley 1994; Thomas 1996*).

Similarly, if we turn to the Baltic Sea basin as an example, it is clear that hunter-gatherers, as individuals and as communities, played an active part in the introduction of agro-pastoral farming and the appearance of the first Neolithic communities on the north European plain. In so doing, they have contributed to the generation of the Neolithic in two ways: by the transformation of their own communities and by their influence on the established farming settlements (*Zvelebil 1986b; 1993; 1998; Bogucki 1988; Midgley 1993; Whittle 1996; Janik 1998; Price 2000; see also Thomas 1996 and contrast with Thomas 1988*). The remarkable cultural diversity which characterises the first Neolithic of the TRB (Trichterbecherkultur or Funnel Beaker) tradition there and of the subsequent cultural groups is a reflection of the divergent ways in which Neolithic communities developed through contact and native transformation.

Western Baltic region

The historical situation of the west Baltic region is marked by the extended delay and then a rapid adoption of farming – long availability, short substitution. As hunter-gatherers of relative social and economic complexity (*Rowley-Conwy 1983; 1999; Price 1987; 2000; Larsson 1990; Tilley 1994*) the inhabitants of the coastal zone were better equipped demographically and technologically to interact with the farming communities on a more equal basis than the foragers of the interior. Here, the erosive effects of the competition may never have gained the upper hand. The early and extended phase of contact between forager and farmer communities in the fourth millennium bc may have established enduring kinship ties, and resulted in associated transferral of ex-

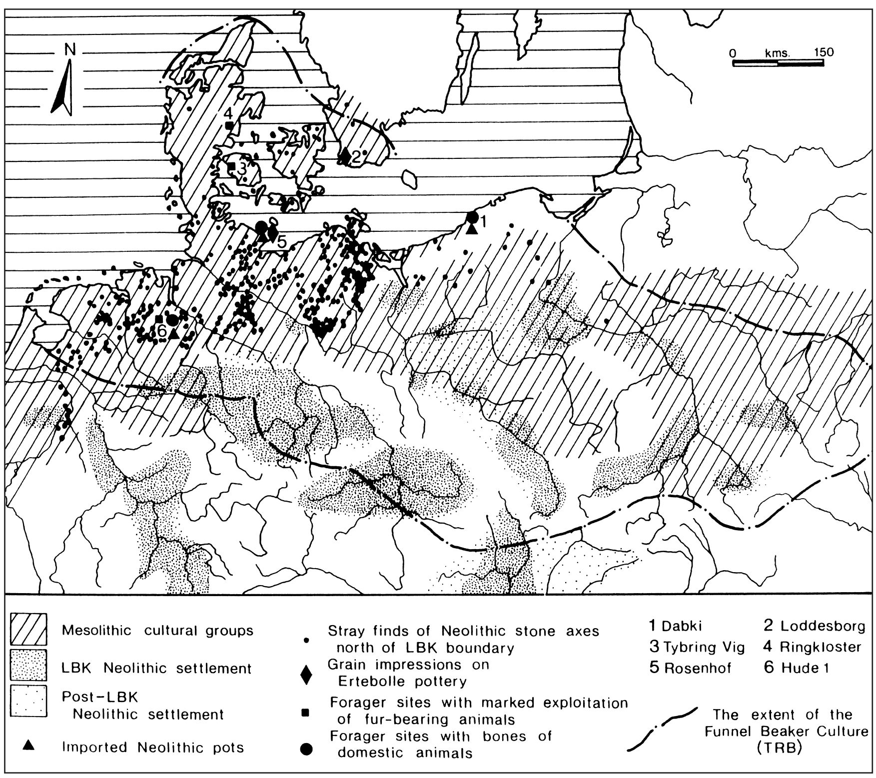


Fig. 4. Origins of the Neolithic communities on the north European plain. Several sources (*see Zvelebil 1996*).

change from the inter-tribal to tribal context, i.e. from negative to generalised/balanced reciprocity. Such relations were also likely to result in intermarriage rather than loss of women to farming communities, and consequently in the blending of cultural traits and the genesis of a new archaeological culture. In terms of cultural developments, listed in Figure 2, these considerations suggest processes of acquisition, absorption, and then adoption of the farming way of life in this region (Tab. 1, Fig. 5).

Southern Baltic Region

The genesis of the TRB culture east of the Odra (Oder) river on the north European (Polish) plain shows similar patterns of change and continuity. One of the most striking features of the conditions prevailing on the Polish plain is the long co-existence of farming and hunting-gathering communities, co-existence that lasted for more than 2500 years between 4400 and 1700 bc. In some areas, such as Kuyavia or Pomerania, hunter-gatherers and farmers – both of the TRB and the Danubian tradition – lived side by side only a few kilometres apart (*Zvelebil, Dennell and Domaska 1998*). Despite the coarse spatial and temporal resolution of the evidence available today, such patterning suggests a very gradual incorporation of foraging communities with those of farmers after an extended history of contact, occurring within some established and effective framework. Such a framework may have been created by hunter-gatherers responding to the needs of the farming settlements and to their own social needs by commercialising their operations. Within such a framework, hunter-gatherers would play the role of suppliers of specialised goods and services, such as products of hunting, fishing, and sealing, and act perhaps as herders in client-patron relationships. The inter-marriage between the two communities would result in the breakdown of the early farming (LBK and Lengyel) social and ideological structure, witnessed, for example, in the final stage of the Brzesc Kujawski settlement in Kuyavia (*Bogucki 1995; 1998*), and a subsequent development of a new foraging-farming community, identified archaeologically as TRB (*Midgley 1993*). This process would have been accomplished inter-generationally, as one generation replicated and combined the cultural traditions of earlier foraging and farming generations, in an act of cultural creolisation. These considerations suggest the processes of commercialisation followed by integration of farmers as the basis of the cultural transformation responsible for the emergence of the TRB Neolithic (*Zvelebil 1998; Zvelebil and Lillie 2000*) (Tab. 1, Fig. 4).

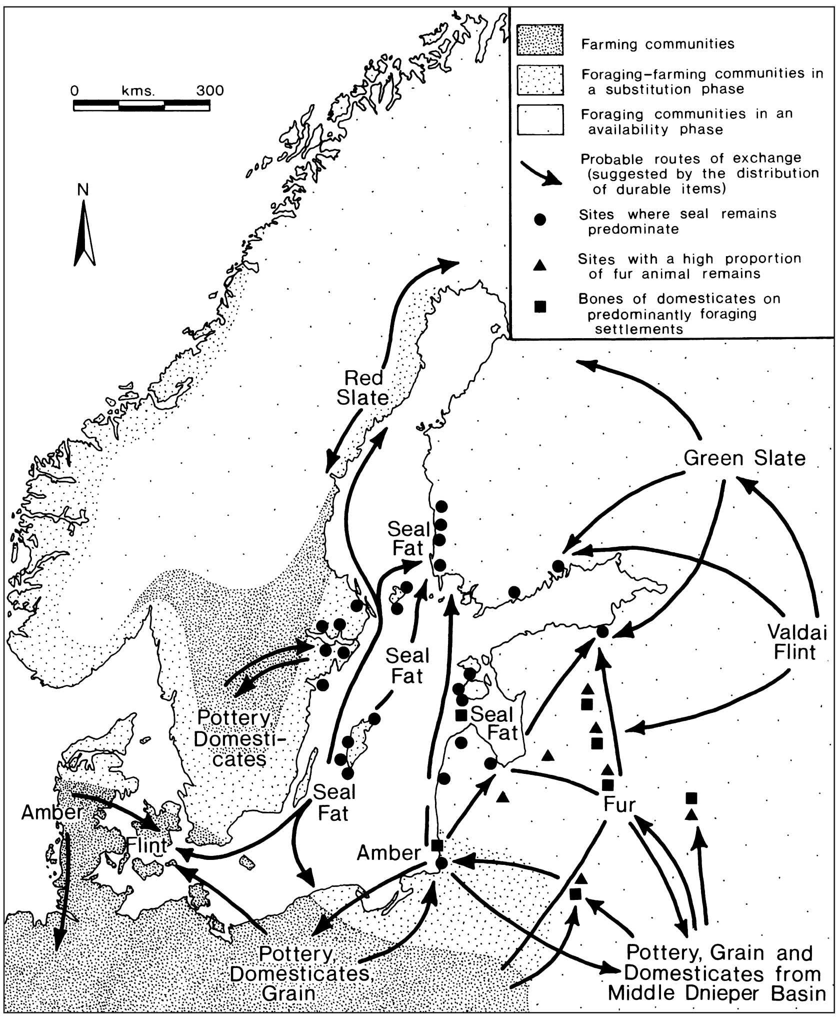


Fig. 5. Agricultural Frontier Zone and forager-farmer contacts in central and eastern Baltic 2500-1500 bc (*after Zvelebil 1996*).

East Baltic Region

In the Eeastern Baltic, the picture was different again. Instead of generations of separate co-existence and creolisation, we can identify the slow and staggered adoption of cultural traits and innovations, traditionally associated with the Neolithic, by communities of indigenous hunter-gatherers. The use of ceramics was adopted first, between 4500 and 4000 bc (*see Timofeev 1987; 1998; 1999; Dolukhanov 1979; 1986; 1996; Zvelebil and Dolukhanov 1991*). Elements of agro-pastoral farming were adopted at a very slow rate over the following three thousand years: the decisive shift to an agro-pastoral economy occurred between 1300 and 600 bc. In between, there was a society based principally on hunting and gathering for subsistence, yet making some occasional use of domesticates and possibly cultigens from about 2500 bc (*Rimantiene 1992; Vuorela and Lempiäinen 1988*). The presence of domesticates in such low numbers can be explained as a result of wide-ranging trading networks, operating within the context of the Corded Ware/ Boat Axe culture (*Dolukhanov 1979; Zvelebil 1993*); while their limited use, which continued until the end of the second millennium bc, fits with the notion of their ritual and symbolic, rather than economic significance (*Hayden 1990*). The picture emerging here, then, is one of acquisition of Neolithic technology by hunter-gatherers and commercialisation of hunter-gatherer communities during some 3000 years before the final adoption of farming (Tab. 1, Fig. 5)

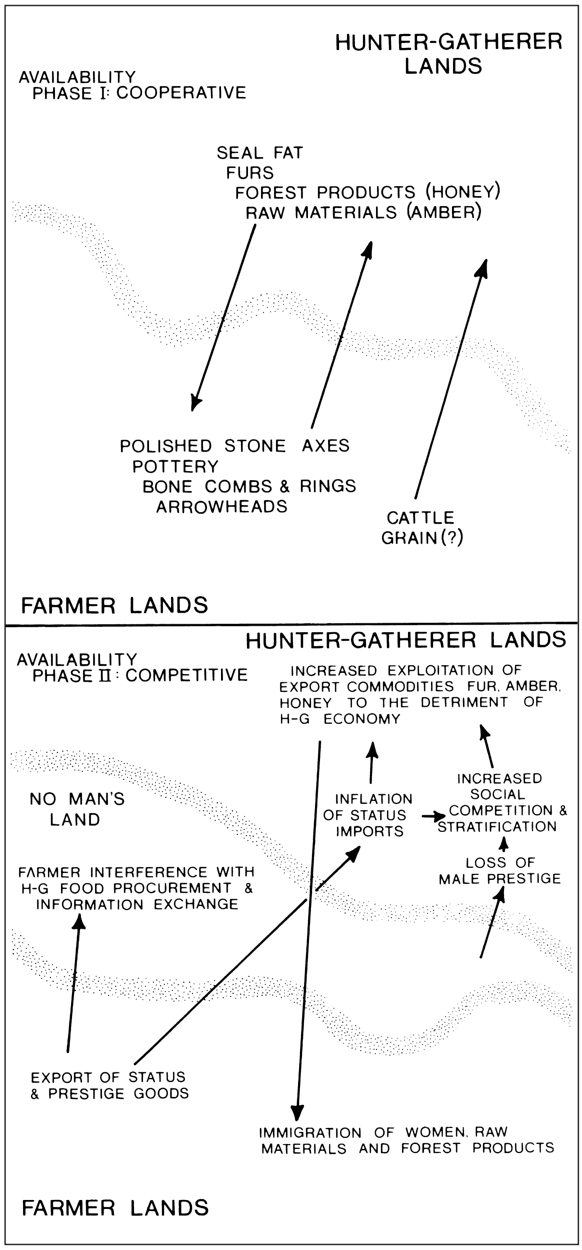


Fig. 6. Exchanges between foragers and farmers within an agricultural frontier zone: a general pattern (**after Zvelebil 1996*****).***

AGRICULTURAL TRANSITION: INTERPRETATIONS OF GENETIC EVIDENCE

A wide range of genetic studies, relating to the agricultural transition in Europe and the origins of the Neolithic, has been carried out to date (*i.e. Ammerman and Cavalli-Sforza 1984; Cavalli-Sforza 1991; 1997; Cavalli-Sforza and Piazza 1993; Cavalli-Sforza et al. 1994; Cavalli-Sforza and Cavalli-Sforza 1995; Richards et al. 1996; 1998; 2000; Calafell and Betranpetit 1993; Barbujani and Sokal 1990; Sokal et al. 1989; 1991; 1992; 1998; Torronni et al. 1998; Renfrew and Boyle 2000; etc.*). These studies include human DNA, as well as the DNA of domestic plants and animals (*i.e. Bailey et al. 1996; Bradley 1997; Renfrew and Boyle 2000*). They involve mostly modern but also ancient samples. Most of this work is at the cutting edge of research and of enormous importance to our understanding of the cultural, genetic and linguistic history of populations in Europe and elsewhere.

At the same time, genetically-driven explanations are usually used to argue the case for the introduction of the Neolithic into Europe through migration or demic diffussion – both forms of population movement. Consequently, such explanations are often at variance with the archaeological interpretation of the evidence. In particular, the question of social context and of socially embedded, small scale genetic exchanges at the agricultural transition represent a problematic issue. In the critical appraisal below I address questions of methodology to my colleges in palaeogenetics and argue that the conditional pattern and structure identified in the genetic patterning of European populations through principal component analyses and other methods can, to my mind, be explained in ways other than migration or demic diffusion.

March of the genes: the case of Europe

Based on published genetic evidence and the papers given at the 1999 HUGO conference at Cambridge (*Renfrew and Boyle 2000*), five major migratory events contributed to shaping the demographic history of modern populations in Europe:

❶ Initial colonisation by *anatomically* modern humans from North Africa/Near East by all or any of three routes: from North Africa, from Anatolia into the Balkans, and by a Circum-Pontic route north of the Black Sea. Date, based on mutation rates (dating by 'molecular clock'), falls between 50 000–30 000 BP. This migration horizon is indicated by mito-chondrial and Y- chromosomal evidence (*Otte 2000; Richards et al. 1996; 1998; 2000*).

❷ Later intrusion into Europe during the Upper Palaeolithic, perhaps associated with the Gravettian culture, dated between 25 000 and 20 000 BP from Eastern Europe/Near East. This is based principally on mitochondrial evidence (*Richards et al 1998; Torronni et al. 1998; Evison 1999 and in press*).

❸ Late Glacial population expansion and colonisation of areas freed by deglaciation in northern Europe. Thought to originate from south-west France/northern Spain, Late Palaeolithic hunter-gatherers of the Magdalenian tradition moved north between 15 000 and 10 000 BP, colonising areas hitherto covered by ice, water or polar desert. This is based on mitochondrial, Y-chromosomal and classical marker evidence (*Torronni et al 1998.1149*). The modern composition of European gene pool reflects this movement more strongly than any other demographic event (according to Richards et al. (*1996; 1998*), around 85% of European mitochondrial sequences thought to originate in the Upper Palaeolithic), and provides the best correlation with archaeological data (*Richards et al. 1996; 1998; 2000; Torronni et al. 1998; Evison 1999 and in press*).

❹ Early post-glacial 'demic diffusion' into Europe by the first farmers from the Near East, ushering the Neolithic into Europe. Identified initially through 'classical markers', this notion is now supported to the extent of 'pioneer' or 'leapfrog' colonisation by mitochondrial DNA and Y-chromosomal DNA: dated to 8500–5500 BP (*Richards et al. 1996; 2000; see below*).

❺ Late prehistoric intrusion from eastern Europe, thought to represent nomadic and pastoral Indo-European speakers, moving into central Europe and adjacent regions in the north, west and south-east. This horizon is dated to 6000–4500 BP and supported mainly by the principal component analysis of classical markers (*Ammerman and Cavalli-Sforza 1984; Cavalli-Sforza et al. 1994; Cavalli-Sforza and Cavalli-Sforza 1995; Renfrew and Boyle 2000*).

❻ Later movements of the classical and early medieval 'migration' period, which are more geographically restricted in character, and much better documented historically. They are held to explain only a small amount of modern genetic variation in Europe, yet the genetic evidence for gene flow in the first millennium AD is more compelling than any other (*see papers in this volume, Cavalli-Sforza et al. 1994; Cavalli-Sforza and Cavalli-Sforza 1995; Laan and Paabo 1997; Torronni et al. 1998; Richards et al. 1998.253, 258*).

It is clear there is disagreement among geneticists themselves on the relative contribution of each of these demographic events to the genetic history of European populations (*compare and contrast, for example, papers in Renfrew and Boyle 2000; Cavalli-Sforza et al. 1994 and Richards et al. 1996; 1998; 2000; Evison 1999; about the Neolithic dispersals, Richards et al. 1996; 1998; Torronni et al. 1998 and Cavalli-Sforza and Minch 1997; Izzagirre and de la Rua 1999 about the late glacial migrations, or see Calafell and Bertranpetit 1993; Lalueza Fox 1996; Jackes et al 1997 about the genetic history of Iberian peninsula*). There are also different degrees of correspondence with archaeological and historical data, the late glacial and the early historic (first millennium AD) perhaps commanding the best support. Against this background, I would like to focus now on the genetic support for the demic diffusion at the beginning of the Neolithic period (the fourth major demographic event).

Population movements at the agricultural transition: a closer look

The genetic evidence for the post-glacial 'demic diffusion' of Neolithic farmers is based on three sets of data:

❶ Principal component analysis of the 'classical markers'. The first principal component explains, according to Cavalli-Sforza (*Ammermann and Cavalli-Sforza 1984; Cavalli-Sforza and Cavalli-Sforza 1997*), about 26%–28% of the modern genetic variation of Europe, mapped as a gradual distribution in values between the Near East and north-west Europe the directionality of spread indicated could be from either margin).

❷ Mitochondrial DNA analysis, which seems to be more reliable than the component analysis of 'classical markers' because fewer assumptions are involved, shows a similar trend, but this accounts only for 10%–20% of mitochondrial sequences (*Richards et al. 1996; 1998; 2000*). Based on the founder analysis of mitochondrial DNA, Richards et al conclude that 'the Neolithic contribution to the extant mtDNA pool is probably on the order of 10%–20% overall. Our regional analyses support this, with values of ~20% for southeastern, central, northwestern and northeastern Europe....Incoming lineages, at least on the maternal side, were nevertheless in the minority, in comparison with indigenous Mesolithic lineages whose bearers adopted the new way of life. This does not exclude the possibility that acculturation occurred principally in southeastern Europe and that there was considerable replacement in central Europe. The Mesolithic component is even higher along the Mediterranean coastline....The Neolithic component here is ~10%. It is similar in Scandinavia, where, again the development of the Neolithic way of life was very late and the impact of newcomers likely was slight' (*Richards et al. 2000.1271*).

❸ Y-chromosomal DNA analysis confirm the mitochondrial evidence: the frequency of Y-chromosome haplotypes originating in the Near East average about 15%, with around 25% in the Balkans, and less than 10% in western Europe (*Semino et al. 1996*). From my understanding of these patterns, two other explanations are more plausible than the demic diffusion model. These would be more in keeping with the more reliable mitochondrial and Y-chronmosomal evidence outlined above:

a 'Star-burst' pattern of regional demic expansion, which I outlined above (in-filling or locally available niches utilised by a genetically mixed population comprising local hunter-gatherers and some immigrant farmers). Arguably, this might produce the graded variation pattern observed in modern genome more faithfully than the demic diffusion would.

b 'Incremental palimpsest' whereby the pattern we see today is a palimpsest of small -scale population movements progressing from south-east Europe to the north-west over millennia. This would not be surprising given that Europe is a north-western peninsular extension of Asia.

Discussion of the genetic evidence

As a non-geneticist, I am all too aware of my own incomplete understanding of methodological issues involved as well as of the implications for the interpretation of broader patterns of human behaviour. But in my opinion, there are uncertainties regarding the understanding and the historical interpretation of genetic evidence. These can be grouped into two types of potential errors:

Category 1 error is a group of potential errors internal to archaeogenetic analysis of human genome as a methodological procedure. Reconstructing genetic history from modern population genetics (i.e. tracing ancestry of modern populations back into the remote past, reconstructing their lines of descent) appear to have the following potential sources of error (Tab. 3):

❶ *The size of the sample*: this is often too small for the size of the sampled population unit, itself often defined in a questionable way (see below), (*Evison in press; Moore 1994; etc*).

❷ *Dating of genetic changes* within samples by mutation rates, or molecular clock. As some have noted, 'molecular clock models are full of questionable assumptions' (*Clark 1997; Lewin 1988a; 1988b*). The mutation rates, held to account for gene or gene-derived polymorphisms is assumed to be constant, but apparently are not always so. The constant rate of accumulation of genetic changes is based on the assumptions of demographically stable populations and on adaptively neutral role of genetic traits. These assumptions are rarely if ever met in reality for reasons outlined below. The result is that the dating of genetic changes, and, by implication, demographic events, such as gene flow (migration) has very broad confidence limits and may be in error altogether.

❸ *Genetic drift*: It is assumed that genetic drift in small isolated populations will result in marked genetic heterogeniety relative to other populations and in the expression of signature mutations through founder effect. Hunter-gatherer populations in general are often quoted as examples of such populations, for example by Cavalli-Sorza et al (*1994.15*) in the case of the European Mesolithic. Yet as many have recognised, exogamy is a common feature of such populations to keep them as viable interbreeding networks (*i.e. Wobst 1974; Cavalli-Sforza and Cavalli-Sforza 1995.19–20*). Moore (*1994.934*) has shown that intermarriage between separate ethnic groups of North American hunter-gatherers was likely to equalise any distinct genetic signatures and homogenise genetic patterning across large areas such the Plains of North America 'within a few hundred years. In reality, many, if not all, small-scale populations share in large interbreeding networks for reasons of survival. This appears to violate the assumption of stable population units (*see also MacEachern 2000*). Would this not homogenise the genetic landscape of small, low-density populations and obscure genetic signatures of population units defined by language or ethnicity (*i.e. Amorin 1999; Moore 1994*)?

❹ *Natural selection* and environmental factors are not given a full role in the explanation of genetic variability. Although genes are assumed to be adaptively neutral, or at least non-directional (in that stochastic variation neutralizes any patterning), it is clear that the presence or absence of specific haplotypes may be related to disease resistance, or otherwise, confers selective advantages or disadvantages on an individual in specific ecological and/or cultural circumstances. The HLA complex (*Cavalli-Sforza et al. 1994; Evison in press*), or genetic mutations controlling for thalassemia (*Cavalli-Sforza et al. 1994*) or for lactase tolerance (*Harrison 1975; McCracken 1971; Simoons 1979; Hollox 2000*) can all be used as examples. Given the well-known selective role of some genetic variants, one is tempted to ask why is the role of selection apparently minimised in archaeogenetics?

❺ *Age-sex structure of the reproducing population.* Mutation rates can be expected to increase as the child-bearing population gets older. This would indicate that mutation rates should have speeded up in the last few generations (c300 years, see *Hammel 1996*), rendering the 'molecular clock' faster. This is at variance with the assumption of the constant rate of mutation changes which forms the basis for the dating of demographic events by molecular clock (*see Richards et al. 2000 for further discussion*).

❻ There is a wide range of *statistical problems* such as spatial auto-correlation, associated with the principal component analysis and other forms of correlation between genes and geography, weakening the statistical treatment of genetic evidence and reducing the probability of the conclusions being correct (*Clark 1997; Bandelt et al. 1995; Amorin 1999; Richards et al. 2000; Renfrew and Boyle 2000*). Failure to address weaknesses inherent in some of the assumptions operationally necessary for the performance of statistical tests is leading to the loss of confidence, 'Cavalli-Sforza uses principal component analysis (PCA) to ransack correlation coefficient matrices for pattern in genetic polymporphisms and isolates a number of principal components, expressed geographically, which are interpreted as time-successive, quasi-historical, migration events....This form of argument from induction is called post-hoc accommodation....a weak form of inference' (*Clark 1997.407, for similar critique, see also Moore 1994; MacEachern 2000*). Are the critics wrong or should the geneticists adhere to a more sober form of statistically-supported interpretation?

❼ *The overall representativeness of the sample:* all the assumptions discussed above bear on the representativeness of the investigated sample. In addition, there is the problem of relationships between different units of analysis within the population as an interbreeding unit. This is true somatically of different genetic units within an individual, as well as extra-somatically, when it comes to specifying the relationship between the individual and the population. As Moore put it: 'It is misleading for synthesists to treat the nodes of genetic cladograms as if they were tribes or demes, not to mention regional or continental populations. Even if we had a complete mitochondrial cladogram for all human beings, it would say nothing about where the individual carriers of the genotypes lived or what the genetic variability in local populations might have been. Individual pedigrees and histories of populations are two entirely different matters. Nevertheless, certain syhtesists continue to treat ancestral sequences as if they were characteristic of populations all carrying the same genotype as the reconstructed individual' (*Moore 1994.934*).

❽ *Inter-demic genome similarities, the dating of demographic events by molecular clock and the palimpsest effect:* All the 'type 1 errors' noted above combine to reduce the reliability of reconstructing population histories from genetic evidence. This is particularly true if the representativenes of the sample is statistically compromised and if the dating of demographic events depends on mutation rates within a single class of genetic data. Genetic variation described by the principal component analysis and other diversity measures reflects not only demographic events such as migrations, but also the genetic distance between incomers and the native population, as well as the genetic distances between incomers at any one time and subsequent population movements (*Cavalli-Sforza and Cavalli-Sforza 1995;*

Zvelebil 1995; 1998; Richards et al. 1996; 2000). Most human genetic diversity is intra-populational, with only a very small proportion of genome accounting for differences between populations (*Amorin 1999.18*). The consequence of this realisation appears to be at least twofold. On the one hand, principal components such those used to argue for the Neolithic colonisation of Europe from the Near East may in fact reflect a diachronic incremental palimpsest of small-scale intrusions into Europe, the patterning of which is set by the geography of Europe as a peninsular extension of Asia. On the other hand, a migration of Neolithic farmers into Europe may not be detected genetically if the donor and target genepools were sufficiently similar.

Category 2 errors are relational, arising from presumed relationships between the genetic population (gene pool) and its related components, such as language, material culture, and ethnicity. We are back to the notion of human societies whose organisation is predicated on the ideology of ethnic nationalism, and on the normative definition of ethnicity, based on descent (and therefore genetic uniformity). But these relational components are not corresponding units, in either the analytical sense, or in conceptual sense (*Moore 1994; Pluciennik 1996; MacEachern 2000*). As MacEachern notes: 'Probably the most obvious of these problems is one that bedevils all interdisciplinary investigations of the human past: to what extent are the very different analytical units in these various disciplines comparable? Under what circumstances may we expect that ethnicity, language, material culture and gene pool will co-vary in the past, and when can we expect that they will differ in extent and characteristics?' (*2000.359*).

Analytically, it is a matter of size and definition. Different population sizes pose different sampling and methodological problems. Related to this is the definition of demes, as groups whose members share greater genetic similarity because of greater frequency of interbreeding relative to non-members. How to define these units operationally? As many studies have shown, ethnic identity or shared language is a poor indicator of demes genetically defined (*e.g. Bateman et al. 1990; Moore 1994; and MacEachern 2000*). If this is the case, where do we go from here? Is there a case for random sampling of the gene pool, irrespective of cultural attributes?

Conceptually, it is a matter of meaning and temporality. It is often assumed that human society is organised in culturally meaningful corresponding units ('analogous taxonomies', *MacEachern 2000*), giving us a normative definition of a genetic population as linguistically and culturally uniform ethnic unit so: population = language unit = cultural unit = ethnic unit (tribe)). Yet the analytical units used are not comparable. It cannot be assumed that language, ethnicity, material culture and gene pool will co-vary in the past, and we do not know how such co-variation might work. At best, we can assume a broader relationship approximately as follows: deme = speech community = social network = shared material culture, but not exclusively so.

In the 20th century, European archaeology was mostly dominated by the culture historical paradigm and the normative concept of culture. Formulated at the beginning of the century (*Kossinna 1911; 1926*) it gained broad acceptance through the work of pre-eminent scholars such as Gordon Childe (*1929; 1956*). The organising principle of the normative concept of culture was the belief that archaeological artefacts by their shape and decoration symbolise ethnic identity, and that the distribution of key artefacts or their salient features identify ancient settlement areas of tribes or ethnic groups in prehistory. Following this principle, cultural homogeneity becomes a signature of an ethnic group, differecenes in material culture can be explained in terms of ethnic variation, and the replacement of one set of cultural features by another identifies migration and population replacement. In this way, the normative concept of culture became the principal framework for explaining culture change

David Clarke, in his seminal essays (*1968, 1972*) rejected Childe's approach. He noted that ethnographic case studies of cultural variation showed considerable heterogeneity (*Clarke 1968*). Even within 'homogenous cultures' there was polythetic variation between assemblages from different locations, with overall affinity level ranging from 65%–95%. Assemblages sharing 65%–30% of traits tended to belong to separate social groups with a considerable degree of contact and communication. Assemblages sharing 30% or less of attributes tended to reflect only common functional purpose or a response to similar ecological conditions, lending some empirical support to the notion of techno-complexes (*Clarke 1968.387–388, 398*). Such ethnographic observations, methodological considerations and archaeological case studies (*Clarke 1970; 1972*) convinced Clarke that archaeological cultures should be re-defined as polythetic sets of attributes representing cultural traditions of human groups with different sets of meaning (i.e. trade and contact areas, techno-complexes, cultural identity areas). As Shennan notes, both Childe and Clarke 'adopted classificatory expedients to remove the untidiness in the cross-cutting distributions, rather than taking the more radical step of recognising that this untidiness is, in fact, the essence of the situation, arising from the fact that there are no such entities as 'cultures', simply the contingent interrelations of different distributions, produced by different factors' (*Shennan 1989.13*).

Other workers broadly within the processual school of thought, have drawn attention to patterns of deposition and to post-depositional processes which selectively accord archaeological materials their patterning and distribution (*i.e. Binford 1962; 1965; 1968; 1972; 1983; Schiffer 1972; 1976; etc.*). The essence of the processual critique of the normative concept of culture was that variation in material culture arises from a wide range of different factors, operating at the original time of deposition as well as post-depositionally; that such factors are both human and non-human, and that variation caused by humans may be intentional or incidental. Together, all of this generates varying combinations of cultural patterning in space with very different meanings.

Post-modernist deconstruction of the concept of archaeological culture has been led by Hodder (*1982; 1992; etc.*), Barrett (*1994*), and Shanks and Tilley (*1987*). In summary, culture is represented as a social tradition in a constant state of change, and material culture is perceived as an active agent, employed by 'knowledgeable human actors' in reproducing culture as a social tradition. It is stressed that situationally embedded symbolism and ideological variables have a decisive influence on the spatial patterning of material culture attributes such as shape and decoration of objects. Because the meaning of things is situational and dependent on social context, an object can be loaded with several meanings, whose significance will change with the context of use and with time. Artefacts are not merely used as tools or symbols, but are actively manipulated in the negotiation of identities, negotiation for status and power, negotiation for resources, and negotiation of the meaning of things and events (as, for example, in the representation of the past). It follows then that artefacts do not reveal the past in the way it was, but are 'meaningfully constituted' by a double process of interpretation, 'double hermeneutic'. The first occurred through the agency of human actors in antiquity in the specific context of the ideologies of the past, the second is imposed by the ideological codes and knowledge of the contemporary investigators. Archaeologists are clearly not in a position to understand the full range of meanings embedded in an object's attributes under these conditions.

This is not the place to explain in detail the enormous amount of work carried in archaeology about the nature of archaeological cultures in the last 40 years. But as a result of these developments, we are far less naive today, and the problem of understanding archaeological cultures is far more complicated than under the culture historical paradigm. We now know that archaeological cultures do not, as a rule, correlate with ethnic groups, although there are exceptions. At minimum, we know that the constitution and meaning of archaeological culture can reflect a wide number of variables, such as patterns of discard and deposition reflecting ecological conditions, existing levels of technology, function, cultural tradition and patterns of inter-generational transmission of knowledge, patterns of trade and exchange, social status of artefacts, routine activities in the landscape, a range of overlapping symbolic activities, post-depositional processes of selective destruction and relocation, and the selective interpretation and reinterpretation of cultural remains, mediated by strategic, ideological and political agendas of humans as social actors. Cultural variation symbolising ethnicity is merely one among many variables which play a role the composition of an archaeological culture.

Additionally, problems emerge at both ends of the direct equation between archaeological cultures and ethnic groups. The correlative nature of this relationship has now been evaluated and mostly discredited by anthropologists, archaeologist, and linguists (*for example, see Clarke 1968; Binford 1962; 1965; 1983; Hodder 1978; Shennan 1989; Graves-Brown et al. 1996 and Jones 1997 for archaeology, Ehret 1988; Bateman et al. 1990; and Thomason and Kaufman 1988 for linguistics, and Fried 1967; 1968; Barth 1969; 1994; Moore 1994; MacEachern 2000; or Terrell and Stewart 1996 for ethnography*).

The concept of ethnicity in particular generates its own problems (*Barth 1969; Moore 1994; Pluciennik 1996; MacEachern 2000*). These are both temporal and spatial. Historically, we cannot assume that notions of ethnicity, as we understand them today, can be projected into the past. Ethnic groups are subjective, constructed and situational, deeply embedded in economic and political relations. As Barth (*1969; 1994*) demonstrated, ethnicity is a changing phenomenon, which tends to attain greatest expression in situations of conflict, competition and cultural change. As such, ethnic groups can be characterised as interest groups competing for economic and political resources and territory. This adduces a degree of opportunism to ethnicity in the characterisation of it as a situational resource. It follows that identity, including ethnic identity, must be at least partly understood as a strategic resource, with its definition, membership, symbolic power and material expression changing situationally and with the historical conditions. This fluidity of boundaries of social identity is particularly true among hunter-gatherer societies and other groups with low population densities (*Hodder 1978; MacEachern 2000; Pluciennik 1996; Wobst 1974*).

So, in summary it is incorrect to assume that language, genes and cultural identity (as a broader definition of ethnic identity) are co-evally overlapping in space. First, we are not dealing with corresponding units of definition or analysis (*Moore 1994; MacEachern 2000*). Second, genetic populations, linguistic areas and archaeological cultures, however defined, overlap in space at any one time only rarely, if ever (*i.e. see Clarke 1968 and references above*). In other words, it is difficult to identify which, if any of such elements specify a population's ethnic sense of belonging in its historically situated context. Neither archaeological nor genetic evidence alone shed any light on the linguistic identity or ethnicity of the colonising populations. however interesting, all these suggestions, must retain the status of speculative hypotheses of relative veracity until a carefully considered combination of archaeological, genetic and linguistic data are brought to bear upon them in a methodologically sophisticated assessment.

CONCLUSIONS

To summarise my argument, the agricultural transition in Europe, and the origin of the Neolithic communities can only be understood in its social and historical context, which involved both the resident hunter-gatherer Mesolithic populations, as well as immigrating communities of early farmers. The degree of mobility and the mechanism of dispersal were regionally variable across Europe, as was the genetic contribution of each the foragers and farmers to the subsequent Neolithic populations of Europe. To date, genetic evidence can be interpreted to accommodate several mechanism of dispersal, while archaeological evidence shows hunter-gatherer continuity and contact across the agricultural transition in western, northern and eastern Europe.

From my argument here we should expect that the gene pool of the Mesolithic and the Neolithic populations was largely the same in western, northern and eastern Europe, while in the European continental interior we can expect a mixed gene pool comprising both the indigenous and immigrant elements. In central and south-eastern Europe, this would involve a limited gene flow between the initial farming settlements and the indigenous hunter-gatherers, and in some regions such as Danubian basin, the farmers themselves could be expected to originate mostly in the same region as the foragers, if one accepts that it was the local foragers who adopted farming and then undertook regionally specific dispersals through Central Europe, archaeologically recognisable as the Linear Pottery Ware Culture.

It is often the prevailing view that our genetic inheritance played a key, if not the determining role in our cultural behaviour, that 'Our genes make us what we are' (*John Hands, reporting on recent archaeogenetic research, The Independent, 20.10.96*).

Far from it. Our behaviour, even our physical characteristics are determined in a large measure by our history and our society. The resources placed at our disposal by culture enable us to change and transform the conditions set by our genes and make us into something other than our genes would. That is the essential point if we want to understand the way we were in the prehistoric past, as well as who we are today.

ACKNOWLEDGEMENTS

*An earlier version of this paper was presented at HUGO conference in Cambridge in September 1999 (*Zvelebil 2000*). I would like to thank Professor Lord Renfrew for an invitation to address the HUGO conference upon which the original version of this contribution is based, and to Dr. Mihael Budja for inviting me to submit a revised version to the current volume. I would also like to thank Dr. Jenny Moore for reading, proofreading and commenting on the final draft of this paper. All errors and omissions are my own.*

REFERENCES

ALEXANDER J. 1978. Frontier studies and the earliest farmers in Europe. In D. Green, C. Haselgrove, and M. Spriggs (eds.), *Social Organisation and Settlement, British Archaeological Reports (International Series 47, British Archaeological Reports: 13–29*.

AMMERMAN A. J. 1989. On The Neolithisation in Europe: a comment on Zvelebil and Zvelebil (1988). *Antiquity 63: 162-5*.

AMMERMAN A. J. and CAVALLI-SFORZA L. L. 1984. The Neolithic Transition and the Genetics of Population in Europe*. An Addison-Wesley Module in Anthropology 10: 1–42*.

AMORIN A. 1999. Archaeogenetics. *Journal of Iberian Archaeology 1: 15–25*.

ANDERSEN S. H. 1975. Ringkloster. En jysk indlandsboplats med Ertebøllekultur. *Kuml, 1973–4: 11–108*.

1987. Tybring Vig: A submerged Ertebølle settlement in Denmark. In J. M. Coles and A. J. Lawson (eds.), *European Wetlands in Prehistory: 253–281*.

1995. Ertebølle trappers and wild boar hunters in eastern Jutland. A survey. *J. Danish Archaeology, Vol. 12: 13–59*.

ANTHONY D. W. 1990. Migration in Archaeology; the baby and the bathwater. *American Anthropologist 92: 895–914*.

ARMIT I. and FINLAYSON W. 1992. Hunters-gatherers transformed: the transition to agriculture in northern and westwastern Europe. *Antiquity 66: 664–676*.

ARNAUD J. M. 1982. Neolithique ancien et processus de néolithisation dans le sud du Portugal. *Archeologie en Languedoc, no. special, Actes du Colloque International de Prehistoire: 29–48*.

AUBAN J. B. 1997. Indigenism and Migrationism. The neolithization of the Iberian Peninsula. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji XXIV: 1–18*.

AURENCHE O. and CAUVIN J. (eds.) 1989. *Neolithisations, BAR, International Series 516*.

BAILEY J. F., RICHARDS M. B., MACAULAY V. A., COLSON I. B., JAMES I. T., BRADLEY D. G. and HEDGES R. E. M. 1996. Ancient DNA suggests a recent expansion of European cattle from a diverse wild progenitor species. *Proc of Royal Soc of London, Series B 263: 1467–1473*.

BANDELT H-J., FORSTER P., SYKES B. C. and RICHARDS M. B. 1995. Mitrochondrial portraits of human populations using median networks. *Genetics 141: 743–753*.

BANDELT H-J and FORSTER P. 1997. The myth of hunter-gatherer mismatch distributions. *American Journal of Human Genetics 61: 980–983*.

BARBUJANI G. and SOKAL R. 1990. Zones of sharp genetic change in Europe are also linguistic boundaries. *Proceedings of the National academy of Sciences U.S.A. 87: 1816–1819*.

BARCLAY G. J. 1997. The Neolithic. In K. J. Edwards and I. B. M. Ralston (eds.), *Scotland, Environment and Archaeology, 8000 BC–AD 1000: 127–150*.

BARKER G. 1985. *Prehistoric Farming in Europe*. Cambridge: Cambridge University Press.

BARNETT W. K. 1995. Putting the pot before the horse: Early pottery and the Neolithic transition in the western Mediterranean. In W. Barnett and J. Hoopes (eds.), *The Emergence of Pottery: 79–88*.

BARNETT W. and HOOPES J. (eds.) *The Emergence of Pottery*. Smithsonian Institution Press. Washington (DC).

BARRETT J. C. 1994. *Fragments from Antiquity: an archaeology of social life in Britain, 2900–1200 BC*. Blackwell, Oxford.

BARTH F. 1969. (ed.) *Ethnic Groups and Boundaries*. Little, Brown. Boston (MA).

1994. Enduring and emerging issues in the analysis of ethnicity. In H. Vermeulen and C. Govers (eds.), *The Anthropology of Ethnicity: beyond 'Ethnic Groups and Boundaries': 11–32*.

BATEMAN R., GODDARD I., O'GRADY R., FUNK V. A., MOOI R., KRESS W. J. and CANNELL P. 1990. Speaking of forked tongues. The feasibility of reconciling human phylogeny and the history of language. *Current Anthropology 31(1): 1–13.*

BELLWOOD P. 1996. Phylogeny vs. reticulation in prehistory. *Antiquity 70, 270: 881–890.*

BENNIKE P. 1985. *Palaeopathology of Danish skeletons. A Comparative Study of Demography, Disease and Injury.* Akademisk Forlag, Kobenhavn.

BERGLUND B. E. (ed.) 1990. The cultural landscape during 6000 years in Southern Sweden – the Ystad project', *Ecological Bulletin No. 41.*

BINFORD L. R. 1962 (1972). Archaeology as anthropology. *American Antiquity 28: 217- 25.* (Reprinted in Binford L. R. 1965. Archaeological systematics and the study of culture process. *American Antiquity 31: 203–210.*)

1968. Post-Pleistocene adaptations. In S. Binford and L. R. Binford (eds.), *New Perspectives in Archaeology: 313–341.*

1972. *An Archaeological Perspective.* Seminar Press, New York, 20–32.

1983. *In Pursuit of the Past.* Thames and Hudson, London.

BINFORD S. and BINFORD L. R. (eds.) 1968. *New Perspectives in Archaeology,* Aldine, Chicago.

BOGUCKI P. I. 1988. *Forest Farmers and Stock Herders: Early agriculture and its consequences in North-Central Europe.* New Studies in Archaeology. Cambridge University Press, Cambridge.

1995. The Linear Pottery Culture of Central Europe: Conservative Colonists? In W. K. Barnett and J. W. Hoopes (eds.), *The Emergence of Pottery. Technology and Innovation in Ancient Societies: 89–98.*

1998. Holocene Climatic Variability and Early Agriculture in Temperate Europe. In M. Zvelebil, R. Dennell and L. Domanska (eds.), *Harvesting the sea, Farming the Forest: 77–86.*

BONSALL C. (ed.) 1989. *The Mesolithic in Europe.*

BRADLEY D. G., LOFTUS R. T., CUNNINHAM P. and MavHUGH D. E. 1997. Genetics and domestic cattle origins. *Evolutionary Anthropology 6: 79–86.*

BRADLEY R. 1997. Domestication as a state of mind. *Analecta Praehistorica Leidensia 29: 13–18.*

1998. Interpreting Enclosures. In M. Edmonds and C. Richards (eds.), *Understanding the Neolithic of north-western Europe: 188–203.*

BUDJA M. 1993. Neolitizacija Evrope: Slovenska perspektiva. The Neolitization of Europe. Slovenian aspect. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 21: 163–193.*

CALAFELL F. and BETRANPETIT J. 1993. The genetic history of the Iberian peninsula: a simulation. *Current Anthropology 34: 735–745.*

CANE S. 1990. Desert demography: A Case Study of Pre-contact Aboriginal Densities. In B. Meehan and N. White (eds.), *Hunter-Gatherer Demography. Past and Present. Oceania Monograph 39: 149–159.*

CASE H. 1969. Neolithic explanations. *Antiquity 43: 176–86.*

CAUVIN J. 1994. *Naissance des divinités: Naissance de l'agriculture.* CNRS Editions, Paris.

CAVALLI-SFORZA L. L. 1991. Genes, Peoples and Languages. *Scientific American 263: 72–78.*

1997. Genetic and Cultural Diversity in Europe. *Journal of Anthropological Research 53: 383–404.*

CAVALLI-SFORZA L. L. and PIAZZA A. 1993. Human genomic diversity inEurope: a summary of recent research and prospects for the future. *European Journal of Human Genetics 1: 3–18.*

CAVALLI-SFORZA L. L. and CAVALLI-SFORZA F. 1995. *The great human diasporas: the history of diversity and evolution.* Addison-Wesley, New York.

CAVALLI-SFORZA L. L., MENOZZI P. and PIAZZA A. 1994. *The History and Geography of Human Genes.* Princeton University Press, Princeton.

CAVALLI-SFORZA L. L. and MINCH E. 1997. Paleolithic and Neolithic lineages in the European mitochondrial gene pool. *Am. J. Hum. Gen. 61: 247–251.*

CHAPMAN J. 1994. The origins of farming in South East Europe. *Prehistoire Europeenne 6: 133–156.*

CHAPMAN J. and DOLUKHANOV P. 1992. The baby and the bathwater: pulling the plug on migrations. *American Anthropologist 94: 169–75*.

1993. *Cultural Transformations and Interactions in Eastern Europe.* Avebury Press, Aldershot.

CHAPMAN J. and MULLER J. 1990. Early farmers in the Mediterranean Basin: the Dalmatian evidence. *Antiquity 64: 127–34*.

CHILDE V. G. 1925. *The Dawn of European Civilisation,* 4th Edn., Keegan Paul, London.

1929. *Danube in Prehistory.* Clarendon Press. Oxford.

1956. *Piecing Together the Past.* London: Routledge and Kegan Paul.

1957. *The Dawn of European Civilisation,* 6th Edn., Routledge and Kegan Paul, London.

CLARK G. A. 1997. Multivariate pattern searches, the logic of inference, and European prehistory: a comment on Cavalli-Sforza. *Journal of Anthropological Research 54, 3: 406–411.*

CLARKE D. L 1968. *Analytical Archaeology*, Methuen, London.

1972 (ed.) *Models in Archaeology*, Methuen, London.

1976. Mesolithic Europe: The economic basis. In I. Sieveking, I. J. Longworth and K. E. Wilson (eds.), *Problems in Economic and Social Archaeology: 449–481.*

COWAN C. W. and WATSON P. J. (eds.) 1992. *The Origins of Agriculture. An International Perspective.*

DENNELL R. 1983. *European Economic Prehistory.* Academic Press, London.

1985. The hunter-gatherer/agricultural frontier in prehistoric temperate Europe. In S. Green and S. M. Perlman (eds.), *The Archaeology of Frontiers and Boundaries: 113–140.*

1992. The origin of crop agriculture in Europe. In C. W. Cowan and P. J. Watson (eds.), *The Origins of Agriculture. An International Perspective: 71–100.*

DOLUKHANOV P. M. 1979. *Ecology and Economy in Neolithic Eastern Europe*, Duckworth, London.

1986. The late Mesolithic and the transition to food production in Eastern Europe. In M. Zvelebil (ed.), *Hunters in Transition: 109–120.*

1993. Foraging and Farming Groups in north-eastern and north-western Europe: identity and interaction. In J. Chapman and P. Dolukhanov (eds.), *Cultural Transformations and Interactions in Eastern Europe: 122–145*.

1996. The Mesolithic/Neolithic transition in Europe: the view from the East. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji XXIII: 49–60*.

EDMONDS M. and RICHARDS C. 1998. *Understanding the Neolithic of north-western Europe.* Cruithne Press, Glasgow

EDWARDS K. J. and RALSTON I. B. M. (eds.), *Scotland: Environment and Archaeology, 8000 BC–AD 1000.*

EHRET C. 1988. Language change and the material correlates of language and ethnic shift. *Antiquity 62: 564–74.*

ERIKSEN T. H. 1993. *Ethnicity and Nationalism. Anthropological perspectives.* Pluto Press, London.

EVISON M. 1999. Perspectives on the Holocene in Britain: Human DNA. *Quaternary Proceedings 7: 615–623*.

in press. Population Studies using HLA. *Ancient Biomolecules.*

FEWSTER K. 1996. *Interaction between Basarwa and Bamangwato in Botswana: An Ethnoarchaeological approach to the study of the transition to agriculture in the West Meditterranean.* Unpublished PhD dissertation, University of Sheffield.

FINLAYSON B. and EDWARDS K. J. 1997. The Mesolithic. In K. J. Edwards and I. B. M. Ralston (eds.), *Scotland: Environment and Archaeology, 8000 BC–AD 1000: 109–126*.

GEBAUER A. B. and PRICE T. D. (eds.) 1992. *Transitions to Agriculture in Prehistory, Monographs in World Archaeology 4.*

GRAVES-BROWN P., JONES S. and GAMBLE C. (eds.) 1996. *Identity and Archaeology: the construction of European Communities*.

GREGG S. 1988. *Foragers and Farmers*. University of Chicago Press, Chicago.

GREEN D., HASELGROVE C. and SPRIGGS M. (eds.) 1978. *Social Organisation and Settlement. British Archaeological Reports (International Series 47)*.

GREEN S. and PERLMAN S. (eds.) 1985. *The Archaeology of Frontiers and Boundaries*.

GRONENBORN D. 1990. Mesolithic/Neolithic Interactions. The Lithic Industry of the Earliest Bandkeramik cultures. Site at Friedburg-Bruchenbrüchen, West Germany. In P. M. Vermeersch and P. van Peer (eds.), *Contributions to the Mesolithic in Europe: 173–182*.

1998. Altestbandkeramische Kultur, La Hoguette, Limburg, and ... What else – contemplating the Mesolithic-Neolithic transition in southern Central Europe. In M. Budja (ed.), *Documenta Praehistorica XXV: 189–202*.

GUILLAINE J. 1976. The earliest Neolithic in the West Mediterranean: a new appraisal. *Antiquity 53: 22–30*.

HALSTEAD P. and O'SHEA J. (eds.) 1989. *Bad Year Economics*.

HAMMEL G. 1996. Demographic constraints in population growth of early humans. *Human Nature 7, 3: 217–255*.

HARRIS D. R. (ed.) 1996. *The Origins and Spread of Agriculture and Pastoralism in Eurasia*.

HARRISON G. G. 1975. Primary adult lactase deficiency: a problem in anthropological genetics. *American Anthropologist 77: 812–835*.

HASSAN F. 1975. Determination of the size, density, and growth rate of hunting-gathering populations. In S. Polgar (ed.), *Population Ecology and Social Evolution. World Anthropology.* Mouton Publishers. Chicago (IL).

1978. Demographic archaeology. In M. Schiffer (ed.), *Advances in Archaeological Method and Theory Vol. 1: 49–103*.

HAYDEN B. 1990. Nimrods, piscators, pluckers and planters: The emergence of food production. *Journal of Anthropological Archaeology 9: 31–69*.

HODDER I. 1978. (ed.) *The Spatial Organisation of Culture*.

1992. *Theory and Practice in Archaeology*. Routledge, London.

1999. *The Archaeological Process: an introduction.* Blackwell, Oxford

HOLLOX E. J., POULTER M. and SWALLOW D. M. 2000. Lactase Haplotype Diversity in the Old World. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the population prehistory of Europe: 305–308*.

IZAGIRRE N. and DE LA RUA C. 1999. An mtDNA analysis in ancient Basque populations: Implications for Haplogroup V as a marker for a major Palaeolithic expansion from southwestwast Europe. *American Journal of Human Genetics 65: 199–207*.

JACKES M., LUBELL D. and MAIKLEJOHN C. 1997. On Physical Anthropological Aspects of the Mesolithic-Neolithic Transition in the Iberian Peninsula. *Current Anthropology 38: 839–46*.

JANIK L. 1998. The appearance of food producing societies in the southeastern Baltic region. In M. Zvelebil, R. Dennell and L. Domanska (eds.), *Harvesting the sea, farming the forest: 237–244*.

JENKINS R. 1997. *Re-Thinking Ethnicity.* Routledge, London.

JANKOWSKA D. (ed.) 1990. *Die Trichterbeckerkultur*.

JONES S. 1997. *The Archaeology of Ethnicity.* Routledge, London.

KEELEY L. H. 1992. The introduction of agriculture to the westwastern North European Plain. In A. B. Gebauer and T. D. Price (eds.), *Transitions to Agriculture in Prehistory, Monographs in World Archaeology 4: 81–97*.

KOSKO A. (ed.) 1999. *Beyond Balkanization*.

KOSSINNA G. 1911. *Die Herkunft der Germanen. Zur Methode der Siedlungsarchaeologie.* Mannus-Bibliothek 6. Kabitzsch, Würzburg.

1926. *Ursprung und Verbreitung der Germanen in vo- und fruhgeschichtlicher Zeit.* Mannus-Bibliothek 16. Würzburg: Kabitzsch.

KRETCHMER N. 1972. Lactose and lactase. *Scientific American 227, (4): 71–78.*

LAAN M. and PAABO S. 1997. Demographic history and linkage disequilibrium in human populations. *Nature Genetics 17: 435–438.*

LALUEZA FOX C. 1996. Physical Anthropological Aspects of the Mesolithic-Neolithic Transition in the Iberian Peninsula. *Current Anthropology 37: 689–95.*

LARSSON L. 1990. The Mesolithic of southern Scandinavia. *Journal of World Prehistory 4, 3: 257–291.*

LEWIN R. 1988a. Conflict over DNA Clock Results. *Science 241: 1598–1600.*

1988b. DNA Clock Conflict Continues. *Science 241: 1756–59.*

LEWTHWAITE J. 1986. The transition to food production: a Mediterranean perspective. In M. Zvelebil (ed.), *Hunters in transition: Mesolithic Societies of Temperate Eurasia and Their Transition to Farming: 53–66.*

LICHARDUS J. and LICHARDUS-ITTEN M. (eds.) 1985. *La Protohistoire de l'Europe. Le Neolithique et le Chalcolithique.*

MacEACHERN S. 2000. Genes, Tribes and African History. *Current Anthropology 41, No. 4.*

MALLORY J. P. 1989. *In Search of the Indo-Europeans: Language, Archaeology and Myth.* Thames and Hudson, London and New York.

McCRACKEN R. 1971. Lactase deficiency: an example of dietary evolution. *Current Anthropology 12: 479–577.*

MEIKLEJOHN C. and ZVELEBIL M. 1991. Health status of European populations at the agricultural transition and the implications for the adoption of farming. In H. Bush and M. Zvelebil (eds.), *Health in Past Societies: Biocultural Interpretations of Human Skeletal Remains in Archaeological Contexts, British Archaeological Reports International Series 567: 129–145.*

MIDGLEY M. 1993. *TRB Culture.* Edinburgh: Edinburgh University Press.

MOORE J. A. 1985. Forager/farmer interactions: Information, social organization, and the frontier. In S. Green and S. Perlman (eds.), *The Archaeology of Frontiers and Boundaries: 93–112.*

MOORE J. H 1994. Putting anthropology back together again: the ethnogenetic critique of cladistic theory. *American Anthropologist 96: 925–48.*

NEUSTUPNÝ E. 1982. Prehistoric migrations by infiltration. *Archeologické rozhledy 34: 278–93.*

OTTE M. 2000. The History of European Populations as seen by Archaeology. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the population prehistory of Europe.*

PERRSON O. and PERSSON E. 1984. *Anthropological report on the Mesolithic graves from Skateholm, Southern Sweden, Excavation seasons 1980–1982.* Report Series no. 21, University of Lund, Institute of Archaeology, Lund.

PIGGOT S. 1965. *Ancient Europe.* Edinburgh University Press, Edinburgh.

PLUCIENNIK M. 1996. Genetics, archaeology and the wider world. *Antiquity 70: 13–14.*

1998. Deconstructing 'The Neolithic' in the Mesolithic-Neolithic transition. In M. R. Edmonds and C. Richards (eds.), *Social Life and Social Change in north-western Europe: 61–83.*

POLGAR S. (ed.) 1975. *Population Ecology and Social Evolution.*

PRICE T. D. 1985. Affluent foragers of Mesolithic Southern Scandinavia. In T. D. Price and J. A. Brown (eds.), *Prehistoric Hunter-Gatherers. The Emergence of Cultural Complexity: 341–360.*

1987. The Mesolithic of Western Europe. *Journal of World Prehistory 1: 225–332.*

1991. The Mesolithic of Northern Europe. *Annual Review of Anthropology 20: 211–233.*

1996. The first farmers of southern Scandinavia. In D. Harris (ed.), *The Origin and Spread of Agriculture and Pastoralism in Eurasia: 346–363.*

2000. The introduction of farming in northern Europe. In T. D. Price (ed.), *Europe's First Farmers: 260–300*.

(ed.) 2000. *Europe's First Farmers*.

PRICE T. D. and BROWN J. A. 1985. Aspects of hunter-gatherer complexity. In T. D. Price and J. A. Brown (eds.), *Prehistoric hunter-gatherers: The Emergence of Cultural Complexity: 3–20*.

(eds.) 1985. *Prehistoric hunter-gatherers: The Emergence of Cultural Complexity*.

PRICE T. D. and GEBAUER A. B. 1992. The final frontier: foragers to farmers in Southern Scandinavia. In A. B. Gebauer and T. D. Price (eds.), *Transitions to Agriculture in Prehistory: 97–115*.

RADOVANOVIĆ I. 1996. Mesolithic/Neolithic contacts: a case of the Iron Gates region. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji XXIII: 39–48*.

RENFREW C. 1987. *Archaeology and Language. The Puzzle of Indo-European Origins*, Jonathan Cape, London.

1996. Prehistory and the identity of Europe, or don't lets be beastly to the Hungarians. In P. Graves-Brown, S. Jones and C. Gamble (eds.), *Identity and Archaeology: the construction of European Communities: 125–37*.

2000. At the edge of Knowability: towards a Prehistory of Languages. *Cambridge Archaeological Journal, Vol 10, No 1: 7–34*.

RENFREW C. and BOYLE K. (eds.) 2000. *Archaeogenetics: DNA and the population of prehistoryof Europe*.

RENFREW C. and SHENNAN S. (eds.) 1982. *Ranking, Resources and Exchange: Aspects of the Archaeology of Early European Society*.

RICHARDS M., CÔRTE-REAL H., FORSTER P., MACAULAY V., DEMAINE A., PAPIHA S., HEDGES R., BANDELT H-J., and SYKES B. 1996. Palaeolithic and Neolithic Lineages in the European Mitochondrial Gene Pool. *American Journal of Human Genetics 59: 185–203*.

RICHARDS M. B., MACAULAY V. A., BANDELT H. J. and SYKES B. C. 1998. Phylogeography of mitochondrial DNA in western Europe. *Ann Hum Genet 62: 241–60*.

RICHARDS M. B. (and 37 other authors) 2000. Tracing European Founder Lineages in the Near Eastern mtDNA Pool. *Am. J. Hum. Genet. 67: 1251–1276*.

RIMANTIENÉ R. 1992. Neolithic hunter-gatherers at Šventoji in Lithuania. *Antiquity 66, 251: 367–76*.

ROWLEY-CONWY P. 1980. *Continuity and Change in the Prehistoric Economies of Denmark, 3700–2300 bc*. Unpublished Ph.D thesis, Cambridge.

1983. Sedentary hunters, the Ertebølle example. In G. N. Bailey (ed.), *Hunter-Gatherer Economy in Prehistory: 111–126*.

1999. Economic Prehistory in Southern Scandinavia. *Proc. Brit. Acad. 99: 125–159*.

ROWLEY-CONWY P. A. and ZVELEBIL M. 1989. Saving it for later: storage by prehistoric hunter-gatherers in Europe. In P. Halstead and J. O'Shea (eds.), *Bad Year Economic: 40–56*.

SEMINO O., PASSARINO G., BREGA A., FELLOS M. and SANTACHIARA-BENERECETTI A. S. (1996). A view of the Neolithic demic diffusion in Europe through two Y chromosome-specific markers. *American Journal of Human Genetics 59: 964–968*.

SCHIFFER M. B. 1972. Archaeological context and systemic context. *American Anthropology 37: 156–65*.

1976. *Behavioural Archaeology*. Academic Press, New York.

(ed.) 1978. *Advances in Archaeological Method and Theory* l.

SCHWABEDISSEN H. 1981. Ertebølle/Ellerbek – Mesolithilum oder Neolithikum? In B. Gramsch (ed.), *Mesolithikum in Europa: 129–143*.

SHANKS M. and TILLEY C. Y. 1987. *Social Theory and Archaeology*. Polity Press, Cambridge.

SHENNAN S. J. 1989. *Archaeological Approaches to Cultural Identity*. Routledge, London.

SHERRATT A. G. 1982. Mobile resources: settlement and exchange in early agricultural Europe. In C. Renfrew and S. Shennan (eds.), *Ranking, Resources* *and Exchange: Aspects of the Archaeology of Early European Society: 13–26*.

1990. The genesis of megaliths: monumentality, ethnicity and social complexity in Neolithic northwest Europe. *World Archaeology 22(2): 148–167*.

SHREEVE J. 1999. Secrets of the Gene. *National Geographic Vol 196 (4): 42–75*.

SIMMONS I. G. and TOOLEY M. (eds.) 1981. *The Environment in British Prehistory*.

SIMOONS F. J. 1979. Dairying, Milk Use and Lactose Malabsorbtion in Eurasia: A problem in culture history. *Anthropos. 74: 61–80*.

SMITH A. G. 1981. The Neolithic. In I. G. Simmons and M. Tooley (eds.), *The Environment in British Prehistory: 125–8, 133–83, 199–209*.

SOLBERG B. 1989. The Neolithic transition in Southern Scandinavia: Internal development or migration? *Oxford Journal of Archaeology 8(3): 261–296*.

SOKAL R., ODEN N., LEGENDRE P., FORTIN M-J., KIM J. and VADOR A. 1989. Genetic differences among language families in Europe. *American Journal of Physical Anthropology 90: 393–407*.

SOKAL R., ODEN N. and WILSON C. 1991. Genetic evidence for the spread of agriculture in Europe by demic diffusion. *Nature 351: 143–145*.

SOKAL R., ODEN N. and THOMSON B. 1992. Origins of the Indo-Europeans: Genetic Evidence. *Proceedings of the National Academy of Sciences U.S.A. 89: 7669–73*.

1998. A problem with Synthetic Maps. *A paper presented in the symposium 'Genetics and Origins of human Diversity' at the annual Meeting of the American Association of Physical Anthropologists*.

STRAUS L. G. 1998. The peopling of Europe: A J. A. R. Debate. *Journal of Anthropological Research 54: 399–419*.

TERRELL J. and STEWART P. 1996. The paradox of human population genetics at the end of the twentieth century. *Reviews in Anthropology 26: 13–33*.

THOMAS J. 1988. Neolithic explanations revisited: the Mesolithic-Neolithic transition in Britain and south Scandinavia. *Proceedings of the Prehistoric Society 54: 59–66*.

1996. The cultural context of the first use of domesticates in continental Central and Northwestwast Europe. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 310–322*.

THOMASON S. G. and KAUFMAN T. 1988. *Language Contact, Creolization, and Genetic Linguistics*. University of California Press, California.

THORPE I. J. 1996. *The Origins of Agriculture in Europe*. Routledge, London.

TILLEY C. 1994. *A Phenomenology of Landscape*. Berg, Oxford.

1996. *An Ethnography of the Neolithic*. Cambridge: Cambridge University Press.

TIMOFEEV V. I. 1987. On the problem of the early Neolithic of the East Baltic area. *Acta Archaeologica 58: 207–12*.

1990. On the links of the East Baltic Neolithic and the Funnel Beaker culture. In D. Jankowska (ed.), *Die Trichterbeckerkultur: 135–49*.

1998. The Beginning of the Neolithic in the Eastern Baltic. In M. Zvelebil, R. Dennell and L. Domanska (eds.), *Harvesting the Sea, Farming the Forest: 225–236*.

1999. The East-West relations in the late Mesolithic and Neolithic Baltic region. In A. Kosko (ed.), *Beyond Balkanization. Baltic Pontic Studies: 44–58*.

TOMASZEWSKI A. J. 1988. Foragers, Farmers and Archaeologists: A Comment on B. Olsen's Paper 'Interaction between Hunter-Gatherers and Farmers': Ethnographical and Archaeological Perspectives from the Viewpoint of Polish Archaeology. *Archeologia Polski 33: 434–440*.

TORRONNI A., BANDELT H-J., D'URBANO L., LAHERNO P., MORAL P., SELLITO D., RENGO C., FORSTER P., SAVONTAUS M-L., BONNE-TAMIR B., SCOZZARI R. 1998. mtDNA analysis reveals a major Late Palaeolithic population expansion from southwestern to northeastern Europe. *American Journal of Human Genetics 62: 1137–1152*.

Van ANDEL T. H. and RUNNELLS C. N. 1995. The earliest farmers in Europe. *Antiquity 69: 481–500.*

VANKINA L. V. 1970. *Torfyanikovaya Stoyanka Sarnate*. Riga, Zinatne.

VAQUER J. 1989. Innovation et inertie dans le processus de néolithisations en Languedoc occidental. In O. Aurenche and J. Calvin (eds.), *BAR, International Series 516: 187–197*.

VENCL S. 1986. The role of hunting-gathering populations in the transition to farming: a Central European Perspective. In M. Zvelebil (ed.), *Hunters in Transition: 43–52*.

VERHART L. B. M. and WANSLEEBEN M. 1997. Waste and prestige: the Mesolithic-Neolithic transition in the Netherlands from a social perspective. *Analecta Praehistorica Leidensia 29: 65–73*.

VERMEERSCH P. M. and Van PEER P. (eds.) 1990. *Contributions to the Mesolithic in Europe*.

VERMEULEN H. and GOVERS C. (eds.) 1994. *The Anthropology of Ethnicity: beyond 'Ethnic Groups and Boundaries'*.

VOYTEK B. and TRINGHAM R. 1989. Rethinking the Mesolithic: the case of south-east Europe. In Bonsall C. (ed.), *The Mesolithic in Europe: 492–500*.

VUORELA I. and LEMPIAINEN T. 1988. Archaeobotany of the oldest cereal grain find in Finland. *Annales Botanici Fennici 25: 33–45*.

WOODBURN J. 1982. Egalitarian societies. *Man (N.S.) 17: 431–51*.

WHITE N., MEEHAN B., HIATT L. and JONES R. 1990. Demography of Contemporary Hunter Gatherers: Lessons from Central Arnhem Land. In B. Meehan and N. White (eds.), *Hunter-Gatherer Demography. Past and Present. Oceania Monograph 39: 171–185*.

WHITTINGTON G. and EDWARDS K. J. 1997. Climate Change. In K. J. Edwards and I. B. M. Ralston (eds.), *Scotland. Envrionment and Archaeology, 8000 BC–AD 1000*.

WHITTLE A. 1996. *Europe in the Neolithic*. Cambridge University Press, Cambridge.

WILLIS K. J. and BENNETT K. D. 1994. The Neolithic transition – fact or fiction? Palaeoecological evidence from the Balkans. *The Holocene 4: 326–30*.

WILLIS K. J., SÜMEGY P., BRAUN M., BENNETT K. D. and TOTH A. 1998. Prehistoric Land Degradation in Hungary: Who, How and Why? *Antiquity 72: 111–113*.

WOBST M. 1974. Boundary conditions for Palaeolithic social systems: a simulation approach. *American Antiquity 39: 147–78*.

ZILHÃO J. 1993. The spread of agro-pastoral economies across Mediterranean Europe: View from the far west. *Journal of Mediterranean Archaeology 6: 5–63*.

1997. Maritime pioneer colonisation in the Early Neolithic of the west Mediterranean. Testing the model against the evidence. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 24: 19–42*.

ZVELEBIL M. 1981. From Forager to Farmer in the Boreal Zone. *BAR, International Series, Oxford, 115*.

1986a. Postglacial Foraging in the Forests of Europe. *Scientific American 254, 5: 104–115*.

(ed.) 1986b. *Hunters in Transition. Mesolithic Societies of Temperate Eurasia and their Transition to Farming*.

1989. On the transition to farming in Europe, or what was spreading with the Neolithic: a reply to Ammerman (1989). *Antiquity 63: 379–383*.

1993. Hunters or farmers? the Neolithic and Bronze Age societies of north-east Europe. In J. Chapman and P. Dolukhanov (eds.), *Cultural Transformation and Interactions in Eastern Europe: 146–162*.

1995. At the interface of archaeology, linguistics and genetics: Indo-European dispersals and the agricultural transition in Europe. *Journal of European Archaeology 3 :1: 33–70*.

1996. Agricultural frontier and the transition to farming in the circum-Baltic area. In D. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 323–345*.

1998. Agricultural frontiers, Neolithic origins and the transition to farming in the Baltic basin. In M. Zvelebil, R. Dennell and L. Domanska (eds.), *Harvesting the Seas, Farming the Forests: 9–28.*

2000. The Social Context of the Agricultural Transition in Europe. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the population prehistory of Europe: 57–79*.

ZVELEBIL M., DENNELL R. and DOMANSKA L. (eds.) 1998. *Harvesting the Seas, Farming the Forests.*

ZVELEBIL M. and DOLUKHANOV P. 1991. Transition to farming in eastern and northern Europe. *Journal of World Prehistory 5(3): 233–278.*

ZVELEBIL M. and LILLIE M. 2000. Transition to agriculture in eastern Europe. In T. D. Price (ed.), *Europe's First Farmers: 57–92*.

ZVELEBIL M. and ZVELEBIL K. V. 1988. Agricultural transition and Indo-European dispersals. *Antiquity 62: 574–83*.

UDK 903'12/'15(4/5)"633/634":575.17; 903'12/'15(4/5)"633/634":574.91

Documenta Praehistorica XXVIII

The transition to farming in Southeast Europe: perspectives from pottery

Mihael Budja
Department of Archaeology, University of Ljubljana, Slovenia
miha.budja@uni-lj.si

ABSTRACT – *The transition to farming in the Balkans, Ionia and the Adriatic is discussed as the palimpsest relates to artefact assemblages, subsistence and archaeogenetic data. It is argued that it marks a dispersed and selective route towards farming adaptation in the regions. The incoming near-eastern lineages and the difference in values for the Balkans (~20%) and Mediterranean coastal (~10%) area are linked to a network of the circulation of goods and people over long distances which was established after the incipient adoption of farming.*

IZVLEČEK – *V članku analiziramo process neolitizacije na Balkanu ter vzhodni jadranski in jonski obali. Prehod h kmetovanju obravnavamo kot palimpsest (zapisov) povezanih z oblikovanjem artefaktnih zbirov, paleogospodarstev in arheogenetskih sekvenc. Zadnje povezujemo z vzpostavitvijo sistema menjave blagá in ljudi na Balkanu in Mediteranu.*

KEY WORDS – *transition to farming; archeogenetic data; pottery*

INTRODUCTION

After many years of modern investigation the transition from mainly hunter-gatherer Mesolithic to predominantly farming Neolithic societies still remains embedded in the context of a succession of periods, a linear evolution and cultural development, which linked mobile hunter-gatherer groups with the Mesolithic, and sedentary farmers with the Neolithic. The dominant model depicted hunter-gatherer social systems as rigid patrilocal, exogamous and territorial band organizations, and related this to a scarcity of resources and the importance of hunting. Farming, on the other hand, would imply, at the first sight, different relations of production, with cultivation removing many of the risks and uncertainties of hunter-gathering, allowing accumulation, and thus making reciprocity far from desirable. Although it is broadly accepted that early farmers still made extensive use of hunted and gathered resources, it remains the paradigmatic view that the hunter-gatherer and early farming communities can be distinguished from one another in their forces of production, including the technological sets that they employed. It still maintains the premise that hunter-gatherer's (i.e. late Mesolithic) and farmer's (i.e. early Neolithic) artefact sets, being deposited in cave sites in southeast Europe and the Mediterranean mainly, by definition belong to different (mutually exclusive) stratigraphic, chronological and cultural contexts.

The interpretation of the transition to farming in Europe is linked to the assumption that farming emerged in the context of four critical innovations – domestic plants and animals, polished stone tools, and ceramics. The typological determinations and spatially restricted distributions of different pottery types (the normative identification) supposed to correlate with the genesis of Early Neolithic cultures on the regional level on the one hand and, the migration of farmers bringing in all the concomitant knowledge and skills of farming (in accordance with Childean cultural and revolutionary approaches) on the other. Several mutually exclusive regional pottery distributions – the "Balkan-Anatolian complex of painted pottery" in Southeast Europe, the "Cardium-impresso Pottery Culture" in Mediterranean and the "Linear Pottery Culture" in Central and West Europe – were used to objectify the gradual colonisation of Europe. The first and the second have been recognized as the "secondary centres of the neolithisation of Europe", that most direct link to the cultural traditions of Asia Minor. The rate of spread of newcomers across Europe, and the colonisation of the continent, was objectified by a suggestive pattern of hundreds of radiocarbon dates relating to the earliest Neolithic settlement strata comprising pottery and domesticates. When those dates are plotted on the continental map, a south-east to north-west gradient becomes evident, suggesting that it may have taken about 2500 years for the agricultural frontier to reach the ends of the continent and to complete the process of the transition to farming in Europe (*Clark 1965.58–73; Lüning 1988(1991).29–30; Breunig 1987; Parzinger 1993; Müller 1994; Ammerman, Cavalli-Sforza 1984.58–62, Fig. 4.5*).

INTERPRETATIVE BACKGROUNDS

Although it is broadly accepted that the process of neolithisation of Europe was related exclusively to the change from food collection to food production, it still remains a controversial question whether this change in the palaeoeconomy was the consequence of cultural diffusion or demic expansion. The first hypothesises that it was farming that was diffused and adopted by local foragers. The latter states that there were farmers, and their language radiated from the Middle East toward Europe, Central and South Asia, and to some extent North Africa. Perhaps the most popular recent interpretation is based on the model of an "isochronic line of agricultural expansion in Europe" (*Ammerman, Cavalli-Sforza 1984.58–62, Fig. 4.5; Cavalli-Sforza and Cavalli-Sforza 1995; Cavalli-Sforza 1996; Cavalli-Sforza, Menozzi, Piazza 1993.639–646).* Using the concepts of "demic expansion", "wave of advance" and "agricultural frontier zone" they suggest a slow expansion of people into Europe driven by population growth resulting from agricultural surpluses, and either the displacement or absorption of the less numerous hunter-gatherer populations. Thus the rate of advance of agriculture into Europe is held to be compatible with the estimation that the farmers spread, hypothesising fertility rates and mobility of early farmers comparable to those observed in ethnographically similar situations. In correspondence with the relocation of the agricultural frontier, shifting at a rate of 1km per year across the continent, demic expansion is supposed to have had a dramatic effect on the European gene pool. The most important consequence is that the major component of the modern European gene pool derives from Near-Eastern Neolithic farmers rather than indigenous Mesolithic foragers. In other words, the Eurasian neolithisation process in the period 9500–5500 BP was exclusively the domain of Near-Eastern farmers who were allowed to plant their genes and farming practices across Europe, Central and South Asia, and preserve their ethnic, cultural and social identity.

It is important to note here that the evidence provided by the sites where the elements of a farming economy in the contexts of typologically determined "Late Mesolithic (culture)" is rarely discussed, whether because of taphonomic filters operating in a framework of unsystematic and inconsistent research procedures and interpretative postulates which maintain that Mesolithic stone tool assemblages and elements of the "Neolithic package" are culturally, chronologically and spatially mutually exclusive, or because of prejudices toward hunter-gatherers in general and Mesolithic peoples in particular. What I would like to suggest here is that it is no longer sufficient to use the modified "Three-Age" typological paradigm as a heuristic device to direct our interpretational modelling or to minimize the social context of the agricultural transition by such claims as that "...local groups also hunted goats, probably derived from coastal herders, before the former adopted domestication..." (*Chapman & Müller 1990.132*).

A recent revival of interest in the transition to farming has brought about the understanding that agriculture developed independently in several areas of the world and that clear-cut shifts from dependence on hunting, fishing and gathering to dependence on agriculture depended on a number of particular conjunctions of circumstances in particular places at particular times (*Harris 1996b.553, 557*), and it de facto remains a problem to recognise the processes by which agriculture and pastoralism became established throughout Eurasia.

It is important, however, to stress the significance of pre-Neolithic adaptations for the development or adoption of incipient agriculture, since small-scale cultivation of (mainly) wild plants and animals is practised by indigenous foragers in the context of a "continuum of people-plant-animal interaction" (*Harris 1989.11–26; 1996a.1–9*). Therefore, it is a choice of manipulating resources rather than the actual fact of substituting wild resources with domesticates. It was suggested that instead of conceiving the transition from hunting and gathering to herding or cultivation as an evolutionary progression from one distinct type of society to another we have to be aware of the usefulness of treating hunting and gathering, herding and cultivation as alternative strategies which are, separately or in combination, appropriate to particular social or natural environments (*Layton, Foley and Williams 1991.255–274; Hawkes, O'Connell 1992.63–65*). It is useful to remember that the questions of "when", "where", "why" and "who" (*Halstead 1996.296–309*) are still of basic interest in the "late Mesolithic and early Neolithic" palimpsests in Southeast Europe and the Mediterranean. Was "Neolithic man ... the first human producer", and was there "no other before him", as Cauvin (*2000.207*) recently claimed? Was the origin of Neolithic plant and animal packages exclusively in the Near East, which then spread throughout Anatolia and Europe (*Zohary and Hopf 2000*)? Was the Mesolithic population sparse throughout Europe (*Meiklejohn et al. 1997; Jackes et al. 1997*) and was it really genetically replaced by different mechanisms of population diffusion that correlate with agro-pastoral dispersals (*Zvelebil 2000.57–79*)? And finally, the question that might have been asked in the traditional interpretative contexts from the very beginning: was it "cardial" and "monochrome" pottery that marked the initial Neolithic cultures in the Balkans and Mediterranean, or does it, in fact, represent a widely distributed set of shapes and motifs, symbols which were recognized and used by members of different groups and served to signify specific social interactions, power relations and exchange networks (as containers for foods) within and between the late hunter-gatherer and early farming communities?

THE TRANSITION TO FARMING IN EUROPE AND THE GENETIC PALIMPSEST

We have already mentioned that perhaps the most popular interpretation recently is represented in the work of Ammerman and Cavalli-Sforza. They introduce into archaeology the principle of synthetic genetic maps – geographical maps of isopleths (lines of equal value) of principal component values, calculated as optimised linear functions of all available gene frequencies of modern Eurasian populations (*Menozzi, Piazza, Cavalli-Sforza 1978.786–792*). Seven principal components were listed, while the first three are recognized as the most significant and are rather arbitrarily linked with specific historical events and processes. There is no doubt, however, that "a principal components analysis represents a palimpsest of all the processes which have taken place, from the earliest human settlement to the present time." (*Renfrew 2000.5*).

Ammerman and Cavalli-Sforza based the interpretation of the transition to farming in Europe on analyses of correlations of "contour maps" for the first principal component from 95 gene frequencies with the southeast (Levant) – northwest (Europe) gradient and maps of the "latest" Mesolithic occupation and the "spread of early farming to Europe" which is an updated version of the distribution of radiocarbon dated early Neolithic sites published by Clark in 1965 (*Ammerman, Cavalli-Sforza 1984.Figs. 4.5–6, Fig. 6.10; Cavalli-Sforza 1996.61, Fig. 4.1a*). They believe that the "extraordinarily high" resemblance of the maps demonstrates:

- there was "no prolonged chronological overlap between Mesolithic occupation and the onset of early farming" in Europe (*Ammerman, Cavalli-Sforza 1984.60*) and,
- the pattern of temporal and spatial distribution of early Neolithic settlements corresponds well with the contour map of the distribution of the first principal component of gene frequencies in modern European populations (*Cavalli-Sforza 1996.53*).

However, the frontier lines of the 500 year temporal intervals of spatial distribution of early Neolithic sites that run parallel to one another over much of Europe were determined as "an isochronic line of agricultural expansion in Europe" (*Ammerman, Cavalli-Sforza 1984.Fig. 4.5; Sokal, Oden, Wilson 1991. Fig. 1; Cavalli-Sforza, Menozzi, Piazza 1993.Fig. 2a; Cavalli-Sforza 1996.Fig.4.1*). In accordance with "the wave of advance model" they hypothesised the increased population densities within the agricultural frontier zones, causing demic expansion into new territory at an average rate of 1 km per year and a diffusive gene flow between the Neolithic farmers and Mesolithic hunter-gatherers. In consequence, there would be less expectation of continuity between the two, and the contribution of the latter to the subsequent development of the genetic and cultural history of Europe is supposed to be insignificant.

Although the archaeological data cannot directly address the question of demic expansion and genetic replacement, the estimation of the dynamics at the agricultural frontier is directly linked to the identification of the distribution of Early Neolithic sites in "time and space". It is hypothesised that there is a relationship between the distribution and density of archaeological sites and the distribution and density of human populations in the selected regions. An old idea that was revived recently holds that, because of an almost total lack of evidence of Mesolithic sites in both Central and Southeast Europe and the Iberian Peninsula, the Mesolithic population must have been very sparse and, in consequence, this would have allowed farmers to expand and colonise the regions rapidly (*Pinhasi, Foley, Mirazón 2000.50, 54; see also Trinhgam 1968.46–53, 67. Fig.7*). It was already evident that the present distribution of (late) Mesolithic (early) Neolithic was very much affected by the processes (long-term and catastrophic) that restructured the geomorphology and reshaped the relief of the regions in the Holocene. In plotting sites on a general map of Eurasia and in hypothesising a spatial discontinuity between Mesolithic and Neolithic settlements, we have to take into consideration the fact that the patterns available to research are the various outcomes of consecutive cycles of alluvation, erosion, and sedimentation of valleys and the rise in Mediterranean, Marmara and Adriatic sea-levels (*Chapman 1989; 1994; van Andel, Gallis and Toufexis 1995.131; Lambeck 1996. 588–611; Ryan et al. 1997.119–126; Okay et al. 1999.129; see Kotsakis in this volume*). With this in mind, I would argue that many coastal or inland riverside sites of the Mesolithic or, more importantly, many short-term Early Neolithic sites still remain unavailable, buried under alluvium or covered by sea.

Some further thoughts on the restrictions connected with the selection and formation of artefact sets should also be considered. The distinction between Neolithic and Mesolithic sites was based on general typological categorizations, which were used to objectify hunter-gatherers and farmers "cultural" sequences. This objectification maintains the paradigmatic perception that farming practices could only be embedded in Neolithic "cultural" contexts (*Zilhão 1993.47–49; 1997.19–42; Budja 1996a.61–76*). From this point of view it is impossible to ignore the fact that an analysis of spatial distribution of early Neolithic settlements may not reflect the actual diffusion of farming practices and changes in subsistence strategies. However, the story was recorded in the genetic pattern produced by DNA from Y (male) chromosomes (*Cavalli-Sforza and Minch 1997.274–251; Sykes & Renfrew 2000.13–15*). The map for the First Principal Component, representing 28.1% of the modern genetic variance of Europe, showed a clear gradual distribution in values between the Near East and Northwest Europe; however, it was recently realised that:

- a principal components analysis is a palimpsest of all the processes that have taken part in the historical process it accounts for;
- a large part of the first principal component – the classic markers – may have been due to earlier gene flow processes and that the overall genetic impact of the Neolithic in Europe with a greater emphasis on is now being correlated to the initial colonization in the Palaeolithic and subsequent colonization episodes in the Mesolithic;
- the low proportion of variance associated with the first principal component for classical markers (28.1%) indicates a minor input by the Neolithic newcomers and the great significance of the Mesolithic contribution to later European prehistory (*Renfrew 2000.5, 9; Sykes & Renfrew 2000.17; Sykes 2000.26*).

A much more precise story is found in the pattern of mitochondrial DNA genetic gradients, giving us the female (X) picture. Before we continue, a word about the human genome – the collective name for the entire DNA in each cell. It is organized into separate volumes – chromosomes deposited in the cell nucleus. There are twenty-four different chromosomes in the human genome, but we have two sets of most of them, one from each parent. Twenty-two of them are known as autosomes, the other two X and Y-chromosomes determining sex. Males have both X and Y-chromosomes, but females have a pair of X-chromosomes only. The human genome contains one other, very special piece of DNA – mitochondrial (mt) DNA – embedded in the cell cytoplasm. Unlike nuclear DNA, it is inherited from one parent only, the mother. This means that at any time in the past only one woman alive at that time was the maternal and hence the mitochondrial DNA ancestor of a particular person, which is definitely not the case with nuclear DNA, where the number of potential nuclear ancestors doubles at every generation (*Sykes & Renfrew 2000.14*). So far, in archeogenetic studies relating to the origins of the Neolithic and the agricultural transition in Europe, the DNA as it survives in the genes of living people has been used in sampling, sequencing, geographically patterning and interpreting events and processes in the remote past in spite of critical limitations. The methodological topics have already been discussed (*Richards et al. 2000.1251–1276*). But as a non-geneticist I would suggest we remember that the reconstruction of genetic history and its explanation through migration or demic diffusion relates to the survivors, existing descent lines, whether represented in male (Y chromosomes) or female (mtDNA) markers and, that those numerous lineages which became extinct are by definition not recorded in the living record – the extant genetic palimpsest (*Richards et al. 1996.185–198; Sykes & Renfrew 2000.16*).

However, the "founder analysis" of mitochondrial DNA seems to be more reliable in identification and dating of migrations into new territory and in the evaluation of the suggested Neolithic demic diffusion and population replacement. The analysis confirmed the southeast-northwest spatial gradient on the one hand, but showed the low values obtained for the demic component of the Neolithic expansions on the other. It was suggested that "...most of the modern European mtDNA landscape was formed neither in Early Upper Palaeolithic colonization ... not as a result of demic diffusion from the Near East ... but rather in Late glacial re-expansions within Europe itself." (*Richards & Macaulay 2000.148*). Based on the results of the founder analysis of mtDNA, Richards et al conclude that <10% of extant lineages date back to the first colonization of Europe by anatomically modern humans, and that on the order of 10–20% arrived during the Neolithic, but most of the other lineages "seem most likely to have arrived during the Middle Upper Palaeolithic and to have expanded during the Late Upper Palaeolithic" (*Richards et al. 2000.1272*). It is interesting that Neolithic contributions to extant mtDNA evidently vary regionally and that the incoming lineages, at least on the maternal side, were in the minority, in comparison with indigenous Mesolithic lineages, even in those regions where centres of secondary neolithisation and the pioneer colonization of uninhabited areas have been suggested. Regional analysis shows the Neolithic contribution – the incoming lineages with the values of ~20% for Southeast, Central, Northwest and Northeast Europe. In the Mediterranean coastal area it is even lower than ~10%, similar to that in Scandinavia (*Richards et al. 2000.1271*). On the explanatory level, recognizing the major significance of the indigenous Mesolithic lineages, they also suggest that:

- acculturation occurred principally in Southeast Europe;
- the expansion of the LBK (Linearbankeramik) cultural complex through Central Europe did indeed include a "substantial demic component", which in consequence means that there was a "considerable replacement" of population;
- the transition to farming in the Mediterranean and Scandinavia was very late and "the impact of newcomers likely very slight" (*Richards et al. 2000.1271*).

We have to note some salient points in this interpretative context concerning the results of recently available genetic studies of domestication of emmer wheat that "appears to have expanded from the Near East on two occasions, correlating closely with the observation by Richards *et al.* (*1996*)" of the two incoming and chronologically distinctive Neolithic lineages (*Allaby 2000.323*). It is broadly accepted that wild emmer, tertraploid wheat (*Triticum dicocoides*) is endemic to the Near Eastern "arc" where its domestication could only have taken place and Neolithic agriculture have originated. It was suggested also that genetic comparisons between the founder crops and their wild progenitors suggest that the wild ancestors of most of them (except for barley) were introduced into cultivation only once and at only one location (*Zohary & Hopf 2000.243*). However, the results of the molecular phylogenetic studies of modern plants suggest that emmer wheat may have been domesticated more than once, and

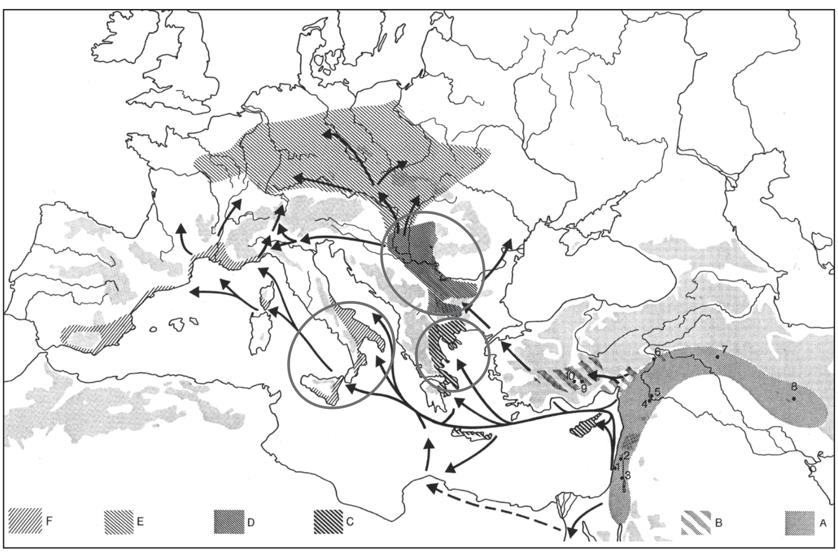


Fig. 1. The Neolithisation of Europe. Primary (Thessaly) and secondary (Balkans and western Adriatic coast) centres of colonisation (*after Lüning 1988(1991).Abb.1*).

that hexaploid wheats (e.g. *Triticum spelta* and *Triticum aestivum*), which arose from a hybridisation of emmer and the wild grass *Aegilops squarrosa,* have multiple origins (*Brown 1999.89–98*).

Genetically-driven explanations are usually used to argue that the biogeography of plant domesticates can indicate "expanding populations" or a "record of human movement" (*Harris 1996b.569; Allaby 2000. 321*), although it is well known that genetic analysis is unable to determine whether the movement of a domesticate from one location to another was due to its being carried by group of migrating humans or if it resulted from trade between two static communities (*Brown 1999.89–98*). Discussing the archaeological data in the western Mediterranean we have already pointed out that no direct or indirect evidence of cereal agriculture has yet been found that could have correlated with the hypothesised initial colonisation and, with all due respect to the motto absence of evidence is not evidence of absence, on the Iberian Peninsula crop-husbandry appeared a few hundred years later than animal-husbandry (*Budja 1999.122–128; cfr. Zilhão 1997.23–26; Bernabeu Aubán 1997.11–12*). In the eastern Mediterranean, in contrast, on the tip of the Balkan Peninsula in the Grevena region, the present-day habitats for wild einkorn exist (*Zamanis et al. 1988*). It is perhaps no coincidence that among the archaeobotanical remains collected from the Mesolithic deposits in the nearby Theopetra cave wild einkorn wheat (*Triticum boeoticum)* has been reported (*Kyparissi-Apostolika 2000.137*). But the Balkans region seems to remain excluded as an area of primary domestication of wild einkorn (*Heun et al. 1997.1312–1314; 1998.65–69; Zohary & Hopf 2000.36–42, 243; Gopher et al. in this volume*). It is worth mentioning that einkorn wheat "appears to be less frequent" than two other founder cereals (emmer and barley) in the Levantine Neolithic, which is certainly not the case in the Balkans where much richer remains of einkorn wheat are available. Einkorn prevails over emmer wheat in "the frequency of pure hoards", retaining its principal role throughout the Neolithic and even later periods (*Zohary & Hopf 2000. 38–39*). It has been demonstrated in Southeast Europe that the evident impact of the first farmers on vegetation was neither on a landscape scale nor in the form of a time-transgressive wave of forest clearance (*Willis & Benett 1994.326–330; Willis 1995. 9–24*). But small-scale forest clearance, burning, and coppicing, however, predate the earliest Neolithic sites in the regions (*Andrič, in this volume*). It is my belief that the application of the concept of a "continuum of people and plant interaction" such as that mentioned above in the context of pre-Neolithic adaptations for the development or adoption of incipient agriculture should definitely be taken into consideration in the Balkans.

An analysis of strontium isotope deposited in human skeletal material confirmed recently the human migration in the context of the genesis of the LBK cultural complex and the dispersion of agriculture in Central and West Europe. The strontium isotope in human teeth and bones provides separate geochemical markers of the place of birth and the place of death. This means that a difference in the isotope ratio provided by the two samples of the same individual indicates a change in residence during the lifetime (*Price at al. 1994.315–330*). Sampling the middle and the late LBK cemeteries in the Upper Rhine Valley, Price and his group found proof of "substantial migration" (*Price et al. 2001.601*). The results in the middle Neolithic cemetery in Flombron indicate a high proportion of migrants (64%) of both sexes had moved there from some distance away. However, a substantially different pattern ap-

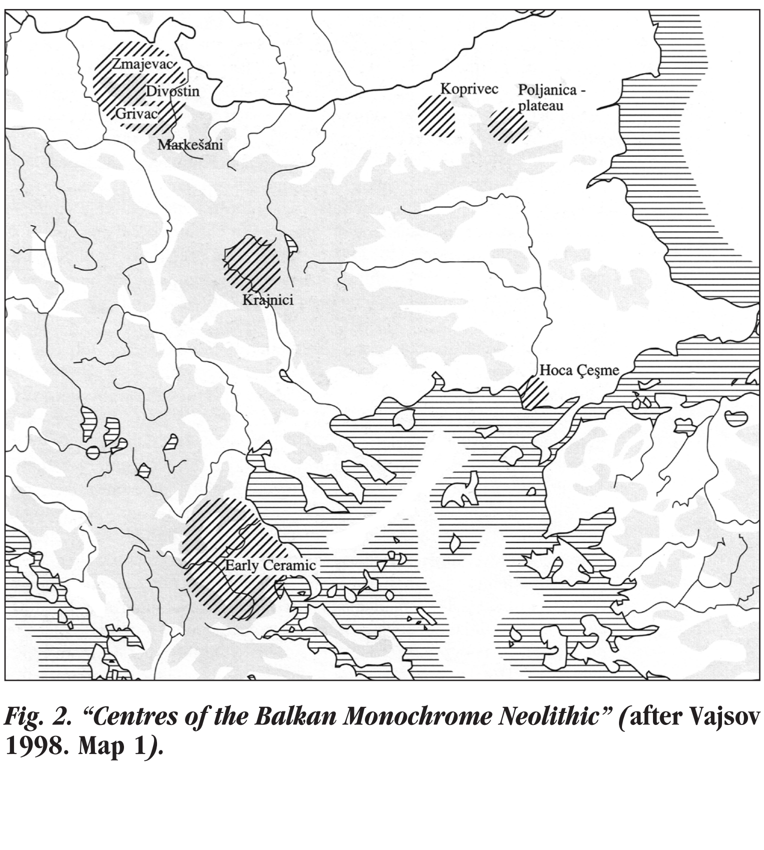


Fig. 2. "Centres of the Balkan Monochrome Neolithic" (**after Vajsov 1998. Map 1*****).***

peared in a late Neolithic cemetery in Schwetzingen. A smaller proportion (33%) of the sampled population were migrants, the majority of them younger women. It was hypothesised in this case that migration may have primarily been a result of residential changes upon marriage, and that these females may have come from neighbouring farming areas or across the agricultural frontier zone from hunter-gatherer communities (*Price et al. 2001.589–601*). Migration and frontier mobility are linked, however, to the pattern of temporal and spatial distribution of the earliest LBK settlements, and it was suggested that the sequence from 5700 BC to 5500 BC of the earliest radiocarbon dates within the normative determination of the earliest LBK cultural phase, demonstrates a rapid expansion of farming communities over hundreds of kilometres from the central Danube and Carpathian basin to the Rhine in the west. Price et al hypothesised on the base of the high proportion of migrants and the appearance of the spondylus shell (artefacts), originating in the Aegean, in Flombron graves, that the "local individuals in the cemetery" represent the descendants of the original farming population of the earliest LBK who initially migrated from the southeast and colonised the central part of Europe. Even more, they believe that the correlation of the strontium isotope results and the orientation of sampled burials in Flombron indicate the westward trend of population movements (*Price at al. 2001.600–601*). However, in my opinion, there are uncertainties regarding the understanding and interpretation of strontium evidence. First of all, the local geology is an essential ingredient in understanding variation in strontium isotopes, which means that the identification of human mobility between the two supposed, economic or social entities is being speculated on the base of geochemical variation in the selected (micro) regions. And, it also means that the short-distance variation in the regional geomorphology, embedded in strontium isotope signal could be interpreted as the long-distance cross regional migration. However, Price at al. "suspect" that the geochemicaly distinct uplands on either side of Rhine were occupied by Mesolithic foragers and that the river valley was colonized and settled by the lowland farming communities. Individuals from these groups who may have migrated to lowland farming settlement should be identifiable by local strontium isotope signal (O. c. 597–598). Finally, some evidence for pre-Neolithic cultivation and for small-scale animal husbandry and horticulture in the region became available recently (*Erny-Rodmann et al. 1997.27–56; Price et al. 2001. cfr. Schweizer 2000*).

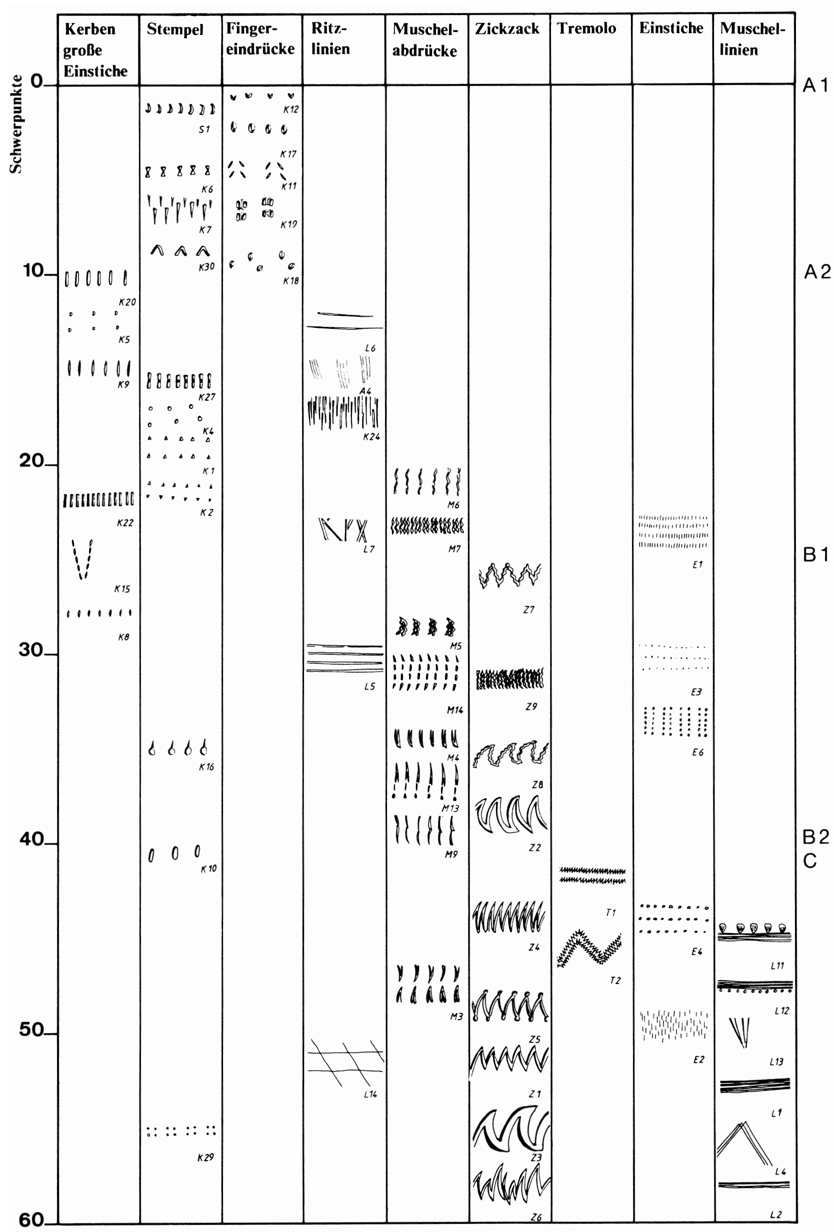


Fig. 3. Early Neolithic ornamental sequence in Eastern Adriatic (*after Müller 1991.Abb. 8*).

Although aware of our own incomplete understanding of methodological approaches involved, as well as of the broader interpretative implications of human lineage patterns, I would point suggest the results of the mtDNA analysis has revised the interpretation of the transition to farming and the neolithisation of Europe. It is broadly accepted that the overall genetic impact now being placed on Palaeolithic and Mesolithic events and neolithisation processes played a minor role in shaping the current European gene pool (*Renfrew 2000; Sykes, Renfrew 2000; Sykes 2000; Richards et al. 2000; Richards & Macaulay 2000*). It is our belief, however, that the dispersal of farming was embedded in the existing, pre-Neolithic social contexts, economic parameters, patterns of mobility, and the palaeoenvironmental conditions of each geographical entity in Southeast Europe. With the growing body of data from different (micro)regions, it has become apparent that the introduction of farming to Europe was not the monothetic consequence of the "wave of advance" and demic expansion as a mean of "an actual colonisation by real people (always without faces, gender, age, etc.)" as was, for example, ironically indicated Ruth Tringham recently (*2000.31*), but the clusters of "several related but different processes, spanning several millennia, and following distinctive regional and local trajectories" (*Halstead 1996.306*). It is worth noting that in order to examine the interactions of communities with different modes of subsistence (foraging and farming respectively), non-metric anatomical variants of the skull and post-cranial bones were examined on sites with the largest number of individuals buried, and where the coexistence of Mesolithic and Neolithic modes of subsistence in the region was demonstrated as having been over one thousand years (*Voytek & Tringham 1990.492–499; Radovanović 1996.39–43; Radovanović & Voytek 1997.21*). In view of a proposed porous frontier between Mesolithic and Neolithic cultures in the region (sensu *Dennell 1985 and Zvelebil 1996*), osteological material does not exhibit significant differences between Lepenski Vir Mesolithic and Balkan-Anatolian complex of Early Neolithic (Starčevo Culture). Furthermore, the data presented by Roksandić (*2000.1–100*) argue strongly against the wave of advance model that proposes the supplanting of local foragers by incoming farmers, even if the substitution is understood as partial and continuous.

POTTERY IN THE CONTEXT OF THE NEOLITHISATION OF EUROPE: THE BALKANS AND THE ADRIATIC

There is no doubt, however, that the pottery in most interpretative contexts was primarily used as a chronological and 'ethnic' marker in determining the genesis of Early Neolithic cultures at the regional level. In the *ex oriente lux* model its symbolic status and social role in farming societies in the Balkans and the Aegean have been limited to the identification of "indisputable typological similarities" with the cultural traditions of Asia Minor. Many authors have traced similarities between the Balkans and Anatolia, and the dependence of the former on the latter has never been questioned. The Aegean and the Balkans were hypothesised as recipients "of repeated waves of migrations from Anatolia and Syro-Cilicia in particular, as well as of cultural influence that came independently, or actual migrations" (*Weinberg 1965. 308*). On the other hand, the pottery was recognized as the "backbone of archaeology" and "the most obvious diagnostic element" in the context of a cultural continuum from east to west. Although at first it was "secondary rather than an indispensable element of the Neolithic", or of the food-producing economy, it nonetheless becomes predominant amongst all the finds from the moment that its use becomes widespread in an Early Neolithic stage" (*Theocharis 1973.39*). It is not surprising that the virtually paradigmatic status of spatially restricted distributions of selected pottery types and ornaments has been used to mark the boundaries of the primary and secondary centres of neolithisation, as well as the sequential colonization of Southeast Europe.

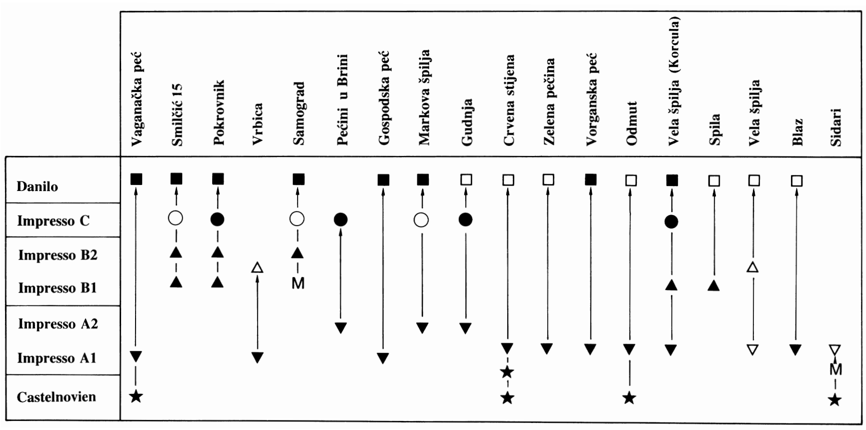


Fig 4. Early Neolithic sequence in Eastern Adriatic (**after Müller 1994.Abb. 74*****).***

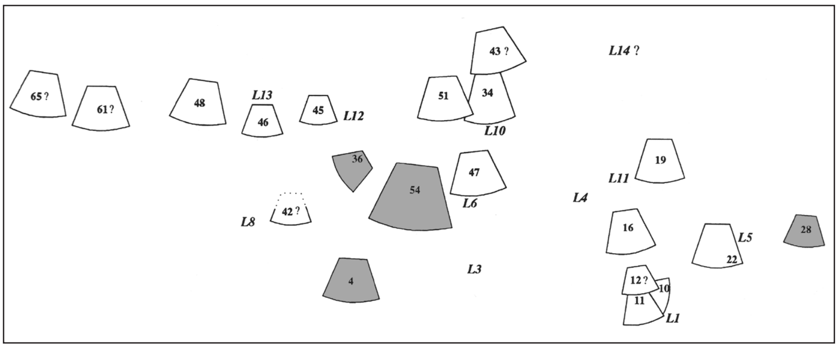


Fig. 5. Lepenski Vir I: Phase 2. A pots in houses 4, 28, 36 and 54, marked with shaded house plans (*after Radovanović 1996; Garašanin & Radovanović 2001.118–125*).

Contemplating the dawn of the Aegean and the Balkan Neolithic, Milojčić and Theocharis hypothesised an Early Neolithic relative chronological and cultural sequence of a "pre-ceramic", "monochrome" (Achilleion or EN I), "red-on white" painted pottery (Protosesklo or EN II) and "impresso" pottery (Presesklo/ Magulitca EN III) (*Milojčić 1959.1–56; 1973a.248–251; Theocharis 1967; Breunig 1987.93–101; Müller 1991.333–340; 1994.205, 215–221*; *Parzinger 1993*). Having correlated the Thessalian, Çatal Höyük and Haçilar sequences, they objectified a paradigmatic mirror chronological scheme equating the Aegean Early Neolithic towards "the short Neolithic" and Middle and Late Neolithic towards "the long Chalcolithic" periods in Asia Minor (*Schachermeyr 1976.174–176*). However, although stressing the contemporaneity, similarity and primitiveness of the earliest Thessalian and Çatal Höyük (East, levels XII–IX) monochrome pottery, Theocharis made the point that "... we do not believe that this primitive pottery was introduced from Asia Minor." (*Theocharis 1967. 173*).

It was hypothesising that the confinement of the region to be settled by Anatolian migrants first, the primary centre of neolithisation in Europe, correspond with the spatial distribution of settlements comprehending "pre-ceramic" and "monochrome" pottery layers in Thessaly. The common marker of the demic expansion, "a breakthrough of the elements of the Balkan-Anatolian complex of the Early Neolithic" towards the Danube and of the creation of secondary centres of neolithisation was determined by the distribution of pottery with white painted decoration. Moreover, in combination with impresso and barbotine pottery it is being used as the determinative element in correlating the Presesklo/ Magulitca and initial phases of Karanovo and Starčevo-Körös-Çris complexes. This made it possible to equate the initial phase of the Early Neolithic in the northern Balkans and Carpathian with its end in Thessaly and the formation of an agricultural frontier zone in the Danubian zone. In diffusionistic perspective the "indisputable typological similarities" of painted pottery distributed between Anatolia, Balkans and Carpathian is recognized as the constitutive "Anatolian" element of the Balkan-Anatolian complex, as well as an "ethnic" marker in the genesis of a *koine* among the first farmers in the Balkans and Anatolia (*Milojčić 1952.313–318; 1956.208–210; 1959.1–56; 1960.320–335; Nandris 1970.192–213; Benac, Garašanin, Srejović 1979.27; Garašanin 1979.84–106; Garašanin, Radovanović 2001. 118–125; Nikolov 1987.8–19; 1990.63–69.Abb.7; 1998.82–83; Lüning (1988)1991.27–93; Todorova 1989.14–15; 1998.27–54; Todorova and Vajsov 1993; Demoule and Perlès 1993.355–416; Parzinger 1993.254–255; Gallis 1994.58; van Andel and Runnels 1995.481–500; Tringham 2000.23–29; Perlès 2001*) (Fig. 1).

However, emphasis has been laid recently on the fact that the growing evidence of the pottery deposited in the so-called aceramic layers in Argissa, Sesklo, Soufli Magula, Gentiki and Achilleion in Thessaly, Franchthi and Dendra in the Argolid, and at Knossos in Crete strongly suggest that the Pre-pottery Neolithic in Greece did not exist (*Bloedow 1991. 1–43; Gallis 1994.58; 1996.32; Perlès 1990. 130–137; 2001.64–97*).

Milojčić's successive phasing of Early Neolithic in Thessaly and the sequential diffusion of monochrome, painted and impresso pottery concerns, for the time being, has no chronological value although they maintain "a critical place because of its importance for dating" (*Gallis 1994.58; 1996.120*). It is not only that impresso pottery (Presesklo or Vorsesklo phase) occurred side by side with the red-on-white painted pottery in the Protosesklo phase (*Thissen 2000a.164*), as recent research in Thessaly has shown, but the impresso decoration that "...was made with the finger nail (nail impressions) or by pinching clay between the finger and thumb, and by deeper nail impressions (barbotine), known from the early levels of the EN." (*Gallis 1996.120*). It follows, then, that a "monochrome" phase of undecorated pottery in *sensu stricto* in Thessaly did not exist and in consequence all the cross-cultural correlations based on the supposition of its appearance and distribution in Southeast Europe must be reconsidered.

However, the interpretation of the processes of neolithisation in the Eastern Balkans is still closely connected with the distributions of "monochrome" and/or white painted pottery. Two alternative approaches have been proposed recently. The first is based on the premise that the sequence of Early Neolithic phases in the central and eastern Balkans (Karanovo I–III) corresponds with the succession of the colours that have been used in colouring the (tulip beaker) pottery: white, wine red, brown and polychrome. While white is the one and only colour that marked the first phase, wine red and brown appeared in the second, and polychrome at the end of the third phase (*Nikolov 1990.63*). The similarity to the Thessalian sequence proposed by Milojčić and Schachermeyr is, of course, not coincidental, although Nikolov hypothesised direct communication between Karanovo and Haçilar and that groups of Neolithic people migrated from the south (mainly from Anatolia) along the Struma and Mesta river valleys, settled in Upper Thrace in the Early Neolithic and gradually colonised northern Bulgaria later (*Nikolov 1988.29–30; 1990.63–69; Stefanova 1996.15–19*). The initial Early Neolithic phase Elešnica, identified in the Mesta valley was recently correlated with Haçilar IX–VI and Ilipinar X levels (*Nikolov 1997.140*).

Todorova and Vaysov posited the second (*1993; 1998*). They believe the initial neolithisation is reflected in the distribution of "monochrome" pottery in the Balkans that is identified as the "Balkan Monochrome Neolithic" and its appearance in Europe has to be embedded in the context of a Balkan-Anatolian cultural *koine* and closely connected with the "great migration" in mid seventh millennium BC that began from south Central Anatolia, entering Europe via Thessaly and on an estuary of the Marica river. It is interesting to note that the colonisation of the southern and northern Balkans supposed to have happened almost simultaneously in the period between 6400 and 6100 cal BC (Fig. 2). Todorova objectifyies the Balkan Monochrome Neolithic as a package of monochrome (undecorated) and impresso pottery, the stone tool assemblage consists of "microliths and typical trapezes", "poorly developed agriculture" indicated by the occurrence of lentils and einkorn and the domesticated sheep and goats that have been found in Poljanica, Orlovec, Koprivec and Obhodov (*Todorova 1989.11–12; 1998.27–36*). Several phases of its development were assumed to be similar to the development in Asia Minor. The latest is supposed to correlate with the appearance of white painted pottery in the Karanovo complex (*Todorova 1998.35–36; Vajsov 1998.108*). According to the ^{14}C series from Poljanica the site is dated to 6180–6120 cal BC at 1σ (*Nikolova 1998. 128*).

It is worth remembering that the correlations with the Impresso (cardium) complex in the Adriatic were hypothesised in two interpretative contexts. While the first, embedded in the concept of "east-west" distribution in Eurasia, Anatolia and Greece remains out of the main route, the "Syrian impresso technique" is supposed to have spread "from Asia

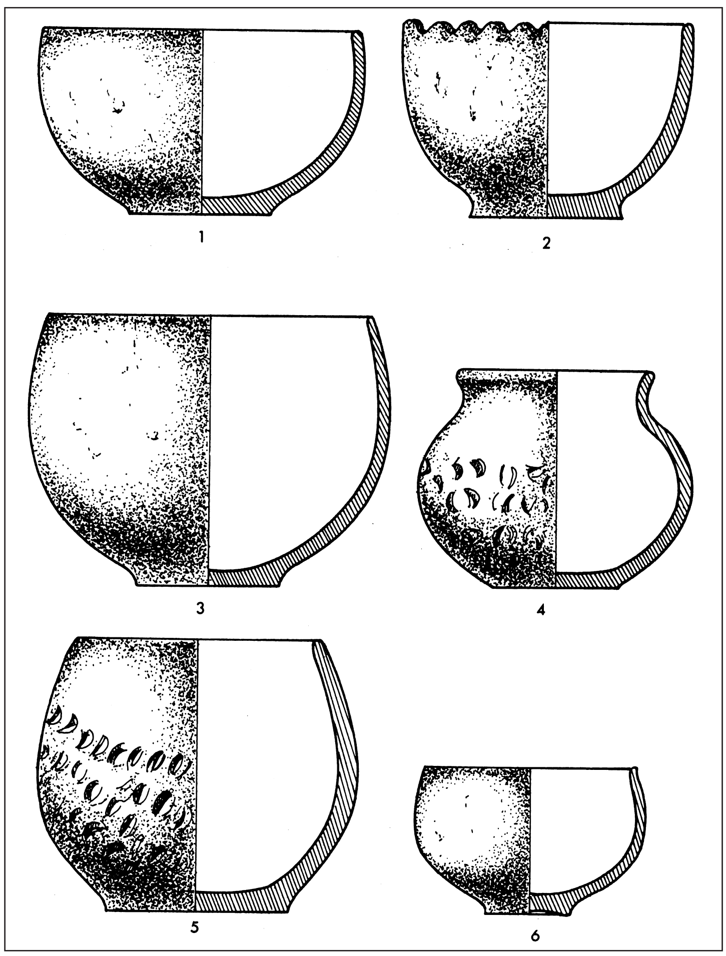


Fig. 6. Monochrome and impresso pottery in Lepenski Vir (**after Srejović 1971.Tafel 8*****).***

Minor to the Dinaric-Adriatic region first“ from where it dispersed to the Balkans, the Danube region and at times to northern Greece (*Schachermeyr 1976.46*). There are two alternative chronological interpretations of cross-cultural connections available. Milojčić himself favoured the idea of asynchronous development in the Balkans region and therefore correlates the beginning of the Neolithic in the Adriatic with its end in Thessaly. Thus the genesis of the Adriatic Impresso (cardium) complex was parallel to the late Presesklo and Sesklo periods (*Milojčić 1973b. 6; Müller 1991.339; 1994.220–221*). Batović, however, hypothesised that the appearance of pottery in Dalmatia (impresso-cardium) and Thessaly (monochrome) was coeval, although it appeared in different regional cultural contexts (*Batović 1966. 122, 234–235*).

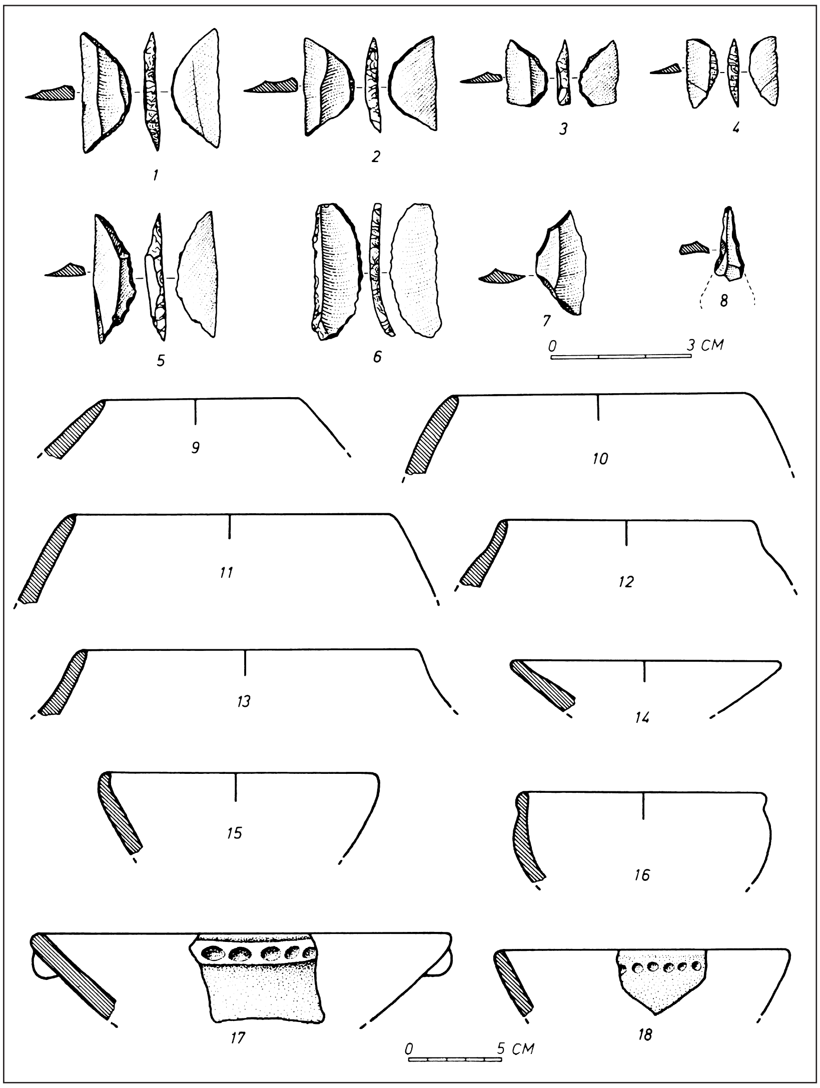


Fig 7. Vlushe (after Prendi 1990.Fig.2).

However, Batović's basic idea has been recently actualised in the second interpretative context favouring the concept of "monochrome" pottery distribution first. Its relative synchronous appearance, objectified in "horizon Ib" (*Parzinger 1993.253–254*), was postulated on the cross-regional axis from Çatal Höyük in Central Anatolia across Thessaly (!) to Škarin Samograd in the Eastern Adriatic (*Müller 1988.233; 1991.338; Parzinger 1993.53, 254; Chapman 1994.133–156*). Having analysed the stratigraphic sequences and corresponding pottery assemblages in the region, they found monochrome pottery in a cave site at Škarin Samograd deposited in the lowest layer superimposed with a later one that contains impresso-cardium pottery. Müller and Parzinger applied the typological sequence to the whole region, maintaining the concept of initial Neolithic that has to be correlated with the appearance of monochrome pottery. Not for long; a year later, Müller, when contemplating the Adriatic neolithisation process and the genesis of Impresso culture pointed out that in the micro region two incompatible sequences are available and that, in fact, impresso-cardium pottery is older than the monochrome. In Škarin Samograd the monochrome pottery was indeed deposited in an older layer (5730–5530(5630) cal BC at 1σ) than the impresso-cardium (5620–5490(5540) cal BC at 1σ) but on the flat, stratified site at Pokrovnik, located in close proximity, the later was recorded in all the lowest, Early Neolithic phases I–III and, according to available ^{14}C dates (5970–5760 (5840) cal BC at 1σ) it is older (*Müller 1994.112–123, 125, 182–185, 347*).

Finally, Müller in modelling the Early Neolithic typological sequence in the Adriatic, contrary to Parzinger (*1993*), objectified the sequential phases in such a way that impressed ornaments (shaped by fingertip, fingernail and awls) determine the initial phases of Impresso A. Shell (*Carduium sp.*) impressions appeared later, determining phases Impresso A2, B1–2 and C (*Müller 1991.322–328; 1994.149–156*) (Figs. 3 and 4). Thus the neolithisation of the Eastern Adriatic was consequently linked to:

- the secondary centre of neolithisation hypothesised for eastern Sicily and Southern Italy,
- the spread of the impressed pottery, domesticates and cultivates across the Adriatic Sea, and along the eastern coast towards the northern Adriatic,
- the gradual colonisation of the Eastern Adriatic coast and its hinterland, supposedly based on an evaluation of the difference in the ^{14}C the dates of the earliest Neolithic deposits in the region that matches the two isochronal lines of Neolithic expansion at a 500 year interval, as defined in this part of Europe by Ammerman and Cavalli-Sforza,
- postulates that the distribution of impresso-cardium pottery in Adriatic reflects the area of farming colonisation and, its most northern extension represents the boundary to a refuge of hunters which supposedly lay beyond (*Müller 1991. 311–358; 1994; Chapman and Müller 1990. 127–134; Forenbaher 1999.521–530; for comments see Budja 1993.188–189; 1996.72–73*).

Fig. 8. Monochrome-impresso pottery dispersal (**after Müller 1988.Abb. 1; Vajsov 1998.Map 1; Todorova 1998.27–36*****).***

POTTERY IN THE CONTEXT OF THE TRANSITION TO FARMING IN SOUTHEAST EUROPE: READING THE PALIMPSEST

It is time, we believe, to point out some facts concerning pottery appearance, its distribution and its technological as well symbolic meanings in the palimpsest of the transition to farming in Southeast Europe.

The pottery in so-called late Mesolithic contexts, although being broadly accepted, still maintains marginal interpretative value thus on the regional as well on the continental level. The demarcation between the "monochrome" and "impresso" pottery distributions that objectifies two, by definition distinct, "cultural and ethnic" complexes in the Balkans and the Adriatic is apparent. The boundary has been set in the region, indeed, but its later appearance correlates with the Early Neolithic painted pottery distributions.

Furthermore, Thessalian pottery is considered either a local invention (*Thissen 2000a.305; 2000b.148–149*), or a result of the indirect diffusion of constitutive Neolithic items such as painting, mud-brick houses and agriculture from Anatolia (*Schubert 1999. 201*). However, it is the fact as stated by Thissen, that according to "... our calibrations the first pottery Neolithic sites in Thessaly date to approximately 6200 cal BC". These sites were settled two centuries earlier than the first occupation at Ilipinar and Fikirtepe in western Anatolia and the Marmara region and of Hoca Çeşme in the Marica River delta in southeast Thrace. Moreover, interpreting the results of the analysis of pottery assemblages from western Anatolia and the southern Balkans, he pointed out that the similarities in pottery are too general to "attest for an Anatolian origin of the Thessalian ceramics" and that Thessalian pottery production was developed on the spot and "not as part of the baggage of the immigrants" (*Thissen 2000a.133, 194–195; 2000b.148–149*). An "early monochrome" horizon embedded in the context of "the earliest known settlement of agriculturalist and pastoralist" was recently identified at Asphaka in Epirus, and dated to 7380 ± 240 BP (*Douzougli 1996.46, 117*).

The situation in the Peloponnese is different as it was contemplated recently. There "we have at least two different pottery traditions: a Thessalian one and a Southern Greek one, neither related in time nor in origin." These different traditions reflect supposedly different patterns of neolithisation of both regions (*Thissen 2000a.193; 2000b.144–146*).

We have already pointed out that the most northerly and the most westerly distribution points of monochrome-impresso pottery in southeast Europe have been fixed in hunter-gatherer contexts (*Budja 1996.73–74; 1999.134–136*). The first is embedded in the Lepenski Vir culture in the Danube Gorges region. Unfortunately, most of the pottery assemblages are still scantily published and being discussed from the very beginning as matters of taphonomic filter and stratigraphic problems of vertical displacement and post-depositional disturbance. The presence of *in situ* pottery was recently directly confirmed inside Lepenski Vir: 4, 28, 36, 54 and Padina: 2, 3, 5, 6, 7, 12, 17 trapezoidal houses (*Borić 1999. 49–53; Garašanin & Radovanović 2001.118–125*) (Figs. 5 and 6). They have been recognized as Lepenski Vir Ib–e or I/2–3 (e. g. IGM IV–V) Mesolithic phases (*Srejović 1969.39; 1973.252–253; Radovanović 1996.287–290*).

Monochrome-impresso pottery appeared in the package together with geometric microliths and a new Montbani blades technique and, it was stratigraphicaly separated from the white painted pottery that was recognised as the marker of the Neolithic Starčevo and Gura Baciului cultures (i.e. the Balkan-Anatolian complex of the Early Neolithic) (*Radovanović 1996.287; Garašanin & Radovanović 2001.121*).

It was confirmed recently that the pottery appeared in the context of "an intermediate phase" from a Mesolithic-type dietary regime, based largely on aquatic resources and then to one based largely on terrestrial resources that "probably included a major agricultural component" (*Bonsall et al. 2000.119–132*). While the transitional phase was dated in the period 6156–5720 cal BC (at 2σ), the dating of house 36 (6390–6020 cal BC at 2σ) and 54 (6170–6130 cal BC at 2σ) in Lepenski Vir seem to predate the process. However, Bonsall et al. (*2000.129*) have pointed out, the charcoal samples were from long-lived tree species (oak and elm) and, such samples can yield ^{14}C ages that are several hundred years older than the archaeological events they purport to date (the "old wood" effect).

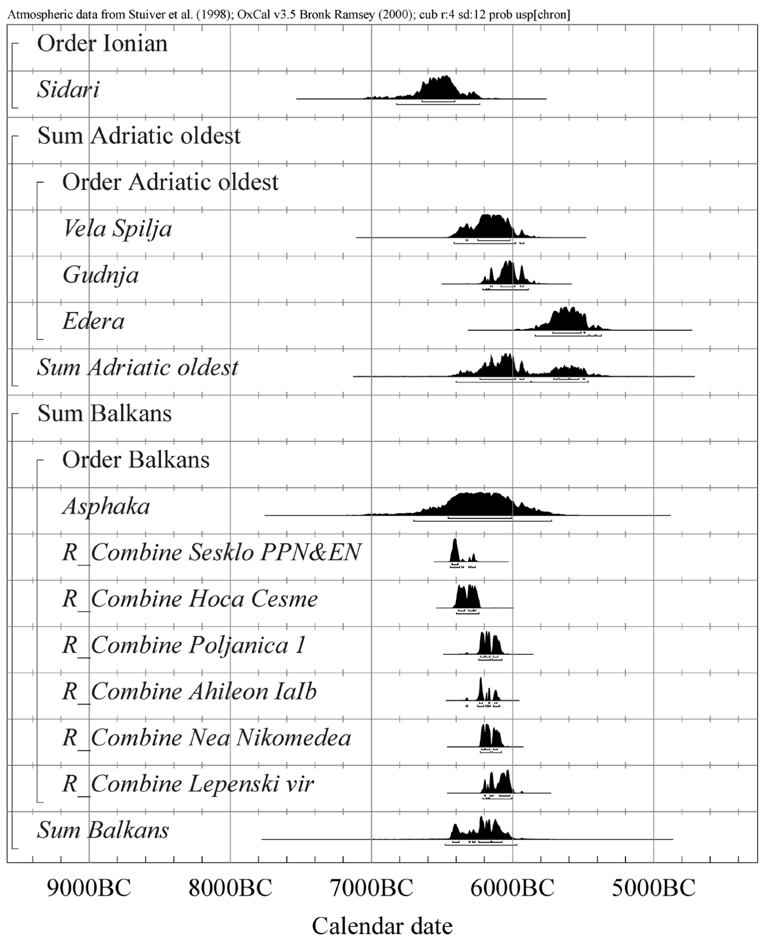


Fig. 9. OxCal radiocarbon sequence of "incipient Neolithic" on Balkans, Ionian and Eastern Adriatic.

Lepenski Vir pottery appearance chronologically corresponds well with pottery in Achilleion (6240–6160 cal BC at 2σ), Nea Nikomedeia (6140–6080 cal BC at 2σ) and Poljanica (6220– 6040 cal BC at 2σ) as discussed above (*Bonsall et al. 2000.128; Thessien 2000b.147–148, Fig. 6, 8; Nikolova 1998.128*).

The most westerly distribution point of monochrome-impresso pottery is fixed for now in Edera (Stenašca) Cave in Trieste Karst. The context where the pottery was deposited is described as a well-defined fireplace in layer 3a. The monochrome (unornamented) pottery was associated with a flint assemblage, "composed of 538 artefacts (shatter included), 61 microburins, 1 core fragment, 1 denticulated bladelet, 1 short endscraper, 2 truncations and 2 trapezes" (*Biagi, Starnini, Voytek 1993.48*). Faunal remains, besides a great amount of marine shellfish remains, were ascribed to 14 individual mammals; half of them belong to a group of domestics: caprines (40.7%), cattle (4.4%) and domestic pig-wild boar (5.9%) (*Boschin and Riedel 2000.74, 83*). The assemblage is determined as a Mesolithic, Late Castelnovian hunter-gatherer complex and dated to

6700 ± 130 BP (charcoal sample) (*Biagi and Spataro 2001.35*).

There are two more sites we can take into consideration: Sidari on Corfu, and Vlushe in Albania. In the later (Vidhëz and Armeninë locations) the monochrome pottery has been connected to Mesolithic traditions in the production of geometric microliths (*Prendi 1990.401. Korkuti 1995.29–32*) (Fig. 7). At Sidari on Corfu, on the Ionian coast, a first Neolithic phase (level C –base) with evidence of impresso pottery, atypical microliths, as well as sheep and goat and an Early Neolithic stratum (level C – top) contain impresso-cardium pottery were separated by a sterile layer. The lower context is dated to 7670 ± 120 BP and the upper to 7340 ± 180 BP (*Sordinas 1967.64; 1969.407; Breunig 1987.91; Perlès 2001. 49*).

We mentioned above Müller's evolutionistic interpretation of Early Neolithic sequence on the eastern Adriatic coast based on the corresponding analyses of pottery assemblages and available stratigraphic (vertical and horizontal) sequences of cave and flat sites in the regions. He objectified the sequence in a way that impressed, nipped and stamped ornaments, shaped by fingertip, fingernail and awls, determine the initial phases Impresso A1. Shell-cardium impressed ornaments constitute the successive phases A2, B1–2 and C (Fig. 3 and 4). Interestingly, in Hercegovina, one of the Dinaric regions, the initial ornamental principle evidently maintains a *longue durée,* as cardium impressed ornaments have never appeared although regularly dispersed some 30 km distance into the Adriatic hinterland. The A1–2 phases are chronologically embedded in the period 6050–5850 cal BC at 1σ (*Müller 1991.311–358; 1994.145–162, 182–185*).

The earliest impresso pottery assemblages appeared in cave sites at Gudnja on Pelješac peninsula and Vela špilja on Korčula island. Having discussed the relevance of the dates in the context of the gradual colonisation of the Eastern Adriatic coast, we mentioned the unreliable stratigraphic correlations between the charcoal samples and artefact depositions (*Budja 1996.72–73)*. However, the excavator of the Vela špilja deposit confirms recently the hypothesised correlation of ^{14}C dates (7300 ± 120 BP) and pottery assemblage, ornamented "exclusively by fingertip and awls impressions" (*Čečuk, Radić 2001.88, 102, 108*). The available dates of Impresso A1 pottery assemblage in Gudnja cave are 7170 ± 70 BP and 6935 ± 50 BP (*Müller 1994.348*).

IN PLACE OF CONCLUDING REMARKS

It is shown in Figures 8 and 9 that monochrome-impresso pottery appeared in a wide area, but in a narrow time span in the Balkans, Ionian and Adriatic. In many cases it was closely connected with hunter-gatherers' stone tool sets. There is no direct evidence of pottery production available, but we have to take into account the presence of some unbaked clay masses, as well as some associated monochrome, primitive and slightly baked pottery that has been documented in late Mesolithic context in Theopetra Cave (*Kyparissi-Apostolika 2000.136*). We pointed out the well-grounded hypothesis "...that "Thessalian ceramic procedures were developed on the spot and not as part of the baggage of immigrants." (*Thissen 2000b.148; but see also Thissen 1999.29–40 and 2000a*). The pattern of monochrome-impresso pottery distribution, indeed, contradicts the concepts of secondary centres of neolithisation and of the fertile core area in Thessaly, where an integrated Neolithic

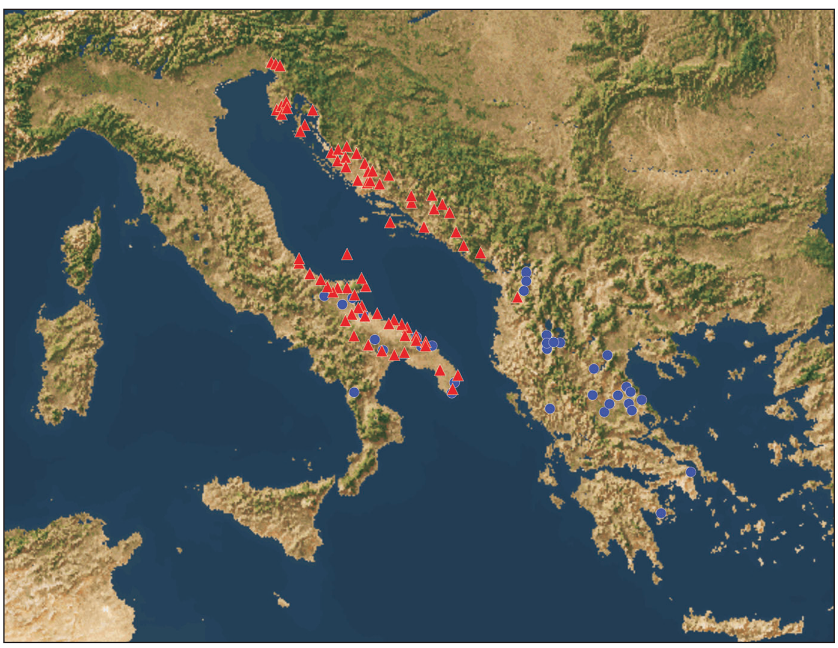


Fig. 10. Impresso-cardium and "red painted" pottery distributions (*after Müller 1994.Abb. 81. and 92; Marjanović 2000.77, Sl. 7*).

package is supposed to have arrived first and exclusively (*van Andel et al. 1995.131–144; van Andel and Runnels 1995.481–500*). We mentioned as well that the Balkans Neolithic wheat harvesting pattern differs from that of the Levant. While emmer and barley wheat prevailed there, einkorn was more frequent in the Balkans. Therefore the presence of wild einkorn wheat (*Triticum boeoticum)* in a Mesolithic context in Theopetra Cave does not seem random because it is near its present-day habitats in Grevena region.

Fig. 11. The distributions of Early Neolithic "stamp seals" (●) and tokens (▲) (**after Budja 1998.219–235*****).***

It was hypothesised that monochrome-impresso pottery in hunter-gatherer contexts at the ends of its dispersal objectify a centralised, either gradual cultural diffusion towards the marginal ends of the Early Neolithic *koine* or sequential demic diffusion and colonisation. I believe, on the contrary, that it marks a dispersed and selective course toward a farming adaptation in the Balkans, Ionian and Adriatic. While being aware of taphonomic filters operating in the contexts of unsystematic research procedures, inconsistent interpretative postulates and weak ^{14}C databases, it seems indeed the process in the Adriatic differs from that in Ionia and the Balkans. In the Corfu, Epirus, Thessaly, Thrace and Danube regions the process of transition to farming was, according to available data, simultaneous and correlative. In the Adriatic the process seems to be unequal (Fig. 9). The distinction between the two areas became obvious when impresso cardium and painted pottery were adopted. The spatial dispersals of two ornamental techniques do not overlap (Fig. 10). Therefore, we may hypothesise the internal "border" formed not between hunter-gatherers and farmers, but incipient farmers in the eastern Adriatic and those in Ionia and Balkans. It seemed to be immediately after the period of incipient regional farming adaptations.

Parallel with painted pottery, a discrete set of items: anthropomorphic figurines, stamp seals, tokens and stylised amulets (the so-called labrets/lobates and earplugs) have been attested in the Balkans Early Neolithic. It was embedded in a trans-Aegean network, initially based on Melian obsidian transmits, exchange networks and long-distance connections and, Near Eastern origins, most of which have been broadly accepted (*Nandris 1970.192–213; Makkay 1974.131–154; 1984; Renfrew 1987.341–374; Müller 1991.337–338; 1994.218–219; 2000.151–159; Perlès 1992.115–164; 2001.54–58, 78–79, 287–288, 296–297; Onassoglou 1996.163–164; Vajsov 1998.108; Budja 1998.219–235*). Some of them have been interpreted recently as tokens – counters used for calculating quantities of goods in systems of exchange (*Budja 1998.219–235*) and messengers between villages, particularly in times of crisis, or even as markers of inter-village marital connections (*Talalay 1993.45–46*).

However, almost none of the items have crossed the border on the eastern Adriatic coast. There was a single exception, a token found in the context of the Impresso-cardium culture in Vrbica site (*Budja 1998.220–222*) (Fig. 11). We can speculate therefore that region after adopting incipient farming did not enter a network of reliable integrative mechanisms maintained through regional exchanges. We may also presuppose society was self-contained and static externally and, as Perlès argues, in such a society there are social barriers to engaging and maintaining the circulation of goods and/or people over long distances (*Perlès 1992.121*).

It is not our intention to discuss the conceptualisation of "availability" and "substitution" phases of agricultural transition as well the principles of forager-farmer interactions and mobility within frontier zones (*see Zvelebil in this volume*) but, to point out that as such, external frontiers do not, we believe, correlate either with "wave of advance" or gradual "demic expansion". The internal boundaries that appeared after the initial adoption of domesticates or substitution wild resources with domesticates we believe related to intensity of processes of social and ideological restructuring of forager and the hunter-gatherer communities. They reflect an isolationism that may be seen as a strong dominance of social and ideological continuity. The incoming near eastern lineages and the difference of the values for the Balkans (~20%) and Mediterranean coastal area, including the Adriatic (~10%) which we discussed above can not be linked to incipient farming, but to a network of the circulation of goods and people over long distances that was consequentially set up later.

∴

REFERENCES

ALLABY R. 2000. Wheat Domestication. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population Prehistory of Europe: 321–324.*

AMMERMAN A. J. and CAVALLI-SFORZA L. L. 1984. *The Neolithic Transition and the Genetics of Populations in Europe*. Princeton University Press. Princeton.

BATOVIĆ Š. 1966. *Stariji neolit u Dalmaciji*. Dissertationes II. Zadar.

BENAC A., GARAŠANIN M., SREJOVIĆ D. 1979. Uvod. *Praistorija jugoslovanskih zemalja II.* Neolitsko doba: 11–31. Sarajevo.

BERNABEU AUBÁN J. 1997. Indigenism and Migrationism.The Neolithisation of the Iberian Peninsula. *Poročilo o raziskovanju paleolitika neolitika in eneolitika v Sloveniji XXIV: 1–18.*

BIAGI P., STARNINI E., VOYTEK B. 1993. The late Mesolithic and Early Neolithic Settlement of Northern Italy: Recent Consideration. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji XXI: 45–58.*

BIAGI P. and SPATARO M. 2001. Plotting the evidence: some aspects of the radiocarbon chronology of the Mesolithic-Neolithic transition in the Mediterranean basin. *Atti della Società per la Preistoria della Regione Friuli Venezia-Giulia XII: 15–54.*

BLOEDOW F. E. 1991. The "Aceramic" Neolithic Phase in Greece Reconsidered. *Mediterranean Archaeology 4: 1–43.*

BONSALL C. et al. 2000. Stable Isotopes, Radiocarbon and the Mesolithic–Neolithic Transition in the Iron Gates. In M. Budja (ed.), *Documenta Praehistorica XXVII: 119–132.*

BORIĆ D. 1999. Places that created time in the Danube Gorges and beyond, *c.* 9000–5500 BC. In M. Budja (ed.), *Documenta Praehistorica XXVI: 41–70.*

BOSCHIN F. and RIEDEL A. 2000. The Late Mesolithic and Neolithic of the Edera Cave (Aurisiana, Trieste Karst): a preliminary report. Atti della Società per la Preistoria della Regione Friuli Venezia-Giulia. *Quaderno 8: 73–90.*

BREUNIG B. 1987. C14 – chronologie des vorderasiatischen, sudost-und mitteleuropaischen Neolithikums. Fundamenta. Monographien zur Urgescichte A13.

BROWN A. T. 1999. How ancient DNA may help in understanding the origin and spread of agriculture. *Philosophical Transactions of the Royal Society of London. Sries B. Volume 354. Number 1379: 89–98.*

BUDJA M. 1993. The Neolithisation of Europe. Slovenian aspect. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji XXI: 163–193.*

1996. Neolithisation in the Caput Adriae region: between Herodotus and Cavalli-Sforza. *Poročilo o raziskovanju paleolitika neolitika in eneolitika v Sloveniji XXIII: 61–76.*

1998. Clay tokens – accounting before writing in Eurasia. In M. Budja (ed.), *Documenta Praehistorica 25: 127–136*.

1999. The transition to farming in Mediterranean Europe – an indigenous respond. In M. Budja (ed.), *Documenta Praehistorica XXVI: 119–142*.

CAVALLI-SFORZA L. L. and CAVALLI-SFORZA F. 1995. *The Great Human Diasporas. The History of Diversity and Evolution*. Addisson – Wesley Publishing Company. Reading.

CAVALLI-SFORZA L. L. 1996. The spread of agriculture and nomadic pastoralism: insights from genetics, linguistics and archaeology. In D. R. Harrris (ed.), *The Spread of Agriculture and Pastoralism in Eurasia: 51-69*.

CAVALLI-SFORZA L. L., MENOZZI P., PIAZZA A. 1993. Demic Expansion and Human Evolution. *Science 259: 639–646*.

CAVALLI-SFORZA L. L. and MINCH E. 1997. Palaeolithic and Neolithic Lineages in the European Mitochondrial Gene Pool. *American Journal of Human Genetics 61:247–251*.

CHAPMAN J. C. 1989. Demographic Trends in Neothermal South-East Europe. In C. Bonsall (ed.), *The Mesolithic in Europe. Papers Presented at the Third International Symposium: 500–515*.

1994. The Origins of Farming in South East Europe. *Préhistoire Europé 6: 133–155*.

CHAPMAN J. & MÜLLER J. 1990. Early farmers in Dalmatia. *Antiquity 64/242: 127–134*.

CLARK J. G. D. 1965. Radiocarbon dating and the expansion of farming from the Near East over Europe. *Proceedings of the Prehistoric Society 21: 58–73*.

CAUVIN J. 2000. *The Birth of the Gods and the Origins of Agriculture.* Cambridge University Press. Cambridge.

ČEČUK B., RADIĆ D. 2001. Vela špilja – preliminarni rezultati dosadašnjih istraživanja. Arheološka istraživanja na području otoka Korčule i Lastova. *Hrvatsko arheološko društvo. Znastveni skup. Vela Luka i Korčula, 18.–20. travnja 1991: 75–118*.

DEMOULE J. P. and PERLÈS C.1993. The Greek Neolithic: A New Review. *Journal of World Prehistory 7/4: 355–416*.

DOUZOUGLI A. 1996a. Epirus – The Ionian Islands. In G. A. Papathanassopoulos (ed.), *Neolithic Culture in Greece: 46–48, 117–119*.

ERNY-RODMAN C., GROSS-KLEE E., HASS J. N., JACOMET S. & ZOLLER H. 1997. Früher "human impact" und Ackerbau im Übergangsbereich Spätmesolithikum-Frühneolithikum im Schweizerischen Mittelland. *Jahrbuch der Schweizerischen Gesellschaft für Ur-und Frühgewchichte 80: 27–56*.

FORENBAHER S. 1999. The earliest Islanders of the Eastern Adriatic. *Collegium Anthropologicum 23: 521–530*.

GALLIS J. K. 1994. Results of recent Excavations and topographical work in Neolithic Thessaly. *La Thessalie. Volume A: 57–60*.

1996. The Neolithic World. In G. A. Papathanassopoulos (ed.), *Neolithic culture in Greece: 23–37*.

GARAŠANIN M. 1979. Centralnobalkanska zona. *Praistorija jugoslovenskih zemalja II.* Neolitsko doba: 79–212. Sarajevo.

GARAŠANIN M. & RADOVANOVIĆ I. 2001. A pot in house 54 at Lepenski Vir I. *Antiquity 75/287: 118–125*.

HALSTEAD P. 1996. The development of agriculture and pastoralism in Greece: when, how, who and what. In D. R. Harrris (ed.), *The Spread of Agriculture and Pastoralism in Eurasia: 296–309*.

HARRIS D. R. 1989. An evolutionary continuum of people-plant interaction. In D. R. Harris, G. C. Hillman (eds.), *Foraging and Farming. One World Archaeology 13: 11–26*.

1996a. Introduction: themes and concepts in the study of early agriculture. In D. R. Harrris (ed.), *The Spread of Agriculture and Pastoralism in Eurasia: 1–9*.

1996b. The origins and spread of agriculture and pastoralism in Eurasia: an overview. In D. R. Harris (ed.), *The Spread of Agriculture and Pastoralism in Eurasia: 552–574*.

HAWKES K. and O'CONNEL J. 1992. On Optimal Foraging Models and Subsistence Transitions. *Current Anthropology 33/1. 63–65.*

HEUN M., SCHAFER-PREGL R., KLAWAN D., CASTAGNA R., ACCERBI M., BORGHI B. and SALAMINI 1997. Site of Einkorn Wheat Domestication Identified by DNA Fingerpinting. *Science 278: 1312–1314.*

HEUN M., BORGHI B. and SALAMINI F. 1998. Einkorn wheat domestication site mapped by DNA fingerprinting. In M. Budja (ed.), *Documenta Praehistorica XXV: 65–69.*

JACKES M., LUBELL D. and MEIKLEJOHN C. 1997. Healthy but Mortal: Human Biology and the First Farmers of Western Europe. *Antiquity 71/273: 639–658.*

KORKUTI M. 1995. Neolithikum und Chalkolithikum in Albanien. V Heidelberger Akademie der Wissenschaften. Monographien B. IV. Mainz am Rhein.

KYPARISSI-APOSTOLIKA N. 2000. The Mesolithic/Neolithic Transition in Greece as Evidenced by The Data at Theopetra Cave in Thessaly. In M. Budja (ed.), *Documenta Praehistorica 2000:133–140.*

LAMBECK K. 1996. Sea-Level Change and Shore-Line Evolution in Aegean Greece Since Upper Palaeolithic Time. *Antiquity 70/269: 588–611.*

LAYTON R., FOLEY R. and WILLIAMS E. 1991. The Transition between Hunting and Gathering and the Specialized Husbandry of Resources. *Current Anthropology 32/3: 255–274.*

LÜNING J. (1988)1991. Frühe Bauern in Mitteleuropa im 6. und 5. Jahrtausend v. Chr. *Jahrbuch des Römisch-Germanischen Zentralmuseums 35/1: 27–93.*

MAKKAY J. 1974. "Das frühe Neolithikum auf der Otzaki Magula" und die Körös-Starčevo Kultur. *Acta Archaeologica Academiae Scientiarum Hungaricae XXVI:131–154.*

1984. *Early Stamp Seals in South-East Europe.* Budapest.

MARJANOVIĆ B. 2000. *Prilozi za prapovjest u zaleđu Jadranske obale.* Monografije. Svezak 2. Filozofski fakultet. Zadar.

MEIKLEJOHN C., WYMAN J. J., JACOBS K. and JACKES M. K. 1997. Issues in the Archaeological Demography of the Agricultural Transition in Western and Northern Europe: A View from the Mesolithic. In R. R. Paine (ed.), *Integrating Archaeological Demography: Multidisciplinary Approaches to Prehistoric Population: 311–326. Center for Archaeological Investigations, Occasional Paper No. 24. Southern Illinois University, Carbondale.*

MENOZZI P., PIAZZA A., CAVALLI-SFORZA L. L. 1978. Synthetic maps of human gene frequencies in Europeans. *Science 201: 786–792.*

MILOJČIĆ V. 1952. Die frühesten Ackerbauer in Mitteleuropa. *Germania 30. 3/4: 313–318.*

1956. Die erste praekeramische baeuerliche Siedlung der Jungstenzeit in Europa. *Germania 34. 3/4: 208–210.*

1959. Ergebnise der Deustschen Ausgrabungen in Thessalien (1953–1958). *Jahrbuch des Römisch-Germanische Zentralmuseums Mainz 6: 1–56.*

1960. Praekeramisches Neolithikum auf der Balkanhalbinsel. *Germania 38, 3/4: 320–335.*

1973a. Zur Frage eines präkeramischen neolithikums in Mitteleuropa. *Actes du VIII[e] congres international des sciences prehistoriques et protohisatoriques. Tome 2: 248–251.*

1973b. Die C14 Methode im Lichte der Komparativ-stratigraphischen Befunde. *Actes du VIII[e] congres international des sciences prehistoriques et protohisatoriques. Tome 2: 6–11.*

MÜLLER J. 1988. Škarin Samograd – eine frühneolithische Station mit monochromer Ware und Impresso-Keramik an der Ostadria. *Archäologisches Korrespondenzblatt 18: 219–235.*

1991. Die ostadriatische Impresso-Kultur: Zeitliche Gliederung und kulturelle Einbindung. *Germania 69/2: 311–358.*

1994. Das ostadriatische Frühneolithikum. Die Impresso-Kultur und die Neolithisierung des Adriaraumes. *Prähistorische Archäologie in Südosteuropa 9: 63–69.*

2000. "Earplugs", ceramics and sheep: examples of communicatiopn and boundaries in the Adriatic Early Neolithic. *Atti della Società per la Preistoria della Regione Friuli Venezia-Giulia. Quaderno 8: 151–159*.

NANDRIS J. 1970. The development and relationships of the earlier Greek Neolithic. *Man N. S. 5: 192–213*.

NIKOLOV V. 1987. Beitrage zu den Beziehungen zwischen Vorder Asien und Südosteuropa aufgrund der frühneolitischen bemal ten Keramik aus dem Zentralbalkan. *Acta Prahistorica et Archaeologica 19: 8–19*.

1990. Das Flusstal der Struma an der frühneolithischechen Strasse von Anatolien nach Mitteleuropa. In *Die ersten Bauern*, Band 2. Zürich.

1997. Periodiserung un Chronologie der südwestlichen Variante der Kultur Karanovo I. In *Uzdarje Dragoslavu Srejoviću. Beograd: 139–145*.

1998. The Circumpontic cultural zone during the 6th millenium BC. In M. Budja (ed.), *Documenta Praehistorica XXV: 81–90*.

NIKOLOVA L. 1998. Neolithic sequence: the upper Stryama valley in western Thrace, (with appendix: radiocarbon dating of the Balkan Neolithic). In M. Budja (ed.), *Documenta Praehistorica XXV: 99–132*.

ONASSOGLOU A. 1996. Seals. In G. A. Papthanassopoulos (ed.), *Neolithic culture in Greece: 163–164*.

OKAY A. I., DEMIRBAG E., KURT H., OKAY N. and KUSCU I. 1999. An active, deep marine strike-slip basin along the North Anatolian fault in Turkey. *Tectonics 18/1: 116–134*.

PARZINGER H. 1993. *Studien zur Chronologie und Kuturgeschichte der Jungstein-, Kupfer- und Frühbronzezeit zvischen Karpaten und Mittlerem Taurus*. Römisch-Germanische Forschungen 52. Frankfurt a. M.

PERLÈS C. 1990. Les industries lithiques taillées de Franchthi (Argolide, Grèce). Vol. II. *Les industries du Mésolithique et Du Néolithique*. In T. W. Jacobsen (ed.) *Excavations at Franchthi Cave, Greece, fasc. 5*.

1992. System of Exchange and Organisation of Production in Neolithic Greece. *Journal of Mediterranean Archaeology 5/2: 115–164*.

2001. *The early Neolithic in Greece. The first farming communities in Europe*. Cambridge World Archaeology. Cambridge University Press. Cambridge.

PINHASI R., FOLEY R. A., LAHR M. M. 2000. Spatial and Temporal Patterns in the Mesolithic Neolithic Archaeological Record of Europe. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population prehistory of Europe: 45–56*.

PRENDI F. 1990. Le Neolithique ancien en Albanie. *Germania 68/2: 400–425*.

PRICE T. D., JOHNSON C. M., EZZO E. A., ERICSON E. & BURTON J. H. 1994. Residential mobility in the Prehistoric Southwest United States: A preliminary study using strontium isotope analysis. *Journal of Archaeological Science 21. 315–330*.

PRICE T. D., BENTLEY A. R., LÜNING J., GRONENBORN D. & WAHL J. 2001. Prehistoric human migration in the *Linearbandkeramik* of Central Europe. *Antiquity 75/289: 593–603*.

RADOVANOVIĆ I. 1996. *The Iron Gates Mesolithic*. Ann Arbor: International Monographs in Prehistory, Archaeological Series 11.

RADOVANOVIĆ I. & VOYTEK B. 1997. Hunters, fishers or farmers: sedentism, subsistence and social complexity in the Djerdap Mesolithic. *Analecta Praehistorica Leidensia 29: 19–32*.

RENFREW C. 1987. Old Europe or Ancient East? The Clay Cylinders of Sitagroi. In Proto-Indo-European, the Archaeology of a Linguistic Problem. *Studies of Maria Gimbutas: 341–374*.

2000. Towards a Population Prehistory of Europe. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population Prehistory of Europe: 3–12*.

RICHARDS M. et al. 1996. Paleolithic and Neolithic Linages in the European Mitochondrial Gene Pool. American *Journal of Human Genetics 59: 185–198*.

RICHARDS M. et al. 2000. Tracing European Founder Lineages in the Near Eastern mtDNA Pool. *American Journal of Human Genetics 67: 1251–1276*.

RICHARDS M., MACAULAY V. 2000. Genetic Data and the Colonization of Europe: Genealogies and Founders. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population prehistory of Europe: 139– 151*.

ROKSANDIĆ M. 2000. Between Foragers and Farmers in the Iron Gates Gorge: Physical Anthropology Perspective Djerdap Population in Transition from Mesolithic to Neolithic. In M. Budja (ed.), D*ocumenta Praehistorca XXVII: 1–100*.

RYAN W. B. F. et al. 1997. An abrupt drowning of the Black Sea shelf. *Marine Geology 138: 119–126*.

SCHACHERMEYER F. 1976. *Die Ägäische Frühzeit I. Die Vormykenischen Periode. Des griechichen festlandes und der Kykladen*. Österreichiche Akademia der Wissenschaften. Philosophisch-historische Klasse. Sitzungsberichte 303. Band. Wien.

SOKAL R. R., ODEN L. N., WILSON C. 1991. Genetic evidence for the spread of agriculture in Europe by demic diffusion. *Nature 351: 143–145*.

SORDINAS A. 1967. Radiocarbon dates from Corfu, Greece. *Antiquity 41: 64*.

1969. Investigations of the prehistory of Corfu during 1964–1966. *Balkan Studies 10/2: 393–424*.

SREJOVIĆ D. 1969. *Lepenski Vir. Nova praistorijska kultura u Poduvalju*. Beograd.

1971. Die Lepenski Vir – Kultur und der Beginn der Jungsteinzeit an der mittleren Donau. In H. Schwabedissen (ed.), *Die Anfänge des Neolithikums vom Orient bis NordEuropa. Teil II. Östliches Mitteleuropa. Fundamenta. Reihe A. Band 3: 1–39*.

1973. Die Anfange des Neolithikums im Bereiche des mittleren Donauraumes. *Actes du VIII^{e} congres international des sciences prehistoriques et protohisatoriques. Tome 2: 252–263*.

STEFANOVA T. 1996. A comparative Analysis of Pottery from the "Monochrome Early Neolithic Horizon" and "Karanovo I Horizon" and the Problems of the Neolithization of Bulgaria. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji XXIII: 15–19*.

SYKES B. 2000. Human Diversity in Europe and Beyond: From Blood Groups to Genes. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population prehistory of Europe: 13–22*.

SYKES B. & RENFREW C. 2000. Concepts in Molecular Genetics. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population prehistory of Europe: 13–22*.

TALALAY E. T. 1993. *Deities, Dolls, and Devices*. In T. W. Jacobsen (ed.), *Excavation at Franchthi Cave, Greece. Fasc. 9*.

THEOCHARIS R. D. 1973. *Neolithic Greece*. National Bank of Greece. Athens.

1967. *I Avgi tis Thessalikis Proïstorias*. Volos.

THISSEN L. 1999. Trajectories Towards the Neolithisation of NW Turkey. In M. Budja (ed.), *Documenta Praehistorica XXVI: 29–39*.

2000a. *Early Village Communities in Anatolia and the Balkans: Studies in Chronology and Culture Contact*. Unpublished Ph.D. dissertation. Leiden.

2000b. Thessaly, Franchthi and Western Turkey: Clues to the Neolithisation of Greece? In M. Budja (ed.), *Documenta Praehistorica XXVII: 141–154*.

TODOROVA H. 1989. Das Frühneolithikum Nordbulgariens im kontakte des ostbalkanischen Neolithikums. *Tell Karanovo und das Balkan- Neolithikum: 9–26*.

1998. der balkano-anatolische Kulturbereich vom Neolithikum bis zr Frühbronzezeit. In M. Stefanovich, H. Todorova, H. Hauptmann (ds.), *In The Steps of James Harvey Gaul. Vol. 1: 27–54*.

TODOROVA H., VAJSOV I. 1993. *Novikamennata epoha v Balgaria (kraja na sedmo-shesto hiljadoletie pr. n. e.)*. Sofia.

TRINHGAM R. 1968. A preliminary study of the early Neolithic and latest Mesolithic blade industries in southeast and central Europe. In J. M. Coles, D. D. A. Simpson (eds.), *Studies in Ancient Europe*.

2000. Southeastern Europe in the transition to agriculture in Europe: bridge, buffer, or mosaic. In T. D. Price (ed.), *Europe's First Farmers: 19–56*.

VAJSOV V. 1998. The Typology of the Anthropomorphic Figurines From Norteastern Bulgaria. In M. Stefanovich, H. Todorova, H. Hauptmann (eds.), *In The Steps of James Harvey Gaul. Vol. 1: 107–141*.

van ANDEL T. H., GALLIS C. and TOUFEXIS G. 1995. Early Neolithic Farming in a Thessalian River Landscape, Greece. In J. Lewin, M. G. Macklin and J. C. Woodward (eds.), *Mediterranean Quaternary River Environments: 131–143*.

van ANDEL H. T., RUNNELS N. C. 1995. The earliest farmers in Europe. *Antiquity 69/264: 481–500*.

VOYTEK B. A. and TRINGHAM R. 1990. Rethinking the Mesolithic: the Case of South-East Europe. In C. Bonsall (ed.), *The Mesolithic in Europe. Papers Presented at the Third International Symposium Edinburgh 1985: 492–499*.

WEINBERG S. 1965. The relative chronology of the Aegean in the stone and early bronze ages. In R. Ehrich (ed.), *Chronologies in Old World archaeology: 265–320*.

WILLIS K. J. and BENNETT K. D. 1994. The Neolithic transition – fact or fiction? Palaeoecological evidence from the Balkans. *The Holocene 4: 326–330*.

WILLIS K. 1995. The Pollen-Sedimentological Evidence for the Beginning of Agriculture in Southeastern Europe and Anatolia. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji XXII: 9–24*.

ZAMANIS A., SAMARAS S., STAVROPOULOS N. and DILLE J. 1988. *Report of an Expedition to Rescue Germplasm of Wild Species of Wheat and Relatives in Greece*. Greek Gene Bank Scientific Bulletin. North Greece Agricultural Research Centre.

ZILHÃO J. 1993. The Spread of Agro-Pastoral Economies across Mediterranean Europe: A View from the Far West. *Journal of Mediterranean Archaeology 6/1: 5–63*.

1997. Maritime pioneer colonisation in the early Neolithic of the west Mediterranean. Testing the model against the evidence. *Poročilo o raziskovanju paleolitika neolitika in eneolitika v Sloveniji XXXIV: 19–42*.

ZOHARY D. and HOPF M. 2000. *Domestication of Plants in the Old World*. Third Edition. Oxford University Press. Oxford.

ZVELEBIL M. 2000. The Social Context of the Agricultural Transition in Europe. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population prehistory of Europe: 57–79*.

UDK 903'12/'15(5-11)"634"
Documenta Praehistorica XXVIII

The "when", the "where" and the "why" of the Neolithic revolution in the Levant

Avi Gopher, Shahal Abbo and Simcha Lev-Yadun
A. Gopher, Sonia and Marco Nadler Institute of Archaeology, Israel. Email: agopher@ccsg.tau.ac.il
S. Abbo, Dept. of Field Crops, Faculty of Agriculture, Hebrew University of Jerusalem, Israel.
Email: Abbo@agri.huji.ac.il
S. Lev-Yadun, Dept. of Biology, University of Haifa, Israel. Email: levyadun@research.haifa.ac.il

ABSTRACT – *An accumulation of data concerning the domestication of plants and the refinement of research questions in the last decade have enabled us a new look at the Neolithic Revolution and Neolithization processes in the Levant. This paper raises some points concerning the "When" and "Where" of plant domestication and suggests that the origins of plant domestication were in a well-defined region in southeast Turkey and north Syria. It presents a view on the process of Neolithization in the Levant and offers some comments concerning the background and motivations behind the Neolithic Revolution.*

IZVLEČEK – *Naraščanje količine podatkov o udomačitvi rastlin in vedno bolj natančna vprašanja raziskovalcev so v zadnjem desetletju omogočili, da na novo ovrednotimo neolitsko revolucijo in proces neolitizacije v Levantu. V članku izpostavljamo nekatere vidike "časa" in "kraja" udomačitve rastlin ter menimo, da je bil izvor udomačitve rastlin na jasno omejenem območju jugovzhodne Turčije in severne Sirije. Predstavimo pogled na proces neolitizacije v Levantu in nekoliko pojasnimo družbeno okolje in motive za neolitsko revolucijo.*

KEY WORDS – *agriculture; cultivation; domestication; Levant; Neolithization*

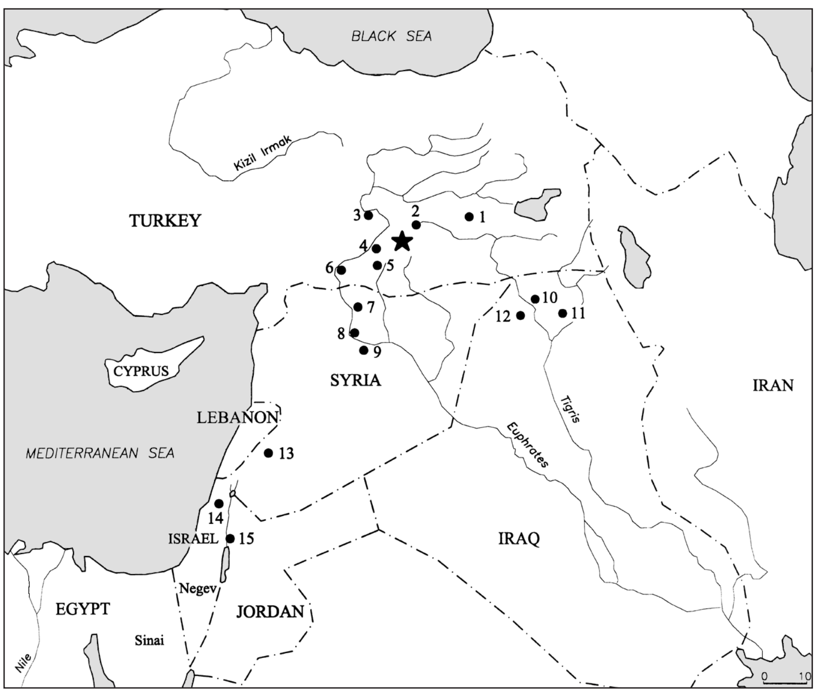
INTRODUCTION

Offering explanations for the "Neolithic Revolution" has gained momentum since the 1960's and has not stopped ever since. Listed here are just a few of these which have become part and parcel of the Neolithic Revolution explantations (*Braidwood 1967; 1975; Binford 1968; Boserup 1965; Flannery 1969; Wright 1968; Smith and Young 1972; Bender 1978*). In addition, we are challenged by a wealth of new explanations based on new ideas and data (*e.g. Rindos 1980; 1984; Rosenberg 1990; 1998; Redding 1988; Diamond 1998*). All these explanations model regional geography, climate and specific environments, demography, social aspects, cultural aspects such as technology and technological innovations, and, the botanical and faunal components reflecting the "bear bones" of the revolution. Although some of the above were based on very specific studies conducted in particular, well-defined regions and sites, these were all aimed at achieving an overall explanation with a high generalization capability and, if possible, a degree of predictive power. An emphasis on the "social", the "cognitive" and the "ideological" aspects of some of the recent explanations of the Neolithic Revolution (*e.g. Hayden 1990; Hodder 1993; Cauvin 1994; 2000*) brought new flavour into this already complex agenda. Although the "When" and "Where" questions were always of interest as basics, the major question on the surgeon's table was naturally the "Why" question – why has such an immense change in human socio-economy taken place? As time went by through the 1970's and 1980' and especially in the 1990's, high precision absolute dating, highly professional problem oriented research teams and high resolution field methods brought back to the stage questions such as the "Where" and "When" of the Neolithic Revolution. These have lost popularity in the 1970's – 1980's being considered as solved.

Developments in archaeological thought in the last two decades (mainly the growing impact of post-proccessual and cognitive archaeology) have paved the way for aspects of Neolithic daily life and everyday activities related to the transition to agriculture, to overtake the centre of the stage. With these as major research goals, a multiplicity of issues could be raised in an attempt to reconstruct and remodel the Neolithic Revolution in local terms, and/or in more human-related terms referring to past individuals or specific segments of past communities.

The basic old world (Middle East, Europe, Egypt/Ethiopia, North Africa) founder domesticated plants package includes, in its primary form, cereals (wheats, barley), pulses (pea, lentil, chickpea, bitter vetch) and flax as a fibre crop. Domesticated animals include mainly sheep-goat, cattle and pig (the dog was domesticated much earlier by Natufian communities in the southern Levant). We may say that it has become generally accepted that the origins of this founder package were in the Near East and that it had spread throughout Europe and parts of Asia and Africa (*Zohary and Hopf 1993; 2000*) (in other parts of the world different agro-packages have emerged). When establishing itself, this package caused immense change in all aspects of life which we usually refer to as "Neolithization" – a term emphasizing the dynamic nature of the Neolithic period. Taking into account the complexity of Neolithization and its demands on aspects of human perception, organization, activity/behaviour etc., this may be considered a very fast process in terms of large-scale prehistoric clocks. In the Levant (northern Levant), it has generally started some 13 000 calibrated years ago and reached a full scale some 8000–7000 calibrated years ago.

In this paper we will concentrate first on the beginning of agriculture in the Levant – from the Upper Euphrathes and Tigris to the deserts of the Negev and Sinai (modern southeast Turkey, Syria, Lebanon, Israel, The Palestinian Authority, Jordan and Egypt, see Fig. 1). We concentrate on plants while animals are only briefly mentioned. The first part addresses the basic questions of man-plant relationship using old and new data from the Levant. It will focus on questions such as: What happened in man-plant relationship (cultivation *vs.* domestication)? How did it happen – has domestication been a one-time/one place event? What was the pace of the process? How fast did agriculture diffuse in terms of archaeological resolution? The "When" and "Where" questions, which we find fascinating in themselves, and of high potential in facilitating answers to the "Why "question, are dealt with afterwards. The paper ends with comments on Neolithization and about the background and possible reasons for the Neolithic Revolution in light of accumulating data from southeast Turkey and north Syria – the newly suggested cradle of agriculture (*Lev-Yadun et al. 2000*).



Map of region and sites mentioned in text: 1. Hallan Çemi Tepesi, 2. Cayönü, 3. Cafer Höyük, 4. Nevalli Çori, 5. Göbekli Tepe, 6. Dja'de, 7. Jerf el Ahmar, 8. Mureybet, 9. Tell Abu Hureyra, 10. Nemrik, 11. M'lefaat, 12. Qermez Dere, 13. Tell Aswad, 14. Yiftahel, 15. Jericho, Netiv Hagdud and Gilgal I. Large asterisk for Karacadağ.

Man-Plant relationship – What happened?

Plants can be exploited in many different strategies. *Foraging* accounts for a state of collecting wild plants with no agricultural manipulation reflecting the hunters-gatherers slot of the classical model. It does however represent the time in which the choice was made by foragers, of species with high potential for human exploitation, some of which later become the founder-crops “package” of agriculture. *Cultivation* refers to treating wild plants with a degree of agricultural manipulation (such as displacement or crop management) but still not causing their dependence on man for survival by conscious or unconscious selection of genotypes that lost some naturally adaptive traits. *Domestication*, in this context, refers to full manipulation of biologically “new types” fully dependent on man for survival. These types went through genotypic change (brake-down of the wild-type mode of seed dispersal and dormancy) either unintentionally – namely, unconscious selection resulting from cultivation and harvesting practices, or, intentional/conscious selection of plants/seeds with particular attributes desirable to the farmer. These three strategies reflect a continuous process of change from foraging of wild plants to farming of domesticated species. Cultivation is however the significant cultural marker of the change to new perceptions and new behavioural patterns of man. Cultivation may have included the establishment of fields near the sites as so vividly shown by Hillman (*2000.Fig. 12.27, 395*). It must have been accompanied by technological developments (agro-techniques such as soil tilling, seeding, weeding, harvesting equipment, threshing equipment and installations, storage facilities etc.) but, more importantly, a major shift in human perception of nature. A move to extended manipulation and dependency, a shift from a view of nature as a “giving environment” the way most hunters-gatherers see it (*Bird-David 1990*), to an active manipulative view of the environment. Looked at as a long-term historical process covering the 6000–7000 years between the later phases of the Epipaleolithic and the end of the Neolithic period in the Levant, this process “widens the gap” between man and nature and leads to increased alienation and thus, in a way, to modern condition.

Summing up the above under the heading “What Happened” in man-plant relationship, we may say that it included two major aspects:

- A change in the perception of nature – establishing manipulative extraction as a major human behaviour in nature and increasing man-nature alienation.
- An increase in man’s manipulation of wild plants up to a full genetic and technological domination over domesticated plants or a full interdependence between man and certain plant types.

Man-Plant Relationship – How did the change happen?

Has domestication of the founder package plants taken place at a certain limited (small) area, in a certain short (or long) period of time? Was it a single-event, or else, have several (or many) domestication events taken place?

It was suggested that for most of the package species (possibly except for barley) the genetic change underlying domestication was a single-event (and therefore occurred at one location for each plant species) that could theoretically have been a fast process [(potentially much faster then archaeological resolution of the relevant period may record) (*e.g. Zohary 1996; 1999; Hillman and Davis 1992; Miller 1991; Garrard 1999*)]. However, very recently, new thought has been raised. For example, Kislev (*1998*), who studied Neolithic archaeobotanical assemblages in Israel, has argued and presented calculations that the transition from a wild population of cereals to a domesticated one would have taken hundreds of years at least. He adds that the process would not have been free of risks and failures that may have made it even longer. From a different angle, Wilcox (*1998; 2000*), who studied Neolithic archeobotanical assemblages in Syria and Turkey, suggests a slow domestication process (lasting hundreds of years or even millennia) and a local one for each crop. He plotted cereals on geographical-temporal charts and argued that in each sub-region of the Levant specific package species have been domesticated – those that fit the specific local ecological conditions. These have survived and remained dominant in their sub-regions for thousands of years (*e.g.* barley in the Jordan valley, emmer wheat in the Damascus basin, einkorn in the middle Euphrates etc.). His two major points are that domestication was a slow process and that it occurred in isolated, sub-regional contexts. Wilcox thus exposes the potential complexity of the process and the data. An attempt to model the pace of domestication worth mentioning here has been presented by Ladizinsky (*1987*). He attempted to model the time required for a dormancy free mutation in lentil to establish itself and give rise to the domesticated crop. His model attracted negative responses (*Zohary 1989; Blumler 1991*) which he later answered (*Ladizinsky 1989; 1993*). Ladizinsky's model suggests a possible quick process that could be as short as 15–18 years, under the assumption that soft-seededness (non-dormant seeds) was the key domestication trait and that pod indehiscent types were selected at a later stage. Additional assumptions underlying this model concern certain aspects of human behaviour. This model too cannot provide a precise answer as to the actual pace of lentil domestication.

The genetics of seed dispersal (cereals and some legumes) and/or dormancy (legumes) may suggest that the domestication of most package-plant species happened once or only very few times. This is not however a simple statement. Relating the number of domestication events to the number of independent genes that control spike disarticulation was advocated by Zohary (*1989; 1996; 1999*). The fact that two such genes appear in barley suggests according to Zohary that barley might have been domesticated in more than one occasion. The assumption that one gene reflects a single event is acceptable provided that there is evidence for more than one such gene in the genome for the critical trait in each respective crop, and that mutants for only one of those genes were selected for in each of the respective domestication events. Thus, Zohary's argument that we agree with needs confirmation by other types of data. Just to illustrate the problematic nature of this issue – in lentil and common vetch, and to some extent in chickpea, a considerable degree of pod shattering is seen in modern cultivars to this very day. Does this indicate several domestication events for common vetch, chickpea or lentil?! This is hard to accept especially in light of the limited distribution of chickpea and the work by Ladizinsky (*1999*) on lentil that indicates a single event.

As for location, the ability to relate certain localized present-day wild populations to modern crops in terms of genetic similarity suggests that domestication of the founder package might have taken place in a fairly small geographic region (*Lev-Yadun et al. 2000; and see below*).

In summary, we are in favour of the one-event/one-place scenario that best represents the biological process of plant domestication and the available data. We are however aware of the fact that from a cultural perspective, the slow nature of the process can easily be acceptable too since Neolithic people had to act by trial and error. The diffusion (through cultural contacts) of ideas, genetic materials (seeds) and possibly humans (through marriage) made the innovations available to all. In simple words, the fact that genetically most package species could have been domesticated in a single event does not bear on the pace of the actual process. We must find a way to model not only the genetic aspects but also aspects of human behavior and cultural processes and pragmatics.

When were plants domesticated?

The "When" question seemed to be an easy one, however, in the last few years some surprises came about. The accepted dates for the domestication of plants – were *ca.* 11 500 years CalBP (*e.g. Zohary and Hopf 1993; 2000; Garrard 1999*). New data now available from Tell Abu Hureyra 1 (*Hillman 1996; 2000; Hillman and Colledge 1998; Hillman et al. 2001*) including accelerator dates on seeds, suggest that rye was domesticated and large seeded legumes, have been possibly cultivated as early as *ca.* 13 000–12 600 years CalBP – over a millennium earlier than previously thought. They also suggest that this is the possible case in other sites such as Mureybet and Jerf el Ahmar in the middle Euphrates and Netiv Hagdud in the Jordan valley (authors comment: all of which are 500–1000 ^{14}C calibrated years later then Tell Abu Hureyra 1). This data was first published in a short note (*Hillman 1996.196*) and later in a conference abstract (*Hillman and Colledge 1998*). Recently, the final detailed report on the Tell Abu Hureyra excavation, including the botanical remains enables a detailed look at these data (*Moore et al. 2000*). This suggestion by Hillman (*2000*) should be considered important. The meaning of this early date after so many years of research and absolute dating is that new data concerning the "When" question can still be added. The fact that we can now date single seeds and go for higher precision may be of importance in providing new chronological evidence. Had the process started as early as suggested by Hillman with the onset of the Younger Dryas, it may reflect an almost direct reaction to the effects of this dry and cool episode. Relating the Neolithic Revolution to the Younger Dryas has gained many supporters in recent writing (*Bar-Yosef and Meadow 1995; Bar-Yosef 1998a; Garrard 1999;* to mention just a few). The possible innovative finds of early domesticated cereals and cultivated legumes at Tell Abu Hureyra 1 (*Hillman 2000; Hillman et al. 2001*), if augmented by evidence from other sites, may support this view.

Another point related to this matter is that we may consider additional cereal and legume species as important components in the process of wild plant cultivation/domestication (e.g. rye). In other words, the package of plants, as referred to by most writers, is not exclusive. For instance, based on the archaeological record (*Zohary and Hopf 1993; 2000*), we see no reason why not include common vetch as a member of the initial Near Eastern crop assemblage tested by the early farmers. Furthermore, it is quite probable that more cereals and legumes and possible other groups as evident by flax, were tested. Somehow, the progenitors of the package domesticates which have been chosen by men and continued (until today), had advantages of which we are not fully aware at the present stage of research, and their mutants appeared, were selected for and spread before it happened to other species. However, all the grain crops are selfers – a characteristic that is critical for the quick and simple isolation of the mutants from other types of the same plant species (*Zohary and Hopf 1993; 2000*). Rye is different since it is primarily not a self-pollinated plant.

A last point to be mentioned here is that there is a considerable chronological gap between the early evidence of domestication and cultivation from Tell Abu Hureyra 1 and the next available data on cultivated or domesticated plants. This necessitates a reassessment of our diachronic reconstruction of the process of plant cultivation/domestication or at least recognition that more data is needed to close the gap. It also emphasizes the fact that cultivation could have been, and probably was, a very long stage in the process.

Where have plants been domesticated?

What one needs in order to answer the “Where” question is: Results of thorough genetic and geobotanical surveys of wild populations across their natural distribution range and of domesticated ones to identify the progenitor populations using distribution, chromosomal and DNA markers – which is not an easy task neither a cheap one. Comparative DNA marker analyses have been used with einkorn wheat, lentil and to a certain extent, for barley but all other progenitors should still be tested. In barley however, chloroplast DNA (*Neale et al. 1988*) gave contrasting results to nuclear DNA (*Badr et al. 2000* and see also *Abbo et al. 2001*).

Series of data indicating man-package plant relationship throughout the region dated to the relevant period, or, in other words a reliable archaeological record. Independent high precision dating of the above mentioned data sets, including the archeobotanical finds themselves.

Based on such as the above mentioned sorts of data (but before new data emerging from the use of DNA markers were published) Bar-Yosef and colleagues have suggested in a series of papers that the “Levantine corridor” is the place of origin of domesticated plants (*e.g. Bar-Yosef and Belfer-Cohen 1991; 1992; Bar-Yosef and Meadow 1995; Bar-Yosef 1995; 1998b*). They emphasized the role of the Jordan valley and the Damascus basin but the corridor could easily be, and was extended to include the middle and upper Euphrates and Tigris as suggested in later statements (*Bar-Yosef 1998a; Belfer-Cohen and Bar-Yosef 2000*). A recent summary of plant domestication in the Levant by Garrard (*1999*), based on a re-evaluation of archaeobotanical and environmental data sets and a better understanding of the cultural context of the domestication process, reached the following conclusions:

❶ “...The data lends support to the findings of genetic research which suggests few rather than multiple origins for certain of the founder crops in the region...” (*Garrard 1999.82*).
❷ There is no evidence for plant domestication in Iraq or southeast Turkey before 10 550 years Cal BP [(Garrard was aware of Hillman’s Abu Hureyra 1 data mentioned above and of the finds concerning the identification of the progenitor population of einkorn wheat at Karacadağ in southeastern Turkey) (see below)].
❸ There is positive evidence from the Damascus basin at Tell Aswad IA and from the Jordan valley at Jericho PPNA (the lowest Pre-Pottery Neolithic stratum) and at Iraq ed-Dubb of domesticated cereals from *ca.* 11 500–11 000 CalBP.
❹ Thus, the Damascus basin – southern Levant (Jordan valley) is the region where domestication started.

In their seminal essay of plant domestication in the Old-World, Zohary and Hopf (*1993; 2000*) also proposed the Near East Arc as the origin of plant domestication.

In 1997, a paper by Heun *et al.* suggested a very specific place for the origin of the einkorn wheat progenitor in southeast Turkey. They also suggested its early domestication in the region of Karacadağ. The genetic study was thorough and based on many plant DNA samples, but archaeological issues were not examined. A few replies and derivatives of this 1997 paper in *Science* would suffice to shed light on the complex situation we still witness in the so called "simple" "Where" question: Jones *et al.* (*1998*) accepted the identification of the progenitor population of einkorn. However, domestication in their opinion has not taken place there but some 700–750 km to the south in the Damascus basin (Tell Aswad) and the Jordan valley (Jericho, Netiv Hagdud, Gilgal) as early as *ca.* 11 500–11 100 CalBP (in their paper they write 8000–7700 uncalibrated bc). They claim that "...On a global scale, centers of past domestication will not be vast distances from centres of present genetic diversity, but the match is likely to be approximate..." (*Jones et al. 1998.303*). They cite examples for such a course of events from corn domestication in America and rice in China. Hole (*1998*) also responded to Heun *et al.* (*1997*) accepting their results about the progenitor population of einkorn. He says however that the conditions (mainly the climate just after the Younger Dryas episod) in the Karacadağ area suggested as the site of einkorn domestication were not suitable for domestication. He then suggests that domestication took place to the south, on the middle Euphrates (referring to the evidence from Tell Abu Hureyra) "...regardless of where the progenitors of any economic species lived..." (*Hole 1998.303*) and views domestication "...as a human achievement that depended on a combination of technological and social adaptations as well as the availability of the requisite species..." (*Hole 1998.303*). In a reply to Jones *et al.* (*1998*) Nesbitt and Samuel (*1998*) show them to be inaccurate with their data – i.e. the sites Jones *et al.* have used as examples for early domestication in the southern Levant (such as Jericho and Tell Aswad) have no such evidence. Nesbitt and Samuel point out data from Cafer Höyük and Tell Abu Hureyra 2A on the middle Euphrates showing domesticated einkorn, emmer and barley at 11 100–10 550 CalBP – which they consider several hundred years earlier then any data from the southern Levant. They also cite evidence for the earlier presence of charred remains of wild einkorn in the region at sites such as Tell Abu Hureyra 1 (*ca.* 12 900 CalBP), Mureybet I (*ca.* 12 500 CalBP), and at Jerf el Ahmar (*ca.* 11 000 CalBP). In their summary they say "... in view of the small number of excavated sites... radiocarbon dates... current evidence ... does not allow localization of agriculture origins. However, ... the genetic evidence of einkorn in southeast Turkey agrees with ... archaeological evidence...". And they add "... as for other species, it is not clear...". So, they accept that the origin of one domesticated plant species accords well with Heun *et al.* (*1997*) but do not go as far as suggesting for more then einkorn.

In a recent paper (*Lev-Yadun et al. 2000*) a more general suggestion was made supporting a one-event domestication in a restricted "core area" in southeastern Turkey and northern Syria which is the only region where the distributions of all founder crops are overlapping (*see Figure in Lev-Yadun et al. 2000*). They used evidence for known genetic stocks of einkorn wheat (*Heun et al. 1997*), pea – with no accurate location (*Zohary and Hopf 1993; 2000. 105*), lentil (*Ladizinsky 1999*) and chickpea (*Ladizinsky 1995; 1998a*; only ten populations of *Cicer reticulatum,* the wild progenitor of chickpea, are known, all restricted to a very small area in southeast Turkey). There is still a lack of genetic data concerning emmer wheat, bitter vetch and flax, which are considered "package" species, and there are reservations concerning a single domestication event for barley (see above). Recently a new paper by Badr *et al.* (*2000*) suggested that the origins of domesticated barley were in the southern Levant. This study still needs to be treated with caution because of various methodological aspects. Another point is that Badr *et al.* used nuclear DNA and did not refer to published chloroplast DNA data (*Neale et al. 1988*) that show a different picture (*Abbo et al. 2001*). However, for barley there is a consensus that it could have been domesticated more than once as indicated by genetic data (*Zohary 1996; 1999; Ladizinsky 1998b*).

In accordance with arguments made by Nesbitt and Samuel (*1998*), Lev-Yadun *et al.* (*2000*) argued that the southern Levant – Jordan valley/Damascus basin data are problematic. Lev-Yadun *et al.* (*2000*) review more data supporting the early presence of package species in their wild state in sites of the northern Levant (the pre Neolithic Tell Abu Hureyra 1, Mureybet I and II, and Hallan Çemi Tepesi as well as in Neolithic Jerf el Ahmar, Mureybet III, Dja'de, Cayönü, Qermez Dere and M'lefaat). Data on the early domestication of package species are pointed out in this region too (in sites such as Tell Abu Hureyra 2A, Cafer Höyük, Cayönü and Nevalli Çori). An advantage of the Lev-Yadun *et al.* (*2000*) paper is that it incorporated archaeological evidence to support the genetic, paleobotanical and geobotanical data. The area between the upper Tigris and the upper and middle Euphrates seems to be not only a core area from which domesticated plants spread throughout the Levant, but, also a centre of cultural innovation, from which other Neolithic innovations have diffused. This is the case with flint technology – i.e. a new method for producing long, straight blades (from "naviform" flint cores) for sickle-blades and arrowheads; flint tool types – such as the Helwan point (*Gopher 1989a; 1989b*) and stone implements – i.e. the case of the "stepped" quern for grinding cereal crops (*Gopher 1996; 1999*). All these diffused from the middle Euphrates area to the central and southern Levant as early as *ca.* 11 500 CalBP. Putting it forward in a simple way, we would say:

❶ There is only a single small region in the northern Levant, where the wild progenitors of all package species appear together – which may be defined as the "core area".

❷ There is increasing evidence indicating that specific genetic stocks of the progenitors of several of these package species are concentrated in a limited part of their distribution, i.e. in this core area.

❸ There is archaeobotanical evidence for all these species in their wild form up to *ca.* 11 000–10 700 CalBP in that core area, and some may have been cultivated or even domesticated as early as 13 000–12 500 CalBP (assuming that if possible for rye it may have happened with other package types as well). There is also evidence for their earliest domestication in that region from 11 000–10 700 CalBP and onward. We may assume that some of the package plants, if not all of them, have already been cultivated long before domestication (*see Hillman 1996; 2000; Hillman and Colledge 1998*). Cultivated wild plants are however morphologically indistinguishable from those gathered from the wild and are indicated by indirect evidence such as specific weeds known to infest cultivated fields.

❹ Archaeological evidence, besides plant material, indicates that the core area was an active cultural centre from which innovations diffused to other parts of the Levant.

Using Ocham's Razor approach, it seems just logical to take advantage of such a wealth of accumulating data and "vote" in favour of this region as the cradle of agriculture. The problems we are left with (in all the above lines of evidence) are not to be ignored and should be tackled in the near future – but nevertheless, the general picture proposed by Lev-Yadun *et al.* (*2000*) seems to better fit the available data now.

Two sets of archaeobotanical data from two Neolithic sites were commonly used in order to point out the Jordan valley/Damascus basin as the area where domestication has first taken place. We wish to comment on these: Botanical data from Jericho used by Jones *et al.* (*1998*), Garrard (*1999.Tab. 3*) and others to indicate the early domestication of cereals, derives from the PPNA and PPNB strata of the site. There is disagreement as for the domestic nature of cereals in the Jericho PPNA (*Nesbitt and Samuel 1998.note 3*). The samples were claimed to include emmer, einkorn and barley grains and chaff identified in mud-brick impressions (*see Hopf 1983*), but there is no evidence of the most important and indicative characteristic – non brittle rachis. Moreover, mud-brick impressions are indirect evidence and should be considered as such. The PPNB stratum reaches, at some areas of the site, a depth of seven meters of occupational sediments. We propose that the domesticated cereal seeds of this stratum should most probably be dated to 10 000–8850 CalBP (the 9th uncallibrated millennium bp), which is the major chronological span of the PPNB at Jericho, and thus represent the arrival of these species from regions where they have been already domesticated earlier. A detailed discussion on the problematic aspects of the stratigraphy of Jericho, the recovery methods and the samples is beyond our scope here. We would only say that this excavation was carried out some 50 years ago using field methods much different than those accepted in prehistoric excavations today.

The remnants considered to be of domesticated emmer wheat from Tell Aswad IA dated to *ca.* 11 000–10 700 years CalBP is one of the most significant evidences used to indicate that the southern Levant/Damascus basin is where cereals were first domesticated. The samples include enlarged (plump) wheat seeds which are, in our opinion, not a clear indication for domestication. Indeed, following Nesbitt and Samuel (*1998*), we suggest that this set of data calls for a reassessment of the chronology and nature of the samples. Moreover, analysis of use-wear marks on glossed flint sickle blades from Tell Aswad IA suggest that emmer wheat could still have been harvested from the wild at this site at 11 000 years Cal BP (*Anderson 1995*). Here too, unmistakable domesticated cereals appear only in stratum II, postdating stratum I, and are later then the ones known from southeast Turkey and north Syria.

The lesson to learn here is that only unequivocal data, such as non-brittle rachis can demonstrate domestication accept for barley in which the lower part of the rachis is non-brittle even in the wild (*see Kislev 1989*). And secondly, both these cases exemplify the problems with data from old excavations, old recovery methods and the lack of direct chronological evidence concerning the seeds dealt with.

Developments in the Neolithization process and their pace

Looked at through the prism of prehistory as a whole, the Neolithic Revolution was, and should be considered, a fast and radical change. However, let us focus and look through Neolithic (and modern) glasses, and in detail. Taking a view on the Levant, as the eagle flies, every *ca.* 1000 years would reveal a mosaic of gradually changing human and natural landscapes.

At 13 000 CalBP – there is still no evidence in the southern Levant for any agriculture whatsoever. The *Natufian* (late Epipaleolithic) communities of the Levant (mainly its southern parts) lived in small sites (0.01–0.2 hectare in size) in which rounded stone houses were built. They were still maintaining a hunter-gatherer-type close relationship with cereals and legumes as well as with the gazelle as established by their antecedents. It is important to mention the presence of bone sickles, flint sickle blades, large assemblages of pounding implements (mainly pestles and mortars) as well as paved and plastered storage installations in their settlements (for a summary of the archaeology of the Natufian culture, *see Belfer-Cohen 1991; Valla 1995; Bar-Yosef 1998b*). Very little can be seen in the northern Levant at this stage. Cultivation of wild and domesticated cereals may have already appeared at *ca.* 13 000 CalBP if we consider the Tell Abu Hureyra 1 new data (*Hillman et al. 2001; Hillman 2000*).

At 12 000 CalBP – there is still no clear sign for agriculture in the southern Levant. The short-lived *Khiamian* communities of the Levant still maintain a hunter-gatherer system. An innovation in their toolkit is the introduction of the El-Khiam point – a "real" arrowhead. Their sites seem to have changed a little with mud-brick technology introduced, however information is scarce (*for details see Crowfoot-Payne 1983; Garfinkel and Nadel 1989; Bar-Yosef and Gopher 1997*). In the northern Levant, sites such as Hallan Çemi Tepesi and Mureybet I, II do exist, while the early strata of Cayönü were established a little later. These sites could reach a size of one hectare (and may be more) and had stone rounded houses in them. The cultivation of the founder package and possibly other plants may have been practiced.

At 11 000 CalBP – evidence for early small-scale patches of cultivated/domesticated cereals and legumes may be seen around the *Mureybetian* sites in the northern Levant – southeast Turkey and north Syria such as Mureybet III and Jerf el Ahmar. However, hunting continues to be an important part of the economy, and of society. Some sites are now much larger with a few reaching "gigantic" size (over 4 hectares) in early Neolithic terms. These still have rounded houses made of stone and mud-brick and public buildings and areas (*for partial summaries see Cauvin 1989; Bar-Yosef and Gopher 1997; Özdoğan 1999; and references therein*). In the southern Levant large (1–3 hectares) *Sultanian* sites appear too with public projects (*e.g.* Jericho, Netiv Hagdud) as well as small (0.01–0.5 hectare) villages and camps (Gesher, Iraq ed-Dubb, Ain Darat, Hatoula and others). Hunting continued and there may have been early cultivation. However, there is no clear evidence for domestication (*Kislev 1989; 1997*).

At 10 000 CalBP – forest cleared area and farmed land increases around the sites of Early and Middle PPNB in the whole Levant. Small herds of sheep and goat have been kept around the villages, mainly in the northern Levant. Settlements in the Mediterranean zone appear in a variety of sizes and houses are usually rectangular (*for summaries see Bar-Yosef 1995 on the southern Levant; Özdoğan 1999 about Turkey; and references therein*). The deserts of the Levant is filled up with many hunters camps.

At 9000 CalBP – well organized and larger scale agricultural fields were farmed around Late PPNB sites throughout the Levant. Animal pens and other fenced areas can be detected with sheep and goat in and around the village. Cattle and possibly pigs have already joined in some parts of the Levant while hunting continued. Settlement size is diverse ranging from "towns" (up to 12–14 hectares) to small villages and camps. A possible new feature to be seen is the beginning of environmental degradation in areas near large and long-lasting sites. The beginning of pottery is evident in the northern Levant shortly after 9000 CalBP.

At 8000 CalBP – "towns" and villages become clear features in the landscape with their accompanying domesticated package. This includes both animal management/husbandry and farming fields. The settlements are usually dense and houses are rectangular. Potter's kilns and workshops are now clearly seen. In the more arid areas, fringe communities in smaller sites and with many animals can be seen now – these are early desert herders who may still live in rounded houses and build animal pens.

At 7000 CalBP – “towns” and villages continue to appear with larger scale agriculture and herds of animals. Early indications of the Secondary Products Revolution (*Sherratt 1981*) make an appearance. Large domesticated animals (bovids) may have been used for traction in the fields and new agricultural activities take their place in the landscape such as growing small orchards of fruit trees. Hunting has almost completely ceased. New activities and new raw materials first appear such as copper metallurgy.

How fast did the domesticated genetic package diffuse within the Levant and from the Levant to adjacent regions or to farther afield areas? Did the whole package diffuse together? Did it move with a package of agro techniques? Was it a migration of a whole population? Or was it a continuous colonization of preferable enclaves?

As for the Levant, it seems that large-scale migration is not the case. However, certain population movement is not ruled out. The question is why didn’t the new innovative economy take over the whole Levantine Neolithic system much faster had it had clear advantages for survival and prosperity and given the relatively fast communications within the Neolithic interaction sphere of the Levant (*Gopher 1989a; 1989b; Lev-Yadun et al. 2000*)? First, Neolithization, mainly the domestication of plants (and animals), has probably not been free of drawbacks and problems in many aspects that could have caused crop failures (*e.g.* droughts, plant diseases). Another reason may be related to the pace of the cultural process. Adopting and absorbing innovations, especially major and influential ones, has limitations and creates cultural and social conflict that slows it down. In the case of agriculture, a major cultural shift was needed and it should have had long incubation and struggle phases. The major factor dictating the pace of a change, thus, was not limitations in communications and the movement of the ideas, seeds and the technology needed but rather, the acceptance of a new social and economic order. As for the diffusion to Europe, the question is very different and so is the chronology. The Levantine package and agricultural tradition was by far on its route before it started the journey to Europe. As for the Mediterranean islands – data is now emerging that neccessitates new considerations. It is however clear that in some cases it must have been a migration with the full package of plants and animals (like in the case of Cyprus). In other cases the picture is not clear and debates are ongoing. The question of whether the Levantine package has diffused to North Africa (Egypt) and Asia (India) is even more complex. Both these questions are beyond the Levantine limited scope of this paper but see for example Braidwood (*1967; 1975*), Ammerman and Cavally-Sforza (*1971*), Cavalli-Sforza (*1996*), Zohary and Hopf (*1993; 2000*), Harlan (*1971; 1986; 1995*).

SUMMARY AND ENDNOTES

Although we have stressed the need for basic information on the “Where”, “When” and “How” did the Neolithic Revolution take place, we believe that the “Why” question and the background to these developments are most intriguing issues. We would like to refer to these questions in light of the growing tendencies to present explanations based on climatic change reconstruction which is now detailed, factual, using high precision dating methods and elaborate meteorological models. This brings us back to the conditions under which the Neolithic Revolution took place – was it environmental stress and decreasing resources that triggered it or was it a socio-cultural development in the first place? Were people forced out of the rich zones by population pressure causing the budding off of sections of the community to the marginal zone that ended up in a revolution the way Binford (*1968*) suggested? Or, did it happen on a background of an affluent, rich in resources environment within the framework of a competitive society driven into production amplification as suggested by Hayden (*1990*)? Or in other words, is it the rich centres communities that advanced the new way of life or the poor semi-desertic marginal zone dwellers?

Recent studies of the Neolithic Revolution in the Levant use reconstruction of the environment and climate emphasizing the major influence of the Younger Dryas dry episode dated to *ca.* 13 000–11 500 CalBP on the very late Natufian populations. These studies are presented under an almost general agreement that the southern Levant was the cradle of plant domestication and that this area provides the vivid “bad memory” (of the Younger Dryas) stressing background for the cultural and economic change. These studies are mainly based on Natufian data sets from the southern Levant indicating that the Natufian culture has provided much of the cultural background and many of the pre-adaptations needed for the revolutionary socio-economic change to come with the Neolithic Revolution. This includes sedentism to begin with, house building, storage facilities (silos), harvesting and food processing implements, the introduction of bifacial tools which are later important for tree felling needed for building, forest clearing for agriculture, fencing etc. Post Natufian – early Neolithic populations of the southern Levant however continued to base their economy on gathering and hunting. Cultivation may have been introduced in the early Neolithic (PPNA) post 11 500 years CalBP while domestication of cereals and legumes does not make a clear appearance in the southern Levant before the Middle PPNB (10 200–10 000 CalBP). The archaeological record has however changed conspicouesly in the PPNA (see above) compared to the Natufian. Another stage of change and growth took place in the PPNB (see above). Turning to the area we have pointed out here as the cradle of agriculture – southeastern Turkey and northern Syria – we face a somewhat different picture. First, we know very little about the Natufian or other archaeological entities preceding the Neolithic period in the northern Levant. Secondly, the influence of climate in these regions seems to be less significant. Some claim that the Younger Dryas influence in the Levant was not major at all (*Wilcox 2000; and see Botema 1995; Helmer et al. 1998*). The presence of both large and small rivers in the core area region, along which many of the major settlements are located, also lessens the effect of a climatic change. The area has record for large-scale sites and sedentism as early as 12 500 CalBP, still within the time span of the Younger Dryas, such as Hallan Çemi Tepesi (*Rosenberg and Redding 2000*), Tell Abu Hureyra 1 (*Moore 1991*) and Mureybet I, II (*Cauvin 1989*). Some of these may have been practicing cultivation of package cereals and legumes (which do appear in these sites but show no sign for domestication). This stage continues for some two calibrated millennia before domestication is evident. Sites such as Cayönü, Tell Abu Hureyra, Mureybet II–III, Jerf el Ahmar, Göbekli Tepe, Nevally Çori, Cafer Höyük and others experience a better climate (post Younger Dryas) and all show evidence for being large permanent sites with public buildings (or areas), rich imagery assemblages and large-scale fascinating stone sculpting, prestige traded materials and items, rich ritual activity etc. (*see series of papers cited in Özdoğan 1999; Guilaine 2000*) all of which must have been supported by well organized and rich communities that had no domesticates but seem to have practiced cultivation. We have no good reason to assume that all this was happening in egalitarian societies or based on an egalitarian ethos (*as suggested for the southern Levant by Kuijt 1996; 2000*). We rather see this as a suitable background for a rich, ranked society in which personal success; accumulation of wealth, potential gift giving or even surplus destruction may have played an important role. Thus, in our opinion, and joining suggestions made in recent years by M. Özdoğan (*1997; 1999*), we may see a rich complex hunter-gatherer socio-economy as the background to the revolution in early Neolithic times in southeast Turkey-north Syria – such a society may eventually become competitive which may have brought individuals and whole communities to increase their production. It would be too daring to state that this was the direct and only cause for the domestication of plants and later animals. However, we would argue that such social developments operated as important factors in promoting food production. In a more general way, the domestication of plants is most probably somehow related to climatic change but this may not be a sufficient condition. A cultural and social infrastructure was needed that is well configurated/designed for change and fully pre-adapted for this change to be successful. Also, there must have been a cultural incentive – a socio-cultural mover (and such a mover can be seen as stress too) that is a necessary and sufficient condition for the process to start and succeed. In other words, the reaction to external (environmental) stress, such as the Younger Dryas, alone does not necessarily lead to domestication and agriculture (Europe is an example where some of the species for potential domestication were available, climatic change has occurred but there was no domestication).

One neglected factor in this discussion is demography. We simply are not in a state of the art that would enable a coherent estimate of population size. It would take an independent research that is beyond our scope here.

If we are to summarize our point, we would say as follows: In a defined, small "core area" of the northern Levant, between the upper and middle Euphrates and the upper Tigris (southeast Turkey and northern Syria), a whole package of local "efficient" cereals and large seeded legume species and flax, have came under intensive use by man. This may have been triggered by the effects of the dry Younger Dryas episode (which still needs better indications than what is available at present) which brought about the practical choice and later cultivation of the package (most efficient) species some of which became domesticated later. This may actually be considered the beginning of cultivation with possible displacement of species or even crop management. Following Hillman (*Hillman 2000; Hillman et al. 2001*) we may say it started as early as 13 000 CalBP with the onset of the Younger Dryas. However, even if it had started sometime after 13 000 CalBP this still precedes the southern Levant by over a millennium of calibrated ^{14}C years. Hunting continued and the economy has flourished and supported large-scale settlements with rich communities. The social order in this climax hunter-gatherer world was changing towards increased differentiation evidenced by trade, prestige (elite?) items and materials and high investments in ritual, art, and other public activities. These socio-economic developments could result in a competitive social environment that in turn accelerated resource exploitation. The stage of wild plant manipulation (cultivation) has been replaced by a new stage (domestication) after over a millennium and a half of getting closer to the species (at *ca.* 11 000–10 500 CalBP). The success of this move was overwhelming. The reason, in retrospect, is that there was something special in the composition of wild plants in this specific region. It included a variety of efficient – very economical and with high dietary value – species that spread in all directions going through local cultural filters (*e.g. Bar-Yosef 1998a*) to create a wealth of variations throughout the Levant. It accelerated social differentiation and eventually changes in social order. A variety of settlement types have spread throughout the Levant, which also enjoyed, post Younger Dryas, "improved" climatic conditions from ca. 11 500 CalBP. The southern Levant, again, as with cultivation, was over a millennium late with this stage. The later developments, especially the introduction of domesticated animals, and continued social reordering have created within a few millennia the traditional Mediterranean zone village based on a mixed economy. The Secondary Products Revolution and other social developments have completed this process and brought the Levant to the threshold of urbanism and thus to the gate of western civilization.

ACKNOWLEDGEMENTS

We thank Ran Barkai for his comments on this text.

∴

REFERENCES

ABBO S., LEV-YADUN S., LADIZINSKY G. 2001. Tracing the wild genetic stocks of crop plants. *Genome 44: 309–310.*

AMMERMAN A. J. and CAVALLI-SFORZA K. L. 1971. Measuring the rate of spread of early farming in Europe. *Man 6: 674–688.*

ANDERSON P. C. 1995. Introduction et Problematic: L'agriculture a Aswad et ses antecedents au Levant. In H. de Contenson (ed.), *Aswad et Ghoraife, Sites Neolithique Damascene (Syrie) aux IX et VIII millenaires avant l'ere chretienne: 221–231.*

BADR A., MÜLLER K., SCHÄFER-PREGL R., EL RABEY H., EFFGEN S., IBRAHIM H. H., POZZI C., ROHDE W. and SALAMINI F. 2000. On the origin and domestication history of barley (*Hordeum vulgare*). *Molecular Biology and Evolution 17: 499–510.*

BAR-YOSEF O. 1995. Earliest food producers – Pre-Pottery Neolithic (8000–5500 bc). In T. A. Levy (ed.), *The Archaeology of Society in the Holy Land: 190–204.*

1998a. The role of the Younger Dryas in the origins fo cultivation in the Levant. Abstract of paper presented in the International workshop *The transition from foraging to farming in southwest Asia.* Groningen, 7–11th Sept. 1998.

1998b. The Natufian culture in the Levant, threshold to the origins of argriculture. *Evolutionary Anthropology 6(5): 159–177.*

BAR-YOSEF O., BELFER-COHEN A. 1991. From sedentary hunters-gatherers to territorial farmers in the Levant. In S. A. Gregg (ed.), *Between Bands and States: 181–202.*

1992. From foraging to farming in the Mediterranean Levant. In A. B. Gebauer and T. D. Price (eds.), *Transitions to Agriculture in Prehistory, Monographs in World Archaeology no. 4: 21–48.*

BAR-YOSEF O. and GOPHER A. 1997. *An Early Neolithic Village in the Jordan Valley, Part I: The Archaeology of Netiv Hagdud*, American School of Prehistoric Research, Bulletin 43, Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge.

BAR-YOSEF O. and MEADOW R. H. 1995. The origins of agriculture in the Near East. In T. D. Price and A. G. Gebauer (eds.), *Last Hunters – First Farmers: New perspectives on the Prehistoric transition to Agriculture: 39–94*.

BELFER-COHEN A. 1991. The Natufian in the Levant. *Annual Review of Anthropology 20: 167–186*.

BELFER-COHEN A. and BAR-YOSEF O. 2000. Early sedentism in the Near East, a bumpy ride to village life. In I. Kuijt (ed.), *Life in Neolithic Farming Communities: 19–37*.

BENDER B. 1978. Gatherer-Hunter to Farmer: A social perspective. *World Archaeology 10: 204–222*.

BINFORD L. 1968. Post-Pleistocene Adaptations. In S. Binford and L. Binford (eds.), *New Perspectives in Archaeology: 313–341.*

BIRD-DAVID N. 1990. The giving environment: Another perspective on the economic system of gatherer-hunters. *Current Anthropology 31: 189–196*.

BLUMLER M. A. 1991. Modeling the origin of sigume domestication and cultivation. *Economic Botany 45: 243–250*.

BOSERUP E. 1965. *The conditions of agricultural growth*, Aldine, Chicago.

BOTTEMA S. 1995. The Younge Dryas in the Eastern Mediterranean. *Quaternary Science Reviews 14: 883–891*.

BRAIDWOOD R. 1967. *Prehistoric Men*, 7th edition, Scott, Foresman and Company, Glenview.

1975. *Prehistoric Men,* Xth edition, Scott, Foresman and Company, Glenview.

CAUVIN J. 1989. La Neolithization au Levant et sa Premiere Diffusion. In O. Aurench and J. Cauvin (eds.), *Neolithization, BAR International Series 516: 3–36*.

1994. *Naissance des divinites Naissance de l'agriculture*, CNRS Editions, Paris.

2000. *The Birth of the Gods and the origins of Agriculture*. Cambridge University press.

CAVALLI-SFORZA K. L. 1996. The spread of agriculture and nomadic pastoralism: insights from genetics, linguistics and archaeology. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 51–69*.

CROWFOOT-PAYNE J. C. 1983. Appendix C: the flint industries of Jericho. In K. M. Kenyon and T. A. Holland (eds.), *Excavations at Jericho, Vol. 5: 622–759*.

DIAMOND J. 1998. *Guns, germs and steel*, Vintage, London.

FLANNERY K. V. 1969. Origins and ecological effects of early domestication in Iran and the Near East. In P. J. Ucko, G. W. Dimbleby (eds.), *The domestication and exploitatin of plants and animals: 73–100*.

GARFINKEL Y. and NADEL D. 1989. The Sultanian flint assemblage from Gesher and its implications for recognizing early Neolithic entities in the Levant. *Paleorient 15/2: 139–151*.

GARRARD A. 1999. Charting the emergence of cereal and pulse domestication in south-east Asia. *Environmental Archaeology 4: 67–86*.

GOPHER A. 1989a. Neolithic arrowheads of the Levant: results and implications of a multidimensional seriation analysis. In O. Aurench, M-C. Cauvin and P. Sanlavill (eds.), *Prehistoire du Levant Vol. 2: 365–378*.

1989b. Diffusion processes in the Pre-Pottery Neolithic Levant: the case of the Helwan Point. In I. Heshkovitz (ed.), *People and Culture in Change, BAR International Series 508: 91–106*.

1996. What happened to the Early PPNB? In S. K. Kozłowski and H-G. Gebel (eds.), *Neolithic Chipped stone Industries of the Fertile Crescent, and their Contemporaries in Adjacent Regions, Ex Oriente: 151–158*.

1999. Lithic industries of the Neolithic period in the southern/central Levant. In S. K. Kozłowski (ed.), *The Eastern Wing of the Fertile Crescent, BAR International Series 760: 116–138*.

GUILAINE J. (ed.) 2000. *Premiers Paysans du Monde*, Editions errance, Paris.

HARLAN J. 1971. Agriculture origins: Centers and noncenters. *Science 174: 468–474*.

1986. Plant domestication: Diffuse origins and diffusion. In C. Barigozzi (ed.), *The origins and domestication of cultivated plants: 21–34*.

1995. *The living fields. Our agricultural heritage*, Cambridge University Press, Cambridge.

HAYDEN B. 1990. Nimrods, piscators, pluckers and planters: The emergence of food production. *Journal of Anthropological Archaeology 9(3): 225–236*.

HELMER D., ROITEL V., SANA M. and WILCOX G. 1998. Interpretations environnementales des donnees archeozoologiques et archeobotaniques en Syrie du Nord de 16000 BP a 7000 BP, et les debuts de la domestication des plantes et des animaux. In M. Fortin and O. Aurench (eds.), *Natural space, inhabited space in Northern Syria (10th–2nd millennium B.C.), Bulletin 33: 9–34*.

HEUN M., SHÄFER-PREGL R., KLAWAN D., CASTAGNA R., ACCERBI M., BORGHI B. and SALAMANI F. 1997. Site of einkorn wheat domestication identified by DNA fingerprinting. *Science 278: 1312–1314*.

HILLMAN G. C. 1996. Late Pleistocene changes in wild plant-foods available to hunter-gatherers of the northern Fertile Crescent: possible preludes to cereal cultivation. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 159–203*.

2000. The plant food economy of Abu Hureyra 1 and 2; Abu Hureyra 1: The Epipaleolithic. In A. M. T. Moore, G. C Hillman and A. J. Legge (eds.), *Village on the Euphrates, From foraging to farming at Abu Hureyra: 327–398*.

HILLMAN G. and COLLEDGE S. 1998. The state of cultivation at Abu Hureyra and some regional implications. Abstract of paper presented in the International workshop *The transition from foraging to farming in southwest Asia*. Groningen, 7–11th Sept. 1998.

HILLMAN G., HEDGES R., MOORE A., COLLEDGE S. and PETTITT P. 2001. New evidence of Lateglacial cereal cultivation of Abu Hureyra on the Euphrates. *The Holocene 11: 383–393*.

HILLMAN G. C. and DAVIS M. S. 1992. Domestication rate in wild wheats and barley under primitive cultivation: preliminary results and archaeological implications of field measurements of selection coefficient. In P. C. Anderson (ed.), *Prehistoire de L'Agriculture, Monographie du CRA no. 6: 113–158*.

HODDER I. 1993. *The Domestication of Europe*, Balackwell, Oxford.

HOLE F. 1998. Wheat domestication. *Science 279: 303*.

HOPF M. 1983. Jericho plant remains. In K. M. Kenyon and T. A. Holland (eds.), *Ecxcavation at Jericho Vol. 5: 576–621*.

JONES M. K., ALLABY R. G. and BROWN T. A. 1998. Wheat domestication. *Science 279: 302–303*.

KISLEV M. E. 1989. Pre domesticated cereals in the Pre-Pottery Neolithic A period. In I. Hershdovitz (ed.), *People and Culture in Change, BAR International Series 508: 147–152*.

1997. Early agriculture and paleoecology of Netiv Hagdud. *An Early Neolithic Village in the Jordan Valley, Part I: The Archaeology of Netiv Hagdud, American School of Prehistoric Research, Bulletin 43: 209–236*.

1998. The agrophyletic origin of annual crops. Abstract of paper presented at the International workshop *"The Trasition from Foraging to Farming in southwest Asia"* Groningen, 7–11th Sept. 1998.

KUIJT I. 1996. Negotiating equality through ritual: A consideration of late Natufian and Pre-Pottery Neolithic A period mortuary practices. *Journal of Anthropological Archaeology 19: 313–336*.

2000. Keeping the peace: Ritual, skull caching, and community integration in Levantine Neolithic. In I. Kuijt (ed.), *Life in Neolithic Farming Communities: 137–162*.

LADIZINSKY G. 1987. Pulse domestication before cultivation. *Economic Botany 41: 60–65*.

1989. Pulse Domestication: Facts and fiction. *Economic Botany 43: 131–132*.

1993. Lentil domestication: On the quality of evidence and Arguments. *Economic Botany 47: 60–64*.

1998a. *Plant Evolution Under Domestication*, Kluwer Academic Publishers, Dordrecht.

1998b. How many tough rachis mutants gave rise to domesticated barley? *Genetic Resources and Crop Evolution 45: 411–414*.

1999. Identification of the lentil's wild genetic stock. *Genetic Resources and Crop Evolution 46: 115–118*.

LEV-YADUN S., GOPHER A. and ABBO S. 2000. The cradle of agriculture. *Science 288: 1602–1603*.

MILLER N. 1991. The Near East. In Van Zeist, Wasylikowa and Behre (eds.), *Progerss in old world Paleoethnobotany: 133–160*.

MOORE A. M. T. 1991. Abu Hureyra 1 and the antecedents of agriculture on the middle Euphrates. In O. Bar-Yosef and F. Valla (eds.), *The Natufian Culture in the Levant, International Monographs in Prehistory no. 1: 277–294*.

MOORE A. M. T., HILLMAN G. C., and LEGGE A. J. 2000. *Village on the Euphrates, from Foraging to farming at Abu Hureyra*, Oxford University Press, Oxford.

NEALE D. B., SAGHAI-MAROOF M. A., ALLARD R. W., ZHANG Q. and JORGENSEN R. A. 1988. Chloroplast DNA diversity in populations of wild and cultivated barley. *Genetics 120: 1105–1110*.

NESBITT M. and SAMUEL D. 1998. Wheat domestication: Archaeological evidence. *Science 279: 1433*.

ÖZDOĞAN M. 1997. The beginning of Neolithic economies in southeastern Europe: an Anatolian perspective. *Journal of European Archaeology 5.2: 1–33*.

1999. Preface; Concluding remarks. In M. Özdoğan and N. Basgelen (eds.), *Neolithic in Turkey – the Cradle of Civilization: 9–12, 225–236*.

REDDING R. W. 1988. A general explanation of subsistance change: from hunting and gathering to food production. *Journal of Anthropological Archaeology 7(1): 56–97*.

RINDOS D. 1980. Symbiosis, Instability and the origins and spread of agriculture: a new model. *Current Anthropolgy 21: 751–772*.

1984. *The origins of agriculture: an evolutionary perspective*, Academic Press, New York.

ROSENBERG M**.** 1998. Cheating the musical chairs. *Current Anthropology 39(5): 653–681*.

ROSENBERG M. and REDDING R. W. 2000. Hallan Çemi and early village organization in Eastern Anatolia. In I. Kuijt (ed.), *Life in Neolithic Farming Communities: 39–62*.

SHERRATT A. 1981. Plough and pastoralism: aspects of the secondary products revolution. In I. Hodder, G. Isaac and N. Hammond (eds.), *Patterns of the Past: Studies in honor of David Clarke: 261–305*.

SMITH P. E. and CUYLER-YOUNG T. Jr. 1972. The evolution of early agriculture and culture in greater Mesopotamia: A trial model. In B. J. Spooner (ed.), *Population Growth: Anthropological implications: 1–59*.

VALLA F. 1995. The first settled societies – Natufian (12 500–10 200 bp). In T. E. Levy (ed.), *The Archaeology of Society in the Holy Land: 169–189*.

WRIGHT H. E. Jr. 1968. Natural environment of early food production north of Mesopotamia. *Science 161: 334–339*.

WILCOX G. 1998. Frequency variation of major cereal components from 9th and 10th millennium (bp. non cal.) sites in the Levant. Abstract of paper presented at the International workshop *"The Transition from Foraging to Farming in southwest Asia"* Groningen, 7–11th Sept. 1998.

2000. Nouvelle donnees sur l'origine de la domestication des plantes au Proch Orient. In J. Guilaine (ed.), *Premiers Paysans du Monde: 121–140*.

ZOHARY D. 1989. Domestication of the southwest Asian Neolithic crop assemblage of cereals, pulses and flax: the evidence from the living plants. In D. R. Harris and G. C. Hillman (eds.), *Foraging and farming: the evolution of plant exploitation: 358–373*.

1996. The mode of domestication of the founder crops of southwest 'Asian agriculture. In D. R. Harris (ed.), *The Origins and spread of Agriculture and Pastoralism in Eurasia: 142–158*.

1999. Monophyletic *vs.* polyphyletic origins of the crops on which agriculture was founded in the Near East. *Genetic Resources and Crop Evolution 46: 133–142*.

ZOHARY D. and HOPF M. 1993. *Domestication of plants in the old world* (second edition), Clarendon Press, Oxford.

2000. *Domestication of plants in the old world* (third edition), Oxford University Press, Oxford.

UDK 903'12/'15(495)"634"

Documenta Praehistorica XXVIII

Mesolithic to Neolithic in Greece. Continuity, discontinuity or change of course?

Kostas Kotsakis
Department of Archaeology, Aristotle University of Thessaloniki, Greece
E-mail: Kotsakis@hist.auth.gr

ABSTRACT – *The paper reviews the status of the Mesolithic/Neolitihc interface in Greece. It is argued that the old dichotomy between "indigenists" and "diffusionists" concerning the neolithization of Greece is simplistic. Instead it is proposed that the discussion should be focused on two separate issues: one factual, emphasizing the form of phenomena and their archaeological description and one interpretive focusing more on content. Concerning the first issue, the hypothesis is made that the discontinuity in the Mesolithic/Neolithic interface is probably the result of the incomplete archaeological record and the biased research on long-term Neolithic sites in Thessaly. As for the second issue, the shift to the Neolithic can be better understood as an effort to control society and its conflicts by manipulating physical and conceptual resources and by constructing new identities.*

IZVLEČEK – *V članku predstavljamo hipoteze o prehodu iz mezolitika v neolitik v Grčiji. Menimo, da je staro nasprotje med "avtohtonisti" in "difuzionisti" o neolitizaciji Grčije preveliko poenostavljanje. Zato predlagamo, da se razprava osredotoči na dve ločeni vprašanji: prvo se tiče dejstev, kjer je poudarek na obliki pojava in njegovem arheološkem zapisu, drugo pa je interpretativno in osredotočeno bolj na vsebino. Glede prvega vprašanja postavimo hipotezo, da je diskontinuiteta prehoda mezolitik/neolitik verjetno posledica nepopolnega arheološkega zapisa in pristranskih raziskav na kontinuiranih neolitskih najdiščih v Tesaliji. Glede drugega vprašanja menimo, da lahko prehod v neolitik bolje razumemo, če v njem vidimo prizadevanje za nadzor družbe in njenih nasprotij z obvladovanjem fizičnih in pojmovnih virov in z oblikovanjem novih identitet.*

KEY WORDS – *Neolithic Transition; Mesolithic; Domestication; Social Identity; Conflict; Anatolia; Thessaly*

INTRODUCTION

Although the Neolithic has been invariably related to the productive activities of farmers as opposed to hunter-gatherers (*e.g. Cauvin 2000*) the current idea that research on the beginning of the Neolithic should focus on describing a process rather than an event has made the dividing line between these two conditions less distinct and the archaeological mental barrier involved open to deconstructive commentary (*e.g. Pluciennik 1998*). The credit for bringing down this conceptual boundary between hunter-gatherers and farmers can be traced as far back as the School of palaeoeconomy at Cambridge and the relevant ecological models of change (*Higgs and Jarman 1969; Dennell 1983*), even though these models did not form the first line of attack of the availability model introduced by Zvelebil and Rowley-Conwy few years later (*Zvelebil 1986*). It is generally accepted that the availability models and the fluidity introduced in demarcating hunter-gatherers vs. farmers have radically changed the landscape of Neolithic origins and brought the dynamics of the indigenous population on stage.

For the Greek Neolithic, however, despite earlier attempts to relativize the Mesolithic/Neolithic dichotomy (*e.g. Kotsakis 1992*), the debate is still largely dominated by the "oriental mirage", i.e. a straightforward process of demic diffusion from the Near

East. Certainly, we are no longer caught in the old – and simplistic – polarized dichotomy between "indigenists" and "diffusionists" which dominated in the times of scholars like Theocharis (*Theocharis 1973*) and Weinberg (*1965*). Indeed Theocharis (*1967*) was the first to open this debate by questioning the generic Childean paradigm of the Near Eastern predominance and introduced a more favourable angle to the possibility of an indigenous course to neolithisation. After more than thirty years, scholars came to realize the subtleties and the complexities involved in this process towards the Neolithic in Greece and are prepared to examine the variable paths of the development of agriculture and pastoralism (*Halstead 1989; Halstead 1996a*). The initial polarity of the issue is considered today archaeologically parochial, even redundant, but, as Zvelebil has rightly pointed out, still remains politically relevant (*Zvelebil 2000b; Zvelebil 2000a*). Ruth Tringham (*2000*), for example, has indicated how the old Childean idea of the bridging role of the Greek peninsula and the Balkan countries has acted as an antidote to the deep seated notion of the Balkans always forming a buffer zone between the Christian Empires of Europe and the Islamic Empires of the Middle East. Similarly, Özdoğan (*1997. 1–2*) described as "reactionary" and "eurocentric" every model that questioned the predominance of Anatolian origins of the prehistory of Southeastern Europe.

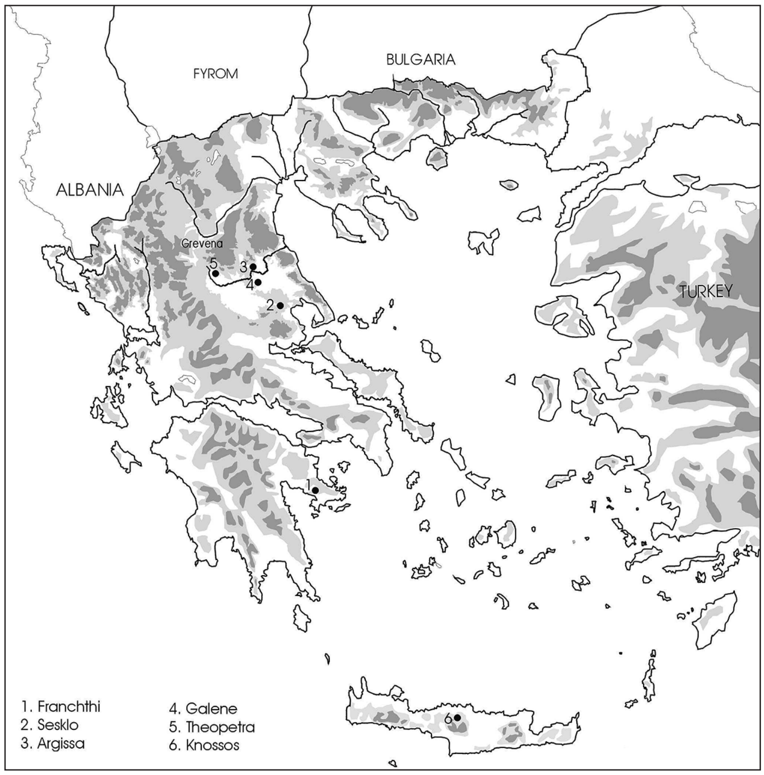


Fig. 1. The distribution of "the Late Mesolithic and Early Neolithic" sites in Greece.

The "wave of advance" by Ammerman & Cavalli Sforza (*1984*) has swept in its unifying simplicity much of the resistance of local developments by subsuming them – in the last instance – under a unidirectional course. I will not discuss here its spatial (hence quantitative and measurable) conception of a predominantly social (i.e. qualitative and interpretative) development that portrays the Neolithic as a physical phenomenon and a function of space and time. Although undoubtedly the diffusion of the Neolithic is a physical phenomenon happening in space and time (like, by analogy, the spread of a virus) it is equally a socially embedded process, taking place in social space and time, which, however, are not part of the model. The social context of diffusion is scarcely touched upon, and this is the deeper reason for a certain uneasiness felt by research informed by social anthropology against such models. For, while in the analogy cited above, the mechanisms for the spatial and temporal transmission of the virus are included in the model as a straightforward biological function, the mechanisms and conditions for either the acceptance or the success of the transportation of the Neolithic package are not, except in the isolated cases where the Neolithic ways are considered superior by definition and their benefits self-evident, a clearly biased political consideration which probably merits no further comment (*Zvelebil 1996*). Recently, there is a more or less general consensus that these (conceptual) mechanisms and conditions are the primary focus of research, the unknown entities about which we need to know more (*e.g. Hodder 1990*). In contrast to Cauvin (*2000*), however, I fail to see, why these process are relevant in the case of the "original" inception of the Neolithic, but beside the point and suppressed when we are dealing with the "secondary" Neolithic. In any case, diffusionist models of this sort, stemming as they do from the positivist phenomenalism of the 1970's, iron out all the fine grain of social context, which some people think contemporary archaeology is, after all, about. This I consider to be the most negative aspect of the diffusion models, demic or of any other variety (*cf. Zvelebil 2000a*). Eventually, it seems that there are two clearly distinct issues here, the conflating of which has created considerable confusion. One is an issue of form and description, occasionally leading to time dependent quasi-historical reconstruction and/or cultural affinities that underline "key" archaeological facts and rest on conceptions of normative archaeological cultures. The other is an issue of content and interpretation that emphasizes the interplay of agency and structure in the process towards neolithisation. Here of prime importance are socially embedded practices such as competition, conflict and group identity, and their recognizable signatures in the archaeological record. In my opinion, there is no way to ignore the latter issue by using exclusively arguments from the former or any merit in disregarding completely the former in favour of the latter, interpretative issue. I will try, therefore, to discuss both issues in turn.

FORM AND DESCRIPTION

The Greek situation is different from that of the Northern Europe, where the "availability model" was initially introduced, in at least two significant ways: (a) the absence of an active stock of hunter-gatherers, and (b) the early adoption of farming. While the presence of Postglacial hunter-gatherers in northern Europe is well-documented (*Bonsall 1989; Zvelebil, Dennell and Domanska 1998*), their existence in the Greek peninsula follows the thin settlement pattern observable in the Balkans (*Chapman 1989; Chapman 1994; Tringham 2000*). The most recent survey of the Mesolithic in Greece reports less than a dozen sites (*Runnels 1995; also cf. Runnels 1996*), only two of which have been excavated and published. Furthermore, Mesolithic sites are unequally distributed throughout the Greek mainland, whole areas of which appear to be devoid of human presence. Indeed, the conclusion often drawn is that large parts of Greece were completely uninhabited during the early Postglacial. For Thessaly in particular, the total absence of Late Palaeolithic and Mesolithic habitation has been accepted as a fact by a number of scholars (*e.g. Perlès 1988; Demoule and Perlès 1993; van Andel and Runnels 1995*). Furthermore, the few Mesolithic sites known from Greece have a coastal orientation and there is an apparent discontinuity between Mesolithic and Neolithic settlement patterns (*Runnels et al. 1999*). According to Runnels (*1995.725–726*), this evidence, together with the break of the Upper Palaeolithic tradition and similarities in material culture, indicates the intrusive and sea-faring character of the Mesolithic in Greece within the broader eastern Mediterranean context.

The same argument for the divergence between developments in the Northern, Central (*cf. Gronenborn 1999*) and Southeastern Europe is further supported by the early date of the emergence of Neolithic settlements in Greece. Although the dates from the earliest Neolithic are not many, they point towards the beginning of the 7th millennium in the case of Franchthi (*Coleman 1993*). This will make the Greek developments roughly contemporary with Catalhöyük East, although the dates from Thessaly (Sesklo, Achilleion, Argissa and Otzaki) are not as conclusive as we will see later on (*Thissen 1999a*). Coupled with the very thin presence of hunter-gatherers in the Greek peninsula in general, this early date makes a long availability phase clearly implausible, another point of weakness for the application of the model in Greece.

Research usually contrasts Franchthi cave in the Argolid, Peloponnese with the open Early Neolithic Thessalian sites, such as Argissa and Sesklo. Following a long Palaeolithic and Mesolithic use of the cave, the Neolithic Franchthi is examined as a possible local adaptation, while Argissa, Sesklo and the Thessalian Neolithic as a clear example of an exogenous, "allohthonous" Neolithic with no contribution from an indigenous hunter-gatherer population. As we have already seen, it is generally believed that such a population did not exist in that area. The main argument comes from material culture and more specifically from the lithic analysis: in terms of technological choices and operational sequences, Franchthi is closely tied to Mesolithic "traditions", while Thessalian sites show, according to Perlès (*1990.130–137; 1988*), a completely new lithic technology, which is tightly linked to the fully developed Neolithic. Perlès has discarded altogether the earlier claim by Theocharis (*1967*) and Tellenbach (*1983*) for a Mesolithic descent of the early Neolithic Thessalian industries, but in doing so she had to rely on a comparison between cave and open sites, clearly sites representing different adaptations and perhaps occupying different positions of their respective settlement networks. Both types were equated as evidence for sustaining a diversified pattern for the introduction of the Neolithic in Greece, with the Franchthi cave representing some form of contact between local foragers and migrant farmers, and the Thessalian open sites as evidence for an intrusive Neolithic stock practicing farming. But leaving aside the unifying narrative of the long term (*e.g. Demoule and Perlès 1993*), and turning instead to the local and the temporary, the difference between those sites may not be solely attributable to divergence in the course towards the Neolithic. There can be at least two alternative explanations that can account for it: a. a chronological difference, which would make the Thessalian sites later and therefore exhibiting more established and recognizable "Neolithic" traits, b. a diversified settlement pattern, of which two possible, but distinct poles, would be open permanent year-round sites and caves or less permanent settlements. Needless to say, arguments involving social dimensions such as kinship relations and marriage patterns are patently relevant.

In any case, a general consensus has been formed that the original Neolithic groups arrived in Greece from somewhere else and that they engaged in either interaction with local population (Franchthi) or penetration in an empty area (Thessaly). In summary, the main arguments in favour of this modified colonization process, apart from the absence of Mesolithic sites, are the absence of the wild progenitors of some of the plants and animals that appear as part of the Neolithic package with the new material culture, the relations of this new material culture with the Anatolia, broadly speaking, the spatial discontinuity between Mesolithic and Neolithic settlements. On the one hand, this line of arguments is a considerable step forward, rendering the sweeping "wave of advance" model somewhat redundant. There is no need for the prediction of a single direction and of a rate for this migratory movement, which on the current – admittedly sparse – evidence is clearly inapplicable in Greece (*Zvelebil 2000b. 69*). On the other hand, the idea of interaction with indigenous population opens the possibility for a whole new range of questions, mainly concerning the contents of this "package," which replaced either rapidly or gradually the Mesolithic material culture.

The basic arguments that support this moderate colonization hypothesis (*cf. Zvelebil 2000a*) are, of course, debatable. Chapman (*1989; 1994*) has argued that the present distribution of Mesolithic sites is very much affected by the rise in sea-level and sedimentation of valleys (*Lambeck 1996*). The work of van Andel himself in the Thessalian plain indicates that alluviation would have covered the smallest sites, i.e. those that did not developed into long-lasting tall tells of the Early and Middle Neolithic (*van Andel, Zangger and Demitrack 1990; van Andel, Gallis and Toufexis 1995.131*). Consequently, the pattern available to research is the selective outcome of consecutive cycles of alluviation. A recent chance find seems to confirm the suspicion that sedimentation of the surface of the Thessalian plain is much more extensive than usually thought: the Late Neolithic site of Galene, near Larisa, was found under a layer of sedimentation 0.80 m thick (*Toufexis, pers. comm.*) The site, being of the flat, extended type was totally unobtrusive and therefore unknown to research so far. Taking these two geomorphological factors into consideration we conclude that many coastal or inland riverside sites of the Mesolithic or, more importantly, many short-term Early Neolithic sites remain buried under alluvium.

The argument for the absence of indigenous population in Thessaly became less plausible after the publication of reports from the Theopetra cave in Eastern Thessaly. The on-going excavation at that site since 1987 has produced a long sequence of radiocarbon dates that cover the span from the Middle Palaeolithic to the Early Bronze Age (*Kyparissi-Apostolika 1998; 1999*). The Mesolithic deposits are dated by seven dates ranging c. 9780–6700 cal BC, thus partially overlapping with the earliest Neolithic dates from Franchthi (*Kyparissi-Apostolika 1999. 237–238*). Theopetra, being a small cave, would accommodate only a small group of foragers, which, to ensure demographic viability must have been part of a larger breeding population moving in the wider region around the cave. It is very likely that this group, tapping different ecological resources, used Theopetra cave only as a station in a more extensive network within a mobile regime. The semi-mountainous plateau region of Grevena, just northwest of Theopetra, could be a zone of foraging activity and the implication is that open sites may remain undiscovered in that region. Among the archaeobotanical remains collected from the Mesolithic deposits of Theopetra wild einkorn (triticum boeoticum) has been reported together with wild barley (*hordeum vulgare*), wild goat and possibly bovids (*Kyparissi-Apostolika 1999*). It is perhaps no coincidence that the Grevena region is one of the present-day habitats for wild einkorn (*Zamanis et al. 1988*). Although specialist analysis seems to exclude the Balkans as a site of primary domestication of wild einkorn so far (*Heun et al. 1997*), the presence of the plant in the Mesolithic deposits of Theopetra, if proven accurate, merits special attention in this context. In this sense, the abrupt change in the botanical and faunal record with the introduction of domesticates, one of the arguments for the exogenous Neolithic, (*e.g. Hansen 1991*), might need to be re-evaluated. Franchthi cave in the future may not stand as the single case in Greece that provides some evidence for local pre-adaptation of domesticated cereals (*Halstead 1996.299*).

The safest conclusion is that the role of Mesolithic human activity in Thessaly has to be drastically revised. Similarly, the absence of any formative stage and the sudden appearance of the full Neolithic "package" need reconsidering. Discontinuity in Thessalian prehistory in the Mesolithic/Neolithic transition is one recurring argument in favour of the colonization process, but on the evidence of Theopetra, discontinuity need not be an inescapable conclusion any more. The sites excavated in Thessaly in the 1950's and 1960's were prominent tells that represented long-term permanent habitation. Research of that time had a definite bias for long-lived sites because it was felt that tells could provide more information for the dominant typo-chronological concerns of that period (*e.g. Milojčić 1960*). In my view, long-lived tells represent successful settlements that succeed an initial experimental phase of cultural and productive acquaintance and appropriation of the specific environments. During this hypothetical phase, short-term settlements, possibly in environments such as those predicted by van Andel & Runnels (*1995*) can be a viable probability. Research up to now has never considered this option seriously, trapped in the post-War mainstream ideas, which placed the early deposits of Sesklo (*Theocharis 1967*) and Argissa (*Milojčić 1960*) at the very start of the Neolithic sequence in a debatable Aceramic phase (*Bloedow 1991*) preceding an early monochrome pottery phase. But even so, geomorphological factors would make the identification of such sites extremely difficult.

On the other coast of the Aegean, in western Turkey, which in many respects is analogous to mainland Greece, recent research has offered new evidence on the Aceramic stage of the Neolithic. Surface survey in the Southern Marmara region identified two Aceramic sites with deposits rich in lithic assemblages (*Özdoğan 1997; Özdoğan and Gatsov 1998*). According to Özdoğan the sites predate the Archaic (ceramic) Fikirtepe phase and they lack microlithic elements, including micro-blades, but incorporate large blades. If I read Özdoğan correctly, these industries are considered as a possible bridge between Epi-Palaeolithic micro-blade traditions (like e.g. Ağaslı) and the large blades of the ceramic Neolithic (*Özdoğan 1999.211–212*), while the coastal Fikirtepe culture incorporates many elements of the Ağaslı industries such as micro-blades, and backed bladelets (*Özdoğan and Gatsov 1998.213*). There are two useful conclusions one can draw from these observations that possibly concern Thessaly as well: (a) that Aceramic sites may be separate from fully ceramic sites like e.g. Illipinar, (b) that the difference between the pre- or formative Neolithic and the full-fledged Neolithic industries can be less sharp than usually assumed, and consequently the argument for the total break between Neolithic and local Mesolithic traditions becomes much weaker, at least in principal. Interestingly, the Aceramic sites of southern Marmara are all located on high plateaus rather than in alluvial plains, so probably represent tiers in a wider network of settlements. An idea of the possible complexity of intersecting settlement patterns can be gained from a Thessalian example. Recent research in the Grevena plateau identified a number of Early Neolithic sites of brief duration (*Wilkie and Savina 1997*). One of them has been excavated (*Toufexis 1994*) and, although dated to the final stage of the Early Neolithic, the differences from the major tell sites of the eastern Thessalian plain in duration, stratigraphy, material culture and architecture are paramount.

The possible date of this proposed initial phase in the Thessalian Neolithic could be a matter of some consideration. The later date for the Mesolithic of Theopetra (6700 cal BC) overlaps with the dates for the Aceramic in Franchthi, but not with the Aceramic in Thessaly (*Coleman 1993.209–211*). Sesklo and Argissa do seem to start later than both Franchthi and Knossos (*Bloedow 1991.42, Fig. 11; Thissen 1999a.192–193*), and this might be associated, to some extent, with the well-known difference described in detail between the industries of "Aceramic" Franchthi and the Thessalian "Aceramic" (*Perlès 1988; Perlès 1990*). Sesklo and Argissa also seem to start later than the final date of the Mesolithic for Theopetra. A date around mid 7th millennium seems probable, while Franchthi dates cluster consistently in around the start of 7th millennium. We conclude that, in any case, even if migrationist hypotheses are justified for Thessaly, there was enough time scope for these scattered immigrants to built a relation with local population and surroundings and interact with them in local palimpsests. As we have already seen, in contrast to Western Turkey, the early sites that would potentially picture this interactive process are still missing from the archaeological record of Thessaly and Northern Greece in general. But, conversely, if the scenario advanced here has any value, it might explain the perplexities of material culture that seem to vex diffusionists and migrationists. Although vague similarities with Anatolia have already been pointed out since the times of Weinberg (*1965*) and more recently by many scholars (*e.g. Demoule and Perlès 1993; van Andel & Runnels 1995*), they never passed the point of being anything but general evaluations. For example, Thessalian pottery is considered either a local invention (*Thissen 1999a.194–195*), or a product of Anatolian indirect diffusion together with painting, mud-brick houses and agriculture (*Schubert 1999. 201*). Anyhow, judging from the Illipinar X radiocarbon dates, the earlier sites in Western Turkey seem considerably later than the Thessalian ones (*Thissen 1999b.31*). In this respect it is difficult to accept the hypothesis proposed by Özdoğan that the settlement in Western Anatolia, the Aegean and the Balkans are but different episodes of a single drama, the "exodus" of the late PPNB or PPNC of egalitarian farmers, shedding behind them the tyranny of centralized authority (*Özdoğan 1997.16–17; Özdoğan and Gatsov 1998*). If we are going to deal with the game of migrations we should keep in mind that migrations happen – and have happened in the Aegean – in both directions.

CONTENT AND INTERPRETATION

Throughout the preceding section I have avoided to discuss in any detail the content of the term "Neolithic". In ascribing meaning to this term we are very much within the broad influence of Childe's early emphasis on food production and of his "Neolithic Revolution". Childe was the first to shift the meaning from an implicitly social evolutionary perspective of the 19th century to a socio-economic one, combining it with the biological (i.e. domestication) and the chronological. For Childe (*1936*) the "Neolithic Revolution" was a paradigmatic transformation of the productive forces, which led to a radical change in the mode of production, following the Marxist model of the pre-War period. However, for reasons that are besides the point of this paper, the socio-economic dimension of this change was marginalized by Childe's successors, especially in eastern countries, which retained the chrono-biological part of the argument (*Zvelebil 1998.2*). The Neolithic economy, in this sense, became almost identical to the domestication and exploitation of plants and animals. It follows that their apparent absence in Greece would seem enough to elucidate the emergence of the Neolithic, as a whole. Following this reasoning, the understanding of the origins of the Neolithic would be identical to the definition of the origins of domesticates.

Naturally, it would be absurd to maintain that we should not somehow account for the presence of "exotic" domesticates in Greece. The theoretical point is, however, that the question acquires central, exploratory importance only within a framework that perceives the Neolithic exclusively as domestication of plants and animals. Otherwise, we can assume that some domesticates were available one way or another in the beginning of the 7th millennium in Greece, either through local domestication (e.g. einkorn wheat, barley, goat, bovines, pig, etc.) – if such a process ever proves to have taken place – or carried with people moving to and from Anatolia, in a continuous interaction with the less mobile segment of the population, for instance through the obsidian exchange network and the knowledge of the sea ways in the Aegean (*Perlès 1989*). Or even the other way round, farmers with domesticates resuming a foraging economy. Therefore, it is this choice rather than the actual fact of using domesticates or substituting wild resources with domesticates that should be the focus of explanation and in this respect it is useful to remember that it happened in a piecemeal way and over a period of several centuries (*Halstead 1996.297*). If the element of choice, a contingent and unpredictable process, grounded in history is not taken into consideration, the domestication issue becomes an essential quality of the Neolithic. A lot of confusion in the relevant arguments comes from this essentialist understanding of the Neolithic, a legacy from earlier, Childean, cultural approaches.

Instead of laying emphasis on the simple presence of domesticates (as the constituting ingredient of agriculture) let us see the problem of the Neolithic transition as a problem of fluid boundaries created in social practice in the sense described by Barth (*1969*). From this point of view choices and decisions acquire a much more central significance as they are tightly connected to practice (*Hodder 1992; Preucel and Hodder 1996*) and can be seen as creating boundaries between foragers and farmers deeply embedded in economic and political relations. The forager/farmer boundaries involve new material, social and ideological categories and therefore represent a fundamental conversion of the social identity of the foragers alongside farmers and vice versa. People create their identities not by drawing boundaries to separate "...'something' from nothingness, but rather ... two 'somethings'..." (*Barth 1969.14–15*) and in this sense boundaries can be seen as a continuous process of becoming Neolithic farmer, a process which presupposes the Mesolithic forager and the hunter-gatherer.

Barth has also underlined how boundaries become more pronounced in situations of conflict and competition. This brings us to the question of defining situations of stress or crisis, a familiar archaeological explanatory device with a long lineage (*e.g. Binford 1983.195–213*). From this point of view it would be very crucial to define socially embedded practices of competition and conflict, and trace their recognizable signatures in the archaeological record. It is true that the notion of external crisis or stress in archaeology has been criticized long ago for having a particularly strong systemic functionalist aspect (*Hodder 1982*) and seems today rather parochial. Much more promising is the perception of conflict within the structural elements of Mesolithic/Neolithic social groups. It is well-known that groups of hunter-gatherers are based on economies that do not produce exchange values (*Sahlins 1972.68; Bender 1978.209*) and therefore sharing – as opposed to hoarding – plays a central role (*Zvelebil 1998*). For the Batek De' of Malaysia "the obligation to share food is one of the fundamental components of Batek self-identity and one of the main bonds that link Batek families together as a society" (*Endicott 1988.127*). Hunter-gatherer groups rely on a network of obligations and alliances of a reciprocal character, operating at different levels of integration, such as kinship or social storage (*Bender 1978; Ingold 1980; O'Shea 1981*). Ingold (*1988.278*) shows how production itself is organized on an individual basis, and although some cooperation is always present "hunter-gatherers act as self-conscious agents endowed with subjective intentionality". Gibson (*1988.176*), for example, discussing meat sharing, points out how the "owner" of the animal, who has the right to distribute the meat, is the one whose arrow first penetrates the animal. This "individuality" is respected even when a hunter has used someone else's arrow giving him the right to share the animal. The obligation of sharing therefore, the collective appropriation, seems to run in the opposite direction of the mode of subsistence, which, as Ingold demonstrates, although taking place within a context of some cooperation, is predominantly individualistic.

This residing conflict and its repercussions must have left their mark on the whole society, especially in times of economic crisis and reduced availability. In Tikopia, Firth reports the dramatic decrease in sharing and the fivefold increase in theft as a result of famine conditions (*Sahlins 1972.127–130*). For the Pintupi Aborigines, even in everyday, normal conditions, there is a constant "tension between a valued autonomy and the claims and necessity of shared identity". This tension leads to concealing things to withdraw them from the network of sharing and is closely related to concepts of ownership and personal obligations (*Myers 1988.59, 56*). To make things somewhat clearer we can say that in the hunter-gatherer social universe the part based on individual production represents autonomy, the liability of fission and the immediate returns of labour. By contrast, the part based on collective appropriation and sharing represents shared identities, stability, social cohesion and delayed returns (*Woodburn 1988*). We can safely assume that buffering the effects of this tension would be essential for the conservation and expansion of the network of reciprocity, vital for group survival and that hunter-gatherer groups would be engaged in a continuous effort to control this potentially destructive conflict. It is this process that would constantly redefine the forager/farmer boundary in Barth's terms. But we have to perceive this boundary not in any deeply structural or functional sense, but simply as an answer to a real problem of daily practice, which under certain conditions may have become occasionally more acute. In this sense the short-term of particular instances and the long-term of the Neolithic as an historical process are equally important.

This approach disengages the Neolithic of Greece from its usual archaeological referents i.e. domesticates (*e.g. Hansen 1991*) and material culture (*e.g. Perlès 1988*). In this sense, it follows closely the concept of domus, introduced by Hodder (*1990.12; 1998*) with its emphasis on the house and on domestication of the wild as "a metaphor and mechanism for the control of society". For the way followed to supersede the conflict described above was twofold: (a) intensifying the production to ease the tension on collective appropriation, and (b) making production more collectively oriented by introducing the household and its control over part of resources, land and staples. Both point to agriculture as a way to control society and its conflicts and as such, agriculture is far more than domestication: although dependent on it, agriculture is produced by the agency of people in constructing identities, relations of ownership control and power. This they do by manipulating their resources, material or conceptual.

CONCLUSIONS

The point made in the above discussion was that the transition to the Neolithic in Greece couldn't be described solely in terms of a straightforward economic process. Of course, I can see no way to understand the "economic" as a self-defined domain, separate from practice and agency. Recent critical discussion on the Neolithic transition has described "economic" approaches as overemphasizing one of the equally possible aspects of change (*Pluciennik 1998. 77*), but usually the concept of "economic" (and /or subsistence) is disappointingly narrow and inadequately informed by the relevant discussion outside archaeology. Economy is usually ascribed under the general label of "materialism" – as opposed to "ideology" – and is often linked to "Marxist" claims for the precedence in the last instance of the economy. In so doing, discussion seems to reinstate the obsession with the opposition between the objective and the subjective. I take a rather different view on this issue that is closer to Marx's first thesis on Feurbach, a view that restores the close relation between the materiality and the subjectivity of human practice: The chief defect of all hitherto existing materialism – that of Feurbach included – is that the thing, reality, sensuousness, is conceived only in the form of the object or of contemplation, but not as *human sensuous activity*, *practice*, not subjectively. Hence it happened that the active side in contradistinction to materialism was developed by idealism – but only abstractly, since, of course, idealism does not know real, sensuous activity as such. (Original emphasis)

To return to the Mesolithic/Neolithic transition in Greece, it is plainly obvious that no exclusive interpretation, either economic or quasi-historical such as migration, diffusion and the like, can deal effectively with the complexity and the variability of human practice in the post-glacial era. The Neolithic was not a one-way street once the first domesticates arrived in the Greek peninsula together with some people who knew what to do with them. Nor was the Mesolithic somehow pre-destined to become Neolithic, as if history follows by necessity the path of the rigid evolutionary stages prescribed by the 19th century ideas. I have proposed here that a lot of crucial information is probably hidden in short-term sites, representing the initial attempts at the Neolithic way of life – and I do not mean here necessarily steps towards the biological domestication of wild plants and animals. In general terms, it can be argued that the domestication concept is repeated every time a farmer sows a field, so the archetypical action of domestication is to a large extent a conceptual abstraction of research. As a working hypothesis, these short-term sites might provide clues for the scale and form of the selective manipulation of novel resources discussed extensively in the previous section and might help on the identification of the new categories and identities thus created. The example of Theopetra certainly proves that this is not an unreasonable expectation and gives much hope that these sites will be a reality in Thessaly – or elsewhere in Northern Greece – in the near future. To this end intensive research suitably organized is a first priority (*Andreou, Fotiadis and Kotsakis 1996.596–597*). Besides, the incapability of research to identify affinities in material culture with any geographical part of the Near East above the level of vague resemblance indicates that the manipulation of cultural resources from the early Neolithic groups in Greece was multiple and complex, ascribing to resources variable meanings within a variability of contexts. Certainly, it did not follow the simple linear progression usually envisaged by the diffusion/migration theorists. The idea that the Neolithic groups came into Greece like proper travellers equipped with a fixed "package" containing economy and culture is obviously useless.

This of course is closely related to the notion of the Neolithic "essentials", such as domesticates, pottery, etc. Although this archaeological practice has a long tradition in defining normative cultures, it is time perhaps to consider its applicability and usefulness in the Neolithisation of Greece. In the Balkans and elsewhere in Europe, the presence of pottery in hunter-gatherer groups is well documented (*Biagi, Starnini and Voytek 1993; Budja 1996; Budja 1999*) and this evidence clearly supports the idea of a wide scale interaction among peoples inhabiting Greece in that period – each group with its own "package". This may sound a minor conclusion, one that has already been discussed to some extent for Greece (*e.g. Perlès 1989*) and for South-East Europe (*Voytek & Tringham 1989*). But we have to take into closer consideration the historical variability of this transition in which agency and construction of identity through practice are central and create meaningful categories. We have to take down archaeological observation to the micro-scale of the particular where discursive or non-discursive meanings are formed instead of dealing exclusively with the normative and the general that creates regularities. We only hope that new research in Greece will address similar issues.

REFERENCES

AMMERMAN A. J. and CAVALLI-SFORZA L. 1984. *The Neolithic Transition and the Genetics of Populations in Europe.* Princeton University Press.

ANDREOU S., FOTIADIS M. and KOTSAKIS K. 1996. Review of Aegean Prehistory V: The Neolithic and Bronze Age of Northern Greece. *American Journal of Archaeology 100: 537–597*.

BARTH F. 1969. *Ethnic Groups and Boundaries*. Little Brown & Co., Boston.

BENDER B. 1978. Gatherer-Hunter to Farmer: A Social Perspective. *World Arcaheology 10: 204–222*.

BIAGI P., STARNINI E. and VOYTEK B. A. 1993. The Late Mesolithic and Early Neolithic Settlement of Northern Italy: Recent Considerations. *Poročilo o raziskovanju Paleolita, Neolita in Eneolita v Sloveniji XXI: 45–67*.

BINFORD L. 1983. *Working at Archaeology*. Academic Press, New York.

BLOEDOW E. F. 1991. The 'Aceramic' Neolithic Phase in Greece Reconsidered. *Mediterranean Archaeology 4: 1–43*.

BONSALL C. (ed.) 1989. The Mesolithic in Europe. *Papers Presented at the Third International Symposium. John Donald Publishers Ltd, Edinburgh.*

BUDJA M. 1996. Neolithisation in the Caput Adriae Region: Bwetween Herodotus And Cavalli-Sforza. *Poročilo o raziskovanju Paleolita, Neolita in Eneolita v Sloveniji XXXIII: 61–76*.

1999. The Transition to Farming in Mediterranean Europe – an Indigenous Response. In M. Budja (ed.), *Documenta Praehistorica XXVI: 119–141*.

CAUVIN J. (1994) 2000. *The Birth of the Gods and the Origins of Agriculture*. Translated by Trevor Watkins. Cambridge University Press.

CHAPMAN J. C. 1989. Demogrpahic Trends in Neothermal South-East Europe. In C. Bonsall (ed.), *The Mesolithic in Europe. Papers Presented at the Third International Symposium: 500–515*.

1994. The Origins of Farming in South East Europe. *Préhistoire Européenne 6: 133–156*.

CHILDE V. G. 1936. *Man Makes Himself.* Watts. London.

COLEMAN J. 1993. Greece, the Aegean, and Cyprus. In R. W. Ehrich (ed.), *Chronologies in Old World Archaeology: 247–279*.

DEMOULE J.-P. and PERLÈS C. 1993. The Greek Neolithic: A New Review. *Journal of World Prehistory 7(4): 355–416*.

DENNELL R. 1983. *European Economic Prehistory: A New Approach*. Academic Press, London.

ENDICOTT K. 1988. Property, Power and Conflict Among the Batek in Malaysia. In T. Ingold, D. Riches and J. Woodburn (eds.), *Hunters and Gatherers. Property, Power and Ideology: 110–127*.

GIBSON T. 1988. Property, Power and Conflict Among the Batek in Malaysia. In T. Ingold, D. Riches and J. Woodburn (eds.), *Hunters and Gatherers. Property, Power and Ideology: 165–179*.

GRONENBORG D. 1999. A Variation of a Basic Theme: The Transition to Farming in Southern Central Europe. *Journal of World Prehistory 13(2): 123–210*.

HALSTEAD P. 1989. Like Rising Damp? An Ecological Approach to the Spread of Farming in South East and Central Europe. In A. Milles, D. Williams and N. Gardner (eds.), *The Beginnings of Agriculture, BAR International Series 496: 23–53*.

1996. The Development of Agriculture and Pastoralism in Greece: When, How, Who, and What? In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 296–309*.

HANSEN J. M. 1991. *The Palaeoethnobotany of Franchthi Cave. Excavations at Franchthi Cave, Greece.* Indiana University Press, Bloomington & Indianapolis.

HEUN M., SCHAFER-PREGL R., KLAWAN D., CASTAGNA R., ACCERBI M., BORGHI B. and SALAMINI F. 1997. Site of Einkorn Wheat Domestication Identified by DNA Fingerpinting. *Science 278 (14. November): 1312–1314*.

HIGGS E. and JARMAN M. 1969. The Origins of Agriculture: A Reconsideration. *Antiquity 43: 31–41.*

HODDER I. 1982. Theoretical Archaeology: A Reactionary View. In I. Hodder (ed.), *Symbolic and Structural Archaeology: 1–16*.

1990. *The Domestication of Europe*. Routledege, London.

1992. *Theory and Practice in Archaeology*. Routledge, London and New York.

1998. The Domus: Some Problems Reconsidered. In M. Edmonds and C. Richards (eds.), *Understanding the Neolithic of North-Western Europe: 84–101.*

INGOLD T. 1980. *Hunters, Pastoralists and Ranchers*. Cambridge Univeristy Press, Cambridge.

1988. Notes on the Foraging Mode of Production. In T. Ingold, D. Riches and J. Woodburn (eds.), *Hunters and Gatherers. History, Evolution and Social Change: 269–285*.

KOTSAKIS K. 1992. *The Neolithic Mode of Production. Native or Settler?* Diethnes Synedrio gia tin Arhaia Thessalia sto mnimi tou Dimitri R. Theochari. TAPA, Athina.

KYPARISSI-APOSTOLIKA N. 1998. The Significance of Theopetra Cave for Greek Prehistory. *Prehistoire d' Anatolie, Genese de Deux Mondes: 241–52*.

1999. The Palaeolithic Deposits of Theopetra Cave in Thessaly (Greece). In G. Bailey, E. Adam, E. Panagopoulou and K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas: 232–239*.

LAMBECK K. 1996. Sea-Level Change and Shore-Line Evolution in Aegean Greece Since Upper Palaeolithic Time. *Antiquity 70: 588–611.*

MILOJČIĆ V. 1960. *Hauptergebnisse der Deutschen Ausgrabungen in Thessalien 1953–1958*. Rudolf Habelt Verlag, Bonn.

MYERS F. 1988. Burning the Truck and Holding the Country: Property, Time and the Negotiation Identity Among Pintupi Aborigines. In T. Ingold, D. Riches and J. Woodburn (eds.), *Hunters and Gatherers. Property, Power and Ideology: 52–94*.

O'SHEA J. 1981. Coping with Scarcity: Exchange and Social Storage. In A. Sheridan and G. Bailey (eds.), *Economic Archaeology. BAR International Series 96: 167–183*.

ÖZDOĞAN M. 1997. The Beginnings of Neolithic Economies in Southeastern Europe: An Anatolian Perspective. *Journal of European Archaeology 5(2): 1–33*.

1999. Northwestern Turkey: Neolithic Cultures in Between the Balkans and Anatolia. In M. Özdoğan and N. Basgelen (eds.), *Neolithic in Turkey. The Cradle of Civilization: 203–224*.

ÖZDOĞAN M. and GATSOV I. 1998. The Aceramic Neolithic Period in Western Turkey and the Aegean. *Anatolica 24: 209–232*.

PERLÈS C. 1989. La Neolithisation de la Grece. In O. Aurence and J. Cauvin (eds.), *Neolithisations, BAR International Series 516: 109–127*.

1988. New Ways with an Old Problem. Chipped Stone Assemblages as an Index of Cultural Discontinuity in Early Greek Prehistory. In E. French and K. Wardle (eds.), *Problems in Greek Prehistory. Papers Presented at the Centenary Conference of the British School of Archaeology at Athens, Manchester, April 1986: 479–488*.

1990. *Les Industries Lithiques Taillees de Franchthi (Argolide, Grece). Les Industries Du Mersolithique et Du Neolithique. Excavations at Franchthi Cave, Greece.* Indiana University Press, Bloomington & Indianapolis.

PLUCIENNIK M. 1998. Deconstructing 'the Neolithic' in the Mesolithic-Neolithic Transition. In M. Edmonds (ed.), *Undesrstanding the Neolitihc of North-Western Europe: 61–83*.

PREUCEL R. and HODDER I. (eds.) 1996. *Contemporary Arthaeology in Theory*. Blackwell Publishers Ltd, Oxford.

RUNNELS C. 1995. Review of Aegean Prehistory IV: The Stone Age of Greece from the Palaeolithic to the Advent of the Neolithic. *American Journal of Archaeology 99: 699–728*.

1996. The Palaeolithic and Mesolithic Remains. In B. Wells (ed.), *The Berbati-Limnes Archaeological Survey 1988–1990: 23–35*.

RUNNELS C., van ANDEL T. H., ZACHOS K. and PASCHOS P. 1999. Human Settlement and Landscape in the Preveza Region (Epirus) in the Pleistocene and Early Holocene. In G. Bailey, E. Adam, E. Panagopoulou and K. Zachos (eds.), *British School at Athens Studies: 120–129*.

SAHLINS M. 1972. *Stone Age Economics*. Aldine, New York.

SCHUBERT H. 1999. *Die bemalte Keramik des Fruhneolithikums in Südosteuropa, Italien und Westanatolien*. Internationale Archaologie. Bd 47. Verlag Marie Leidorf, Rahden/Westf.

TELLENBACH M. 1983. Materialen Zum Prakeramischen Neolithikum in Süd-Ost-Europa. *BeRZK: 23–137*.

THEOCHARIS D. 1967. *I Avgi Tis Thessalikis Proistorias (The Dawn of Thessalian Prehistory)*. Filarhaios Etaireia Volou, Volos.

1973. *Neolithic Greece*. National Bank of Greece, Athens.

THISSEN L. 1999a. *Early Village Communities in Anatolia and the Balkans: Studies in Chronology and Culture Contact*. Unpublished Ph.D. dissertation.

1999b. Trajectories Towards the Neolithisation of NW Turkey. In M. Budja (ed.), *Documenta Praehistorica XXVI: 29–39*.

TOUFEXIS G. 1994. Anaskafi sto Neolithiko Oikismo Kremastos sto Nomo Grevenon. *AEMTh 8: 17–26*.

TRINGHAM R. 2000. Southeastern Europe in the Transition to Agriculture in Europe: Bridge, Buffer, or Mosaic. In T. Douglas Price (ed.), *Europe's First Farmers: 19–56*.

van ANDEL T. H., GALLIS C. and TOUFEXIS G. 1995. Early Neolithic Farming in a Thessalian River Landscape, Greece. In J. Lewin, M. G. Macklin and J. C. Woodward (eds.), *Mediterranean Quaternary River Environments: 131–143*.

van ANDEL T. H. and RUNNELS C. N. 1995. The Ealiest Farmers in Europe. *Antiquity 69: 481–500*.

van ANDEL T. H., ZANGGER E. and DEMITRACK A. 1990. Land Use and Soil Erosion in Prehistoric and Historical Greece. *Journal of Field Archaeology 17: 379–396*.

VOYTEK B. A. and TRINGHAM R. 1989. Rethinking the Mesolithic: The Case of South-East Europe. In C. Bonsall (ed.), *The Mesolithic in Europe. Papers Presented at the Third International Symposium: 492–499*.

WEINBERG S. 1965. The Stone Age in the Aegean. In I. Edwards, C. Gadd and N. Hammond (eds.), *The Cambridge Ancient History: 557–618*.

WILKIE N. C. and SAVINA M. E. 1997. The Eraliest Farmers in Macedonia. *Antiquity 71: 201–207*.

WOODBURN J. 1988. African Hunter-Gatherer Social Organization: Is It Best Understood as a Product of Encapsulation? In T. Ingold, D. Riches and J. Woodburn (eds.), *Hunters and Gatherers. History, Evolution and Social Change: 31–64*.

ZAMANIS A, SAMARAS S., STAVROPOULOS N. and DILLE J. 1988. *Report of an Expedition to Rescue Germplasm of Wild Species of Wheat and Relatives in Greece*. Greek Gene Bank Scientific Bulletin. North Greece Agricultural Research Centre.

ZVELEBIL M. (ed.) 1986. *Hunters in Transition*. Cambridge University Press, Cambridge.

1996. Farmers Our Ancestors and the Identity of Europe. In P. Graves-Brown, S. Jones and C. Gamble (eds.), *Cultural Identity and Archaeology: 145–166*.

1998. What's in a Name: The Mesolithic, the Neolithic, and Social Change at the Mesolithic-Neolithic Transition. In M. Edmonds and C. Richards (eds.), *Understanding the Neolithic of North-Western Europe: 2–36*.

2000a. The Social Context of the Agricultural Transition in Europe. In C. Renfrew and K. Boyle (eds.), *Archaeogenetics: DNA and the Population Prehistory of Europe: 57–79*.

2000b. Transition to Agriculture in Eastern Europe. In T. Douglas Price (ed.), *Europe's First Farmers: 57–92*.

ZVELEBIL M., DENNELL R. and DOMANSKA L. (eds.) 1998. Harvesting the Sea, Farming the Forest: The Emergenace of Neolithic Societies in the Baltic Region. Sheffield Archaeological Monographs. Edited by J. R. Collis. Sheffield Academic Press, Sheffield.

UDK 903'12/'15(46)"633/634"
Documenta Praehistorica XXVIII

Re-thinking the Mesolithic-Neolithic transition in the Iberian peninsula: a view from the West

Luiz Oosterbeek[1]
Instituto Politécnico de Tomar, Landscape Management Department, Estrada da Serra, Tomar
loost@ipt.pt

ABSTRACT – *Paper focuses on Mesolithic-Neolithic transition in the Iberian Peninsula by critical review of avaliable concepts and models. The obvious diversity of archeological record is taken as a strating point. Transition in this perspective is not seen as uniform and sudden economic or demographic change but as a slow political process, where different regional groups would have been forced to share the innovations while keeping their differences.*

IZVLEČEK – *Članek obravnava prehod iz mezolitika v neolitik na Iberskem polotoku s kritičnim pretresom obstoječih modelov in konceptov. Izhodišče je očitna raznolikost arheoloških zapisov. V tej perspektivi prehod ni hitra ekonomska in demografska sprememba, ampak počasen in asinhron politični proces, kjer različne regionalne skupine sprejemajo inovacije, a ob tem ohranjajo razlike.*

KEY WORDS – *Mesolithic; Neolithic; Iberia; "cardial model"; "shifting centres model"*

To discuss the Mesolithic-Neolithic transition in Iberia implies, first, the defining of the concepts. By Neolithic, or Neolithisation, we understand a set of tendencies towards an increasing intensification of resources exploitation, demographic growth, complexity of economic relations, social differentiation, technological improvement and the generation of a new ideology. It was not inevitable, however, and the main question is not how it occurred (even if this is a basic assessment), but why it occurred. In this process, one must not avoid the fact that it implied not only economic or demographic growth, but, primarily for the human groups that were involved in it, it meant more work and increasing alienation. Therefore, it was also a political process. And, using Braudel's (*1972*) notions, if the long-term is measured by the preceding infrastructure variables, the short-term, decisive changes paid tribute to social conflicts, political complexity and individual initiative. The archaeological record does not answer most of these aspects, but they remain essential, nevertheless.

In this sense, the "Neolithic" begins in the late "Mesolithic", the transition period. The evidence for this early stage in Iberia includes (*see Oosterbeek 1994*):

❶ the Muge-Cocina sequence, spanning the 7th, 6th and part of the 5th millennia[2]. This is the "geometric" Mesolithic tradition. In the top layers of the *Cave of La Cocina* (Dos Aguas) and the *Cabeço da Arruda* shell midden (Muge), sherds of pottery relate to an evolved stage of the Neolithic;

❷ the *Mallaetes* sequence, not represented in Portugal, and dominated by a bladelets industry. Some

1 Director of Landscape Management Department and Professor of Prehistory at the Instituto Politécnico de Tomar, Estrada da Serra, P-2300 TOMAR. Email: loost@ipt.pt
2 The chronology discussed always refers to calendar years BC, based on termoluminescense or calibrated radiocarbon dates.

authors relate it to a second Neolithic origin, without cardial impressed pottery;

❸ the macrolithic Mesolithic, divided into different groups of unclear chronology (Asturian, Mirian, Ancorian or Languedocian). These groups do not overlap in space with the microlithic Mesolithic, but they have no clear relation with the earliest Neolithic assemblages. Two facts must be mentioned: the presence of pottery in macrolithic sites in Alentejo (*Xerez de Baixo*) and the Tagus valley (e.g. *Amoreira, Monte Pedregoso)*, and the occurrence of macro-tools in megalithic assemblages, which could indicate some sort of relationship (even if the megaliths are basically 5th to 3rd millenium phenomena);

❹ the sites with cardial impressed pottery. These are associated with other Neolithic improvements, and dominate some coastal areas such as the Spanish Levant, part of the Algarve, the Mondego estuary, with a few inland penetrations (Nabão and Almonda valleys, and an unclear site in the Alentejo), and minor occurrences associated with other types of pottery in other coastal areas (the Alentejo coast, the Sado estuary, Andalusia, north Africa). This spread has been traditionally related to the west Mediterranean Neolithic with cardial impressed pottery, but has also suggested speculation over the relation with the Mesolithic groups in Iberia, namely the Muge shell-middens;

❺ the Neolithic sites without cardial impressed pottery that have a more variable distribution, primarily in the highlands in some areas (Andalusia), or coastal in others (Alentejo, Portuguese Estremadura), with some inland penetrations (like the Nabão valley). This group includes very old dated sites in Andalucia (e.g. *Cueva de la Dehesilla*), but also sites that are clearly older then the cardial impressed group, and some that have no clear chronology (*Rio Maior, Alcobaça or Peniche*);

❻ the earliest megalithic assemblages. M. Heleno (*1956*) identified and excavated a number of cistoid chambers, with microliths and polished stone, that were considered the earliest phase of the megaliths by V. Leisner (*1967*). None of these sites has been properly published, still less dated. However, they could date back to the late 6th millennium, having a mainly inland distribution (like the megaliths of the 5th millennium).

After the late 19th and early 20th centuries, attempts to identify the Neolithic in Iberia by L. Siret in 1890 and 1892 (the Almerian culture, after the site of *El Garcel*), N. Delgado in 1884 (*Cave of Furninha*), N. Åberg in 1921 or Cartaillac in 1886, Bosch-Gimpera (*1932*) made the first synthesis, defining four "cultures": the Almerian, the caves group (with two subgroups, from Andalusia and Estremadura), the Portuguese (megalithic) and the Pirinean. Further developments by J. Martinez Santa Olalla (*1941*) established the first links with Africa: the Spanish-Mauritanian Neolithic (including the caves), and the Iberian-Saharan Neolithic (including the Almerian). Later, a similar approach was defined by J. San Valero Aparisi (*1948*).

The excavation and publication of the cave of *Arene Candide* in Liguria became a turning point for the study of the Iberian Neolithic. The author, B. Brea (*1950*), defined for the first time a model of Neolithic expansion from the east. According to him, the Neolithic had a fast and "Hellenistic" expansion, suggesting a migration of people from the east affecting coastal areas. The cardial pottery had oriental origins in Syria and Silicia (*Tell Iudeideh, Ras Shamra, Mercin, Chagar Bazar, Arpachiyah, Ninive*), Thessally (pre-Sesklo), Greece (*Choirospilia*), Corfu (*Afiona*), Montenegro (*Crvena Stijena*), Herzegovina (*Zelena Pečina*), crossing Italy and reaching Corsica, Liguria (*Arma dell' Aguila, Arene Candide*), Southern France, Catalonia and the Spanish Levant. The penetration inland was thought to be slow, this group hardly reaching the south and west of Iberia, with few exceptions. The strong Mesolithic tradition of sites like *Coppa Navigata* in Italy would indicate local groups' interactions with Neolithic sailors.

This new approach would lead, in the late 1950's and early 1960's, to the definition of several colonisation theories, from the early Neolithic to the Chalcolithic. Meanwhile, the research provided deep stratigraphies for the whole Neolithic process, in sites like *Cueva de la Cariguela* (Andalucia), *Cova de l'Or* (Alicante) or the Muge shell middens. Interest in the problem of navigation in the Mediterranean related to the introduction of Neolithic innovations has been a subject for continuous research. The distribution of obsidian is, for the central and eastern Mediterranean, a direct form of evidence. Such evidence does not exist for Iberia, and contacts by sea with the Maghreb or other parts of the Mediterranean, before the Chalcolithic, remain hypothetical. For instance, G. Camps (*1982*) used decorative patterns to stress that the presence of cardial pottery in the Maghreb (*Achakar* group, *Idols Cave, El-Khril* caves, *Gar Cahal* and *Caf That el Gar*), always coastal, stands for contacts with Iberia, at an epicardial stage, likely with the Levant (and not Andalusia), whereas another group (Oran), would relate to Andalusia, with impressed and grooved pottery, not cardial.

Regardless of the means of distribution, the diffusionist model dominated the 1960's, and it remains one of the most widely accepted views. Among these, the wave of advance model of Ammerman and Cavalli-Sforza (*1971*) is one of the most coherent. It measured those items in a chrono-geographical frame, taking Jericho as the presumed original centre, and defining the west Mediterranean as an area dominated by impressed pottery that could be even older than domestication itself.

From the late 1960's on, following on the one hand the new approaches to territorial analysis, and on the other, the papers of the New Archaeology, namely C. Renfrew (*1979*) (even if concerning later periods), explanatory models of the Neolithic started to be built with greater tribute to the interaction of all areas of human behaviour (technological, economic, social, ideological), with each other and with the environment, while regional studies became a priority of research.

Not much is known about the environment in this period. Following isolated studies, one may assume that after a colder phase, the weather became warmer and more humid. The sea level was higher than it is today. The soils were covered by a forest of *Pinus spp.* and *Quercus spp.* trees, with a rich fauna. From the archaeological assemblages, it is known that hunting was still of major importance in the early Neolithic (including for species such as red deer, wild pig, wild cat, lynx, etc.). The earliest Neolithic sites, like *Cova de l'Or*, indicate a dietary change from proteins to carbon-hydrates. Some Neolithic sites (*Caldeirão, Or*) indicate, from the start, full domestication, but others (*Nerja*) suggest animals were domesticated before plants, and all sorts of possibilities may be found.

The vast majority of early Neolithic sites studied with stratigraphy are caves. In Portugal they are in most cases burial assemblages, although habitats are known from open-air sites (*Vale Vistoso, Vale Pincel, Salema, Forno da Cal, Várzea do Lírio,* etc.). What is known indicates a pattern of estuary or riverine groups of round or oval huts, without natural or artificial defences, corresponding to a still mobile settlement (seasonal?), unlike the east Mediterranean villages.

J. Guilaine (*1996*) points to the fact that these sites could be associated with an economy dependent on exploiting marine resources. Economic data is still limited, however, and an evaluation of these sites must still be based on other criteria. I believe that the very early Neolithic with cardial impressed pottery reached the interior at a later stage, as may be recognised in Alcobaça (and, one could add, Tomar or Torres Novas). A second phase of the Neolithic would then include sites like the cave of *Furninha* (Peniche), *Bocas I* (Rio Maior), *Casa da Moura* (Cesareda), the shell midden of *Cabeço do Pez* (Sado estuary) or *Lapa do Fumo* (Sesimbra). This phase, combining heavy decorated pottery (impressed, sometimes with cardium, with incised, plastic decoration) would be parallel, in the 5th millennium, to early megalith building, this one dominating the inland areas). Guilaine also notes strong relations between this group and the Andalusian Neolithic, and speculates on defining the origins of each of the identified groups. All in all, Guilaine proposes a model for the western Mediterranean where each region integrates itself in the world of food producers by means of its own specific process, depending on several variables (location, resources, soils potential, the characteristics of the local Mesolithic, the ability of the groups to accept certain acquisitions, etc.), even if this does not imply a multitude of original Neolithic focus. He interprets the persistence of lithic traditions and the variability of pottery types and decorative motifs as evidence for these regional groups. In this sense, the similarities between different groups in the French Midi, Andalusia or Portugal, throughout the whole Neolithic, would stand for a general evolutionary tendency, rather than for a single phenomena.

The problem of the origins of the Neolithic become even more complex with the set of sites without cardial that have been dated in the southeast from the 7th and 6th millennia: *Cova Fosca de Castellón, Abrigo Grande 2 del Barranco de los Grajos,* (Murcia), *Cueva del Nacimiento* (Jaen), *Cueva de Nerja* (Malaga), *Cueva Chica de Santiago* (Sevilla), *Cueva de la Dehesilla* (Cadiz). They have incised, corded and grooved pottery, sometimes painted (almagre, ocre, magnesium), but rarely impressed (and never cardial), blades, bladelets, rare geometric microliths, a poor bone industry, few ornaments, and domestications associated with hunting and gathering. These dates, still controversial for some archaeologists, but which are tending to be more and more coherent and numerous, prove that this early Neolithic is, at least, as old as the cardial group. It should be noted that these sites, although broadly coastal, are actually in the highlands (Sierras). This is also the case for most early Neolithic sites without cardial pottery in Portugal.

A discussion of the origins of the Neolithic in Iberia can not ignore the evidence from north Africa, which lies 13 km south of Gibraltar. A. Gilman (*1974*) identified two major groups that could relate to Iberian assemblages: Oran and northern Morocco. In Oran, early Neolithic site with an assemblages close to the Iberian early Neolithic, with impressed non cardial ware, provided radiocarbon dates from the mid 6th millennium (*Cimitière des Escargots*) and the 5th millennium (*Deux Mamelles*), whereas in a related inland site (*Columnata*) two 5th millennium dates have been obtained. There are no absolute dates in northern Morocco, but there is a stratigraphic layer with cardial impressed and grooved ware (*Achakar, Caf Taht el Gar*) (*Jodin 1959*). Stressing the problems of dating and the stratigraphic reliability of the Moroccan sites, Gilman also underlines the difference of decoration patterns between these and Andalusia: the difference of composition and virtual absence of the cardial in Andalusia, the dominance of rocker-stamping in Tangier (rare in Andalusia), the dominance of linear impressions in Andalusia (rare in northern Morocco), and the much later occurrence of the grooved ware in Iberia. Therefore, apart from an eventually vague relation to the impressed ware of the west Mediterranean, no clear links could be established with Iberia.

The Iberian Neolithic, at least in the southeast, would have been associated with irrigation works. Gilman underlines the absence of a significant difference in the early Neolithic assemblages in different areas of Spain (dry and humid), that suggests that in dry areas, the lack of water was balanced by "*regadio*" (irrigation), which became very important in the social process.

The approach by G. Camps (*1982*) uses basically the same evidence as Gilman, but draws different conclusions. He considers the differences of cardial and impressed ware from northern Africa and Iberia within the variability of the epicardial complex, although agreeing with a greater proximity to the Levant than to Andalusia. However, he maintains that the Oran pottery belongs to a different tradition of incised, impressed and grooved ware, with good typological and chronological relations with Andalusia (*Murciélagos, Nerja*) in the 6th millennium.

After Gilman's (*1975*) research, the excavation of *Ma Izza* in Atlantic Morocco, provided an interesting stratigraphy. There, Berthélémy and Accart (*1987*) recognized an early Neolithic layer with cardial impressed and incised pottery, under another layer with grooved ware. This is curious for two reasons: first, it is an unsuspected area for the occurrence of cardial pottery; second, the impressed and incised ware precedes the grooved ware. Also, both layers are pit burials, dug and reinforced with stones. This pattern is not very different from what is to be observed in many Iberian regions in the 5th millennium, and makes us rethink the problems of stratigraphic interpretation of *El-Khril, Gar Cahal* and other Northern Morocco sites.

According to J. Lewthwaite (*1986*), the transition to the Neolithic in the west Mediterranean was slow, due to a system where seasonal crops became complementary to hunting and gathering, together with sheep and goat-herding. The village mode of social organisation was not adopted, and macro-tools continued to be used. This "contradiction" could be a result of animals, as well as pottery, being prestige goods. Also, the islands may have worked as a filter of the eastern Neolithic package, due to the restrictions of the insular landscapes and environment.

Considering an older Neolithic in the Italian peninsula, Lewthwaite proposed three processes of diffusion that could have taken place. The first is the traditionally accepted European coastal one, bearing a major Cardial/Ligurian influence. The second would reach Iberia following an open sea voyage, for which evidence is found at early Neolithic island sites. The Neolithic package in these islands would be adapted to the natural conditions of the islands, namely steep mountains, thus being filtered to the profit of pastoralism over agriculture, this filtered version being that which reached southern Iberia. A third model implies a north African diffusion from Italy to Tunisia (which does not imply more than 70 km by direct sea route), passing through Morocco before reaching Iberia or not. These alternative routes would explain the existence of two types of the earliest Neolithic in Iberia.

Following similar reasoning to Guilaine's, but integrating the newly dated sites, M. Pellicer and P. Acosta (*1982*), discussed the possibility of different natures for the two main early Neolithic groups: the Cardial (from the Levant) and the Andalusian (from *Dehesilla, Mujer,* etc.). The former could be a direct result of the impact of the Southern France cardial, whereas the later could be of local origin to a greater extent, becoming powerful enough to influence other areas of Iberia, such as the Spanish Meseta or Portugal.

In this discussion, the radiocarbon dates tend to be a major concern of many scholars. Based on the recent studies of important sites from the Levant, such as *Cova de l'Or, Cueva de la Sarsa* and *Cova de les Cendres*, M. Oliver (*1987*) considers two stages in the Early Neolithic, a cardial and an epicardial, the latter being different from the French, and characterized by the rarity of the cardial impressed pottery, and a general decay in the quality of the fabric and decoration of potteries. Both stages would date from the 6th millennium, this epicardial also corresponding to the early Neolithic layers of sites from the Levant and Andalusia (thus refuting the 7th millennium dates obtained for some of those sites).

After their research on the early Neolithic sites of Sines in the Alentejo coast (*Vale Pincel I, Salema, Vale Vistoso*), Tavares da Silva and J. Soares (*1987*) identified two Early Neolithic layers that they consider both excluded from the cardial network, and relates to the Andalusian Neolithic, namely *Cueva de los Murcielagos*. While agreeing with Marti, they consider also the possibility of two separate Neolithic processes with a similar chronology, the non-cardial being of major importance in Andalusia and Portugal.

These assemblages, together with the Sado estuary, have been the basis for J. Arnaud (*1982*) proposing two alternative models. Model A considers a first phase of the Mesolithic population in the mid-Sado valley, with episodic incursions to the coast or the interior in critical periods. A second phase would correspond to a mobile frontier between these Mesolithic people and the newly arriving Neolithics, which would nevertheless retain fishing and hunting as the main subsistence activity. Sedentism and agriculture would generate population growth, the occupation of the best agricultural lands (without the abandonment of others) and the gradual disappearance of the mobile frontier. The final phase would correspond to the emergence of proto-megaliths (cists). Model B considers for the first phase a seasonality of occupation of coastal (Autumn-Winter) and mid-Sado (Spring-Summer) sites, followed by the arrival of Neolithic innovations, when the shell-middens would still have been seasonally occupied by part of the population, the majority of which would settle in the coast, combining hunting, fishing and farming (*Vale Pincel 1*, etc.). Phase 3 would still have the occupation of the middens, the lithic variability indicating the specialization of the sites. The last phase would be similar to model A, thus considering the megaliths as a result of coastal population growth and subsequent occupation of the interior.

R. Chapman (*1988*) discussed these views, suggesting the possibility that the major population concentration was already to be found inland (Alentejo), due to the problems of diseases and flooding in the estuaries. He refused to see long-distance interaction as a major stimulus for complexity, as well as the implication that similar structures in distant areas are indicative of that interaction.

Pushing further the approach to regional variability, S. Jorge (*1990*) pointed out that the fitness of some Mesolithic groups prevented Neolithic improvements until the late 5th millennium. It would be the case of the shell-middens of the Tagus and Sado estuaries, which relied on the marine and terrestrial resources. This author suggests differences within this broad strategy between the two areas, the Muge sequence, including large mounds that indicate several generations of occupation (apart from the visual impact of these middens), with a richer assemblage of lithics (microliths of Mediterranean type, including strong regional variants), antler and bone, whereas the Sado middens are smaller and without typical regional artifacts. The marginal occurrence of pottery in the top of the Muge sequence also would contradict the Sado acceptance of this item and point to a greater persistence of the Mesolithic in the Tagus valley.

I would note, at this stage, that the importance of marine resources was not merely coastal, as the cave Mesolithic shell-midden of *Lapa do Papagaio* (near Fátima) proves. This site also has the importance of drawing our attention to the complexity of exchange routes between coastal and inland areas, as early as the 9th millennium, since it is a huge cave shell midden, 40 km inland, at the top of the limestone massif: clearly a ritual site, indicating a very complex behaviour pattern.

Entering the debate concerning the origin of the Neolithic, S. Jorge (*1990*) stressed the distinction between the Alentejo sites, with rare cardial pottery, and those at Mondego, Estremadura and Ribatejo, much closer to the cardial of the Spanish Levant. This picture suggests "influences" from different Iberian groups over the first Neolithic populations of Portugal (that are also contemporary with the Mesolithic shell middens, and without stratigraphic continuity). Following Zvelebil's and Rowley-Conwy's model (*1986*), S. Jorge considered that the second half of the 6th millennium could correspond to the availability phase, with a network of information uniting both Mesolithic and Neolithic populations. Only in the late 6th and in the 5th millennium would one observe the substitution phase, with less coastal and increasingly inland sites (towards soils with higher arable potential), the occurrence of Neolithic items in the Sado and Muge shell-middens (pottery and lithics, as in the layer III of *Cocina*), new artefact types (retouched blades and bladelets, an increasing number of polished stone tools, incised and plastic pottery decoration, and domestic animals. From this process would eventually emerge, in the 5th millennium, the first proto-megaliths.

As I have mentioned, apart from details, there are the two basic theories explaining the origins of the Neolithic in Iberia. Whereas some, although interested in the local and region variability, stress links with the Mediterranean, others take this variability as a starting point.

It is obvious the basic problem, on which everyone agrees, is the lack of evidence to unscramble what J. Lewthwaite (*1952*) called the "cardial disorder". If one removes from the record all sites that did not have good stratigraphies or were badly excavated, one might end up with very few, or close to none. Tomar provided probably the best Portuguese sequence for the early Neolithic, and I think its study casts new light on the issues considered above.

One aspect seems to be accepted by all the models mentioned: the extreme variability associated with elements of resemblance. Everything points to a mosaic of groups that, although keeping their differences, do share a similar path. C. Runnels and T. H. van Andel (*1982*) proposed the existence of an information network born of the need for information about unstable weather, different resources, etc., which generated a centre/periphery relation in the Holocene. In fact, this unity/diversity dialectic is already present in the Mesolithic, in the relations of *Moita do Sebastião* and *Cocina I*, and the affiliation of the *Cocina* sequence with the Sauveterrian and Castelnovian complexes.

It has been discussed to what extent the early Neolithic represents a major break with the Mesolithic. As we have mentioned, scholars have recognised the importance of the Mesolithic tradition in the early Neolithic assemblages, even if they differ in its interpretation. From our point of view, it is clear that there is not a moment of simultaneous discontinuity (as the synchronic sequences of the shell middens and early Neolithic sites indicate), but the introduction of a new socio-economic structure, even if marginal at first, which marks a change in the generic process. The different regional groups would have been forced to share the innovations.

This, however, is still a period of economic variability, social continuity and political dispersion. It only announces a new cycle of increased differentiation which becomes clear in the 4th millennium.

The two basic perspectives are conditioned by various theoretical plans. On the one hand there are authors who understand the Neolithic process pre-eminently as a phenomenon of alogeneous origin, and for whom the Neolithic and Mesolithic concepts are, fundamentally, diverse. Following the pioneer work of J. Guilaine and V. Ferreira (*1970*), the main defender of this perspective, which we will call the "cardial model", is J. Zilhão (*1992*).

The coherence and simplicity of the diffusionist perspective is not to be found in the other perspective. In fact, the Mesolithic and the Neolithic, especially in their long-lasting coexistence, may be conceived as fundamentally associated, or as a single and integrated complex system. Various models may derive from this perspective, expressed in the defence of the originality of some contexts, or in the search for polygenetic origins for Neolithisation, or still in the refusal to accept the cardial ceramics or any other item (including the domesticated fauna and flora) as a major indicator.

The defenders of the first perspective try to emphasise the clarity of their statements, disdaining the apparent "confusion" of the remaining. They say that in science we proceed with univocal statements, and that their proposals are supported by irrefutable documents. Furthermore, they try to emphasise the archaeo-graphic weakness of their "opponents" (*Guilaine 1996; Zilhão 1997*).

As defenders of a dialectical and plural view of the Neolithic process, with this contribution we want to emphasise two essential aspects: the archaeo-graphic basis of the cardial model can not be understood in a univocal way; and theoretical simplicity does not allow an explanation of important "irregularities" in the archaeological record.

Let us take, for example, the problem of the Mesolithic/Neolithic transition in Western Iberia, and particularly in the Alto Ribatejo. The "Alto Ribatejo" (North Ribatejo) is a region of central Portugal, characterised by the merging of three different geo-morphological units: the limestone massif of Estremadura, to the west; the Miocene basin of the Tagus, with its quaternary terraces, to the south; and the granites and schists from the "Beiras", to the east (which will form the Spanish "Mezeta"). It is a region that finds its unity in the diversity of landscapes and natural and cultural resources, and through the connection of the main rivers (the Tagus, Zêzere and Nabão) that constitute a sort of skeleton of the region.

Several sites (*see Cruz 1992; 1993; 1995; 1997*) related to the Mesolithic and early Neolithic have been excavated in this region: *Povoado da Amoreira* (Mesolithic/Early Neolithic), the open-air site of *Santa Cita* (Mesolithic) (*Bicho 1997.10–29*), several caves with early Neolithic burials (*Gruta do Caldeirão, Gruta de Nossa Senhora das Lapas, Gruta do Almonda*) and an early passage-grave (*Anta 1 de Val da Laje*) (*Drewett et al. 1992*).

The *Gruta do Caldeirão* was the subject of a very detailed and well presented monograph in 1992 by J. Zilhão, who has built from it a Portuguese version of the "cardial model" (*Zilhão 1992*).

In short, the earliest Neolithisation of western Iberia would have taken place in Estremadura, as a new colonisation of a type of ecosystem abandoned by people since the end of the upper Palaeolithic, by groups already adapted to the new agricultural and pastoral economic model. The Estremadura, uninhabited, would have been available for this change and would have constituted a "cardial" enclave, around which the Mesolithic shell middens would persist. Different ecosystems would correspond to various economic models, accepting the Neolithic process as a colonisation beginning in the littoral.

In this model, the key element is the evaluation that is made of other sites attributed to the early Neolithic in the Iberian Peninsula. J. Zilhão systematically questions the validity of the interpretation of stratigraphic sequences in various Neolithic places in Spain, and continually valorises the contexts with cardial ceramics, particularly the "*Cova de l'Or*". Actually, this methodology, extends to several sites in Portugal; this is how J. Zilhão and A. Carvalho (*1998*), initially leave out sites like *Nossa Senhora das Lapas* (with a dated context very similar to the non-cardial early Neolithic of the *Gruta do Caldeirão* (*Oosterbeek 1993*)), or like Set (*conjunto*) 4 of *Buraca Grande* (excluded because of not have decorated ceramics), while dates without closed stratigraphic contexts are included, like those from the *Algar do Picoto* or from the *Casa da Moura*. This is, as one may notice, a clear option: preferring the model rather than the "pressure" of the archaeological record; valorising evidence according to the pre-defined model.

In the same work from 1995 the conclusion is repeated: the absence of Mesolithic sites similar to the *Muge* industries (except for *Forno da Telha*, in Rio Maior) would confirm the secondary character of the human settlement in Estremadura during that period. It is that the authors indicate, regarding open-air sites, the predominance of quartz and quartzite industries over flint and chert, without establishing, nevertheless, their correlation, which I consider more logical, with pre-Neolithic industries of an identical nature.

A similar approach, with the recurrent use of the notion of a hiatus between the Epipaleolithic and the early Neolithic, is made by J. Guilaine, who was, in fact, the first author responsible for the modern introduction to Portugal of the "cardial paradigm" (*Guilaine and Ferreira 1970*). In his recent revision of the Neolithic process in the western Mediterranean, Guilaine (*1996*) argues against "very low Epipaleolithic dates" and "very high dates for ceramic contexts", suggesting a hiatus in the sequences of *Araguina Senola* (*Corsica*), of *Corbeddu* (*Sardinia*), or of several, *Andaluzia* sites, while subscribing to Zilhão's model of Portugal.

It happens that the cardial model, presented in various publications, is an excellent example of an induction exercise, whose limited overtaking we discussed elsewhere. On a pure theoretical-methodological basis, in its extreme version as offered by J. Zilhão, it is a model that argues from a theory based on one site (the *Gruta do Caldeirão*, in spite of mentioning others), against theories that are landscape and multi-site based. Alternatively, J. Guilaine bases his reasoning on a selection of "key sites", but the procedure is, in the end, the same. In order to do so, it questions all the remaining sites that are then grouped into two categories: those that, although even if without a clear stratigraphy, may be accepted (those that integrate, in the collection, cardial ware), and those that are considered as inaccurately excavated (those that, although having early absolute dates, or alleged stratigraphic sequences, do not have cardial ware).

What has been discussed requires a return to the question of the Neolithic process model. Should we accept the priority of the diffusion mechanism, or of the evolutionary mechanism? I think this is a false question. I previously defended (*Oosterbeek 1994*) a multi-linear evolution model with what I called "shifting centres". It is, in a certain way, the same idea that V. Garcia (*1997*) proposes, after the notion of reciprocity between groups, by suggesting a Neolithic "capillarity" process, or from what we can deduce, although for a more recent period, from the study on the distribution of jadeite polished axes in Europe (*Pétrequin et al. 1998*). The most recent data, again, makes it difficult to separate, chronologically, the Early Neolithic (except for the pre-cardial layers) and even Middle Neolithic occupations. There is a difference in material culture, but there is a superimposition of dates, and there are no arguments strong enough to make the option in favour of a chronological, rather than geographical or "cultural" differentiation. The choice of identifying a "first stage" of the Neolithic process, grouping all this evidence, suggested by A. R. Cruz (*1997*), still seems, from an archaeological point of view, the most cautious.

The Neolithic process must have been a process without sudden discontinuities, marked by many inter-group articulation mechanisms, sharing a general tendency, but nevertheless without any of the elements of the so-called Neolithic package being indispensable; a process in which the novelties are accepted by some groups (as *V. Garcia 1997* suggests), or socially imposed in some cases. In fact, when reading J. Guilaine's balance once again (*1996*), what seems to stand out is that the cardial model is limited to two areas (the French Midi and Valencia) and, above all, the fact that in the insular and southern contexts there are, frequently, very early dates for Neolithic contexts without cardial (!). However, it occurs that the type of model we are suggesting is not easy to test in archaeology. Ultimately, it is so diffuse, that archaeological evidence that could confirm or invalidate it will never be found. Is this a useless model, then? No! It simply belongs to prehistoric and not to archaeological research. It is refutable and possible to test in the logical and palaeoanthropological comparison domain, and not in the contextual description domain.

We are again in a paradoxical situation which recalls Markosian's (*1996*) text: what is the best question we can ask about the Neolithic process? The obvious answer that the defenders of the cardial model support, as well as many of their opponents, is the question, "What is the best way of archaeographically testing the various hypothesis that are, or will be, generated concerning Neolithization?" But the best answer is: "The best way is to test them outside the archeographic field". So, the best question is not the obvious one, but the other, that we can only formulate correctly, as we are building the answers, which is, by redefining the truth criteria.

From this we infer that the problem of the Neolithic process *is obviously not an archaeology problem, it is a prehistory problem*. The basic epistemological error of the cardial models occurs from trying to answer in the archaeological field a problem that has little to do with it. Inevitably, it develops a strange relation with the archaeological record, and produces a hybrid in the strict sense of the word: even if occasionally endowed of internal coherence (which, as we have seen, is not always the case), it is incapable of breeding, and pernicious for the development of knowledge. Hence, it is in the prehistoric field that V. Garcia (*1997*) explains the *Cova de l'Or* as a social storage place, in an argument that we could also apply to the *Gruta do Caldeirão*. In the so-called "Early Neolithic" of Iberia, the absence of villages, in association with exogamic practices, has at least two elements of proof: in the archaeographic plan there is no evidence for the first; in the biological plan, the reproductive *nexus* would impose the existence of the practices derived from the second assumption. Consequently, we can revise certain emblematic sites of the Neolithic process, such as *Gruta do Caldeirão*, or *Cova de l'Or*, and some artefacts, like the cardial ceramics or bracelets made of *Glycymeris glycymeris*, as a further advance in the anthropisation of the landscape, similar to rock art. The absence of the village model, on the other hand, is the strongest argument against the idea of a rapid and finished Neolithic period. Contrarily to other elements of the "package", like cattle breeding or ceramics, agriculture brought about a dramatic break in the management of the communities' time. By tying them to the soil, it ordered and gave rhythm to people's behaviour, contributing to the alienation of a part of the community. This process certainly took a long time, and had to cope with much opposition.

REFERENCES

ABERG N. 1921. *La civilisation énéolithique dans la Péninsule Ibérique*. Uppsala.

AMMERMAN A. J., CAVALLI-SFORZA L. 1971. Measuring the rate of spread of Early Neolithic farming in Europe. *Man. 6: 674–688*.

ARNAUD J. M. 1982. Le Neolithique ancien et le processus de Neolithisation au Portugal. *Le Néolithioque Ancien Méditérranéen – Actes du Colloque International de préhistoire. Montpellier, Éd. du C.N.R.S.*

BERNABÓ BREA L. 1950. Il neolítico a ceramiche impresse e la sua difussione nel Mediterraneo. *Rivista di Studi Ligure, vol. XVI(1-3): 25–36*.

BERTHÉLÉMY A., ACCART R. 1987. Ma Izza, site néolithique marocain. *Bulletin de la Société Préhistorique Française, vol. 84: 75–82*.

BICHO N. F. 1997. A Escavação de Emergência do Sítio Paleolítico de Santa Cita/Tomar. *Em busca do passado, 1994–1997: 10–29*.

BOSCH-GIMPERA P. 1932. *Etnologia de la Península Ibérica.* Barcelona.

BRAUDEL F. 1972. *The Mediterranean and the Mediterranean World in the age of Philip II.* London, Collins.

CAMPS G. 1982. *Les relations entre l'Europe et l'Afrique du Nord pendant le Néolithique et le Chalcolithique*. Travaux du LAPMO – 1982.

CARTAILHAC É. 1886. *Les âges préhistoriques de l'Espagne et du Portugal.* Paris.

CARVALHO A. F. 1998. O Abrigo da Pena d'Água (Rexaldia, Torres Novas): resultados dos trabalhos de 1992–1997. *Revista Portuguesa de Arqueologia, vol. 1(2): 39–72*.

CHAPMAN J. 1988. From 'space' to 'place': a model of dispersed settlement and Neolithic society. C. P. T. Burgess C. Mordent, M. Maddison. Enclosures and defenses in the Neolithic of Western Europe. Oxford, B.A.R. -International Series.

CRUZ A. J. C. da 1992. Análise geoquímica da coluna de amostragem D (camadas A/B/C–Eb) da Gruta do Caldeirão. In Zilhão J. (ed.), *Gruta do Caldeirão. O Neolítico Antigo: 203–214*.

1993. *Estudo Geoquìmico de Preenchimentos Sedimentares de Grutas da Estremadura com vestígios de ocupação humana pré-histórica.* Lisboa, dissertação de Doutoramento (dact.).

CRUZ A. R. 1995. *Amoreira:trabalhos de emergência no IP6. TECHNE–Revista da Arqueojovem, nº1: 28–37*.

1997. *Vale do Nabão. Do Neolítico à Idade do Bronze*, Tomar, CEIPHAR, col. ARKEOS, vol. 2.

DELGADO J. F. N. 1884. La grotte de Furninha à Peniche. *Congrès International d'Anthropologie et d'Archéologie Préhistoriques à Lisbonne, 1880. Lisboa.*

DREWETT P., OOSTERBEEK L., CRUZ A. R., FÉLIX P. 1992. Anta 1 de Val da Laje 1989/90 – The excavation of a passage grave at Tomar (Portugal). *Bulletin of the Institute of Archaeology London.*

GILMAN A. 1974. Neolithic of Northwest Africa. *Antiquity, vol. 48: 273–282*.

1975. *A late Prehistory of Tangier, Morocco*. American School of Prehistoric Research Bulletin. Peabody Museum.

GRIMALDI S. P. R., CRUZ A. R., OOSTERBEEK L. 1999. A geo-archaeological interpretation of some "Languedocian" lithic collections of the Alto Ribatejo (Central Portugal). In A. R. Cruz, S. Miliken, L. Oosterbeek, Peretto C. (eds.), *Human Population Origins in the Circum-Mediterranean Area: Adaptation of the Hunter-Gatherer groups to environmental Modifications, série ARKEOS, vol. 5: 231–242*.

GUILAINE J. (1996), La Neolithisation de la Méditérranée Occidentale. In R. G. Cremonesi, J. Guilaine, J. L'Helgouac'h (eds.), *The Neolithic in the Near East and Europe, Forlé, XIII International Congress of Prehistoric and Protohistpric Sciences: 53–68*.

GUILAINE J. and FERREIRA O. da V. 1970. Le Néolithique ancien au Portugal. *Bulletin de la Société Préhistorique Française, vol. 67: 304–322.*

HELENO M. 1956. Um quarto de século de investigação arqueológica. *O Arqueologo Portugues, vol. 3 (Nova Série): 221–237*.

JODIN A. 1959. Les Grottes d'El Khril Achakar (Province de Tanger). *Bulletin d'Archéologie Marocaine, vol. 3: 249–313*.

JORGE S. O. 1990. *Dos Últimos Caçadores-Recolectores aos Primeiros Produtores de Alimentos.* J. Alarção. Portugal das Origens À Romanização. Lisboa, Presença.

LEISNER V. 1967. Die Verschiedenen Phasen des Neolithikums in Portugal. J. B. Wolters. Palaeohistoria, vol. XII.

LEWTHWAITE J. 1986. The transition to food production: a Mediterranean perspective. In M. Zvelebil (ed.), *Hunters in Transition. Mesolithic Societies of Temperate Eurasia and their transition to farming.*

1992. *Cardial disorder: ethnographic and archaeological comparisons for problems in the early prehistory of West Mediterranean.* Le Néolithique Ancien Méditérranéen. Montpellier, Éditions du CNRS.

MARKOSIAN N. 1996. O paradoxo da pergunta. In *Disputatio,* vol. 1 (http://purl.inesc.pt/pub/disputatio).

MARTINEZ SANTA-OLALLA J. 1941. *Esquema Paletnologico de la peninsula ibérica.* Madrid.

MARTI OLIVER B. 1978. El Neolitico de la Peninsula Ibérica; Estado actual de los problemas relativos al proceso de neolitización y evolución de las culturas neoliticas. *Sagvntvm, vol. 13: 59–98.*

OOSTERBEEK L. 1985. Elementos para o estudo da Estratigrafia da Gruta do Cadaval (Tomar). *Almadan, vol. 4/5: 7–12.*

1993. Nossa Senhora das Lapas – excavation of Prehistoric cave burials in Central Portugal. *Papers of the Institute of Archaeology, vol. 4: 49–62.*

1994. *Echoes from the East: the western network. An insight to unequal and combined development, 7000–2000 BC.* Londres, University of London, PhD. Dissertation (2 vols.).

PELLICER M., ACOSTA P. 1982. *El Neolítico antiguo en Andalucia Occidental.* Le Néolithique Ancien Méditérranéen. Montpellier, éditions du CNRS.

PÉTREQUIN A.-M., PÉTREQUIN P., CASSEN S. 1998. La función de las hachas en el Neolítico. *Mundo Científico Nº 195: 68–73.*

RENFREW C. 1979. *Problems in European Prehistory.* Edimburgh University Press.

RUNNELS C., van ANDEL T. H. 1988. Trade and the origins of Agriculture in the Eastern Mediterranean. *Journal of Mediterranean Archaeology, vol. 1: 83–109.*

SAN VALERO APARISI J. 1948. *La península Hispánica en el Mundo Neolítico.* Madrid, Seminário de História Primitiva del Hombre.

SILVA C. T., SOARES J. 1987. *Les Communautés du Neólithique Ancien dans le Sud du Portugal.* Premières Communautés Payannes en Méditerranée Occidentale. Paris, Éditions du C.N.R.S.

SIRET L. 1890. *Las primeras edades del metal en el S.E. de España.* Barcelona,

1892. La fin de l'époque néolithique en Espagne. *L'Anthropologie, vol. 4:*

VICENT GARCIA J. M. 1997. The Island Filter Model Revisited. In Miriam S. Balmuth, A. Gilman, L. Prados-Torreira (eds.), *Encounters and Transformations. The archaeology of Iberia in transition: 1–13.*

ZILHÃO J. 1987. A Gruta do Caldeirão (Pedreira, Tomar). Balanço de sete anos de escavaçóes arquelógicas (1979–1985). *Algar, vol. 1: 29–38.*

1992. *Gruta do Caldeirão. O Neolítico Antigo.* Lisboa, IPPAR.

1993. *Gruta do Caldeirão (Pedreira, Tomar). Relatório técnico-científico dos trabalhos arqueológicos realizados em 1983.* Lisboa, dact. para o IPPAR.

1997. Maritime pioneer colonisation in the early Neolithic of west Mediterranean. Testing the model against evidence. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 24: 19–24.*

ZILHÃO J., ANTÓNIO M. F. CARVALHO 1995. O Neolítico do Maciço Calcário Estremenho. Crono-estratigrafia e povoamento. *I Congrés del Neolitic a la Peninsula Ibérica, Gavá-Bellaterra, RUBRICATUM, nº1: 659–71.*

ZILHÃO J., MAURÍCIO J., SOUTO P. 1991. A Arqueologia da Gruta do Almonda (Torres Novas). Resultado das escavações 1988–89. *Actas das IVªs Jornadas Arqueológicas.*

ZVELEBIL M., ROWLEY-CONWY P. 1986. Foragers and farmers in Atlantic Europe. In M. Zvelebil (ed.), *Hunters in Transition. Mesolithic Societies of temperate Eurasia and their transition to farming.*

UDK 303'12/'15(4-191.2)"634"
Documenta Praehistorica XXVIII

Recent research on early farming in central Europe

Peter Bogucki
School of Engineering and Applied Science, Princeton University, USA
E-mail: bogucki@Princeton.EDU

ABSTRACT – *Farming communities were established in many parts of central Europe Between approximately 5600 and 4500 BC. Although these communities have been studied for over a century, much more remains to be learned about them. This article will provide an overview of the history of this research, some important recent discoveries, and a sense of the ongoing debate about the origins of these agricultural communities.*

IZVLEČEK – *Kmetovalske skupnosti so v številnih delih osrednje Evrope nastale med približno 5600 in 4500 BC. Čeprav jih preučujemo že več kot stoletje, je naše znanje še vedno pomanjkljivo. V članku podajamo pregled zgodovine raziskav, nekatera pomembna novejša odkritja in na kratko pogledamo razpravo o izvoru teh kmetovalskih skupnosti.*

KEY WORDS – *Central Europe; transition to farming; the Earliest Linear; La Hoguette and Limburg Pottery*

This article is dedicated to Dean James Wei,
School of Engineering and Applied Science, Princeton University.

INTRODUCTION

Between approximately 5600 and 4500 BC, farming communities were established in many parts of central Europe, from Ukraine to eastern France and from Hungary nearly to the coasts of the Baltic and North Seas (Fig. 1). Although these communities have been studied for over a century, much more remains to be learned about them. This article will provide an overview of the history of this research, some important recent discoveries, and a sense of the ongoing debate about the origins of these agricultural communities.

Agriculture based on cultivated wheat and barley had emerged in the period between about 9000 and 7000 BC in the Near East. Domestic livestock, including sheep, goat, cattle, and pig, were soon added to the agricultural economy. Yet it did not remain a localized phenomenon, and it rapidly spread to Anatolia and southeastern Europe to the northwest, to the Iranian Plateau and Turkmenistan to the east and northeast, and to the Nile valley to the southwest. It is the *dispersal* of agriculture, as well as its origin, that resulted in the most profound transformation of human society since the advent of fire and speech.

The establishment of agricultural communities in central Europe is of interest for several reasons. First, it represents the first cultivation of Near Eastern plants under climatic and hydrological conditions that were substantially different from those of southeastern Europe and the Near East. Marked seasonality and shorter growing seasons were two critical differences, and the selection of habitats in which wheat and barley could be grown reflects increasing agricultural sophistication. Second, the animal component of the economy shifted from one in which sheep and goat played the main role, as was the case in southeastern Europe and the Near East, to one in which domestic cattle were the primary animal species (although sheep and goat remained present). Third, settlement structure and construction techniques changed from mud brick and adobe to timber structures with wattle-and-daub walls, reflecting the available raw materials in forested central Europe and its harsher environment.

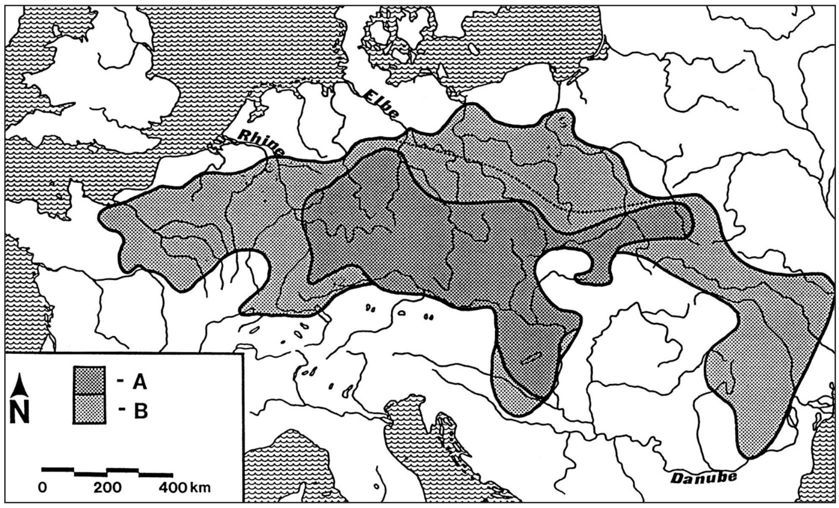


Fig. 1. Map of central Europe showing areas in which Linear Pottery culture sites are found in loess basins in major river drainages (*based on map in Lüning, Kloos and Albert 1989*). Key: A–area of settlement of Earliest Linear Pottery; B–area of subsequent expansion of Linear Pottery settlement.

A major debate in the study of the earliest European farmers is whether they were local hunter-gatherers who adopted domestic plants and animals and new house forms or whether they were colonists who settled in the major river valleys of central and northern continental Europe. This debate has polarized some of the archaeologists who study these communities into "indigenist" and "migrationist" camps, which is unfortunate. It is important to remember that this discussion is primarily about the causes of the spread of agriculture in central Europe, less about the identities of the individuals involved. The apparent polarity of this debate masks what surely were complicated family histories and shifting affiliations among locals and immigrants in Neolithic central Europe.

The primary archaeological entity discussed in this paper is known in English as the "Linear Pottery Culture", after the incised lines on its fine pottery (Fig. 2), distributed from Slovakia and western Ukraine to Belgium and eastern France. Frequently, various other notations are used in the literature, such as the German "Linearbandkeramik" (sometimes abbreviated "LBK") or simply "Bandkeramik." The terminology introduced by V. Gordon Childe (*1929*), in which he referred to Linear Pottery as "Danubian I," is no longer in common use. Although strikingly homogenous at a very general level, there are many regional and temporal variants of Linear Pottery. In addition, two anomalous pottery types are found along the western and northwestern fringes of the Linear Pottery settlement area, known as "La Hoguette ware" and "Limburg ware". The significance of these will be discussed further below.

THE GEOGRAPHY OF EARLY FARMING IN CENTRAL EUROPE

Early farming settlement in central Europe is linked very closely with major river systems, although rarely with the major rivers themselves. Each of the principal drainage systems of central Europe – the Danube, the Elbe, the Rhine, the Meuse, the Oder, and the Vistula – contained large clusters of Linear Pottery settlements. These settlements are most commonly found along the brooks and small rivers that drain into the major rivers, although sometimes they appear on low terraces along the large streams.

Within these river drainages, Linear Pottery settlements usually occur on or near patches of loess soil. It has been suggested that the location of loess was a major determinant of early farming settlement, but a closer examination of the data suggests that this association is a by-product of the selection of specific habitats within these drainages. Most Linear Pottery settlements are located in terrain characterized by broad watersheds than slope steeply down to the streams, where alluvium from the watersheds recharges the natural fertility of the valley-bottom soils. Where Linear Pottery sites are found away from loess, as in the Aisne valley of eastern France and the lowlands of northern Poland, locations along stream channels with similar alluviation suggest that terrain and hydrology rather than the presence or absence of loess were the primary determinants of settlement location.

Along these smaller streams, Linear Pottery settlements are found in small clusters. They consist of

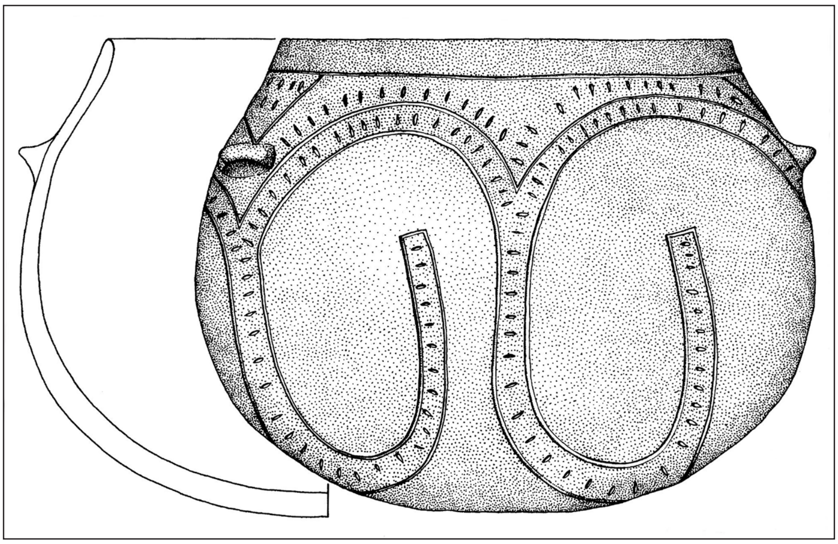


*Fig. 2. Ceramic vessel from grave 66 at Aiterhofen-Ödmühle (*after Nieszery 1995.Pl. 25*).*

groups of longhouses separated by several hundred meters. Although at first glance, these longhouse groups may appear to form small villages, closer examination of their stratification and ceramic chronology often indicates that they were instead dispersed farmsteads at which longhouses were built and rebuilt at various times. Such farmsteads, presumably occupied by a single Neolithic household, appear to have been the primary unit of Linear Pottery settlement. Over time, the archaeological traces of these farmsteads, consisting of one or more longhouses and their associated pits, accumulated, so that the multiple houses and pits suggest a great density of habitation than was actually the case.

THE CHRONOLOGY OF EARLY FARMING IN CENTRAL EUROPE

Calibrated radiocarbon dates that have been obtained using both accelerator mass spectrometer (AMS) and conventional methods have established a general chronological framework for the Linear Pottery Culture that complements the ceramic typology. Over a century of study of Linear Pottery ceramics has indicated that there are three major chronological divisions, each of which contains several phases. The oldest, first identified by Hans Quitta (*1960*), is known as the Earliest (*älteste*) Linear Pottery and is distributed from Transdanubia in Hungary and Austria west to Franconia and the Neckar valley and north to Lower Saxony in Germany and Silesia in Poland. This period has received considerable attention over the last two decades. It is followed by the Earlier (*ältere*) Linear Pottery, which extends further into the Rhine valley, Dutch Limburg, and the valleys of the Oder and Vistula in southern and northern Poland. The final Linear Pottery period is the Later (*jüngere*) Linear Pottery, which saw the expansion of this culture into Belgium, Normandy, and eastern France, as well as continued settlement in the core areas settled earlier.

Until the 1980s, it appeared that the Earliest Linear Pottery was a quick, ephemeral phase of the earliest farming settlement, poorly known from sites without houses or much internal structure. By 1990, however, it was clear that this view was in error. Large sites of the earliest phase were found in Franconia and Austria, and other areas yielded early sites as well. This research will be discussed in greater detail below.

Radiocarbon dating has been important for understanding the chronology of the Linear Pottery Culture since the development of this process 50 years ago. The initial radiocarbon dates in the 1950s permitted the dating of the Linear Pottery Culture between 4500 and 4000 radiocarbon years bc (unrecalibrated), 1000 years earlier than it had previously been believed to have flourished. Calibrated, this would place the beginning of Linear Pottery somewhere around 5400/5300 BC. The final phases of Later Linear Pottery would date somewhere around 4900/4800 BC, resulting in the initial assignment of a duration of about 500 years for this culture.

Recent AMS dates have both extended the overall duration of Linear Pottery and in particular Earliest Linear Pottery. Gronenborn (*1999*) proposes that on the basis of these new dates, the beginning of the Earliest Linear Pottery in Transdanubia should be placed around 5700/5600 BC and in Franconia around 5500 BC. Linear Pottery sites appeared on the upper Rhine around 5400 BC and in the Rhineland, Alsace, and Limburg around 5300 BC. Early (but not Earliest) Linear Pottery sites are also found in northern Poland around this time (*Kirkowski 1990, Sosnowski 1990*), based on conventional radiocarbon dating. Thus, the initial Linear Pottery settlement, rather than being quick and ephemeral, appears to have been of several centuries' duration, although still not especially protracted when considered in its broader context.

The end of Linear Pottery still appears to have taken place around 4900 BC. It is succeeded in the west by the Rössen Culture and the Cerny Culture, in central Germany, Bohemia, and Silesia by the Stroke-Ornamented Pottery Culture, and in Poland, Moravia, Slovakia, Hungary, and Austria by the Lengyel (or Lengyel-Polgár) Culture. In all these areas, clear continuities in material culture indicate that there was simply gradual transformation rather than a sharp break.

CLASSIC LINEAR POTTERY SITES

The Linear Pottery Culture was identified in the 1880s by the German prehistorian Friedrich Klopfleisch. At that time, it was known from small, poorly-excavated sites, but it was clear from their stratigraphy that this was the earliest Neolithic culture in central Europe. It was not until the first half of the twentieth century that information began to accumulate on Linear Pottery mortuary practice and settlement. Although today, we associate the Linear Pottery Culture with its classic longhouse settlements, some of the earliest information came from the cemetery at Flomborn in the Rhineland, excavated in 1901. The 85 graves at Flomborn contained crouched skeletons lying on their left side, a typical position for Linear Pottery burials.

Limited areas of excavation on Linear Pottery sites in the early 20th century had exposed large pits associated with postholes, which led to the conclusion that the inhabitants of these sites lived in large semi-subterranean structures with uneven floors characterized by many nooks and hollows. Excavations at Köln-Lindenthal, on the western outskirts of Cologne, Germany, in the early 1930s, revealed traces of larger post structures, up to 30 or more meters in length (*Buttler and Haberey 1936*). Yet the pit-house model remained ingrained in prehistorians' minds. Thus, the excavator of Köln-Lindenthal, Werner Buttler, interpreted these new structures as granaries or barns, while the large pits alongside them continued to be seen as the houses. Critical examination of the plans from Köln-Lindenthal and other sites established that the long post structures really were houses, and the numerous pits were the places from which clay was taken to plaster their walls.

The discovery of Linear Pottery houses and the internal structure that they provided to the settlements fired the imagination of archaeologists and led to an immense amount of research during the 1950s and 1960s. By this time, it was established that Linear Pottery settlements could only be investigated through the removal of topsoil over an area of hundreds, if not thousands, of square meters. Only in this way could the houses and their related features be exposed completely. In the 1950s, one focus of Linear Pottery research was on Dutch Limburg, where P. J. R. Modderman excavated a series of classic sites including large settlements at Sittard and Elsloo (*Modderman 1970*). These excavations provided a remarkable amount of comparative data on Linear Pottery houses and permitted generalizations about their size and internal differentiation. At Elsloo, a large Linear Pottery cemetery was also found, in which there were 47 cremations and 66 inhumations among the 113 graves. In 1953, Bohumil Soudský and his collaborators began excavations and surveys at Bylany in Bohemia, which turned out to be an immense complex of Linear Pottery settlements with a complicated chronological interrelationship (*Soudský 1966*). Research at Bylany continues into the present day (*Pavlů 1998*).

Research on Linear Pottery sites continued at a fast pace during the 1960s. Excavations by Sarunas Milisauskas at Olszanica (Fig. 3) established that Linear Pottery longhouses could be found north of the Carpathians (*Milisauskas 1986*). At Hienheim on the upper Danube, excavations by Modderman (*1977*) revealed a large settlement with abundant animal bones (not normally preserved on most Linear Pottery sites) and botanical remains. Excavations by Juraj Pavúk (*1972*) at Nitra, Slovakia, in 1964–65 revealed a Linear Pottery cemetery in which the grave goods from the 73 burials provided important information about sex and status differences.

The late 1960s and 1970s were a period of great regional projects. Two of the most important took place on the Aldenhovener Platte in northwestern Germany and in the Aisne Valley in eastern France. Brown-coal mining on the Aldenhovener Platte west of Cologne led to the exposure of enormous areas, and close coordination with a team of archaeologists that included Jens Lüning, Petar Stehli, J. P. Farruggia, Rudolph Kuper, and Andreas Zimmerman led to the excavation of many Linear Pottery settlements (*Lüning 1982*). Several of these settlements were clustered along a small stream called the Merzbach, forming a small "cell" of Linear Pottery settlement.

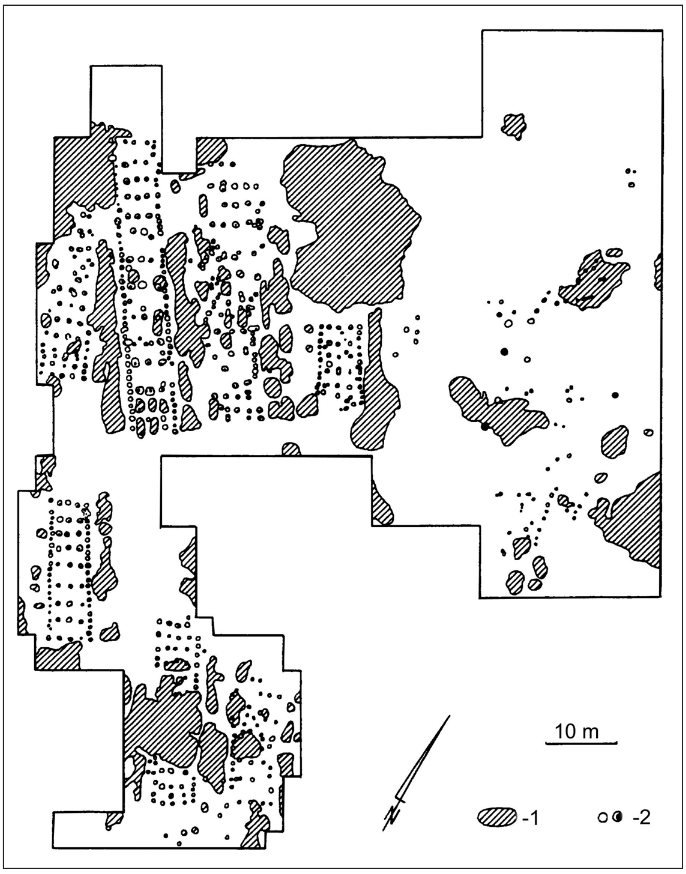


*Fig. 3. Portion of Linear Pottery settlement at Olszanica, Poland, showing classic arrangement of longhouses and associated pit features (*after Milisauskas 1986*).*

Further west, gravel extraction along the Aisne river in northeastern France led Soudský to initiate a research project that was carried forward after his death by a team that included Jean-Paul Demoule, Mike Ilett, Claude Constantin, and Anick Coudart. Important sites in this cluster included Cuiry-lès-Chaudardes and Berry-au-Bac (*Ilett 1983*).

IMPORTANT RECENT EXCAVATIONS

For the purposes of this review, "recent" research will include that carried out in the two decades between 1980 and 2000. During this period, many of the major research projects begun in earlier decades continued, while others were established in other parts of central Europe to study Linear Pottery settlements and cemeteries. Archaeological research connected with large-scale highway and pipeline projects, particularly in eastern Europe after the collapse of communism, have led to important new discoveries. These include several main categories of investigation: the earliest traces of Linear Pottery settlement; extending the range of Linear Pottery settlement; additional information on Linear Pottery burials; new features of Linear Pottery settlements including fortifications, wells, and mass graves; and identifying possible indigenous forager adoption of pottery and domesticates.

Settlements of the Earliest Linear Pottery

A major research project between 1979 and 1990, based at Johann Wolfgang Goethe University in Frankfurt am Main undertook an investigation of earliest Linear Pottery sites. One of the first sites investigated by this project was an important Linear Pottery site reported by Lüning and Modderman at Schwanfeld, in the Main drainage east of Frankfurt (*Lüning 1986*). Here, they found longhouses from the earliest phase of the Linear Pottery Culture that had a distinctive ground plan in which the outside post walls were supplemented by smaller curtain walls or braced against logs laid lengthwise in small bedding trenches. Later in the 1980s, this project excavated a settlement of the earliest Linear Pottery at Bruchenbrücken in Hessen. Houses at Bruchenbrücken were clustered closely together and were built with the outlying bedding trench construction first observed at Schwanfeld (*Stäuble 1997*).

In Austria, many new sites of the earliest Linear Pottery have been discovered in the last two decades. In 1984–1986, Lüning and Eva Lenneis investigated settlements of the earliest Linear Pottery at Neckenmarkt and Strögen in eastern Austria, which yielded additional traces of early longhouses (*Lenneis 1995*). To the southeast, at Brunn am Gebirge in Austria, two earliest Linear Pottery sites were discovered during road construction (*Stadler 1999*). Excavations by the Natural History Museum of Vienna at one of them (Brunn II) exposed a large settlement with over 26 longhouses dated between 5600 and 5100 BC. At Mold, also in Austria, an enormous longhouse 40 meters long and 7 meters wide dating to the transition between earliest Linear Pottery and its middle phase was found (*Lenneis 1995*).

New Features: Fortification Ditches and Wells

Although an enclosure ditch was found at Köln-Lindenthal in the 1930s, it was not until the 1970s and

1980s that such features regularly began to turn up at Linear Pottery sites. A particularly notable series of such sites has been found in the Hesbaye region of Belgium (*Keeley and Cahen 1989*) in which three late Linear Pottery settlements – Darion, Oleye, and Longchamps – were enclosed by substantial ditches (Fig. 4). Keeley and Cahen argue that these ditches were fortifications, based on their size and the fact that some of the houses at these sites had been burned, suggesting conflict. In their view, the Linear Pottery farmers dug such ditches (which presumably had banks of earth behind them to form a rampart) as protection against indigenous hunter-gatherers who had reason to resent the intrusion of the farmers.

Excavations that began in 1994 at the Linear Pottery site of Vaihingen/Enz exposed a substantial ditch system that appeared to enclose a large part of the settlement (*Krause 1997; 2000*). The settlement at Vaihingen was established in the earlier phase of Linear Pottery, and the enclosure dates from the beginning of the settlement. The ditch fill contained a large number of burials, so it appears that after some time it ceased to function as an enclosure or fortification and became used as a cemetery.

Another entirely new feature found at Linear Pottery sites recently has been timber-lined wells (*Weiner 1995; Windl 1996*). Four are now known, from sites at Erklenz-Kückhoven in the Rhineland, Mohelnice in the Czech Republic, Asparn-Schletz in lower Austria, and most recently Zwenkau near Leipzig in eastern Germany. They are generally about a meter square and several meters deep. The timbers used to build these wells are split sections of tree trunks, so the wood provides good data for tree-ring dating. The Kückhoven well has been dated to 5089 BC, while the wood used in the Zwenkau well was dated to 5098 BC. It seems possible that such features will be found on other Linear Pottery sites and that they may have been overlooked in earlier excavations or thought to belong to a later period.

Sites with La Hoguette and Limburg Pottery

During the last 20 years, two distinctive types of ceramics that are very different from the typical Linear Pottery wares in composition, shape, and decoration have been a major topic of discussion in the study of the Neolithic of western Europe (*Lüning, Kloos and Albert 1989*). La Hoguette ware, named after an outlying site in Normandy but distributed primarily in Alsace and southwestern Germany, is characterized by bag-shaped pots with applied bands and rows of incisions. Stylistically, it bears similarities to the Cardial pottery of the Mediterranean zone. Limburg pottery, first identified in southern Holland but primarily distributed in Belgium and northeastern France, commonly occurs as bowls with dense bands of incisions and chevrons. Limburg ware was first recognized at Köln-Lindenthal in the 1930s, while La Hoguette pottery did not come to light until the 1970s.

The dating of La Hoguette and Limburg has become clearer in the last two decades, although it is still not precise. La Hoguette does appear to be contemporaneous with earliest Linear Pottery, based on its occurrence at Bruchenbrücken and other early sites. This association would place it in the vicinity of 5600/5500 BC. The question is whether La Hoguette somehow predates earliest Linear Pottery, and it seems appealing to some researchers to identify an indigenous pottery tradition at such an early date. A part of the problem is the presumed stylistic association of La Hoguette with Cardial ware. Since Cardial ware appears in southern France around 5900 BC, there is a tendency to shade the dating of La Hoguette backwards in that direction, perhaps to as early at 5800 BC. At the moment, however, no solid basis exists for placing La Hoguette earlier than the earliest Linear Pottery in western central Europe. It may turn out, however, that it predates the first appearance of later Linear Pottery in parts of western Europe in which the earliest Linear Pottery does not occur, such as the Paris Basin. For example, at the Bavans rockshelter in the Doubs valley of northeastern France, a La Hoguette occupation was followed by a Linear Pottery one (*Gronenborn 1999.138*).

Limburg pottery appears to be a later phenomenon, contemporaneous with later Linear Pottery in the Netherlands, Belgium, and northeastern France. It primarily appears as an anomalous element in the ceramic assemblages from large Linear Pottery sites, although a few sites with only Limburg pottery have also been found (*Modderman 1974*).

Flint tools associated with La Hoguette pottery have a distinct Mesolithic character, so there is a basis for arguing for its in situ development. Subsistence remains provide sparse evidence on La Hoguette subsistence. At Stuttgart-Bad Cannstatt, domesticated sheep and/or goat bones were found associated with a La Hoguette assemblage (*Schütz et al. 1992*). This would not be surprising, in light of the proximity of

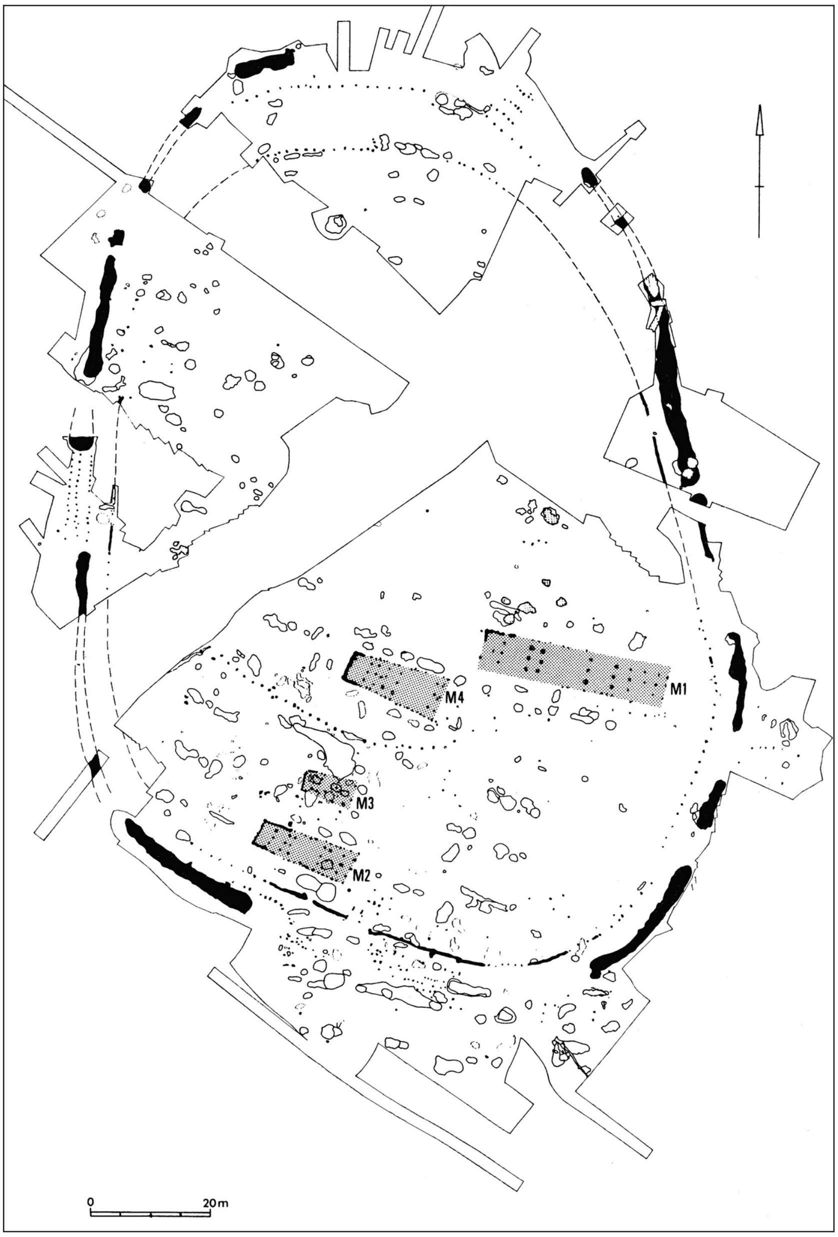


Fig. 4. Linear Pottery settlement with ditch system interpreted as a fortification at Darion, Belgium (*after Keeley and Cahen 1989*).

Linear Pottery settlement from which domestic animals could be obtained through trade, theft, or as hunted feral livestock. Feral livestock could easily have passed from areas of Neolithic settlement to areas populated by indigenous foragers, so the appearance of sheep and goat bones on non-Linear Pottery settlements should not be surprising (*Bogucki 1995b*).

Mortuary Sites

Since the late 1970s, the number of Linear Pottery mortuary sites has risen considerably. In almost every region of central Europe, large cemeteries have been discovered (*Nieszery 1995; Jeunesse 1997*). Only in Poland is there the continued absence of a large Linear Pottery cemetery; in fact, relatively few settlement burials have been found as well. This absence is surprising, and it may be an artifact of the fact that archaeologists have focused their attention on archaeologically-visible settlements and there have not yet been the large infrastructure projects that would reveal cemeteries that lack numerous finds or a cultural layer. Perhaps as these projects get underway (see below) Linear Pottery cemeteries may also be discovered in Poland. Bohemia is also surprisingly lacking in Linear Pottery cemeteries, although again this may be due to the intensive focus on settlements in the last 50 years.

Several of the largest Linear Pottery cemeteries discovered in recent decades have been Schwetzingen near Heidelberg with 202 burials, Fellback-Öflingen in the Neckar valley with 110, Stuttgart-Mülhausen with about 200, Wandersleben-Gotha in Thuringia with 311, Aiterhofen-Ödmühle in Bavaria with 228, and Vedrovice in Moravia with about 110. Many smaller cemeteries, mortuary precincts within settlements, and isolated settlement burials have also been found. For example, at Marainville-sur-Madon in northeastern France, a compact group of seven burials was associated with a small later Linear Pottery settlement (*Blouet and Decker 1993*).

An interesting aspect of the recent cemetery excavations is the fact the cremation appears to have been more common in some places than hitherto observed in Linear Pottery burial practice (*Jeunesse 1997*). Among the 311 graves at Wandersleben, for example, there were 179 inhumations compared with 132 cremations, while at Aiterhofen-Ödmühle, the 228 burials included 59 cremations (*Nieszery 1995*). Elsewhere, however, the frequency of cremation is very low.

A particularly dramatic and grisly aspect of Linear Pottery burial first came to light in the 1980s with the discovery of a mass burial at Talheim in southwestern Germany (*Wahl and König 1987*). A tangled mass of human bones contained 34 complete articulated skeletons, including 11 men, 7 women, and 16 children. Twenty of the skulls had received violent blows to the head. Some had lozenge-shaped holes caused by lethal impacts from instruments with a similar crossection, which corresponds to those of common Linear Pottery ground stone tools. Other skulls show signs of trauma that was also probably fatal. The circumstances of the Talheim massacre remain a mystery. In the early 1990s, another example of mass Linear Pottery killing came to light in the fortification ditch at Asparn in Austria (*Windl 1996*). The Asparn bodies were not packed so densely as were those at Talheim, but nonetheless, it is clear that the victims did not die peacefully. In contrast, the burials in the enclosure ditch at Vaihingen in southwestern Germany appear to be deliberate, a result of the changed function of the ditch from fortification to cemetery.

Extending the Range of Linear Pottery Settlement

Although the general extent of Linear Pottery settlement was established by the 1930s, only now is it coming clear that large numbers of sites can be found on the fringes of its distribution. Of particular importance are new sites that have been discovered in the last two decades along the lower Oder and Vistula in northern Germany and Poland, in eastern and central France along the Seine and Yonne, and in Ukraine. Moreover, within the established area of Linear Pottery settlement, new sites are coming to light in areas where they had not been found previously.

Along the lower Vistula and Oder, some Linear Pottery sites were known already in the 1920s and 1930s (*Kostrzewski 1929; Kunkel 1934*). More sites, particularly along the lower Oder, were noted in the decades that followed World War II (*Wiślański 1974*), although systematic surveys had not been carried out. In the 1980s, however, the area north of the city of Toruń along the lower Vistula in Poland was surveyed, and dozens of new Linear Pottery sites were discovered where previously only a handful had been known (*Kirkowski 1987*). Two particularly significant sites in this area are at Boguszewo (sites 41 and 43b) and Stolno (site 2), where relatively early radiocarbon dates indicate that Linear Pottery communities extended this far to the north at a relatively early date. Near the mouth of the Oder, an important Linear Pottery site was excavated in the 1980s at Zollchow (*Heussner 1989*). All these sites are within a hundred kilometers of the Baltic coast, making it likely that at some point 7000 years ago, a Linear Pottery farmer looked out over the Baltic. Moreover, given the presence of maritime foragers along the Baltic coast, these northernmost Linear Pottery sites are prime candidates for the contact between foragers and farmers that eventually led to domestic plants and animals being adopted in the western Baltic zone.

New Linear Pottery sites have been discovered recently in Ukraine, and this will be a region in which further work will be needed to clarify the eastern limits of Linear Pottery. In the west, Linear Pottery sites have been found in the valley of the Yonne river southeast of Paris, thus pointing towards an extension of the area settled by these farmers in this area. Of great importance will be tracing Linear Pottery finds onto the glacial outwash of Lower Saxony. Axes that may possibly be Linear Pottery forms have been found near Soltau, just south of Hamburg, as stray finds, for example (*Brandt 1995*). Nearer to the areas already known to have Linear Pottery settlements, sites are beginning to be found in areas where they had hitherto been unsuspected. For example, a Linear Pottery site was recently identified in the valley of the Dunajec river east of Kraków, some distance from its closest known neighbor (*Valde-Novak 1998*). The Moselle valley was also a gap in Linear Pottery settlement as recently as the early 1980s, but sites have now been found there as well.

The Impact of Infrastructure Projects

During the first decades of the 21st century, major advances in our knowledge of the earliest farmers of central Europe will come from major infrastructure construction projects such as pipelines and highways. This will be especially true in the formerly communist countries of Poland, the Czech Republic, Slovakia, and Hungary. In Poland, new superhighways are planned to cut through areas of prime Linear Pottery settlement. On such area is north and west of the city of Włocławek, while other threatened areas are in southern and northwestern Poland. In eastern Germany, near Leipzig and Dresden, brown coal extraction promises to yield further important discoveries.

Recently, excavations along a pipeline right-of-way in north-central Poland brought to light a Linear Pottery longhouse at Bożejewice (*Czerniak 1998*). The question of whether or not Linear Pottery communities on the North European Plain lived in longhouses has long puzzled archaeologists. Despite the fact that large areas had been investigated on uneroded sites, none had ever been found until the late 1980s, when it appears that one was excavated at Łojewo (*Czerniak 1994*). The Łojewo house, to the knowledge of the author, has unfortunately only been published as a tiny illustration and mentioned in passing, and thus it is difficult to assess it critically. The Bożejewice house is also unusual in that it appears to be stratified directly under a trapezoidal-plan longhouse of the Lengyel culture. At least a 500–year gap separates the Linear Pottery occupation of the Polish lowlands from the trapezoidal longhouses of the Brześć Kujawski group of the Lengyel culture, so this superimposition is particularly unusual in light of all the other land available to build the later house. It will be interesting to see whether further Linear Pottery structures come to light as the infrastructure research proceeds.

WHO WERE THE FIRST FARMERS IN CENTRAL EUROPE?

For decades, the traditional view of the establishment of farming communities in central Europe by the Linear Pottery culture has been that it was the result of the dispersal of farming peoples who originated somewhere along the middle course of the Danube and colonized the loess soils. V. Gordon Childe (*1929*) attributed this movement to their continual depletion of soil that forced the early farmers to pack up and move after several years of cultivation in one spot. This model of wandering agriculture (to which was added the presumption that as "primitive agriculturalists" the Linear Pottery farmers used slash-and-burn shifting agriculture) persisted in the literature for many decades. It was not until the 1970s, after the excavation of many major settlements with longhouses and the close examination of settlement patterns, that it was determined that Linear Pottery farmers were very sedentary and tended to reside in fixed locations for a long time (*Modderman 1971*). The loess soils can sustain continued cropping, and thus the notion that Linear Pottery cultivation would deplete them was not sustainable. The question was, then, what led the Linear Pottery farmers to disperse throughout an area of approximately 750 000 square kilometres? In 1988, I suggested that we should look for the explanation in the goals and aspirations of the individual Linear Pottery households, as new generations sought new opportunities and chose to locate their daughter households some distance from those of their parents. Thus this dispersal could be explained without having to invoke single-factor explanations such as soil depletion or population pressure to drive it along. I have elaborated on this idea to suggest that the use of a standard and fairly conservative settlement strategy, the use of modular house forms, and the production of standard pottery made it easier for new households to relocate and thus to advance the Neolithic frontier (*Bogucki 1995a*).

During the 1990s, however, the debate as to whether the earliest European were colonists who settled in the major river valleys of interior riverine Europe or whether they were local hunter-gatherers who adopted domestic plants and animals and new house forms has been reopened. This has been largely an outgrowth of the enormous amount of research that has been done in the last two decades on the earliest Linear Pottery sites as well as the discovery of the anomalous Limburg and La Hoguette wares. On a number of the earliest Linear Pottery sites, some number of stone tools that bear similarities to antecedent Mesolithic forms in south central Europe have been identified (*Gronenborn 1994; 1999*). Elsewhere, some early Linear Pottery faunal assemblages have been determined to have a higher than usual proportion of wild animals. The "indigenist" suggestion has been advanced (*Tillmann 1993; Kind 1998*) that the introduction of agriculture to central Europe was largely an *in situ* process. Whittle (*1996*) has suggested that the Linear Pottery settlements were less sedentary than has been hitherto believed, thus also opening the possibility for greater involvement by indigenous foragers in this process. The "migrationist" school has stood its ground and steadfastly maintained that the establishment of farming communities in central Europe was the product of Linear Pottery dispersal, citing the sharp break in almost all categories of material culture from antecedent forms over the entire area of central Europe.

Several things are clear. First, the main vectors of agricultural dispersal across this region are certainly from the southeast to the north and northwest, due to the Near Eastern origin of many of the primary domesticates. A slight possibility exists that some domesticates arrived in central Europe from the Mediterranean via the Rhône valley, but wheat, barley, sheep, and goats simply do not occur in wild forms in central Europe. Second, the general impression from artefacts, house forms, subsistence, and settlement patterns is one of very broad homogeneity across regions. Until very late in the Linear Pottery sequence, ceramics from one region are superficially almost indistinguishable from those from another. Longhouses are of uniform proportions and orientation over broad areas. Third, it is clear that there is minor regional variation in flint tools and details of house construction; the anomalous pottery styles that differ markedly from the widespread Linear Pottery fabric and decoration appear early in the sequence, possibly even predating the local appearance of Linear Pottery in the Rhine valley.

A recurring question is: where are the indigenous foragers in areas that are congruent with early Linear Pottery settlement? The evidence for antecedent local settlement directly in the areas of Linear Pottery settlement is very elusive, and it is tempting to say that it was sparse to non-existent. This is dangerous, of course, for negative evidence does not make a particularly strong argument. Nonetheless, the establishment of fairly dense forests during the warm climate of the Atlantic period may have cut down their natural productivity and attractiveness for foragers. Lake belts, sandy soils with lighter forests, and seacoasts would have grown in attractiveness. While it is possible to track Mesolithic cultures in some areas during the period down to about 6500 BC, it is very difficult to find sites that fill the gap of the last few centuries before the initial appearance of Linear Pottery around 5700/5600 BC.

Although I believe that the earliest agricultural communities of central Europe were established primarily through the dispersal of Linear Pottery households, it is still entirely possible for hunter-gatherers to have played a role. In order for them to participate in the agricultural economy, however, they would need to be very special sorts of foragers. First, they would have to be more willing to take risks and delay returns than are most foragers. Second, they would need to be willing to defect from their band society in which sharing was the norm. Third, they would have to be willing to engage with the farmers and not to retreat into refugia such as the central Polish outwash or the Tertiary hill systems of central Europe. This sort of engagement probably took place on the individual or the family level rather than the band. Susan Gregg (*1988*) suggested that labour drawn from friendly Mesolithic neighbors would have helped solve the labour shortcomings of Linear Pottery households. On the other hand, Lawrence Keeley has suggested, based on his observations at Darion and other fortified Linear Pottery sites in Belgium, that relations between the farmers and the foragers were hostile. Clarifying these connections will be a key research challenge of the next several decades.

CONCLUSION

Although we know much more about the earliest farmers of central Europe than we did twenty years ago, much work remains to be done in order to understand the spread of farming. The challenges come less from the need to recover additional data and more from the need to analyse the available data in novel and creative ways. Thousands of longhouses have been excavated, and perhaps millions of sherds of Linear Pottery lie on museum shelves. A new Linear Pottery house on the lowlands of northern Europe would be a revelation, another in the Rhineland or Bohemia is almost redundant. The tradition of detailed publication of major Linear Pottery sites has resulted in a corpus of information almost unparalleled in the archaeological world.

New analytical techniques hold great promise, however. Of critical importance is to obtain a sense of how Linear Pottery individuals were related to each other, in an effort to resolve the question as to whether they were locals or migrants. For this reason, skeletal remains from the cemetery sites are important evidence. It may prove possible to extract DNA from certain anatomical elements and thus establish the relationships among the individuals in the cemeteries. An especially promising new analytical technique, pioneered at the Archaeological Chemistry Laboratory at the University of Wisconsin, involves the study of trace elements in the bones from these cemeteries and comparison of the amount of these elements with their proportion in the local geology. Various patterns of isotopic uptake in the bones and teeth can help establish whether an individual spent his or her whole life in a limited region or whether they immigrated from elsewhere.

It is also necessary to look at the spread of farming in central Europe in ways that depart from traditional attempts to find a single underlying cause. In this regard, understanding it as part of a category of phenomena known as "complex adaptive systems" is especially promising (*Bogucki 2000*). Complex adaptive systems are those in which the decisions and choices made by small adaptive units called "agents" produce cumulative and sometimes unexpected results. Such systems are "self organizing" in that there is no central authority or force controlling their development. The Linear Pottery household can be seen to have functioned in the role of the agent, and it is possible that the rapid dispersal of agriculture throughout a large area occurred as a result of a myriad of small decisions about household relocation. Over 7000 years ago, the Linear Pottery farmers of central Europe lived in the largest buildings in the world at the time and brought about a dramatic transformation in European society. Agriculture eventually made its way to the indigenous foragers of western Europe, the British Isles, and southern Scandinavia. In the areas of Linear Pottery settlement, later communities of the Rössen, Lengyel, and Cerny cultures refined the mixed farming system of dispersed farmsteads that is observed over the following millennia.

∴

REFERENCES

BLOUET V. and DECKER E. 1993. Le Rubané en Lorraine. *Le Néolithique du Nord-Est de la France et des Régions Limitrophes. Actes du XIIIe colloque interrégional sur le Néolithique, Metz: DAF no. 41: 84–93.*

BOGUCKI P. 1988. *Forest Farmers and Stockherders: Early Agriculture and its Consequences in North-Central Europe*. Cambridge: Cambridge University Press.

1995a. The Linear Pottery culture of central Europe: conservative colonists? In W. K. Barnett and J. W. Hoopes (eds.), *The Emergence of Pottery. Technology and Innovation in Ancient Societies: 89–97.*

1995b. Prelude to agriculture in north-central Europe. In D. V. Campana (ed.), *Before Farming: the Role of Plants and Animals in Early Societies. Research Papers in Science and Archaeology, Volume 12 Supplement: 105–116.*

1996. The spread of early farming in Europe. *American Scientist 84: 242–253.*

2000. How agriculture came to north-central Europe. In T. D. Price (ed.), *Europe's First Farmers: 197–218.*

BRANDT K. H. 1995. Donauländische Geräte aus dem Südkreis Soltau-Fallingbostel. *Die Kunde 46: 1–27.*

BUTTLER W. and HABEREY W. 1936. *Die bandkeramische Ansiedlung bei Köln-Lindenthal*. Berlin: Walter de Gruyter.

CHILDE V. G. 1929. *The Danube in Prehistory*. Oxford: Oxford University Press.

CZERNIAK L. 1994. *Wczesny i Środkowej Okres Neolitu na Kujawach, 5400–3650 p.n.e.* Poznań: Polish Academy of Science, Institute of Archaeology and Ethnology.

1998. The first farmers. In M. Chłodnicki and L. Krzyżaniak (eds.), *Pipeline of Archaeological Treasures: 23–36.*

GREGG S. 1988. *Foragers and Farmers. Population Interaction and Agricultural Expansion in Prehistoric Europe*. Chicago: University of Chicago Press.

GRONENBORN D. 1994 Überlegungen zur Ausbreitung der bäuerlichen Wirtschaft in Mitteleuropa. Versuch einer kulturhistorischen Interpretation ältestbandkeramischer Silexinventare. *Praehistorische Zeitschrift 69: 135–151.*

1999. A variation on a basic theme: the transition to farming in southern Central Europe. *Journal of World Prehistory 13: 123–210.*

HEUSSNER K.-U. 1989. Bandkeramische Funde aus Zollchow, Kreis Prenzlau. *Bodendenkmalpflege in Mecklenburg 1988: 7–23.*

ILETT M. 1983. The early Neolithic of north-eastern France. In C. Scarre (ed.), *Ancient France, Neolithic Societies and their Landscapes, 6000–2000 bc: 6–33.*

JEUNESSE C. 1997. *Pratiques Funéraires au Néolithique Ancien. Sépultures et Nécropoles des Socié-*

tés Danubiennes (5500/-4900 av. J.-C.). Paris: Editions Errance.

KEELEY L. H. and CAHEN D. 1989. Early Neolithic forts and villages in NE Belgium: a preliminary report. *Journal of Field Archaeology 16: 157–176.*

KIND C.-J. 1998. Komplexe Wildbeuter und frühe Ackerbauern. *Germania 76: 1–23.*

KIRKOWSKI R. 1987. Kultury cyklu wstęgowego na Ziemi Chełmińskiej. In T. Wiślański (ed.), *Neolit i Początki Epoki Brązu na Ziemi Chełmińskiej: 185–200.*

1990. Boguszewo, gmina Gruta, województwo toruńskie, stanowisko 41, obiekty 3 i 5. In D. Jankowska (ed.), *Z Badań nad Chronologią Absolutną Stanowisk Neolitycznych z Ziemi Chełmińskiej: 9–14.*

KOSTRZEWSKI J. 1929. Osada starszej ceramiki wstęgowej w Chełmży w powiecie toruńskim na Pomorzu. *Roczniki Muzeum Wielkopolskiego 4: 1–27.*

KRAUSE R. 1997. Grabenwerk-Siedlung-Gräberfeld: drei Jahre Ausgrabungen in der bandkeramischen Siedlung bei Vaihingen an der Enz, Kreis Ludwigsburg. *Archäologische Ausgrabungen in Baden-Württemberg 1996: 37–41.*

2000. Von der ältesten zur jüngsten Bandkeramik Zur Geschichte des bandkeramischen Siedlungsplatzes bei Vaihingen a.a. Enz, Kreis Ludwigsburg. *Archäologische Ausgrabungen in Baden-Württemberg 1999: 29–33.*

KRUK J. and MILISAUSKAS S. 1998. *Rozkwit i Upadek Społeczeństw Rolniczych Neolitu.* Kraków: Institute of Archaeology and Ethnology.

KUNKEL O. 1934. Die Bandkeramik in Pommern. *Germania 18: 173–178.*

LENNEIS E. 1995. Altneolithikum: die Bandkeramik. In E. Lenneis, C. Neugebauer-Maresch and E. Ruttkay (eds.), *Jungsteinzeit im Osten Österreichs: 11–56.*

LÜNING J. 1982. Research into the Bandkeramik settlement of the Aldenhovener Platte in the Rhineland. *Analecta Praehistorica Leidensia 15: 1–29.*

1986. Die Ausgrabungen zum Neolithikum in Schwanfeld, Landkreis Schweinfurt. *Mainfränkische Studien 37: 9–16.*

LÜNING J., KLOOS U. and ALBERT S. 1989. Westliche Nachbarn der bandkeramischen Kultur: La Hoguette and Limburg. *Germania 67: 355–420.*

MILISAUSKAS S. 1986. *Early Neolithic Settlement and Society at Olszanica.* Ann Arbor: Museum of Anthropology, University of Michigan.

MODDERMAN P. J. R. 1970. *Linearbandkeramik aus Elsloo und Stein* Leiden: Analecta Praehistorica Leidensia 3.

1971. Bandkeramiker und Wandernbauerntum. *Archäologisches Korrespondenzblatt 1: 7–9.*

1974. Die Limburger Keramik von Kesseleyk. *Archäologisches Korrespondenzblatt 4: 5–11.*

1977. *Die neolithische Besiedlung bei Hienheim, Ldkr. Kelheim.* Kallmünz: Michael Lassleben.

1985. Die Bandkeramik im Graetheidegebiet, Niederländisch Limburg. *Bericht der Römisch-Germanischen Kommission 66: 25–121.*

NIESZERY N. 1995. *Linearbandkeramische Gräberfelder in Bayern.* Espelkamp: Marie L. Leidorf (Internationale Archäologie 16).

PAVLŮ I. (ed.) 1998. *Bylany Varia I.* Prague: Archaeological Institute.

PAVÚK J. 1972. Neolithisches Gräberfeld in Nitra. *Slovenská Archeololit 20: 5–105.*

QUITTA H. 1960. Zur Frage der ältesten Bandkeramik in Mitteleuropa. *Prähistorische Zeitschrift 38: 1–38, 153–189.*

SCHÜTZ C., STRIEN H.-C., TAUTE W. and TILLMAN A. 1992. Ausgrabungen in der Wilhelma von Stuttgart-Bad Cannstatt: die erste Siedlung der altneolithischen La-Hoguette-Kultur. *Archäologische Ausgrabungen in Baden-Württemberg 1991: 45–49.*

SOSNOWSKI W. 1990. Stolno, gmina Stolno, województwo toruńskie, stanowisko 2, jama 2. In D. Jankowska (ed.), *Z Badań nad Chronologią Absolutną Stanowisk Neolitycznych z Ziemi Chełmińskiej: 15–19.*

SOUDSKÝ B. 1966. *Bylany – Osada Nejstaršich Zemědělců z Mladši Doby Kamenné.* Prague: Academy of Sciences.

STADLER P. 1999. Frühneolithische Fundstellen von Brunn am Gebirge, Flur Wolfholz, NÖ. Http://www.nhm-wien.ac.at/nhm/prehist/Stadler/Brunn/Brunn_g.html. Accessed December 24, 2000.

STÄUBLE H. 1997. Häuser, Gruben und Fundverteilung. In J. Lüning (ed.), *Ein Siedlungsplatz der ältesten Bandkeramik in Bruchenbrücken, Stadt Friedberg/Hessen: 17–150*.

TILLMANN A. 1993. Kontinuität oder Diskontinuität? Zur Frage einer bandkeramischen Landnahme in südlichen Mitteleuropa. *Archäologische Informationen 16(2): 157–187*.

VALDE-NOWAK P. 1998. Badania osady neolitycznej w Łoniowej (Pogórze Wiśnickie). *Acta Archaeologica Carpathica 34: 195–206*.

WAHL J. and KÖNIG H. G. 1987. Anthropologisch-traumatologische Untersuchung der menschlichen Skelettreste aus dem bandkeramischen Massengrab bei Talheim, Kreis Heilbronn. *Fundberichte aus Baden-Württemberg 12: 65–193*.

WEINER J. 1995. Bogenstab- und Pfeilschaftfragmente aus dem altneolithischen Brunnen von Erklenz-Kückhoven. Ein Beitrag zur Bogenwaffe der Bandkeramik. *Archäologisches Korrespondenzblatt 25: 355–372*.

WHITTLE A. 1996. *Europe in the Neolithic: the Creation of New Worlds*. Cambridge: Cambridge University Press.

WINDL H. (ed.) 1995. *Rätsel um Gewalt und Tod vor 7.000 Jahren*. Asparn a.d. Zaya: Museum für Urgeschichte.

WIŚLAŃSKI T. 1974. Kultura ceramiki wstęgowej rytej na Ziemi Pyrzyckiej. In F. Lachowicz (ed.), *Studia Archaeologica Pomeranica: 53–77*.

UDK 303'12/'15(4-191.2)"634"

Documenta Praehistorica XXVIII

The beginning of the Neolithic in Austria – a report about recent and current investigations

Eva Lenneis
Department of Prehistoric Archaeology, University of Vienna, Austria
e.lenneis@cpsnet.at

ABSTRACT – *The "Earliest Linear Pottery-Culture" (LPC I) is to be seen as a synonym for the beginning Neolithic in Central Europe and therefore also in Austria. The distribution of this culture was limited by several facts of the natural environment, as its economic base was agriculture and stockbreeding. Traces are only to be found through Austrian territory outside the Alps in altitudes up to 400/450 m, on the best arable soils (mainly on loess base) and in the driest and warmest climatic zones with a clearly defined limit of tolerance. In the last two decades excavations of very different scale have been effected. A short overview is given upon the biggest ones and their main results. The first field researches had been between 1984–1986 within an international investigation project. Their results were analysed in detail and just gone into print. In this article they were presented shortly in a sort of summary. At least an outlook is given on current excavations and other projects.*

IZVLEČEK – *Najzgodnejša kultura linearnotrakaste keramike velja kot sinonim za začetek neolitika v srednji Evropi in zatorej tudi v Avstriji. Razširjenost te kulture so omejevali dejavniki naravnega okolja, saj je gospodarsko temeljila na poljedelstvu in živinoreji. Njene sledi v Avstriji smo našli le izven alpskega področja in na nadmorskih višinah do 400/450 metrov, na najbolj plodni prsti (pretežno aluvialnega izvora) in v najbolj suhih in toplih klimatskih področjih z jasno določeno mejo tolerance. V zadnjih dveh desetletjih pa smo opravili obsežna nova izkopavanja. V članku podajamo kratek pregled največjih izkopavanj in glavne izsledke. Med leti 1984 in 1986 smo v okviru mednarodnega raziskovalnega projekta opravili prve terenske raziskave. Rezultati teh raziskav so bili podrobno analizirani in so trenutno v tisku. V članku jih na kratko povzamemo in predstavimo. Pregledamo tudi izkopavanja, ki so v teku, in druge projekte.*

KEY WORDS – *distribution of LPC I in Austria; recent and current excavations; main results of analyses of two settlement sites*

THE MESOLITHIC BASE

Our knowledge of the Mesolithic in Austria still is very poor. The last statement upon this subject is by W. Antl-Weiser (*1993*), who named 10 sites for the whole territory. Only 5 of them lay in the northeastern region of Austria from where most of the early Neolithic places are known (*see also Leitner 1989*). Meanwhile there are some new mesolithic sites, but only in the alpine region due to more intensive field surveys and even excavations following the discovery of the famous "Ötzi" (*Leitner-Stadler 1992; Schäfer 1998; 1999*). Until now there are no excavations on Mesolithic sites in the east of Austria and all late Mesolithic flint industry is just known by surface collections. This situation gives a very unsafe base for all research concerned with geneses of Neolithic in our region.

THE EARLIEST LINEAR POTTERY CULTURE (*LPC I*) – FIRST TRACES OF NEOLITHIC IN CENTRAL EUROPE

Since H. Quitta (*1960*) published his fundamental study upon the "Earliest Linear Pottery-culture" this culture became a synonym for the beginning Neolithic in Central Europe and the number of findspots grew remarkably. By an increasing number of excavated sites we know quite a lot upon houses and settlements, economy and trade (*see for example Gronenborn 1999*) giving a picture of a fully sedentary life based mainly on agriculture and stock breeding, the hunt reduced to an unimportant role. The hamlets might have consisted of up to 3–5 contemporaneous houses only (*Modderman 1988.98*) and the number of settlement sites was much smaller than in the following younger *LPC* (*Petrasch 2001*). Also the whole territory of the *LPC I* is about half of that of the younger *LPC* (*Lüning 1988.Abb. 4; Pavlů 1998/99*). The Austrian sites are part of the eastern group within this territory, where most authors suppose to be the forming region of the *LPC* (Fig. 1). As recent ^{14}C–dates suggest the *LPC I* lived approximately between 5480/5450–5200 BC (*Lenneis, Stadler, Windl 1996*), the begin might even be more than 100 years earlier[1].

DISTRIBUTION OF *LPC I* IN AUSTRIA AND THE RELATION TO THE NATURAL ENVIRONMENT

In 1960 H. Quitta only could mention 6 sites in Eastern Austria (*Quitta 1960.153 ff*). Since then their number is steadily increasing. While publishing the first excavated *LPC I*–material in 1976 from Austria E. Ruttkay knew 19 places yet (*Ruttkay 1976. 850, Abb.3*), in 1989 my collection of that sort brought together 40 findspots (*Lenneis 1989*), meanwhile their number doubled to 80 (Fig. 2 and register[2]). This new evidence shows a distribution pattern with some clustering, which should not be misunderstood as settlement clusters. The density of sites is mainly the result of the activity of even single persons or of intensive building activities leading to rescue excavations as for example on the southern border of Vienna (Fig. 2: spots 67–74). The distribution pattern we see therefore may only indicate the different settlement regions of the beginning Neolithic not the density of habitation. For reconstruction that sort very intensive surveys and analyses would be necessary as was demonstrated recently by S. Ostritz (*2000*). What we can see in the here presented map scale is the restriction of the earliest Neolithic settlement to some extra alpine regions and within this to areas with special suitable conditions for these first agriculturists.

It is commonly known the most important facts for farmers are to have fertile soils and good climatic conditions. The problem is to find out which facts were most important and where was the limit of tolerance for this people while choosing their living places. I tried to find out the sought conditions for the whole *LPC* (phase I–III after *R. Tichý 1962*) in Austria nearly twenty years ago on the base of 240 sites and discussed there the problems of using recent soil maps and climate charts for the 6th millenium BC (*Lenneis 1982*). To summarise: the main relations were made to the soil bases, pointing out specially the loess and some other subsoil after the system of soil types by J. Fink (*1958*). As the climate was wetter and hotter during the 6th millennium

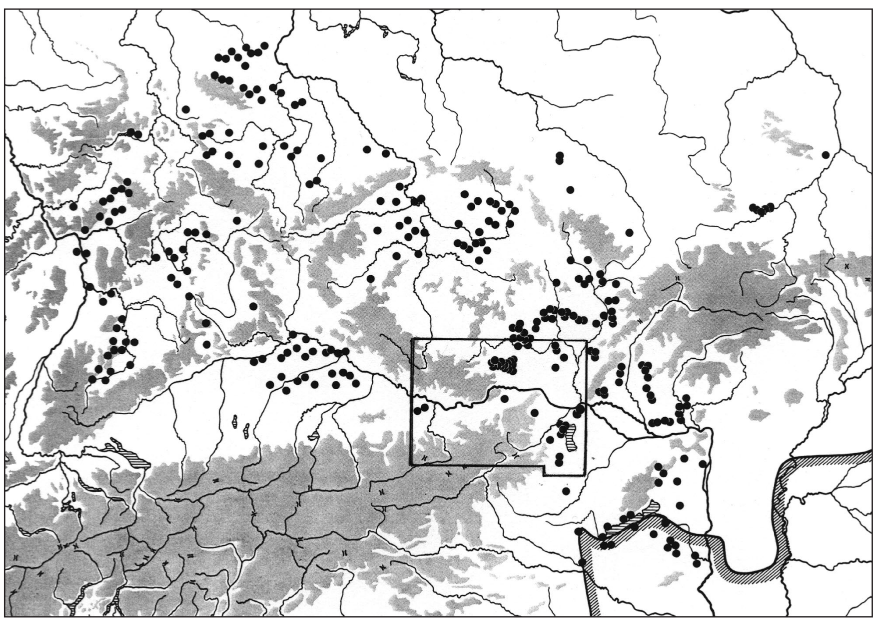


Fig. 1. Distribution of the LPC I in Central Europe (**after Petrasch 2001. Abb.1*****). The frame in the centre corresponds to the area given in more detail on Figures 2 and 3.***

1 Unpublished dates of Brunn II (see later) – personal communication by P.Stadler

2 In this register in the annex the thick black numbers are for sites with LPC I – material only, from the other younger LPC finds are also known. To shorten up the references all sites presented in some detail in my article of 1989 have as reference *Lenneis 1989*, in the other cases not all but the most informative reports are named. "FÖ" = Fundberichte aus Österreich. The references given only with an author's name and "FÖ...." are short find reports, some with drawings of single findings.

than today the absolute values of recent climate charts can't be used, but as there hasn't been any considerable change on the relief, the relative sequence of climatic zones gives useful information.

The localisation of all *LPC* sites has been done on maps with a scale of 1:50 000 and than put on a map with a scale of 1:500 000, the soil- and climate- charts were of the same scale. That way I found out for the whole *LPC* in Austria that the sought conditions were easy arable and most fertile soils (relevant soil types see Fig. 6) combined with the driest and warmest conditions. The tolerance border was 900 mm of recent average rainfall per year and 7°C of recent average temperature per year (after *Steinhauser s. a.*; *Lenneis 1982.9 ff, Karte 4–6, Abb. 1–3*). Figure 3 shows a map where the area limited by the above mentioned conditions is shown as "potential *LPC* settlement area". There are doted zones indicating good soils with non-sufficient climatic conditions. The relevant areas south of the Danube are too wet, the ones in the north, close to the Moravian border indicate good brown earth but too cool conditions. Most of the meanwhile around 300 sites of the younger *LPC* lay within this "potential *LPC* settlement area" (see hatched zones "settlement area of the younger *LPC*), only 6 find spots are outside, three of them are caves, the others may have had other special functions.

For the *LPC I*–sites I collected ecological data as follows: elevation above sea level (Fig. 4), situation in the climate zones (Fig. 5) and relation to soil types (Fig. 6). A detailed discussion will be given rather soon (*Lenneis 2003*) so I just present here the main results.

As to be seen in Figure 4 the main part of sites are in elevations between 200–300 m above sea level and not in the lowest zones of the country. The tolerance border is up to 450 m, 200 m higher than in regions of the *LPC* in Germany for example (*Sabel 1983. 160*).

There are only 21 places with only finds of the earlier *LPC* (*LPC I* only), the bigger part (59) are places with evidence also for the following younger LPC (*LPC I* pp). To be able to compare the data I also gave here those of the whole *LPC* as published in 1982 (*LPC I/III*). The distribution of sites in the zones of recent average rainfall per year shows an increasing importance of the driest zones while the tolerance border is going up from the line of 800 mm to the line of 900 mm with a very low percentage of the places.

During the same time the preference concerning the temperatures changed from the hottest to the second hottest zone. The tolerance border of 7°C seems not to bee crossed over during *LPC I*, while in the later *LPC* phases 3 sites are to be found just over this isothermal line in the northern region close to Moravia (*Lenneis 1982.Karte 6*).

The most important soil base for the earliest farmers in our region was the loess, having even an increasing values during the development of the *LPC I*. The average for the whole *LPC* was nearly 74% (*Lenneis 1982.Abb.1*). The absolute favourite type was the brown earth on loess (IV/1), also with increasing importance. The black earth "Tschernosem aus Tegel" (non-loess subsoil) is a slightly heavier soil with very high fertility, which seams to have lost of importance from the beginning with 19% to 12,8% for the whole *LPC*.

To summarise the evidence upon the relation of the earliest farmers to the natural environment on Austrian territory one get the impression of a cognisant choice for their living places, looking for them in the most suitable zones for agriculture. This zones seam to be strictly defined by light and most fertile soils (especially on loess-subsoil), very dry and warm climatic condition with a tolerance border of 900 mm recent average rainfall per year and 7°C recent average temperature per year just from the beginning. As there are plenty of watercourses in our region, their presence is not a restricting factor to the choice of settlement areas. There is only to point out that people avoided mainly the floodplains of the big rivers as the Danube and preferred the upper parts of streams and streamlets (see Fig. 2 and 3).

meters over sea level	LPC I only		LPC I pp.		LPC I total	
	number	%	number	%	number	%
100–150	1	4.76	2	3.38	3	3.75
151–200	2	9.52	7	11.86	9	11.25
201–250	8	38.10	17	28.82	25	31.25
251–300	7	33.33	20	33.90	27	33.75
301–350	2	9.52	6	10.17	8	10.00
351–400	1	4.76	5	8.47	6	7.50
401–450	0	0	2	3.38	2	2.50
	21	100.00	59	100.00	80	100.00

Fig. 4. Altitude of LPC I–sites in Austria.

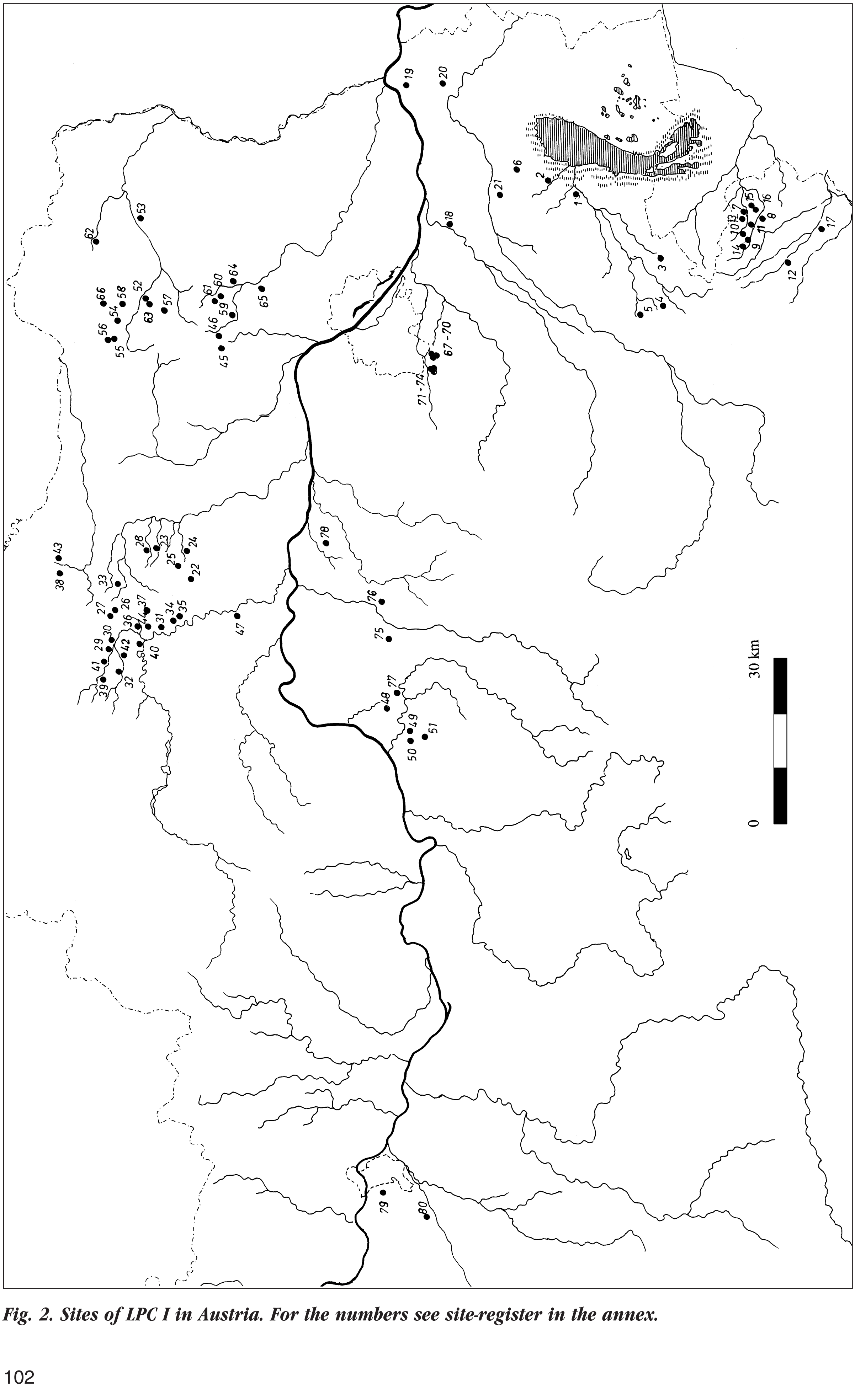


Fig. 2. Sites of LPC I in Austria. For the numbers see site-register in the annex.

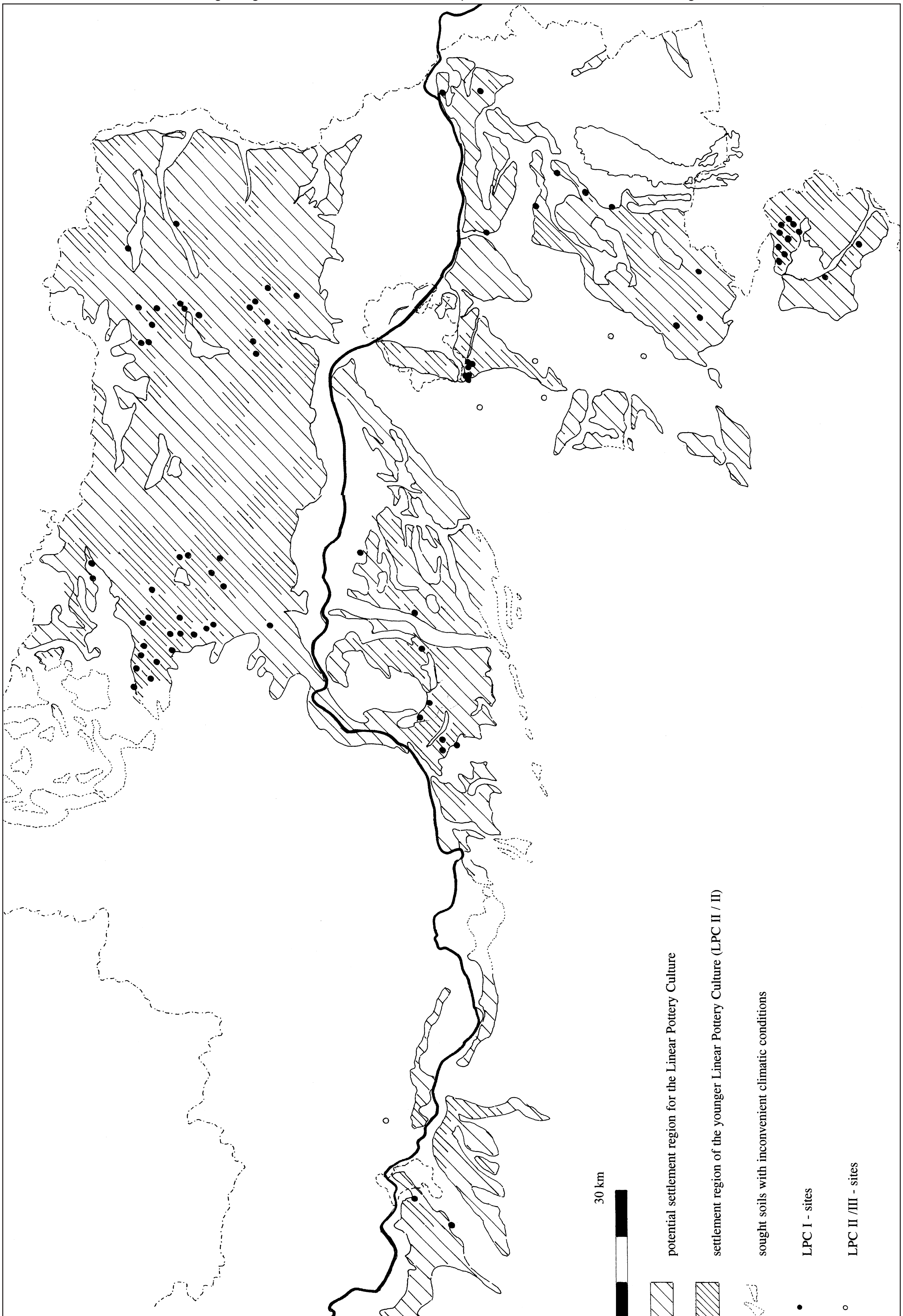


Fig. 3. Sites of LPC I in Austria with relation to the natural environment.

EXCAVATIONS AT *LPC I*–SETTLEMENTS IN THE LAST TWO DECADES

When J. Lüning and I started in 1984 the first research excavation on a *LPC I*–site in Austria at Neckenmarkt within his international investigation project "excavations for the beginning Neolithic in Central Europe" we found the first house plans of this culture on Austrian territory. Since then – as if the ice were broken – there are investigations of different size for this time, some as rescue excavations and few as research projects (see site register for Fig. 2). I won't be able to give here detailed information about all these field activities and only will refer about the biggest projects I am or was involved to some extent.

	LPC I only		LPC I pp.		LPC I total		LPC I–III	
	number	%	number	%	number	%	number	%
climatic zones								
average annual rainfall								
500–600 mm	8	38.10	26	44.07	34	42.50	109	45.04
600–700 mm	6	28.57	27	45.76	33	41.25	106	43.80
700–800 mm	7	33.33	4	6.78	11	13.75	22	9.09
800–900 mm	0	0	2	3.39	2	2.50	5	2.06
	21	100.00	59	100.00	80	100.00	242	100.00
average annual termperature								
over 9° C	13	61.90	14	23.73	27	33.75	88	36.36
8–9° C	6	28.57	28	47.46	34	42.50	100	41.32
7–8 ° C	2	9.53	17	28.81	19	23.75	51	21.07
under 7 ° C	0	0	0	0	0	0	3	1.23
	21	100.00	59	100.00	80	100.00	242	100.00

Fig. 5. LPC I–sites and their relation to climatic conditions (**after climate charts by F. Steinhauser; numbers and percentage for LPC I–III after Lenneis 1982*****).***

Asparn/Schletz, Lower Austria (Fig. 2 – point 52; plan Fig. 7)

There is a very large-scale research project of the "Niederösterreichische Landesmuseum" going on under the direction of H. Windl since 1984. The main interest of the large surfaces investigated was to uncover the late *LPC*-settlement with rests of an 8 m deep well and a very impressive ditch system, consisting of two parallel ditches describing an oval form with a maximum diameter of 330 m. The ditches with an average width of 4 m and 2 m depth contained more than 60 disturbed human skeletons-traces of a massacre at the end of the 6th millennium (W*indl 1994; 1996; 1998*). Beside these younger tra-

	LPC I only		LPC I pp	
soil type	**number**	**%**	**number**	**%**
loess-base				
I/7 Kalkige, vergleyte Lößkolluvien des Trockengebietes	1	4.76	0	0
III/4 Tschernoseme aus Löß	2	9.52	4	6.78
III/6 entkalkte (alte) und verbraunte Tschernoseme	1	4.76	2	3.39
III/7 Lößrohböden	1	4.76	3	5.08
IV/1 Braunerden aus Löß	10	47.62	31	52.54
IV/3 Braunerden über Schotter	0	0	0	0
IV/4 Braunerden auf (früh trockengefallenen Niederterrassen)	0	0	2	3.39
IV/5 leicht durchschlämmte Braunerden aus Löß	0	0	4	6.78
	15	71.43	46	77.97
other bases				
III/2 Übergänge kalkfreier zu kalkigen Tschernosemen	1	4.76	1	1.69
III/5 Tschernoseme aus Tegel	4	19.05	5	8.47
IV/2 Braunerden aus Sand	0	0	1	1.69
IV/12 alte Verwitterungsdecken, stark solifluidal durchmischt	1	4.76	2	3.39
VII/4 Braunerden aus Kristallin, im Wechsel mit alten Verwitterungsdecken	0	0	2	3.39
VII/5 Braunerden aus Kristallin, am Rand zum Trockengebiet im Komplex m jungen Staubdecken	0	0	2	3.39
	6	28.57	13	22.03
	21	100.00	59	100.00

Fig. 6. LPC I–sites and their relation to soil types (**after Fink 1958*****).***

ces of habitation in the northern part of this site a trapeze-form ditch of 400 m length was detected with an average width of 4 m and a varying depth up to 2 m. This ditch only contained *LPC I*-pottery and might be the last remain of an elder settlement. As this site is partly damaged by erosion there are no house plans for the *LPC I* habitation until now.

Brunn, site I–IV, Lower Austria (Fig. 2 – point 67–70; Fig. 8)

The beginning of the excavations at Brunn was due to roadwork beside the motorway A 2 at the southern border of Vienna (site I in 1989). Meanwhile the investigations under the direction of P. Stadler grew up to the biggest excavations for the beginning Neolithic in Austria. Until 1999 a surface of about 100 000 m^2 has been uncovered with the remains of 43 houses, which belong to 4 hamlets close to each other (*Stadler 1999*). As series of ^{14}C-dates and the find material indicate there was a sequence of the habitation of these 4 sites which is subject of a big scale investigation being published soon (S*tadler 2002*).

The most important place of these excavations is certainly site II (Fst. II) with indications for more than 25 houses (part of them see *Stadler 1996.Abb. 3*). The house plans are not very well preserved, their length in average of 20 m and width of 7–8 m are mostly deduced from the long pits as only traces of the main posts and nothing of the walls remained. The findings indicate a very early datation within the *LPC I*: a high percentage of the ceramics is undecorated, reminding the forms of the *LPC* as well as the Starčevo Culture (*Lenneis 2002.Fig. 8*), a spectacular amount of flint (more than 6000) shows some Mesolithic characteristics and the ^{14}C-dates reach up

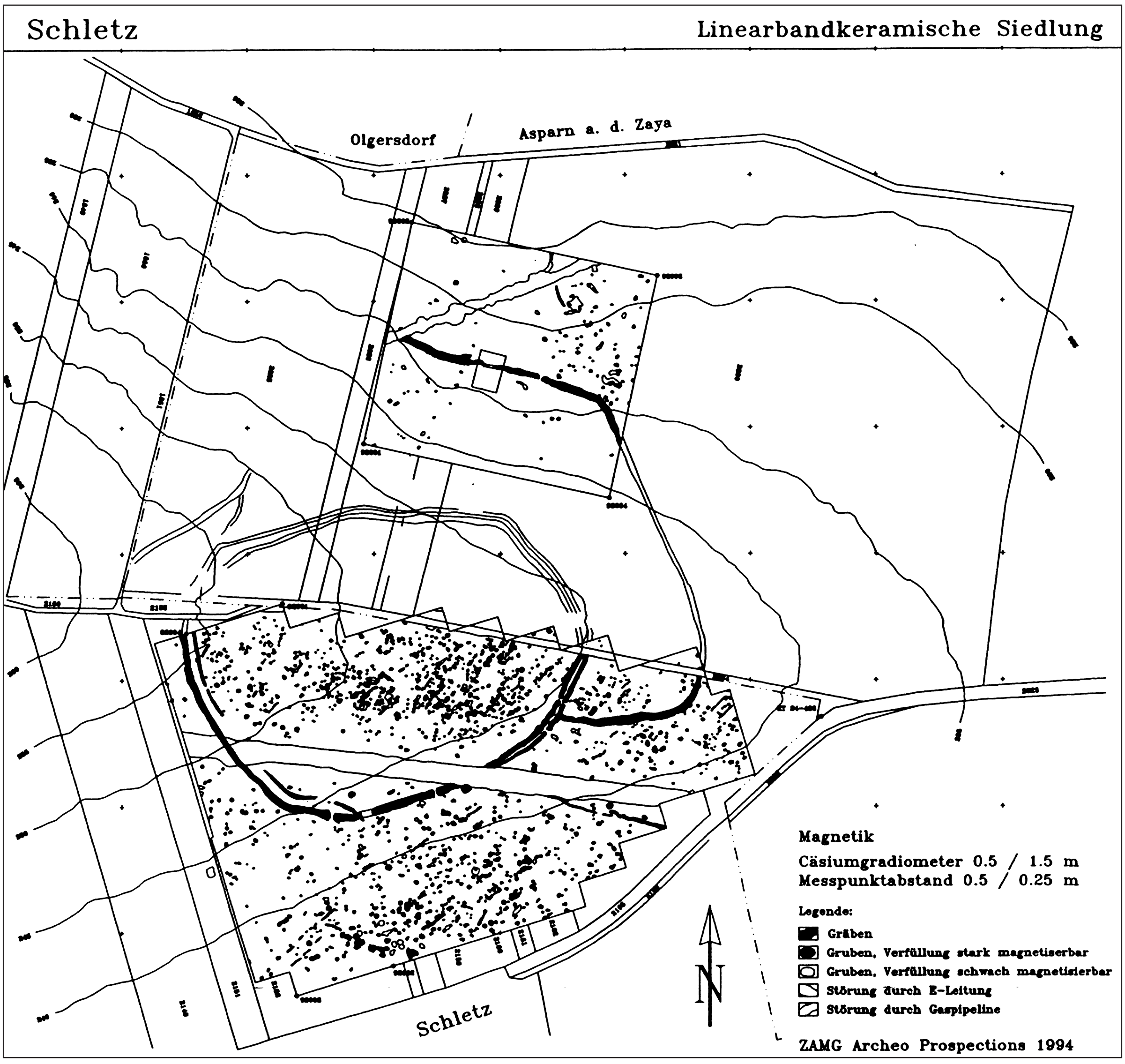


Fig. 7. Geomagnetic survey of the LPC-site at Asparn/Schletz, Lower Austria.

to 5620 BC. One get the impression that on this sites the formation process of the *LPC* might be to follow.

Neckenmarkt, site NM 1, Burgenland (Fig. 2 – point 9; Fig. 9 and 14)

Excavations have been effected in 1984 and 1985 under the common direction of J. Lüning and me, uncovering a surface of 2400 m^2 that was only a small part – as intended by the project – of the whole settlement with an estimated surface of about 28 000 m^2. In the area under investigation we found parts of four and complete surfaces of two houses, one of them with a very well preserved nearly complete plan of the posts (Fig. 14 – house 1). This house had a slightly trapeze-form outline with a total length of 19,8 m and a width of 6,7 m at the southern, 5,0 m at the northern end (*Lüning 2001.330, Abb. 70, 71*). The houses had been built partly so close together some of the long-pits have been in use from two sides, making the analysis of the situation and of the findings quite difficult. A detailed publication of this site is under print (*Lenneis, Lüning 2001*).

Recently made ^{14}C-analysis gave an approximately lifetime for the *LPC I*–habitation of this site within the frame of 5380–5200 BC (*Lenneis, Stadler 2001*). There are few traces of later use of the place at the end of the younger *LPC* and also at the end of the Neolithic.

Mold, Lower Austria (Fig. 2 – point 36; Fig. 10 and 11)

Investigations of this site started in 1995 and are still going on. They are effected with support and for the "Niederösterreichisches Landesmuseum" under my direction. Including the last campaign in summer 2001 we uncovered a surface of more than 8000 m^2 which only might be about 20% of the whole settlement, who's surface can be estimated of around 40 000 m^2. The speciality of this place are partly wonderful soil conditions which resulted excellent preserved plans of houses, some of them being far the biggest houses of that time on Austrian territory (*Lenneis 1997*). The nearly complete plan of house 1 has a preserved length of 37,5 m, which originally might have been about 42 m, and a total width of only 6,5 m. The house plan belongs to a very small group of "Großbauten" of the *LPC*, characterised by 4–5 rows of double/triple posts in the southern part. These additional posts are to be seen as supporting a granary, which in the case of house 1 must have been a divided one, a further speciality of this construction (*Lenneis 2001* and Fig. 11). Within the area of the "Hofplatz" (homestead?) of this remarkable building were pits with partly extremely rich findings. Especially on the east side of the house we found animal bones in quantities and sizes I never have seen before.

The ceramics from the pits around house 1 – after a first glance – might date from the end of the *LPC I*. First unpublished ^{14}C-samples measured within a big project (*Friesinger et al. 1999*) of a pit not too close brought dates in the time span of 5300–5200 BC. There are more findings of the LPC I as well as of the younger *LPC* (phase II/III after *Tichý 1962*) so it seams this large settlement area of Mold was inhabited for a longer period, may be without any break.

Rosenburg, Lower Austria (Fig. 2 – point 40; Fig. 12)

Only 4 km west of the above-described site of Mold lies the settlement of Rosenburg. Originally it may have covered a surface of around 10 000 m^2 and therefore belongs to the smallest *LPC* places. I excavated the remaining part of 7400 m^2 between 1988–1993 also with the support and for the "Niederösterreichische Landesmuseum". The lacking part between the two excavation surfaces was destroyed while building a road over it many years ago. In 1994 we did geomagnetic prospecting on 14 000 m^2 looking for the southern end of the Neolithic hamlet, but the following excavation teached me all structures in this part were of late iron age or even younger.

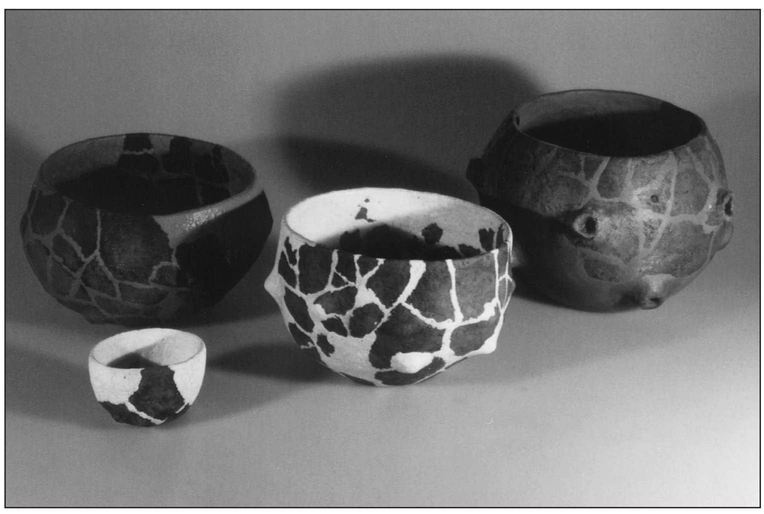


Fig. 8. Pottery from Brunn, site II, Lower Austria (photo: P. Stadler).

Fig. 9. Neckenmarkt, Burgenland. Pot from pit 14, occupation phase 3.

Seven house plans of the small hamlet of Rosenburg are preserved in varying quality, there may have been originally up to 10. As the ^{14}C-dates indicate a rather long habitation time of 200–300 years (*Lenneis, Stadler, Windl 1996.104 ff*) further analysis of the findings will have to find out if there was more than one building existing at once. The rather unusual situation of this hamlet compared with "normal" *LPC* settlement situations within a small loess area surrounded even today by dense, natural forest supports the idea of a "special" place. Beside this situation there is also another speciality of this site: there were 21 (!) slit pits, most of them parallel on a line N to S between the houses 2 and 7 (Fig. 12). These slit pits are seen on the surface as on the average 2 m long and only 20–40 cm widths structures. Their depths can reach more than 1 m (for further details see *Lenneis 1992*). As the profiles are so extremely narrow, their construction and also their use is still a matter of discussion: most colleagues think they might have been tan pits (*van de Velde 1973*), but they also may have been used for cooling (*Struck 1984*), for hanging in loom weights (*Gronenborn 1989*) and so on. The exceptional high amount of snail houses in the pits of Rosenburg may even indicate a use as cages. An analysis of the snail rests showed species of forest and steppe together, probably caused by men (*Kuijper 1992*).

More than 2500 litres of sediments have been sieved to get botanical macro rests. Part of it, 55 samples were analysed and published (*Kreuz 1990*), the bigger part of 127 samples did O. Brinkkemper, university of Leiden, with the support of an own research project. All cereals known for the *LPC* are proven but in striking small quantities, within the collected wild plants the high amount of carpinus seams to be also a speciality of this site.

To summarise the evidence of this site at the moment: there are some indications for a special function of this may be lonely farmstead within the *LPC* settlement cluster ("Siedlungskammer") of that region. Final analysis and publication is planned for the next years.

Strögen, Lower Austria (Fig. 2 – point 42; Fig. 13 and 15)

Again within a distance of only a few kilometres the small site of Strögen lies in the area of the same set-

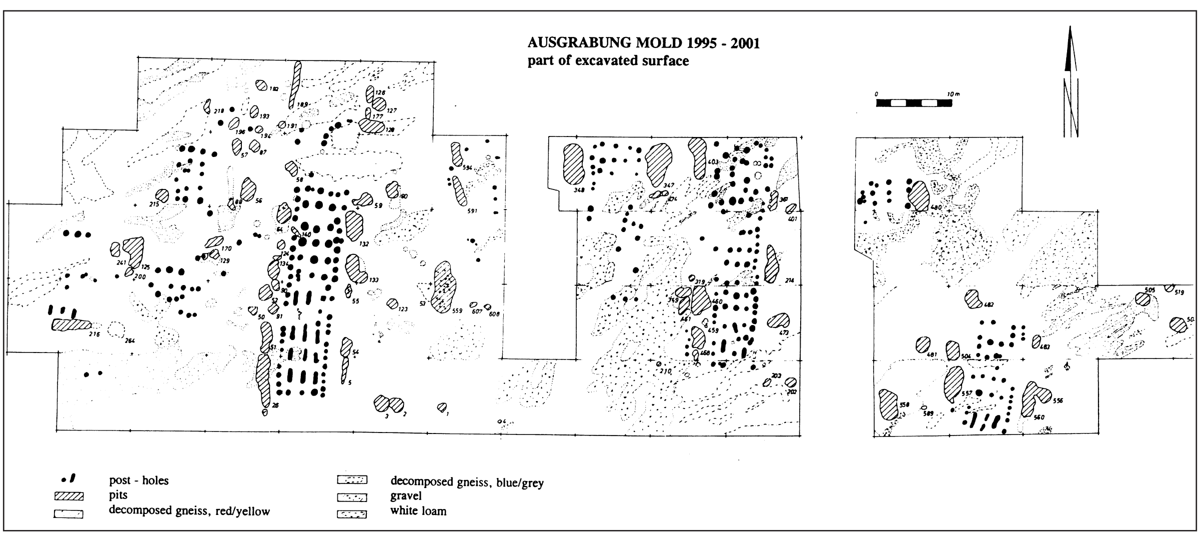


Fig. 10. Mold, Lower Austria. Part of surface excavated between 1995–2001.

tlement cluster in a rather unusual high position. This caused stronger damages by erosion than the geologist predicted after boring. The excavation in 1986 was also part of the above-mentioned project by J. Lüning, the work affected under our common direction. The investigated surface of 2100 m² uncovered totally the rests of this small hamlet.

We discovered the rests of 4 houses, three of them only indicated by one raw of the deepest postholes. The plan of one house (Fig. 15 – No. 4) proves the construction of the southern and middle part, giving the first evidence for a southern part with double posts in Austria (*Stäuble 2001.430 f, Abb. 120*).

The analysis of the partly very rich and extraordinary well preserved ceramics (Fig. 13) proved all 4 houses existed one after the other (*Lenneis, Lüning 2001*).

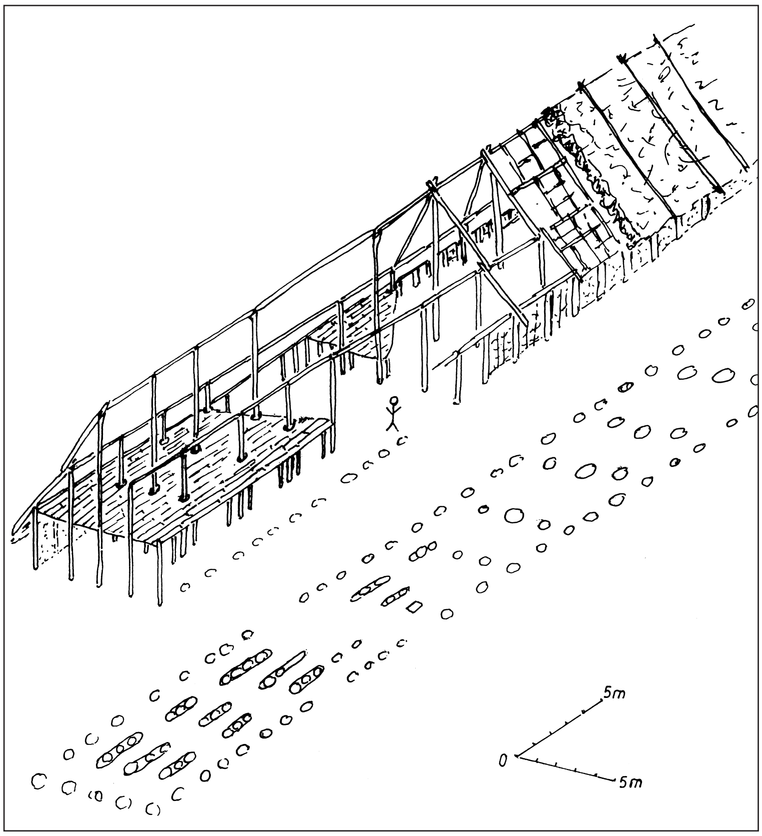


Fig. 11. Mold, Lower Austria. Reconstruction of house 1.

MAIN RESULTS OF THE ANALYSIS OF TWO *LPC I*–SITES

Neckenmarkt and Strögen (Figs. 14 and 15)

A short description of the situation and the excavations at the two sites has been given above. The analysis of house remains were done by J. Lüning (*Lüning 2001*), the ones upon all find inventories and the ceramics by myself (*Lenneis 2000*)[3].

During the excavations, finds from the pits were recorded by metre squares and 10-cm thick layers. These recording units are the basis for the whole finds inventory. Decorated and undecorated pottery as well as burnt daub material were counted and weighed. Stone artefacts, animal bones and carbonised plant remains were listed and published by the respective specialists (*Gronenborn 1997; Kreuz 1990; Pucher 1987*), the relevant totals included in an overall inventory. This inventory was the basis for the statistical analysis of finds distributions carried out by P. Stadler with the help of his WinSerion 1.0 programme. The results presented on 20 plans of the different finds categories show very interesting distribution patterns. Their analysis gave the following main results:

- Clear concentrations of decorated pottery at the south-east end and east of the houses especially in the northern part of Neckenmarkt;
- Some indications of the burning of a house, seen in the unusually high weights of burnt daub material relative to sample size in two long-pits beside house 5 at Neckenmarkt;
- Indications of hearths inside the houses, suggested by burnt daub material in postholes of houses 3 and 4 at Strögen;
- A striking coincidence of the main foci of distribution of flint artefacts and animal bones, which could be the result of meat preparation.

Despite the low numbers of finds, indications that the area of the middle part of the houses was of some importance for the manufacture and/or use of hard stone tools (other than flint).

Comparison of these results with other Linear Pottery culture settlements from France to Southern Poland proved difficult due to the different kinds of finds recording in use. The few comparable distribu-

3 The text given below follows in big parts the abstract kindly translated by A.Whittle.

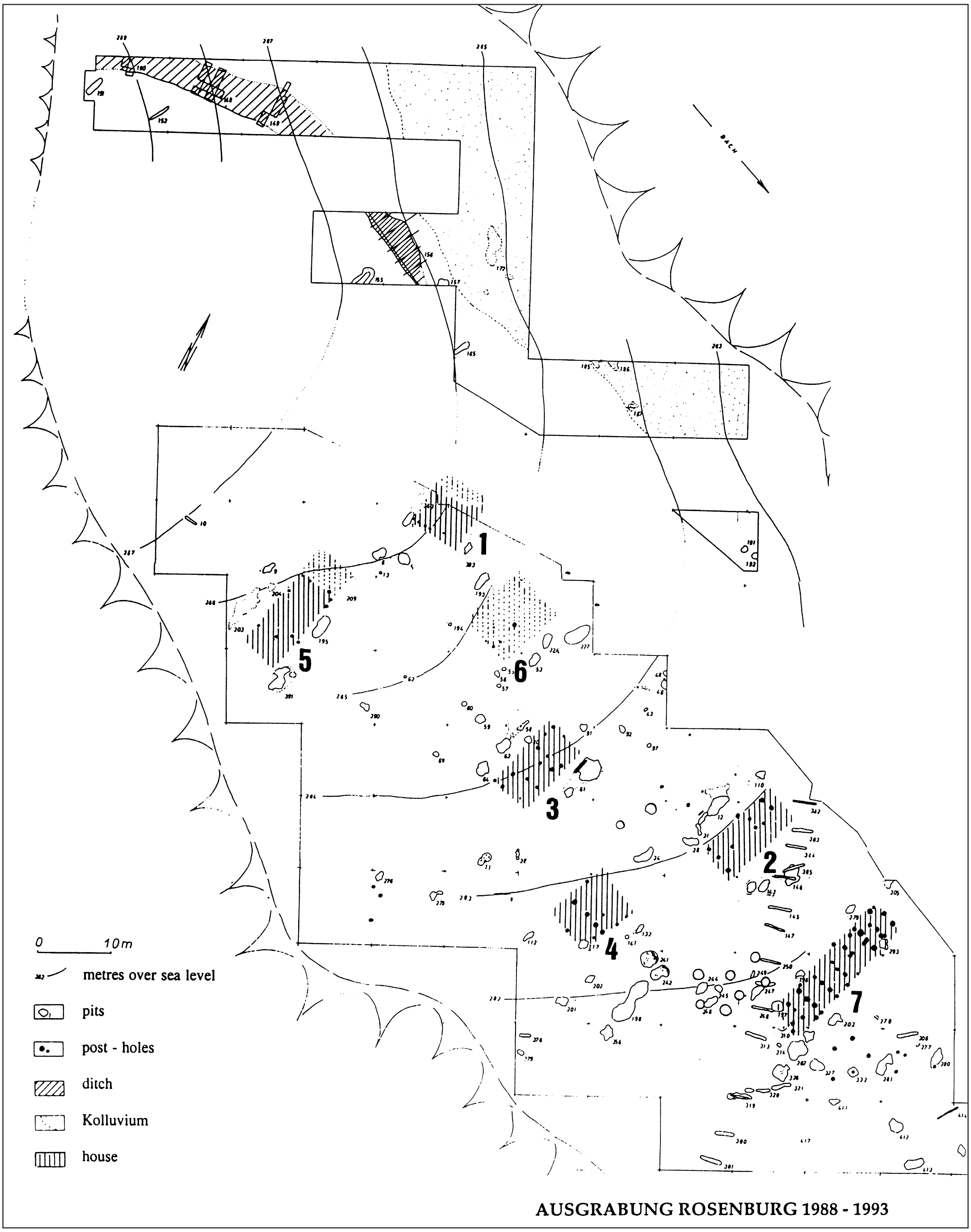


Fig. 12. Rosenburg, Lower Austria. Excavations 1988–1993.

tional data, together with those of the two sites, suggest the following picture of the structure of early Linear Pottery culture settlements in central Europe. The model of defined activity zones in the immediate surroundings of the house (within the area of the so-called *Hofplatz*), which had been worked out on the basis of analysis of later Linear Pottery culture sites on the Aldenhoven Plateau in the Rhineland, does not apply to the preceding earlier Linear Pottery culture. Some concentrations of finds in the southern surroundings of houses may indicate a special importance for the space immediately south of houses, but this observation does not allow a definition of different activity zones within this area.

All sherds, pit by pit (with the exception of the big long-pit between of house 1 and 5 at Neckenmarkt), were examined to see if they fitted or matched, and the recording of the pottery was done by the resulting 'vessel units'. These vessel units were recorded via a numerical code and all the data put into a Microsoft Excel dataset. The proportion of vessels put together from different recording units varied considerably from pit to pit. Graphs of matching sherds from the 10 cm layers and 1 metre squares from the various pits show clearly a very varied extent of mixing of the pit fills. Some big pits at Neckenmarkt show such extensive secondary mixing that their finds could only be evaluated individually and not in relation to their often disturbed contexts. Other pit contents are largely undisturbed, and the distribution of the individual vessels parts among varying recording units is the product of the excavation method.

Two very different but in the event highly compatible methods were used for analysis of the pottery. The illustrated pottery was the sole basis of typological analysis. All attributes that have been suggested in the Linear Pottery culture literature as relevant to chronological development were taken into account, as well as the often secondary mixing of Neckenmarkt pits in the subsequent evaluation of relative chronology. The listing of the securely dated pieces for individual pits and parts of pits at Neckenmarkt confirmed the results suggested by vessel units. In this way at least two occupation phases could be recognised within the earlier Linear Pottery culture at Neckenmarkt. The great majority of the material is assignable to the late phase of the *LPC I*. The few traces of late *LPC* settlement (*LPC III* after *Tichý* including some Želiezovce pieces) could be recognised only in mixed contexts including of the Late Neolithic, to which the whole contents of some pits also belonged.

In the pottery of Strögen two typological phases of the earlier Linear Pottery culture could be distinguished. About half of the material from this site belongs to the early phase of the earlier Linear Pottery culture (western long-pit of house 2). The inventory of one pit shows some characteristics of the later phase of the earlier Linear Pottery culture (western long-pit of house 3). None of the rest, belonging to the single better preserved house plan (house 4) could be precisely phased.

The basis of the seriation was the Microsoft Excel dataset with its numerically coded description of all 3237 ceramic vessels from both sites. Up to 40 attributes of form and 20 of decoration were considered for each pot. P. Stadler ran many seriations with his WinSerion 1.0 programme, and this began to give reliable

Fig. 13. Strögen, Lower Austria. Ceramics from pit 5, occupation phase 1.

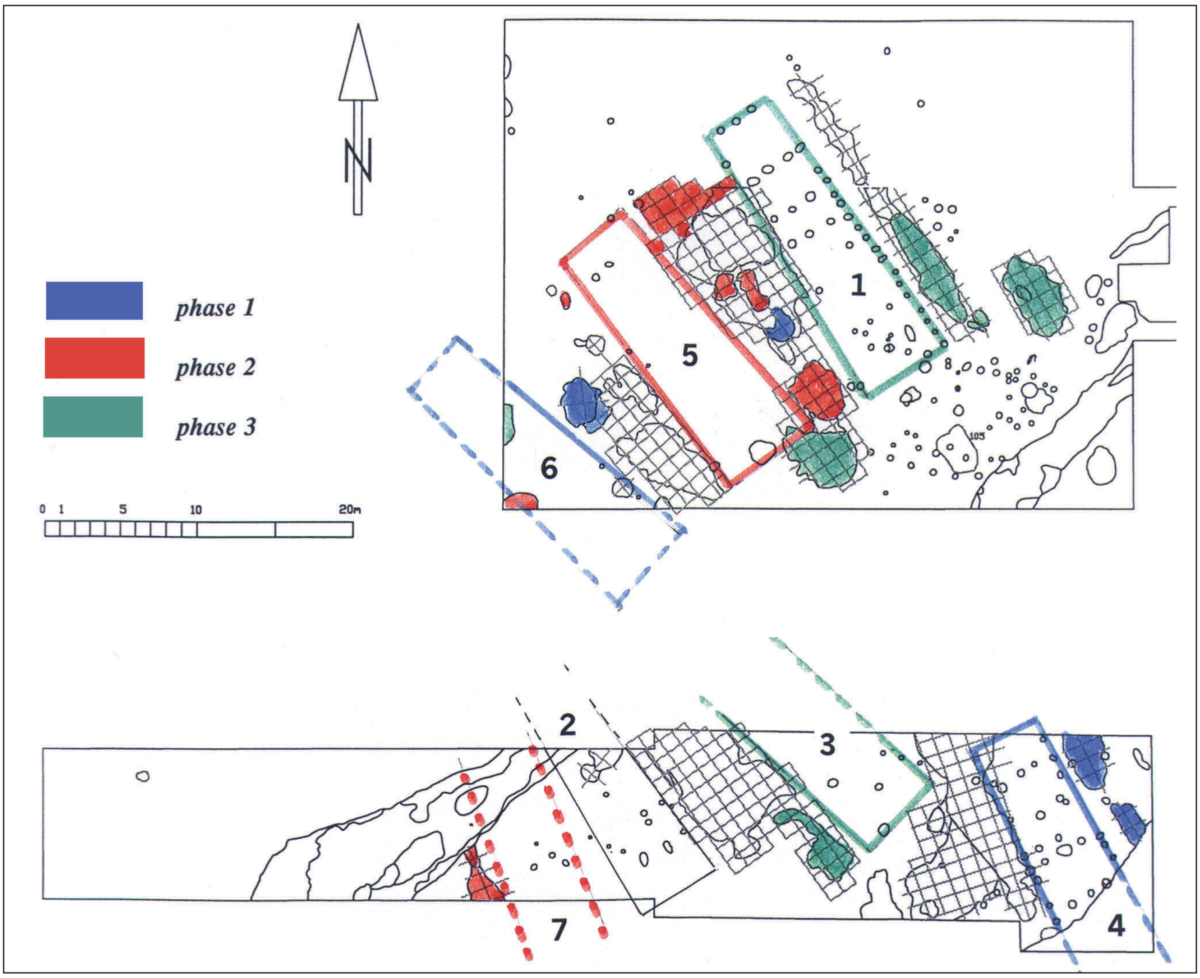


Fig. 14. Neckenmarkt. Occupation phases deduced from pottery seriation.

results when we decided to include only those inventories that the analyses above had suggested to be homogeneous and to lump the data from both sites. That meant restricting analysis to the *LPC I* material, for which there now appeared to be three chronologically significant groups. The surprising result was the assignment of the pottery of both settlements to three phases within the *LPC I*; the imprecisely dated finds from the two long-pits beside house 4 at Strögen could then be clearly put with the latest group. This result is the first successful attempt with the pottery, in this international investigation project involving 10 sites in Germany and Austria, to define settlement phases within the *LPC I*. A very extensive but methodologically rather different effort on the 8 German sites had concluded that this was not possible, and instead interpreted all differences as regional or site-based.

The occupation phases deduced from the pottery analysis served as the basis for the description of the development of the two settlements (Figs. 14 and 15). According to this, occupation started in the small- excavated part of the big Neckenmarkt settlement with 2 houses (late phase *LPC I a*). In the second phase there were only 1 or 2 houses (reconstruction of house 6 is quite unsure; beginning of phase *LPC I b*) and in the third phase there were 2 houses again (late phase 1b) There was no evidence of buildings from the excavated area for the fourth or late Linear Pottery culture occupation, and the finds from this were recovered from secondary, mixed contexts in the earlier pits. The structures in question probably lie in the space between Areas 1 and 2 and to their north. The finds suggest an occupation around 5000 BC. The next re-occupation, dating to the Late Neolithic/Early Bronze Age, came after a long hiatus of about two millennia, during which there were further significant changes to the natural surface. The evidence at this point consists of a few postholes and pits, as well as single sherd on the surface and in the fill of earlier contexts.

The pottery analysis of the small, totally excavated site of Strögen showed that there was a succession of houses (very poorly preserved). This is an *Einzel-*

hof, a single homestead or farmstead. Each successive building was always a little to the east of its predecessor. This is absolutely clear for the three, more or less parallel buildings (house 2–4) at Strögen (equivalent in date to occupation phases 1–3 at Neckenmarkt). The poorly preserved fourth house (Fig. 15 – house 1) lacked dateable finds, but since it occupied the westernmost position, it could have been the earliest structure on the site.

The two sites, Neckenmarkt and Strögen, not only represent a part of a big and a very small hamlet but also show a different sort of settlement structure. While in Strögen each house, even as belonging to only one homestead, has some empty area around, in Neckenmarkt some houses have been built so close together, the successors dug parts of their long-pit into an older one. By the analysis of all the data from the profiles and the plan of the pits of Neckenmarkt J. Lüning reconstructed their succession and came to a slightly different solution than me for the building phases of the houses in the northern part: house 5–1–6 (*Lüning 2001.414 ff*). Anyway the houses turned around the space immediately south of the houses proven also as the most important activity zone by the find distribution. This sort of clustering of the houses within the "Hofplatz"-area has very seldom been observed yet. Comparable situations are known from Schwanfeld, Bavaria (plan see *Gronenborn 1997.Abb. 2.14*) and from Brunn, site II (*Lenneis, Stadler, Windl 1996.Abb. 3*).

CURRENT INVESTIGATIONS AND OUTLOOK TO THE FUTURE

Thus briefly described, the main results of the investigations concerning the settlements Neckenmarkt and Strögen and the insights which they provide into settlement structure have wider implications: first, for the analysis and evaluation of other settlements of the earlier Linear Pottery culture which have been excavated in the meantime in Austria by the author and by other colleagues, and secondly, perhaps, also for wider areas beyond. One hopes especially that more ceramic evidence recorded and analysed on a similar basis will produce a better relative chronology for the Early Neolithic of a wider region. This is vital for the understanding of economic development in this exciting period of change, as strikingly shown by the new interpretations, presented by E. Pucher (*2001*), of changes in the structure of the animal economy; these new insights rely on the inner chronology of the two sites (Neckenmarkt and Strögen) as outlined above.

At the moment systematic field research is going on in Asparn, Mold and may be later also in Brunn. As

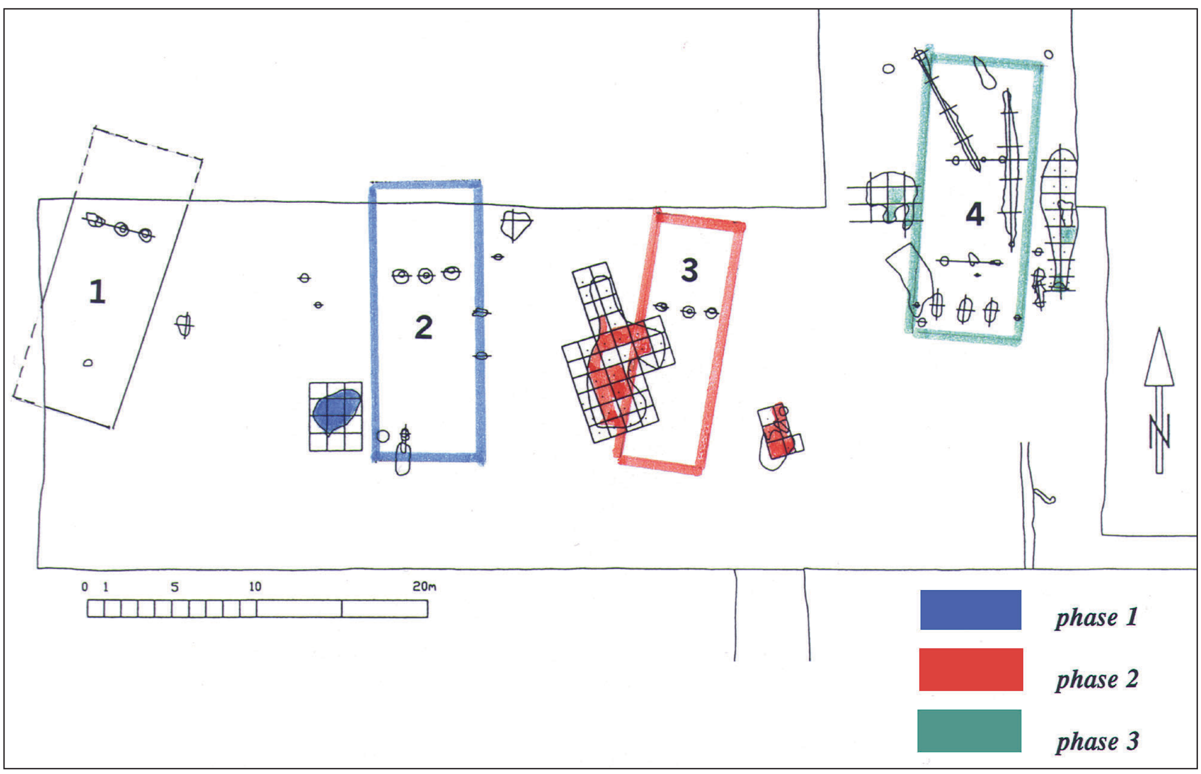


Fig. 15. Strögen. Occupation phases deduced from pottery seriation.

geomagnetic prospecting in an area of about 50 000 m^2 showed structures of 15–20 more houses (*Stadler 1999 and personal communication*) some further investigations should be done.

As mentioned above large-scale analysis of the 4 sites at Brunn by P. Stadler are in preparation. A young colleague, Carina Grömer, doing the ceramics of site III with the methods applied in Neckenmarkt and Strögen for her thesis, should join him. I myself plan to effect similar analysis for the site of Rosenburg.

Since 1999 a large project for dating ^{14}C-samples from Austria and the neighbour states is running. It includes samples especially for the beginning Neolithic but also from other times (*Friesinger et al. 1999*). Until the end of February 2002 about 1000 samples should be measured, 200/250 for the *LPC* (*personal communication P. Stadler*). One expects by the results of all these measurements a new, much more secure base for the chronology of the second half of the 6th and the early 5th millennium.

As to be seen, a rather good start of research upon the beginning Neolithic in Austria has been achieved. One hopes for further useful results of our investigations bringing at least a more accurate and vivid picture of this most interesting time.

∴

REFERENCES

ANTL-WEISER W. 1993. Spätpaläolithikum und Mesolithikum. In C. Neugebauer-Maresch (ed.), *Altsteinzeit im Osten Österreichs: 81...*

FINK J. 1958. *Die Bodentypen Niederösterreichs, Atlas von Niederösterreich*. Wien 1958, Blatt VII/1 and VII/2.

FRIESINGER H., KUTSCHERA W., WILD E., STADLER P. 1999. Absolute Chronology for Early Civilisations in Austria and Central Europe using ^{14}C Dating with Accelerator Mass Spectrometry, Forschungsprojekt Institut für Ur-und Frühgeschichte und Institut für Radiumforschung und Kernphysik, Universität Wien, Prähistorische Abteilung, Naturhistorisches Museum Wien.

GRÖMER K. 2001. *Jungsteinzeit im Großraum Linz*. Linzer Archäologische Forschungen 33.

GRONENBORN D. 1989. Überlegungen zur Funktion von Schlitzgruben. *Archäologisches Korrespondenblatt 19: 339–347.*

1997. *Silexartefakte der ältestbandkeramischen Kultur*. Universitätsforschungen zur Prähistorischen Archäologie 37.

1999. A Variation on a basic theme: the transition to farming in southern Central Europe. *Journal of World Prehistory 13/2: 123–210.*

HARRER A., LENNEIS E. 2001. Die ersten Nachweise der älteren Linearbandkeramik und andere wichtige Neufunde des Frühneolithikums aus dem Raum Melk, Niederösterreich. *Archäologie Österreichs 12/1: 31–38.*

KREUZ A. M. 1990. *Die ersten Bauern Mitteleuropas – eine archäobotanische Untersuchung zu Umwelt und Landschaft der ältesten Bandkeramik*. Analecta Praehistorica Leidensia 23.

KUIJPER W. J. 1992. Die Molluskenfunde der Ausgrabungen in Rosenburg, Niederösterreich. *Archaeologia Austriaca 76: 35–37.*

LAUE S. 1990. Strohschneider, Altneolithikum im Burgenland. *Archäologie Österreichs 1/1–2: 36.*

LAUE-STROHSCHNEIDER S. 1988. Eine Siedlungsgrube mit Vornotenkopfkeramik aus Purbach. *Burgenländische Heimatblätter 50/4: 145–153.*

LEEB A. 1992. Ravelsbach, Ried Urtlfeld. Ein bedeutender prähistorischer Fundplatz. A*rchäologie Österreichs 3/2: 19 f.*

LEITNER W. 1989. Zum Stand der Spätpaläolithikum- und Mesolithikumforschung in Österreich. In Frühes Leben in den Alpen, Innsbruck 1989.

LEITNER W., STADLER H. 1992. Eine Freilandstation mesolithischer Jäger am Hirschbühel in den Hohen Tauern (Osttirol). *Schriften des Vorarlberger Landesmuseums A/5: 53 ff.*

LENNEIS E. 1982. Die Siedlungsverteilung der Linearband-keramik in Österreich. *Archaeologia Austriaca 66: 1 ff.*

1989. Zum Forschungsstand der ältesten Bandkeramik in Österreich. *Archäologisches Korrespondenzblatt 19: 23 ff.*

1992. Vorbericht über die Ausgrabungen 1988–1991 der linearbandkeramischen Siedlung in Rosenburg im Kamptal, Niederösterreich. *Archaeologia Austriaca 76: 19 ff.*

1995. Altneolithikum: Die Bandkeramik. In E. Lenneis, C. Neugebauer-Maresch, E. Ruttkay (eds.), *Jungsteinzeit im Osten Österreichs.*

1997. Houseforms of the Central European Linearpottery culture and of the Balkan Early Neolithic – a comparison. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji XXIV: 143–146.*

2000. Die Funde. Studien zu Struktur und Entwicklung frühneolithischer Siedlungen im östlichen Mitteleuropa. In E. Lenneis, J. Lüning, *Die altbandkeramischen Siedlungen von Neckenmarkt und Strögen, Universitätsforschungen zur Prähistorischen Archäologie 82, in print.*

2001. Ein bandkeramischer Großbau aus Mold bei Horn, Niederösterreich. In Gedenkschrift für Viera Pavúková 2001, in print.

2002. Zu einigen wesentlichen Merkmalen der Keramik von Brunn. In Stadler 2002 ? – in preparation.

2003. Die frühneolithische Besiedlung Österreichs in Bezug zur natürlichen Umwelt. In Festschrift für Jens Lüning 2003, in print.

LENNEIS E., LÜNING J. 2001. Die altbandkeramischen Siedlungen von Neckenmarkt und Strögen. Universitätsforschungen zur Prähistorischen Archäologie 82: in print.

LENNEIS E., STADLER P. 2001. ^{14}C-Daten und Seriation altbandkeramischer Inventare. In Festschrift für Marie Zápotocká, Archaeologické Rozhledy 4/2001, in print.

LENNEIS E., STADLER P., WINDL H. 1996. Neue ^{14}C-Daten zum Frühneolithikum in Österreich. *Préhistoire Européenne 8: 97 ff.*

LÜNING J. 1988. Frühe Bauern in Mitteleuropa im 6. und 5. Jahrtausend v.Chr., Jahrbuch des Röm.-German. *Zentralmuseums Mainz 35: 27 ff.*

2001. Die Befunde. In E. Lenneis, J. Lüning, *Die altbandkeramischen Siedlungen von Neckenmarkt und Strögen. Universitätsforschungen zur Prähistorischen Archäologie 82: in print.*

MODDERMAN P. J. R. 1988. The Linear Pottery Culture: Diversity in Uniformity. *Berichten van de Rijksdienst voor her Oudheidkundig Bodemonderzoek 38: 63 ff.*

OSTRITZ S. 2000. Untersuchungen zur Siedlungsplatzwahl im mitteldeutschen Neolithikum. *Beiträge zur Ur- und Frühgeschichte Mitteleuropas 25, Weissbach 2000.*

PAVLŮ I. 1998/99. Die chronologische und geographische Verteilung der Linienbandkeramik in Mitteleuropa. In J. Preuß (ed.), *Das Neolithikum in Mitteleuropa, Band 1: 274 ff; Band 2: 55 ff.*

PETRASCH J. 2001. "Seid fruchtbar und mehret Euch und füllet die Erde und machet sie euch untertan": Überlegungen zur demographischen Situation der bandkeramischen Landnahme. *Archäologisches Korrespondenzblatt 31: 13 ff.*

PUCHER E. 1987. Viehwirtschaft und Jagd zur Zeit der ältesten Linearbandkeramik von Neckenmarkt (Burgenland) und Strögen (Niederösterreich). *Mitteilungen der Anthropologischen Gesellschaft in Wien, 117: 141 ff.*

2001. Anmerkungen zu den linearbandkeramischen Tierknochenfunden aus Neckenmarkt und Strögen aus aktueller Sicht. In E. Lenneis, J. Lüning, *Die altbandkeramischen Siedlungen von Neckenmarkt und Strögen, Universitätsforschungen zur Prähistorischen Archäologie 82: 265 ff.*

QUITTA H. 1960. Zur Frage der ältesten Bandkeramik in Mitteleuropa. *Prähistorische Zeitschrift 38: 1 ff u. 153 ff.*

RUTTKAY E. 1976. Eine Kulturschicht der ältesten Linearbandkeramik in Prellenkirchen, p.B. Bruck, Niederösterreich. *Annalen Naturhistorisches Museum Wien, 80: 843 ff.*

SABEL K. J. 1983. Die Bedeutung der physisch-geographischen Raumausstattung für das Siedlungsverhalten der frühesten Bandkeramik in der Wetterau (Hessen). *Prähistorische Zeitschrift 58/2: 158 ff.*

SCHÄFER D. et al. 1998. Untersuchungen zur mesolithischen Begehung des Fotschertales. *Urgeschichtliche Materialhefte 12: 161 ff.*

1999. Untersuchung zur mesolithischen Begehung in Tirol. *Universitätsforschungen zur Prähistorischen Archäologie 55: 37 ff.*

STADLER P. 1996. Brunn. In E. Lenneis, P. Stadler, H. Windl, Neue ^{14}C-Daten zum Frühneolithikum in Österreich. *Préhistoire Européenne 8: 97 ff.*

1999. Die älterlinearbandkeramische Fundstelle von Brunn am Gebirge, Flur Wolfholz (5620–5200 v. Chr.), Ausstellung Brunn. www.nhm-wien.ac.at/NHM/Prähist/Stadler/Brunn

2002. Bilddatenbank "Montelius" zur Erstellung einer dynamischen Typologie als Ausgangspunkt für Relativchronologie durch Seriation und Analyse des nächsten Nachbarn, Mitteilungen der Prähistorischen Kommission, in preparation.

STÄUBLE H. 2001. Strögen. Die Häuser und Gruben. In E. Lenneis, J. Lüning, *Die altbandkeramischen Siedlungen von Neckenmarkt und Strögen, Universitätsforschungen zur Prähistorischen Archäologie 82: 425 ff.*

STEINHAUSER F. (s. a.). Lufttemperaturkarte von Österreich für das Jahresmittel des Normaljahres 1901–1950, Bundesamt für Eich- und Vermessungswesen, Wien.

(s. a.). Niederschlagskarte von Österreich für das Normaljahr 1901–1950, Bundesamt für Eich- und Verrmessungswesen, Wien.

STRUCK W. 1984. Schlitzgräbchen im Kaiserstuhlgebiet. *Archäologische Informationen 7: 13 ff.*

TICHÝ R. 1962. Osídlení s volutovou keramikou na Morave. *Památky Archeologické 55: 245 ff.*

VAN DE VELDE P. 1973. Rituals, skins and Homer: the Danubian "tan-pits". *Analecta Praehistorica Leidensia 6: 50 ff.*

WINDL H. 1994. Zehn Jahre Grabung Schletz, VB. Mistelbach, NÖ. *Archäologie Österreichs 5/1: 11 ff.*

1996. Schletz. In E. Lenneis, P. Stadler, H. Windl (eds.), *Neue ^{14}C-Daten zum Frühneolithikum in Österreich, Préhistoire Européenne 8: 97 ff.*

1998. Der Brunnen der Linearbandkeramik von Schletz/Asparn a.d. Zaya, p.B. Mistelbach, im Nordosten Österreichs. In *Brunnen der Jungsteinzeit, Materialien zur Bodendenkmalpflege im Rheinland 11: 85–94.*

ANNEX

SITE-REGISTER FOR MAP 2

N°	commonalty	field name	provenience of finds	references
BURGENLAND				
district Eisenstadt-Umgebung				
01	Donnerskirchen	Weide ober der Trift	rescue excavation 1988	Lenneis 1989; Laue 1990
02	Purbach	Ried Fellner	rescue excavation 1984	Laue-Strohschneider 1988
district Mattersburg				
03	Draßburg	Taborac	excavations 1929–34	Lenneis 1989
04	Mattersburg	bei Bahnhof Wiesen–S.	surface	Lenneis 1989
05	Pöttsching	Ortsfriedh. Sauerbrunn	rescue excavation 1984	Lenneis 1989
district Neusiedl/See				
06	Winden	Kräftenäcker	rescue excavation 1948/49	Lenneis 1989
district Oberpullendorf				
07	Haschendorf	Kräftenriegel	rescue excavation 1998	Lenneis 2000
08	Horitschon	Rakitsch	surface	Lenneis 1989
09	Neckenmarkt	NM 1: Lackendorfer Feld	excavation 1984/85	Lenneis, Lüning 2001
10	Neckenmarkt	NM 2: Ziegelei	surface	Lenneis 2000
11	Neckenmarkt	NM 3: südl. Goldbach	surface	Lenneis 2000
12	Neckenmarkt	Ortsteil Samersdorf	surface	Lenneis 2000
13	Neutal	südlich Ort	surface	Lenneis 1989
14	Ritzing	südöstlich Ort	surface	Lenneis 2000
15	Unterpetersdorf	Ried Grübläcker	surface	Lenneis 2000
16	Unterpetersdorf		surface	Lenneis 2000
17	Unterpullendorf		surface	Lenneis 1989
NIEDERÖSTERREICH/LOWER AUSTRIA				
district Bruck/Leitha				
18	Enzersdorf /Fischa		single find	Lenneis 1989

19	Hainburg	Teichthal	single finds of excavation	Lenneis 1989
20	Prellenkirchen		rescue excavation	Ruttkay 1976;Lenneis 1989
21	Sommerein	Wolfsbründl	single finds of excavation	Lenneis 1989
		district Hollabrunn		
22	Eggendorf/Walde	Kapellenfeld	surface	Maurer, FÖ.38, 1999, 743
23	Limberg	Heidenstatt	surface	Lenneis 1989
24	Oberravelsbach	Ried Urtlfeld	rescue excavation 1992	Leeb 1992
25	Wilhelmsdorf	Moosang	single find	Lenneis 1989
		district Horn		
26	Breiteneich	Kalkgraben	surface	Lenneis 1989
27	Breiteneich	Trift	surface	FÖ.30–38,1991–1999
28	Etzmannsdorf	Stadtfeld	surface	Maurer, FÖ.35, 1996. 401
29	Frauenhofen	Neue Breiten	excavation 1975–1979	Lenneis 1986; 1989
30	Frauenhofen	Ried Milchtaschen	surface	Lenneis 1977; 1989
31	Gars am Kamp	Kleiner Teich	surface	Maurer, FÖ.32, 1993, 657
32	Groß-Burgstall	Preisenfeld	surface	Maurer, FÖ.37, 1998, 697
33	Kleinmeiseldorf		single find	Lenneis 1989
34	Maiersch	Baugrund	surface	Lenneis 1989
35	Maiersch	Stoßfeld	surface	Maurer, FÖ.32,1993, 666
36	Mold	Im Doppel	excavation since 1995	first report: Lenneis 2001
37	Mörtersdorf	In der Au	surface	FÖ.29–36, 1990–1997
38	Obermixnitz	Hermannsdorf	single find	Maurer, FÖ.33, 1994, 484
39	Poigen	Bachrain	surface	Lenneis 1989
40	Rosenburg	Hofmühle	excavation 1988–1994	first report: Lenneis 1992
41	St. Bernhard	Teichbreiten	surface	Maurer, FÖ.33,1994,490; FÖ.38,1999, 754
42	Strögen	Böhmerthal	excavation 1986	Lenneis, Lüning 2001
43	Untermixnitz	Hungerfeld	surface	Lenneis 1989
44	Zaingrub	Winkelthal	single find	Winter, FÖ.30,1991,243
		district Korneuburg		
45	Lachsfeld		surface	Lenneis 1989
46	Wetzleinsdorf		surface	Lenneis 1989
		district Krems		
47	Langenlois	Ried Schenkerbühel	single find	Lenneis 1989
		district Melk		
48	Lanzing		surface	Harrer, Lenneis 2001
49	Roggendorf	R 1 – Ort	surface	Harrer, Lenneis 2001
50	Roggendorf	R 2 – "Scheibn"	surface	Harrer, Lenneis 2001
51	Schollach		surface	Harrer, Lenneis 2001
		district Mistelbach		
52	Asparn (+Schletz)	Am Wald	excavations since 1984	first report: Windl 1994; 1996
53	Bullendorf	Wiesental	surface	Adler, FÖ.30,1991, 233
54	Friebritz	nördlich Ort	surface	Lenneis 1989
55	Gaubitsch	südlich Ort	surface	Lenneis 1989
56	Gaubitsch	Alpenberg	surface	Maurer, FÖ.33,1994, 472; Hasenöhrl FÖ.36,1997,742
57	Grafensulz	Haltergarten	surface	Maurer,FÖ.33,1994,476; 35, 1996, 402; 36, 1997, 744
58	Hagenberg	Ziegelofenbreiten	surface	Lenneis 1989
59	Hornsburg	Ritzenhof	surface	Schwammenhöfer, FÖ. 21, 1982, 224
60	Niederkreuzstetten		surface	Lenneis 1989
61	Oberkreuzstetten	südöstlich Ort	surface	Schwammenhöfer, FÖ. 35, 1996, 414
62	Poysdorf	Obere Lüß	rescue excavation 1994	Blesl, Neugebauer, FÖ.33, 1994, 579 ff
63	Schletz		surface	Lenneis 1989
64	Traunfeld	südlich Ort	surface	Lenneis 1989
65	Ulrichskirchen	südwestlich Ort	surface	Schwammenhöfer, FÖ. 35, 1994, 421 f
66	Wultendorf	Angerl	surface	Lenneis 1989
		district Mödling		
67	Brunn/Gebirge	Wolfholz, Fst. I	rescue excavation 1989	Stadler 1999
68	Brunn/Gebirge	Wolfholz, Fst. II	rescue excavation 1990/92	Stadler FÖ.31, 1992, 395; Stadler 1996
69	Brunn/Gebirge	Wolfholz, Fst. III	rescue excavation 1999	Stadler 1999
70	Brunn/Gebirge	Wolfholz, Fst. IV	rescue excavation 1997	Stadler 1999
71	Perchtoldsdorf	Bachacker	rescue excavation 1993/94	Herrmann FÖ.32, 1993,708 FÖ. 33, 1994, 485
72	Perchtoldsdorf	Industriestraße	surface	Herrmann,FÖ.31,1992, 458
73	Perchtoldsdorf	Judenacker	rescue excavation 1990/91	Talaa, FÖ.29,1990, 184 f; FÖ.30, 1991, 239
74	Perchtolsdorf	Zwingen	rescue excavation 1995	Talaa, FÖ.34,1995,623
		district St. Pölten		
75	Obermamau	bei .Anwesen Nr.18	single find	Lenneis 1989
76	Pottenbrunn	Löberfeld	single find	Wallner, FÖ.29,1990,186
77	Wimpassing/Pielach	Kirchenfeld	surface	FÖ. 33,1994,498 ff; FÖ. 34, 1995, 632 f.
		district Tulln		
78	Trasdorf	südöstlicher Ortsrand	rescue excavation	Neugebauer, FÖ.24/25, 1984/85, 219
		OBERÖSTERREICH/UPPER AUSTRIA		
		district Linz – Land		
79	Leonding	Gendarmerieposten	rescue excavation 1994	Grömer 2001
80	Rutzing	Schottergrube Rieder	rescue excavation 1968	Lenneis 1989

UDK 903'12/'15(4-17)"634"
Documenta Praehistorica XXVIII

Technology, mythology and the travels of the agricultural package in Europe

Helena Knutsson
Department of Archaeology and Ancient History, Uppsala University, Sweden
Helena.Knutsson@arkeologi.uu.se

ABSTRACT – *A group of artefacts is used here to explore the possibilities of explaining how the spread of agricultural techniques affected the peoples of Northern Europe whenever and wherever they met the earliest farmers. An attempt is made to correlate movements of artefacts and their social and political contexts during the Neolithic.*

IZVLEČEK – *S pomočjo artefaktov raziskujemo možne razlage, kako je širjenje kmetovalskih tehnik vplivalo na prebivalce severne Evrope ko in kjer so se srečali z zgodnjimi kmetovalci. Poskušamo ugotoviti povezave med širjenjem artefaktov in njihovim družbenim ter političnim kontekstom v neolitiku.*

KEY WORDS – *Neolithisation; stone-tool assemblages; Central and Northern Europe*

INTRODUCTION

The debate on the mechanisms behind the spread of agriculture from the Middle and Near East, as summarised by Budja (*1999*), Aubán (*1999*) and others in the same volume, still provokes sharp expressions. The Scandinavian debate on this issue has partly suffered from lack of material explicitly supporting any of the "indigenist" or "diffusionist" hypotheses. In this respect, Scandinavia must remain one of the last margins of Europe where farming became an important issue only when all other really suitable regions had been exploited and established. Nevertheless, the "modern" ideas of exploitation of resources eventually reached even this end of the world. If we look at the problem from another point of view, i.e. that of the hunter-gatherers, we may say that Scandinavia was saved for millennia from the acquisitive, aggressive and nature-destroying policies which constitute the farming mentality. The faint traces which fit together with the remains from areas where domestication obviously first occurred relate to domesticated plants and animals, exotic raw materials and technology.

We can follow a route for the biological parts of the so-called agricultural package from the Middle and Near East to northern Europe without encountering problems. We can also follow the spread of the first pottery, metal-working techniques and metal objects. The movement of stone tools is easy to follow, as it concerns exotic raw materials with well-defined sources. Flint-knapping technology has not yet been compared. The example that I give here is presented in an attempt to evaluate this aspect. Hitherto, in attempts to trace movements, stone-tool assemblages have been examined for tools made from imported raw materials. I would like to propose that special production modes could be "exported" or applied to local materials to serve the needs of "colonising or resource-surveying" groups. The point of departure is that long blades in southern contexts are closely connected with the appearance of agriculture, but they are also common in the Palaeolithic and Mesolithic forager settings of northern Europe. It is actually the mode of their production, which reveals the producers or the "customers" who ordered them. Furthermore, if it was important to apply a special mode of production, we may ask if and how it was transmitted to other groups and why it was so important. These considerations cannot be evaluated without consulting different kinds of non-archaeological sources and making predictions about human behaviour in different situations and in different contexts, in other words, without using ethno-analogies.

THE SOUTHERN BLADES

In the Near East and southern Europe, the regular blade industry was recognised as belonging to the farming-society setting. The blades serve as a chronological indicator bound to agriculture (*see Cauvin 2000.36, 39ff; Kozłowski 1994.595–601; Özdoğan & Gatsov 1998.209–232*). The production of blades follows special methods and is visible in materials from at least Natufian and Pre-pottery Neolithic B (PPNB) up to the Uruk period in the Near East. Very early extraction of obsidian is documented in Cappadocia, and the consumption of the products in the Levant is dated around 9000 BC (*Cauvin 2000.93ff; Balkan-Atli et al. 2000.133–145*). The mines in Eastern Taurus at Bingõl and at Lake Van later complete this extraction area, which supplied wide areas with obsidian (*Cauvin 2000.96f; Fig. 1*). The standardisation of blade production started as early as 8000 to 6500 BC. Between 6000 and 5500 BC the sizes of the blades and cores increased, as well as the quality of the raw materials and the products (both for obsidian and for flint/chert, both of which were imported when needed) (*Kozłowski 1994. 143ff*). This production belongs to the phenomenon following the spread of agricultural techniques, which is sometimes called the "Agro-standard". The standardised production of blades was carried out in specialised workshops, the raw material was brought from obsidian and flint mines, and these blades, among other products, seem to have been handled in widespread market networks. The end of production and the breakdown of the market networks have been dated to the same time as the breakdown of town-states at the end of the Uruk period at *c.* 3100 BC (*Kozłowski 1994.164ff; Rosen 1983.20ff*).

There also existed a much simpler production of blades, bladelets and tools from local raw materials which was carried out on the same site in parallel with the above described specialised industry. This production can be followed all along the path of the Agro-standard or the agricultural package from the Near East to central and northern Europe. At the end of the Copper Age, local production and standardised production may have merged into the production of so-called Canaanean blades, produced in local settings, but from imported, very fine-grained flint and good-quality obsidian (*Otte & Behm-Blanke 1992; Rosen 1983*). An example of a production site bound to an "elite" setting is room 29 in the complex of Hassek Höyük on the Euphrates, where twenty-eight cores prepared for the production of Canaanean blades were found in a pile beside a wall, while twelve others and production waste were distributed throughout the room. The layers with flint cores in the room were dated to the Uruk period and the Early Bronze Age. Very few blades were found in one of the other houses. In a layer dated to an earlier period, a cluster of ten blades was found. The flint source that could have been used as a quarry at Hassek was found only one hour's walk away from the settlement, but the obsidian used for the implements here came from Bingõl, which is a much more distant source. The products (the blades) of the same blade-knapping method used in Hassek were found at distances of 600–1000 km from the settlement (Fig. 1; *Behm-Blanke 1992.1ff, 216ff*). Canaanean blades seem to have been used in some tasks related to harvesting, as sickles and also as insets in threshing sledges which have been used up to modern times in some parts of the Near East (*Skakun 1993; Weiner 1992. 225ff; Collin 1992.248ff; Skakun 2000; Gurova 2000; Anderson 2000*).

The situation during the Neolithic in Greece, as described by Perlès (*1992*), shows a similar complex picture. Local production occurred during the Early and Middle Neolithic, along with an emerging, long-distance movement of ready-made or semi-manufactured products from Melian (and Gialian) obsidian mines, western-Greek honey-flint products and other types of resource materials. Perlès states that the cores for prismatic-blade production were made in a few workshops around the consumption areas and the blades were then produced at the settlement sites, a few at a time, and the cores were moved to be used at other sites as well (*Perlès 1992.125ff*).

The use of obsidian as raw material for tools in the central and western Mediterranean regions is "strictly associated with pottery-using agro-pastoralists" from the Early Neolithic onwards (*Tykot 1996.46*). Obsidian from four sources (Monte Arci in Sardinia; the island of Palmarola, west of Naples; the island of Lipari north of Sicily; and the island of Pantellearia in the Straits of Sicily) supplied an area from North Africa through Corsica and Italy, and from the Dalmatian coast to south-western France. Tykot states that the movement of obsidian was involved in a prestige-goods exchange or market in the area tied to the development and establishment of the Neolithic economy. Tykot's source determinations show some main directions in the movement of obsidian objects, mostly from Sardinia and Lipari towards the north, and some additional "exports" from the other sources in different directions (Fig. 1).

In summary, it is possible to follow a development through the Mediterranean region, similar to that in the Levant and the Middle East, towards the specialised Neolithic production of large blades and use of raw-material resources in the establishment of a wide "production-consumption" network.

CENTRAL EUROPEAN BLADES

Although found already in the Palaeolithic, blades and blade production may also have been tied into a prestige-goods exchange in central Europe. A settlement-based production of blades occurs at the Gravettian and Magdalenian sites. A whole chain of production is detectable in the assemblages of these sites involving local materials. But there is also a tendency to bring ready-made products from distant sources, for example flint from mines in the Cracow region or chert from Bavaria (*Svoboda et al. 1994. 129ff; Klima et al. 1997; Cziesla et al. 1990*). The method of extracting the blades was via preparation, in which the facets on platforms produced suitable angles for detachment (Fig. 2).

The Mesolithic groups of central Europe rejected the production of long blades. Instead, the technology concentrated on the production of microblades, microliths and to a certain extent the use of the bipolar method for other types of tools. The connection be-

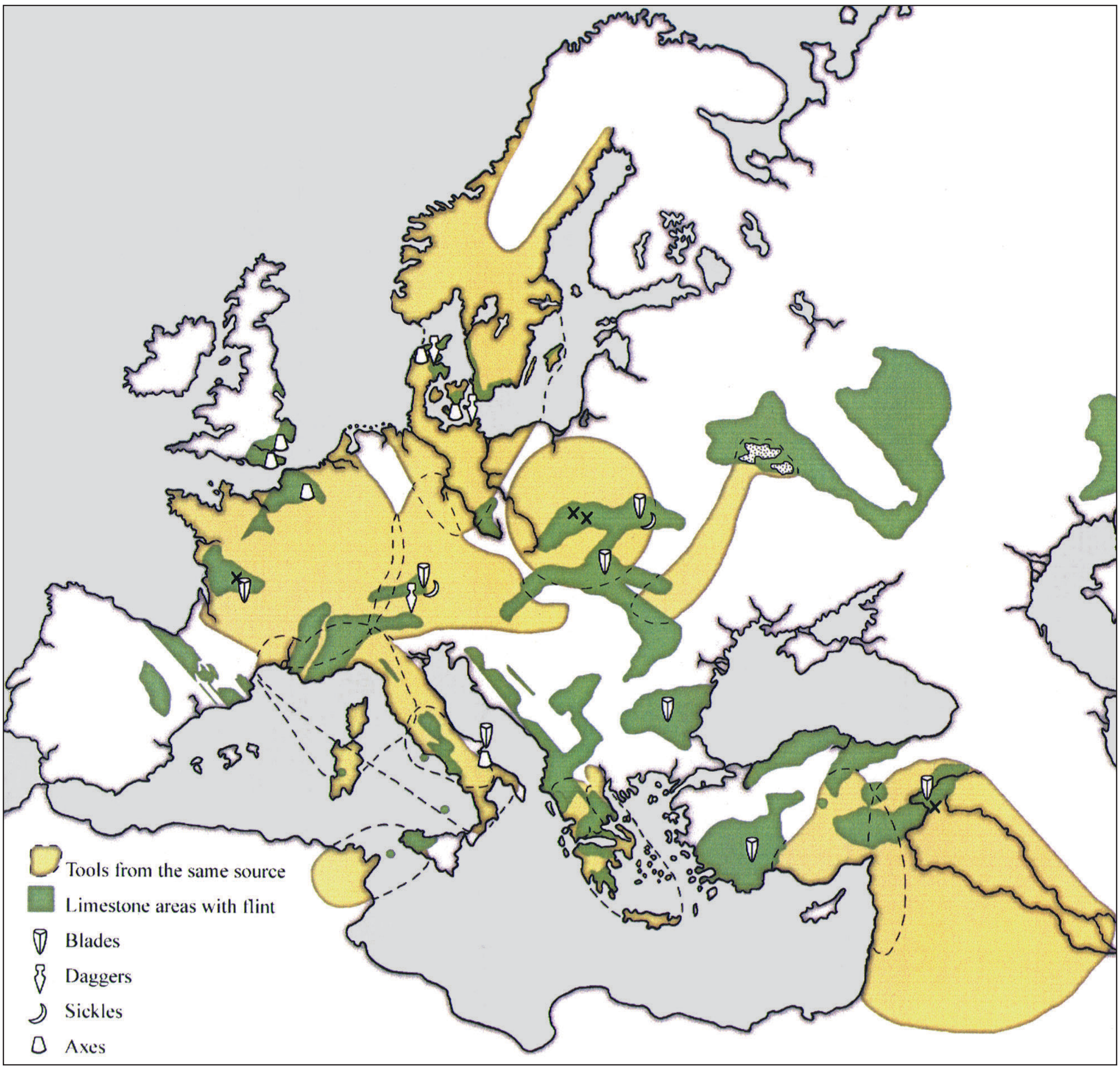


Fig. 1. Some of the European flint, chert and obsidian sources used during the Neolithic period and the approximate areas of distribution of artefacts from the sources.

tween long blades and their systematic use as harvesting tools is not described from the Palaeolithic and Mesolithic contexts of central Europe.

During the Neolithic, a more systematic production of long blades seems to have followed the agricultural package from the south-east. The blades were found on the early Band Ceramic settlements, and the same mode of production can be followed via the Pre-pottery Neolithic, Sesklo, Karanovo (the white-painted pottery), Starčevo and Körös groups. An interesting fact is that production sites for these types of long blades are still missing. The conclusion must be that the blades were produced outside the settlements and that both the blades and the method of their production were imported into central-European settlements (*Kaczanowska 1982; Kozłowski 1982; Gatsov 1982; 1993; Perlès 1987; Moundrea-Agrafioti 1981; 1983; Tellenbach 1983; Todorova 1989; Özdoğan 1999*).

An important factor in the spread of production methods may have been the search for new sources of available raw material. As we have seen in the case of Hassek Höyük (and several other mines and production sites in the Near Eastern region), some raw materials and some products showed a tendency to spread throughout wide areas (*see also Özdoğan 2000; Cauvin 2000*). During the Early Neolithic, a systematic exploitation and spread of products from several flint, obsidian and other raw-material mines in Europe seem to have started (Fig. 1). As mentioned above, some of the sources, like the chert and flint deposits in Poland and Germany, were already exploited during the Late Palaeolithic. However, between 6000 and 2400 BC, mining was intensified and specialised production in the mining areas, with wide distribution areas, began. Some of the mining districts housed the production of blades; the best-known are Swieciechów, Saspów and Jerzmanowice in Poland and Le Grand Pressigny and Mouthiers "le Martins" in France (*Balcer 1981.310–317; Babel et al. 1981.578–627; Desloges et al. 1981.474–509; Kelterborn 1981.228–232; Weiner 1981.233–235*). Production sites for daggers, axes and adzes appeared in several parts of Europe, and whole flint nodules were brought to central Europe from north-eastern flint sources in the Volhynian mountains

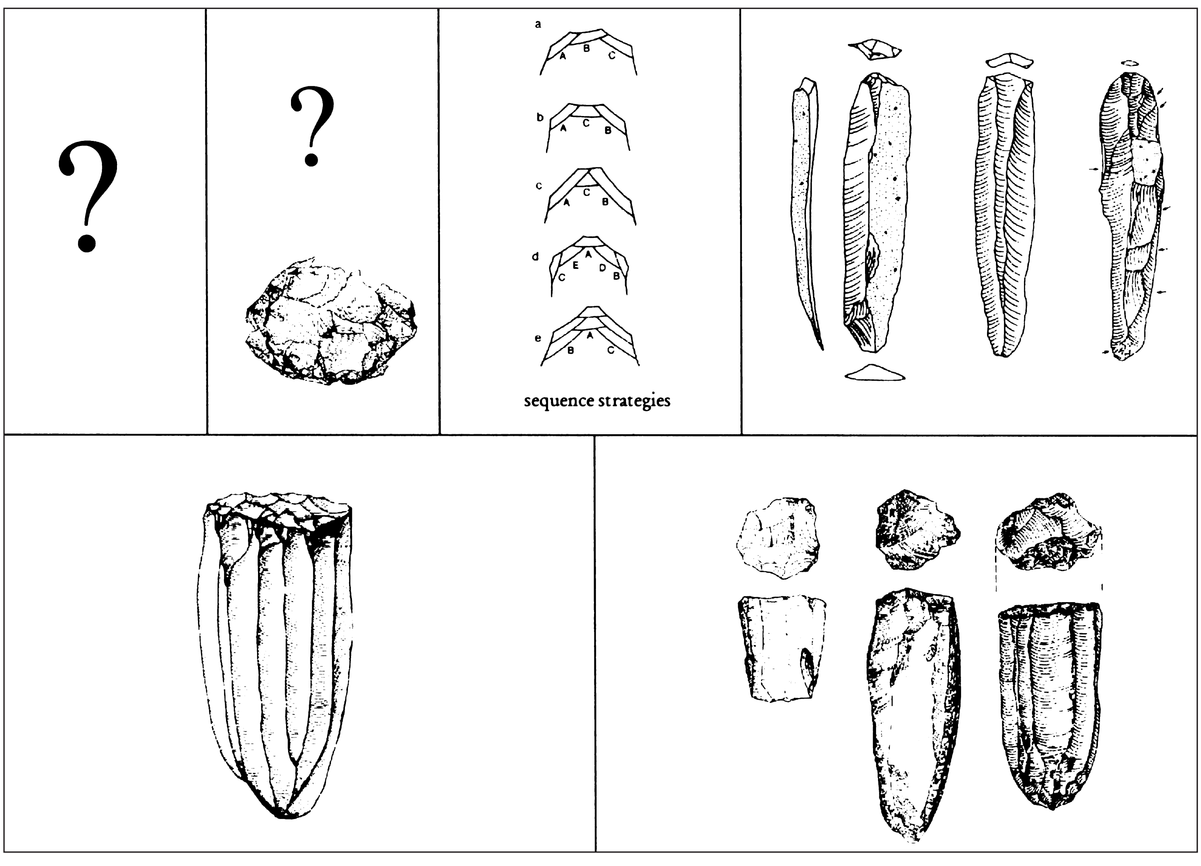


Fig. 2. The production chain of Neolithic blades made on one-sided platform cores. Some of the production steps have left no remains or waste. The method of decortification is not known. The reduction for platform is unsure. The blades and some cores are the only clear remains of production. The Swedish cores pictured are old stray finds.

(*Modderman 1981.308f; Schmid 1981.141–165; Olauson et al. 1981.183–204; Becker& Weisgerber 1981.456–473; Apel 2000*). Midgley (*1992.239f*) has proposed that systematically organised prospecting and extracting of flint around Europe based on specialisation, consumption groups and regional markets existed since the Early Neolithic, Band Ceramic period. Specialists such as flint prospectors and "middlemen" or "agencies" were responsible for the production and distribution of goods.

The flint mines and other extraction places in central Europe were found and described, with some exceptions, during the latter half of the 20th century. New ones are still being found and there are probably more to come. So the picture of their frequency and distribution across the continent is still to some extent guesswork. Intensively used sites for the production of specialised tools usually surround the known mines – we could call them factories. The extraction seems to have started in some places in the Late Palaeolithic (*Midgely 1992.239f; Balcer 1983*), but the main period of use and systematic production was from the Early Neolithic to the Copper Age (*Lech 1971; 1972; 1975; 1979; Dzieduszycka-Machnikowa 1976; Balcer 1971.71–132; 1975; 1976.179–199; 1981.310–317; Zimmermann 1982; Smolla 1987.127–129*).

The use of these sources seems to run in parallel with the use of gold and copper ores, which were extracted in other types of mines already in the Early Neolithic. We may speak of two different industries, in which the extractors were well aware of the possibilities of finding raw-material deposits in Europe as early as Neolithic times. Specialists were surely needed in these types of enterprises (*Lichardus 1981.265–270; Lech 1981.274ff*).

The central European blades are found in all possible contexts. They are usually broken on the settlement sites, and they are usually whole, often in clusters, in hoards and graves, especially in the Copper Age. There are some graves in which the contents have been associated with flint extraction and/or knapping (*Lech 1981.272–278; Kruk 1969.399–403*). Many graves of the Copper Age, Tisza-Polgár Culture in Slovakia and Hungary contain, as an important part of the grave goods, blades and cores of flint brought to the settings from the Volhynian-Podolian mountains, about 400 km to the north-east as the crow flies. Some also contain raw nodules, weighing up to 3 kg, of the same type of flint (*Lichardus-Itten 1981.279–283; Bognár-Kutzián 1972; Šiška 1964. 293ff;* Fig. 3).

In summary, a change of blade production and consumption is detected even in central Europe which relates to the spread and establishment of agricultural techniques from the South East and the following material changes. There seems to have been a shift in detection and utilisation of available raw material sources around the area during this time. There are two possible interpretations of the production and consumption patterns in central Europe. When people moved to another place, the settlements were carefully cleared of any knapping waste, or there were rules about who was permitted to produce the tools or blades and where they could be produced. In the second case, the tools or blades were mainly produced to maintain a ritual-mythical tradition of a group in the society, the group not necessarily being the producers.

THE NORTHERN BLADES

The situation in the northern-European contexts is different. Excellent, regular, blade production is indicated in the Villingebæk phase of the Kongemose culture of Scandinavia (*ca.* 6000–5000 BC cal) (*Sörensen 1996; Vang Petersen 1993.14*). The establishment of the Linear Pottery Culture in Poland happened in the period corresponding to the other half of the Villingebæk phase. The excessive production of blades indicated in the newly excavated settlement of Tågerup may be interpreted as production corresponding to new contacts and new needs expressed by these southern (continental) groups. This is a behaviour documented in many contact situations between hunter-gatherers and different, land-colonising groups. (For example, the painter Albert Namatjira in Alice Springs, Australia, and his family group, have delivered water-colour paintings in English " landscape style" in great numbers to galleries and collectors. A production of Kimberley points is also known in the prisoners' colony on Rottnest Island on the Australian west coast. The points were sold to museum employees, among others) It is necessary, however, to mention that the production methods of the Kongemose blades are defined as endemic in southern Scandinavia. They were produced by locals, although responding to some needs expressed by groups living further south, who looked for new, exploitable resources.

In the Ertebölle time (the end of the Mesolithic) the blade-production industry disappeared from the settlements, and regularly produced blades did not appear before the Early Neolithic TRB and the Middle

Neolithic Battle Axe and Pitted Ware Cultures. The lack of blades at Late Mesolithic settlements and the evaluation of the flint industry as generally crude are interesting phenomena which I shall address later.

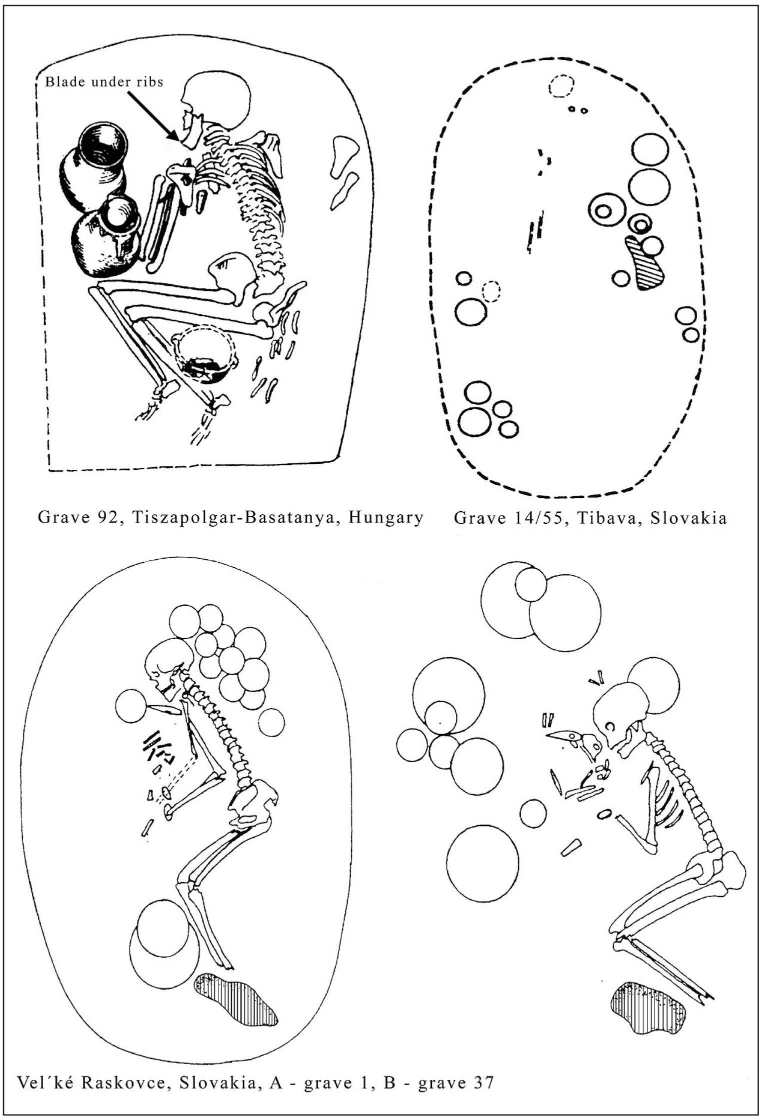


Fig. 3. Some graves of the Tiszapolgar group, with finds of flint blades and nodules of Volhynian-Podolian flint.

The blades are found in burial assemblages in both the latter contexts. They are also parts of the settlement assemblages, but there are some differences. In the Mesolithic graves, we find tools used in different ways (according to the results of use-wear analysis) as parts of the personal possessions of the deceased. This seems to be the case also in the graves of the Neolithic Pitted Ware Culture. The situation is complex; hitherto, the Pitted Ware Culture graves have been found in settings very distant from the nearest flint sources, and the number of blades, both in the related settlements and in the graves, is small. The settlements belonging to this tradition in flint-rich areas are full both of blades and of the waste from their production. The method of their production is defined as "cylindrical". The cores have two platforms, and blades are extracted around these in order to make them as straight as possible. A number of the blades have been transformed into large arrowheads with tongues. The raw material is not the best sort of flint – rather small beach nodules have often been selected – and most of the cores have been used to exhaustion (Fig. 4).

The Corded Ware Culture graves (the Boat Axe Culture in Sweden and Norway, the Battle-Axe Culture on the Danish islands and in northern Europe, and the Single Grave Culture on Jutland) form another type of context, which contains blades. The same type of blade has been found in some graves, as well as in hoards around the flint-bearing areas, sometimes together with thick-butted, flint axes (*Karsten 1994*). Most of the Swedish Boat Axe Culture blades have been subjected to a technological and functional analysis. They were subsequently compared with samples from Mesolithic blade production and samples from the central-European, Corded Ware Culture blades. The Swedish Neolithic blades showed traces of detachment from conical cores of good-quality flint; the waste from the production could not be detected either in the graves, or in the contemporary settlements. After a thorough investigation, only three cores were detected among the stray-find collections in Sweden, their patina indicating depositions in bogs. The type of cores used for the detachment of blades found in the Corded Ware Culture graves is easy to recognise and distinguish from the cylindrical and even the Mesolithic blades. They are of a conical type, with bases slightly wider than the platform part. The platform is prepared for blade detachment by striking blows into the platform (and not, as in the Mesolithic methods of preparation, by blows from the platform towards the sides), the platform showing facets and ridges shaping angles suitable for the knapping of blades. The blades from these cores are also easily recogni-

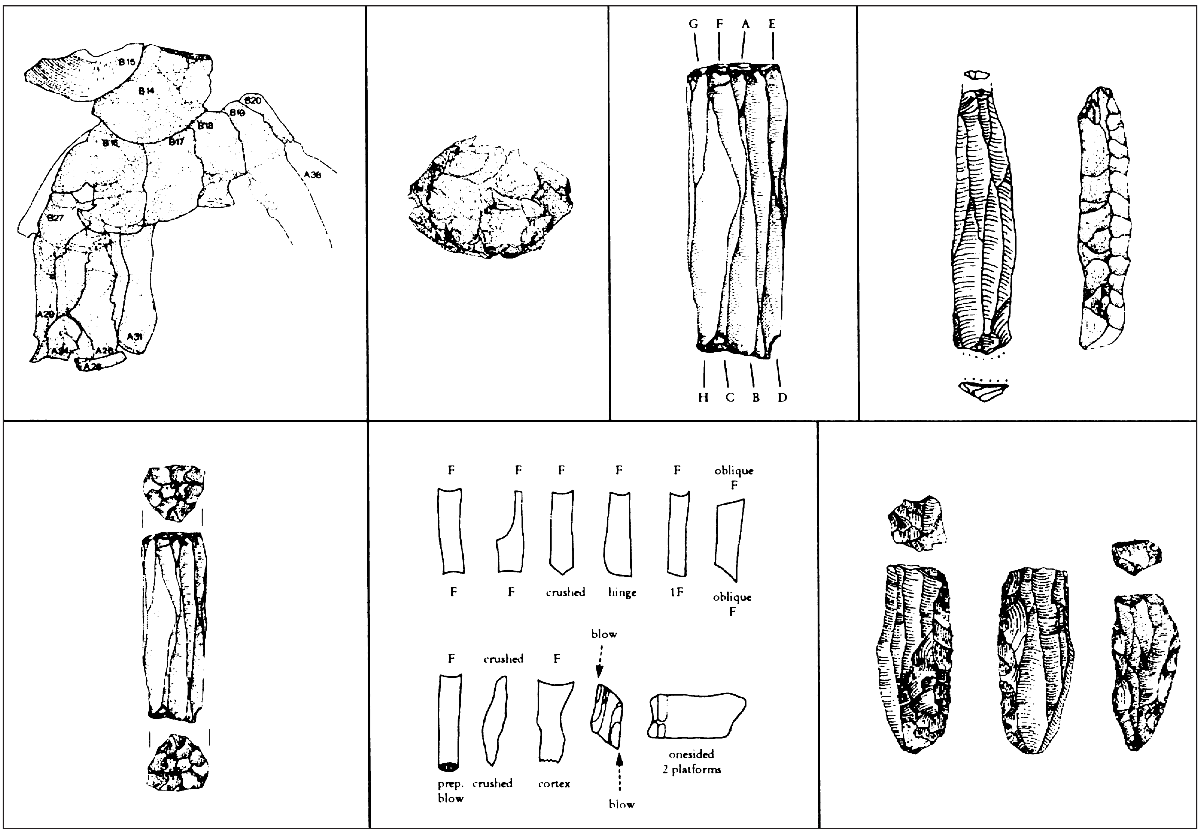


Fig. 4. The reduction strategy used in the production of Scandinavian Pitted-ware Culture blades. All the steps are represented in the settlement materials. The reduction sequence could be as shown in the figure. Several types of cores were recognised in the production waste.

sable: they have facets on the platform; they show traces of detachment with punches and are curved (Fig. 2; *Callahan 1995.224ff*). A microwear analysis of the available blades from Sweden showed two distinctly separate patterns. In the graves situated close to the flint sources, there was often more than one blade and they were either unused or had unrecognisable traces. In the parts remote from the flint areas, there was normally only one blade in a grave and most of them were heavily used for harvesting purposes (*Larsson 1988; Lekberg et al. manus; Knutsson 1995.150ff, Fig. 5*). In Denmark, a similar situation has been described (*Vang Petersen 1993.56*). A comparison with the material from a Corded Ware Culture burial ground in Vikletice in northern Bohemia showed a similar pattern of use and burial gifts in the graves (*K. Knutsson 1995. 221ff; H. Knutsson 1995.108f*). A summary of the production and the deposition of flint blades in Scandinavia is presented in Figure 6. Further studies showed that the Scandinavian (and the central-European) blades were probably produced in the same manner as the blades that came to Europe together with the "Agro-standard" or the agricultural package from the Near East.

INNOVATIONS, TRADITIONS AND HIERARCHIES

There are, of course, several different reasons for the movement of tools and technologies. One of these is scarcity or an uneven distribution of resources. This type of tool and technique movement is well documented among different groups of mobile, egalitarian societies without agriculture. The preferential use of artefacts made from materials from distant sources is documented by McBryde and Lukin Watson from among other places, the hostile environments of the Simpson Desert in eastern Australia (Fig. 7). Grindstones, native tobacco (*pituri*), ochre, adzes and shells have been found hundreds or thousands of kilometres from the places where they were gathered or made. McBryde describes an intricate system of exchange networks, which, like the system of *Xharo* among the African Bushmen, had, apart from purely functional reasons, the important purpose of strengthening and building positive social relations between individuals and groups (*McBryde 1988; Lukin Watson 1980; Wiessner 1986*). The movement of grindstones hundreds of kilometres from quarries is especially interesting. Their weight was considerable. We may compare it

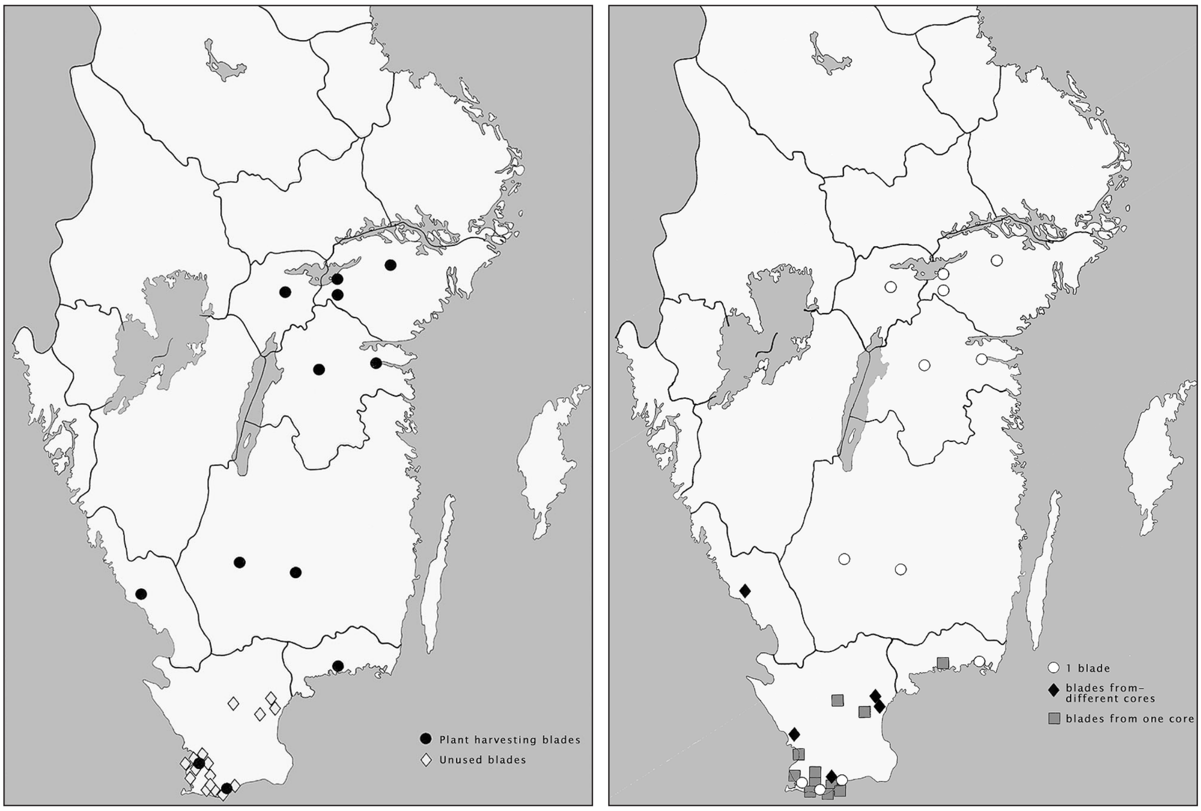


Fig. 5. The distribution of blades from the Swedish Battle-axe Culture and the use-wear identified on them. All the blades were found in graves.

with the weight of the flint nodules which were brought to Hungary and Slovakia from the Volhynian flint areas during the Copper Age and then buried, together with dead members of the Tiszapolgar and other communities (Fig. 3 and 7).

I would suggest an alternative explanation of the traits visible in northern and central-European material from periods before the Neolithic. I would also like to relate the picture to the beginning of blade production in the Middle and Near Eastern traditions of the Natufian culture and its contemporary and preceding groups.

While the Australian (and probably also the European Palaeolithic and Mesolithic) objects were intended for practical use and the construction and reconstruction of social contracts, the European Neolithic objects ended up in graves often unused, being most probably designed to mark social possibilities and differences between individuals and groups. Another reason for the movement of tools and technologies was consequently a need to mark and enhance the status of the owner, dead or living, with the help of valuable objects made from materials from distant sources (*Helms 1988; Swadling 1996; Taffinder 1998*).

The production of symbolic objects which show the status of the bearer, the "customer" or sometimes even the producer, seems to be a normal way of thinking from the modern, western-European point of view. But, as I see it, a culture that promotes individual competitive behaviour is needed as a starting-point for this type of technology movement. When human societies develop a culture which measures the status of individuals, then the tools and objects, as well as the technologies as media for communication, start to be used in a competitive way to ensure a better position for the individual and his family or clan. A complex relation to material culture develops; its "value" supported and enhanced by mythology, increases, which may justify also a "non-use" of tools specially produced for burial purposes only (*Weiner 2000*).

Hayden (*1998*) offers an explanation of changes and differences in the use of technology in the social structuring of societies. He is of the opinion that technology is primarily to be seen as a practical phenomenon and that in all societies it is used in that way. But, very early on in human "evolutionary history", there begins a development towards the use of technology as an object of competition between individuals and groups of peoples. He concludes that there is a development of prestige technology and the use of objects as competition items, driven by ambitious, aggressive and acquisitive individuals, *aggrandisers*, based on the opportunity for them to act, with the help of groups of supporters, in the interest of their own needs. In other words, these *aggrandisers* operate on the basis of the decline of common, societal and cultural barriers to such individual interests. The material culture will be used in such societies to support the power positions of individuals or their classificatory or biological families, and not the need of co-operation between individuals and groups. If a need of co-operation arises in such a society, a network will be constructed, but still the need of the primary group will be maintained before the common needs or the needs of other groups in the network. If we try to interpret the archaeological findings from the Neolithisation period, we have to bear in mind that a shift from "collective" needs to more "individual", prestigious needs may have taken place during this period. It is, however, important to see the cultural remains in the light of such a change. But it is also important to acknowledge the need of community support and networking for the development of specialist production and specialised extraction.

What aspects of the archaeological material could be interpreted in this way? To begin with, there would be rather faint traces of such behaviour. If we look at the production of Neolithic blades in the Middle and Near East and later in central and western Europe, which is the concern of this article, we can follow some important changes. The systematic production of large blades concentrated in some production centres in the Middle East developed at this time. These blades were used for arrowheads and especially as harvesting tools and were widely exported and marketed around the region (see Fig. 1; *Cauvin 2000.35ff, 94f, Fig. 33, 102f, 145ff, 174ff; Özdoğan 2000; Behm-Blanke 1992.176; Kozłowski 1994*). The production of such blades spread to Europe as a part of the "agricultural package", but partly to areas where the production of blades was already established, for other purposes. However, with the help of technological analysis, we can follow the "original", south-eastern, blade-production mode as far as to the southern parts of Scandinavia. There the blades arrived with other "agricultural traits", for example, special burial customs with grave gifts symbolising control of nature and control of other groups of people (storage, harvesting, clearing of forests, killing of animals and men, i.e. war).

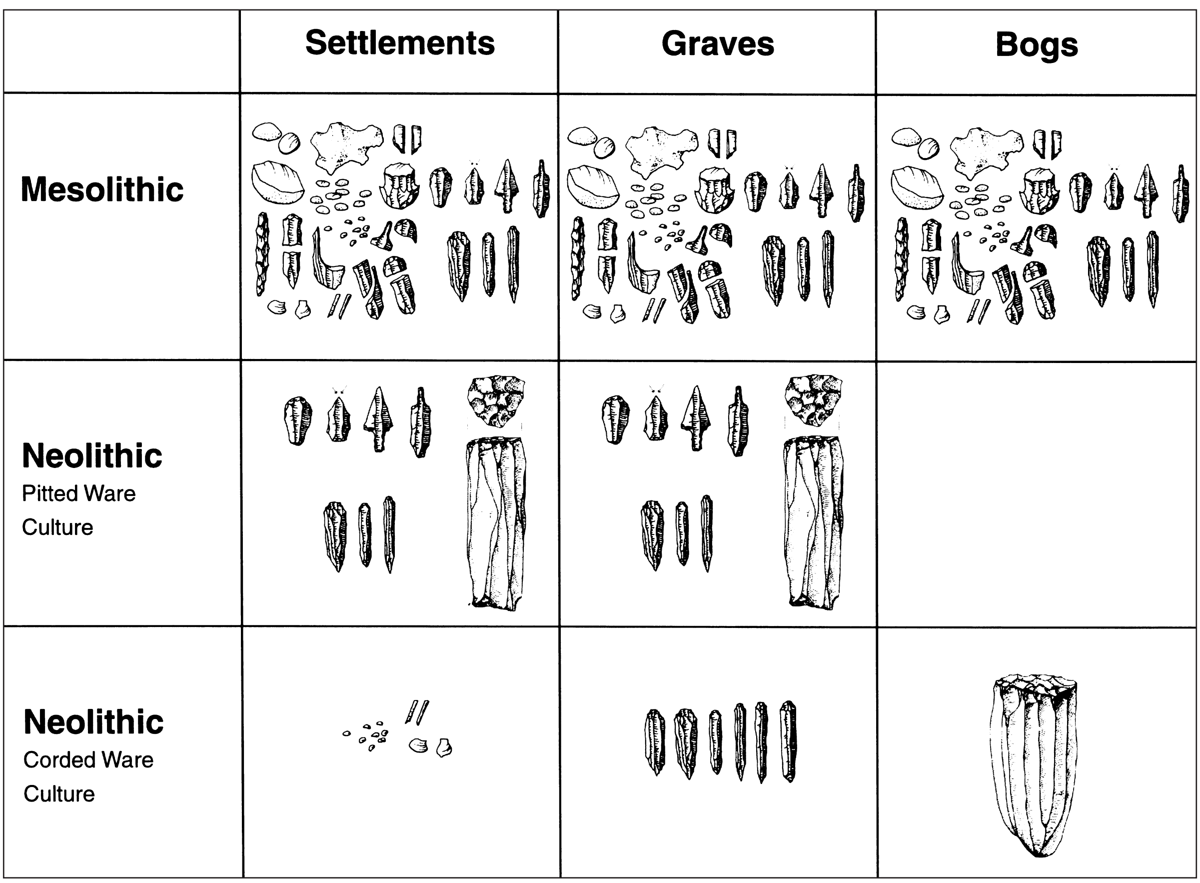


Fig. 6. Model proposed for the production and deposition of Mesolithic and Neolithic blades in Scandinavia.

All these features together indicate a change in social structure. Returning to the blades, in the Scandinavian material, as well as the central-European, the use-wear analysis tells us that the burial gifts were not used or that they were used in special, recurrent tasks, i.e. the harvesting of silica-rich plants. The production of such blades went on through Europe and the Orient for millennia and ended at the beginning of the Bronze Age (*for example, Knutsson 1995; Sherratt 1997; Price 2000*).

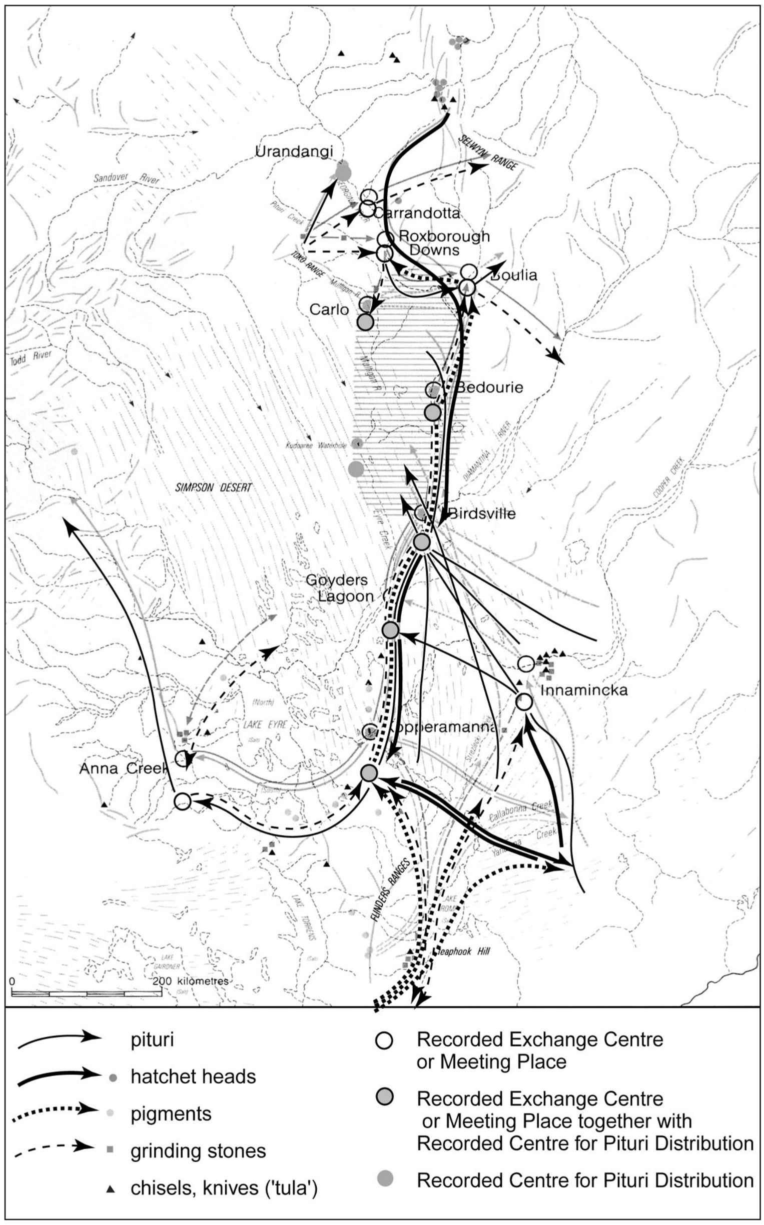


Fig. 7. A map showing the travels of different artefacts and materials in the Simpson Desert area in Australia (*After McBryde, 1988*).

TECHNOLOGY AND MYTHOLOGY

What is needed to keep up and give value to a technology already known and used by local specialists to produce a rather simple type of tool and to authorise the superiority of just this sole technology over other production techniques for use in rituals like burial? What further inducement was required, and what was needed to help the spread of ready-made products into areas where they were "not needed" and, even more, into areas where other equal techniques had been known for millennia?

One of the answers to this question may be a conscious or even subconscious use of cosmological concepts, mythology and ritual rules. Agriculture, including animal husbandry and breeding, must have been a complex structure of technologies, techniques and methods, which grew in one or a few specific, environmental settings. This complexity of tasks needed a "Farmers' Almanac", and these growing and pasturing rules had to be reconstructed for every move that the farming groups or techniques made and produced. If the agricultural groups had remained few and small, there would never have been a need to move into more and more hostile or unsuitable environments, or environments containing new and different types of resources. The reconstruction or recollection must have been connected with the feeling of togetherness of the moving groups. In such situations, mythology pointing out common ancestors and their ways of "doing the life" might be a powerful tool. It could create a feeling of security and identity; it could explain the necessary routines and mediate connections with former homes and ancestors. At the same time, it could be used to create a feeling of superiority over the groups which inhabited the coveted land and, if needed, could motivate the violent conquest of new territory. References to the central part of a cosmology through mythology are a necessary instrument in forming élite groups, as well as for their survival and reproduction.

In this connection, it may be valuable to describe the differences between modern and historical foragers and farmers' mythologies in an analysis written by Eliade (*1979.27f, 47ff*). He summarises the focus of foragers' mythology in the following terms: fire, sex and sexual passion, the sky and cosmic phenomena, darkness, hunting, killing, death, madness, human cruelty and voraciousness (*for a similar view, see Duerr 1987*).

In contrast, the farmers focus on fertility, birth equal to rebirth, the cult of dead ancestors, the connection between women and growth in cultivated earth, the inhabited space as *imago mundi*, centre of the universe symbolism and beliefs in an after-life or rebirth.

This shows quite clearly how the focus of mythology moves from nature towards people as the centre of the world and how this construction makes it possible for individuals to manipulate mythology to promote themselves and their closest family members and friends. A very interesting fact is that ideas about human cruelty disappear from the focus of myths at the same time as wars become frequent or casual. Eliade himself does not hesitate to transfer his reasoning to prehistory and he supports this opinion in his own survey of the earliest, Old World mythologies, which fit very well into the farming-mythology model.

Ian Hodder (*1998*) gives some reconsiderations of his thoughts on the concept of *domus* and house-building in the Early Neolithic cultures of western Asia and Europe, as defined in his 1990 work. Here, he states that the division between the wild and the domestic among the "fresh" farmers was necessary both technically (to enclose domestic crops and animals, and to separate them and keep them away from "wild nature") and "metaphorically" (to remember and strengthen the technology or practicality). To him, the regularity in building new houses on the walls of old ones through long periods (as exemplified by the different traditions in Asikli Höyük and Catal Höyük) is striking. His interpretation of this phenomenon involves three aspects. His first suggestion is that principles for the structuring of local cultural geography, i.e. house-building and settlement structuring, were general and simple. This allowed their transformation into a variety of contexts. The second is the narrative aspect of human living, i.e. coherence was sought between the tradition of, in this case, building and new conditions appearing in time and space. A mythology was created around the phenomenon of house-building. This mythology was adjusted to new conditions through the restructuring of the myth. The third aspect, according to Hodder, is the implicit use of technology and the mythology connected with it. This, in turn, allowed the dominant groups to manipulate society towards the conservation of these habits. In his article, Hodder describes the spread and conservation of house-building and rebuilding due to these structuring principles over large areas and long periods. These explanations and principles can be applied to other kinds of technique, for example, those relating to harvesting habits. As we see, there is both a wide space and a long time span for the above-described, blade-production technology. There is also a bond between the production of "harvesting blades" and the production of cereals. Although this production is not so monumental as house building, it may provide a finer or better instrument for detecting and understanding exactly the structuring behaviours or principles, which Hodder suggests. The fascinating aspect of the "harvesting blade" production in northern Europe is the use of the special method in areas where blades had been produced for long periods (for millennia, in fact) by other means and methods of production. As suggested above, the intensification of blade production in the Villingebæk phase of the Kongemose Culture in Sweden may be understood in the light of the need for good raw material for harvesting tools among central-European (or continental) farming groups. The need was strengthened by the mythological importance of the tools.

There has been an intensive debate about the complexity of late Nordic, hunter-gatherer groups during recent decades. Some questions still haunt me like the ghosts who haunted my ancestors. One such question concerns the feelings of the Scandinavian and northern-European hunters, fishermen and gathering women, when they encountered the every-day life of their farming neighbours, or the women or men who joined their own groups. Attempts had to be made to make their own mythology coherent with the new traits and structuring principles, which certainly needed a great deal of adjustment, by the mobile landscape maintainers that they were. The life of hunter-gatherers of the Mesolithic certainly did not consist of only subsistence. There were traditions, relations, world-views, memories, narratives, culture, empathy, humanism and so on. Now, the following question would be, what mechanisms could make hunters and gatherers adopt a new cosmology and interpretation of the world, which should be a part of the transformation of the new habits, techniques, plants and animals used in their every-day lives?

THE WILLINGNESS OF HUNTER-GATHERERS TO ADOPT NEW LIFESTYLES

The reading of ethnographic reports usually shows that hunter-gatherer groups exhibit a great deal of integrity in their contacts with, for example, surrounding groups of settled farmers. The examples mention an acceptance of items and even rituals to some extent. Both in Africa (*for example, Schebesta 1941; 1950; Turnbull 1965; 1979*), and in Australia and New Guinea (*Strehlow 1915; Myers 1986; Knutsson 1995; Verhardt 2000*), there are documented abrupt departures of whole groups involved in ongoing rituals or other transactions with the settlers (at missions, in native villages or meeting-places). This behaviour is very easy to understand, knowing that hunter-gatherer groups usually reduce aggression by separating themselves or by moving away from the group, and forestall violence by cracking jokes (*Knutsson 1995*). Moving as a means of settling aggression is documented among Indian groups (*for example, Fürer-Heimendorf 1943*) and, as especially the early authors noted, by roaming and unpredictability, which caused a great deal of trouble for the colonising groups. Usually, the mobile groups disappeared into environments regarded as hostile and dangerous by the settlers. It would not be easy to dominate or change the world-views of such groups. But, on the other hand, the other groups' needs for land were intense, and the methods of approaching neighbours and solving conflicts among these groups followed other routes, so usually the problems were solved by the demonisation of the hunter-gatherers and by their subsequent liquidation. It took about 50 years to colonise the whole of Australia in the early 19th century, with no other vehicles than oxen-hauled carts and horses (*Mulvaney & White 1987; Cam et al. 1987.45ff*). A noteworthy episode was described to me by a young Russian archaeologist. During the industrial colonisation of Siberia, and even today, it was very hard to engage the local populations of hunters in the business of mining, even if there is a great attraction in earning a lot of money. It was easier to take people from the Ukraine by air 9000 km to the gold mines of Chukchee peninsula than to find and employ the local Chukchee people (*Dimitri Gerasimov, Museum of Ethnography, St. Petersburg, personal communication*). It might have been the hardships of the work, which they saw, that stopped these people from joining the miners; it might have been mobility that was important to them. Nevertheless, they resisted the temptation for 150 years. That is a time span that can be grasped from an archaeological point of view.

It is necessary, I think, to explore the nature of mobile hunter-gatherers more deeply to understand the possible mechanisms for the adoption of farming, using non-endemic plants and animals. There must have been a very strong incitement to move the "agricultural package" around from the Middle East to Europe, and the move must have been combined with very positive, environmental and climatic circumstances. It would be more logical to adopt the idea and to use it on endemic species, as proposed by Hansen (*1991*) and summarised by Budja (*1999*) for the Franchthi cave in southern Greece and the Uzzo cave in Sicily. This concerns especially Scandinavia, where the keeping and harvesting of Mediterranean species must have been quite unpredictable. However, so far, a process of domestication of native species has not yet been identified.

In this respect, it is tempting to see the movements of a ready-made, ritual-mythological prescription tied to a material package to support and prepare the necessary movements of slowly but steadily growing groups of people. In the same way, the first European colonisers in America or Australia had their homes and personal equipment justified and explained by a package of beliefs and prescriptions which clearly showed them their own superiority and legitimised their right to take the land.

REFERENCES

ANDERSON P. 2000. Use of cereals and of related tools in SW Asia: Observations from the Natufian to the Bronze Age. *Paper given at Symposium Semenov, January 31st to February 4th, 2000, in St. Petersburg.*

APEL J. E. 2000. Några formella konventioner och ett halvdant teknologiskt handlag. In Hjärthner-Holdar E. & Risberg C. (eds.), *Hantverksproduktion och reproduktion. Tredje nationella workshopen för hantverksspecialisering.*

AUBÁN J. B. 1999. Pots, symbols and territories: the archaoleogical context of neolithisation in Mediterreanen Spain. In M. Budja (ed.), *Documenta Praehistorica XXVI: 101–118.*

BABEL J., BALCER B., CHMIELEWSKA M., DAGMAN-GINTER A., GINTER B., LECH J. & SCHILD R. 1981. Katalog der Feuerstein/Hornstein-Bergwerke. Polen. In Weisgerber G. Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzei*: *578–627*.

BALCER B. 1971. Kopalnia krzemiena w Swiciechówie-Lasku, pow. Krasnik, w swietle badan 1967 roku. *Wiadomosti Archeologiczne 36: 71–132*.

1975. *Krzemien swieciechowski w kulturze pucharkow lejkowatych. Eksploatacja, obróbka i rozprzestrzenie.* Ossolineum. Wroclaw.

1976. Position and stratigraphy of flint deposits, development of exploitation and importance of the Swieciechow flint in prehistory. *Acta Archaeologica Carpatica 16: 179–199.*

1981. Zu den Problemen der Verbreitung der Feuersteine von Swieciechploitation and importance of the Swieciechów und Krzemionki. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 310–317*.

BECKER C. J. & WEISGERBER G. 1981. Katalog der Feuerstein/Hornstein-Bergwerke, Dänemark. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 456–473.*

BOGNÁR-KUTZIÁN I. 1972. *The Early Copper Age Tiszapolgár Culture in the Carpathian Basin*. Akadémiai Kiadó. Budapest.

BUDJA M. 1999. The transition to farming in Mediterrenean Europe. In M. Budja (ed.), *Documenta Praehiostorica XXVI: 119–141.*

CAMM J. C. R., MCQUILTON J., PLUMB T. W. & YORKE S. G. (eds.) 1988. *Australians. A Historical Atlas.*

CAUVIN J. 2000. *The Birth of the Gods and the Origins of Agriculture.* Cambridge, England.

DESLOGES J. M., DIJKMAN W. H. M. N., GUILLAUME C. & MALLE N. 1981. Katalog der Feuerstein/Hornstein-Bergwerke, Frankreich. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau: Die Suche nach dem Stahl der Steinzeit: 578–627.*

DZIEDUSZYCKA-MACHNIKOWA A. & LECH J. 1976. *Neoliticzne zespoly pracowniane z kopalni krzemienia w Saspowie*. Polskie Badania Archeologiczne 19. Wroclaw.

DUERR H. P. 1987. *Sedna eller kärleken till livet.* Stockholm.

GATSOV I. 1982. The archaeological cultures of the Late Pleistocene and Early Holocene in the western Black Sea region, and their significance for the formation of the Neolithic flint industries. In Kozłowski J. K. 1982 (ed.), *Origin of the Chipped Stone Industries of the Early Farming Cultures in Balkans.*

1993. *Neolithic Chipped Stone Industries in Western Bulgaria*. Krakow.

GUROVA M. 2000. Analyse fonctionelle des outillages en silex néolithique de la région Thrace (Bulgarie du sud). *Paper given at Symposium Semenov, Jan. 31st to Feb. 4th, 2000, in St. Petersburg.*

HANSEN M. J. 1991. *The Palaeoethnobotany of Franchthi Cave. Excavations at Franchthi Cave, Greece.* Fascicle 7. Bloomington and Indianapolis.

HAYDEN B. 1998. Practical and prestige technologies. The evolution of material systems. *Journal of Archaeological Method and Theory. Vol. 5, No. 1: 1–55.*

1996. *Archaeology: the science of once and future things.* New York.

HELMS M. 1988. *Ulysses' Sail: An Ethnographic Oodyssey of Power, Knowledge, and Geographical Distance.* Princeton, New Jersey.

HODDER I. 1990. *The Domestication of Europe.* Oxford.

1998. The domus: Some Problems Reconsidered. In Edmonds M. & Richards C. (eds), *Understanding the Neolithic of North-Western Europe.*

JENNBERT K. 1984. *Den produktiva gåvan. Tradition och innovation in Sydskandinavien för omkring 5300 år sedan.* Acta Archaeologica Lundensia Series in 40, No. 16. Lund.

KACZANOWSKA M. 1982. Aus Forschungen über die Steinindustrie des Linienbandkeramikkreises. In *Siedlungen der Kultur mit Linienbandkeramik in Europa: Internationales Kolloquium, Nové Vozokany 17–20. November 1981: 63–68.*

1985. *Rohstoffe, Technik und Typologie der neolithischen Feuersteinindustrien im Nordteil des Flussgebietes der Mitteldonau.* Warszawa.

1986. Kontakte zwischen der Ostslowakei und Kleinpolen angesichts der Importe von Steinrohstoffen. In *Urzeitliche und Frühhistorische Besiedlung der Ostslowakei in Bezug zu den Nachbargebieten: 77–84.*

KELTERBORN P. 1981. Zur Bedeutung der "livres de beurre". In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 228–232.*

KLÍMA B., VLČEK E., ADOVASIO J. M., DAMBLON F., HYLAND D. C., JAROŠOVA L., MUSIL R., VAN DER PLICHT J., SOFFER O., SVOBODA J., ŠKRDLA P., TRINKAUS E., VANDIVER P. & VERPOORTE A. 1997. *Pavlov I – Northwest:. The upper Paleolithic burial and its settlement context.* Dolní Vestonice Studies, Volume 4/1997. Brno.

KNUTSSON H. 1995. Slutvandrat: Aspekter på övergången från rörlig till bofast tillvaro. *Aun* 20. Societas Archaeologica Upsaliensis. Uppsala.

KNUTSSON K. 1995. Funktionsanalys av flintspån från stridsyxegravar i Vikletice, Tjeckiska republiken. In Knutsson H. 1995. Slutvandrat. Aspekter på övergången från rörlig till bofast tillvaro. *Aun* 20. Uppsala: Societas Archaeologica Upsaliensis.

KOZŁOWSKI J. K. 1982. La néolithisation de la zone balkano-danubienne du point de vue des industries lithiques. In Kozłowski J. K. (ed.), *Origin of the Chipped Stone Industries of the Early Farming Cultures in Balkans.* Warszawa and Kraków.

KOZŁOWSKI S. K. 1994. Chipped Neolithic industries at the eastern wing of the fertile crescent. In Kozłowski S. K. & Gebel G. H. (eds.), *Neolithic Chipped Stone Industries of the Fertile Crescent: 595–601.*

KRUK J. 1969. Grob szkieletowy kultury ceramiki wstegowej rytej w Michalowicach, pow. Kraków. *Sprawozdania Archeologiczne 21: 399–403.*

LARSSON L. (ed.) *Stridsyxekultur i Sydskandinavien.* Rapport från det andra nordiska symposiet om Stridsyxetid i Sydskandinavien. 31.X. 2. XI 1988. Institute of Archaeology Report Series, No. 36. Lund: *53–76.*

1989a. Boplatser, bebyggelser och bygder. Stridsyxekultur i södra Skåne. In Larsson L. (ed.), *Stridsyxekultur i Sydskandinavien. Institute of Archaeology Report Series* No 36. Lund.

1989b. (ed.) *Stridsyxekultur i Sydskandinavien.* Institute of Archaeology Report Series, No. 36. Lund.

LECH J. 1971. Z badan nad kopalnia krziemenia na stanowisku I v Saspowie, pow. Olkusz. In Kozłowski J. K. (ed.) *Z badan nad krzemienarstwiem neolitycznym i eneolitycznym: 115–133.*

1972. Odkrycie koplani krzemienia na stanowisku I w Saspowie, pow. Olkusz. *Sprawozdania Archeologiczne 24: 37–47.*

1975. Neolithic flint mine and workshops at Saspow, near Cracow. *Tweede Internationale Symposium over Vuursteen, 8–11 Mei 1975, Maastricht. Staringia, Vol. 3: 70–71.*

1979. Krzemienarstwo w kulturze spolecnosci ceramiky wstegowej rytej w Polsce. Próba zarysu. In Wojciechowski W. (ed.), *Poczatki neolityzacji Polski poludniowo-zachodnej: 121–136.*

1981. Das Grab eines Steinschmiedes von Michalowice bei Kraków und das Problem der Arbeitsspezialisierung unter der ersten Ackerbau betreibenden Bevölkerung Mitteleuropas. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau: Die Suche nach dem Stahl der Steinzeit: 272–278.*

LEKBERG P. (ed.) in press. *Fågelbacken, ett fornlämningskomplex i östra Vätsmanland: 1. Lämningar från tidigneolitikum, mellanneolitikum och järnålder undersökta 1993.* Tryckta rapporter från Arkeologikonsult 14. Upplands Väsby.

LICHARDUS J. 1981. Zur Bedeutung der Feuersteingewinnung in der jüngeren Steinzeit Mitteleuropas. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 578–627.*

LICHARDUS-ITTEN M. 1981. Silex als Rohstoff in frühkupferzeitlichen Gräbern des Karpatenbeckens. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 279–283.*

LUKIN WATSON P. 1980. *This Precious Foliage. A Study of the Production, Distribution and Consumption of Mulliga River Pituri.* Unpubl. BA Hons. Thesis. University of Queensland, Brisbane.

MALMER M. P. 1962. *Jungneolithische Studien.* Acta Archaeologica Lundensia, Series in 8º Nr. 2. Lund.

1975. *Stridsyxekulturen i Sverige och Norge.* Lund.

MCBRYDE I. 1988. Goods from another country: Exchange networks and the people of the Lake Eyre Basin. In Mulvaney D. J. & White J. P. (eds.), *Australians to 1788: 252–273.*

MIDGLEY M. S. 1992. *TRB Culture: The First Farmers on the North European Plain.* Edinburgh University Press, Edinburgh.

MODDERMAN P. J. R 1981. Die Verbreitung von Lousberg-Feuerstein in der Niederlanden und Belgien. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 578–627.*

MOUNDREA-AGRAFIOTI H. 1981. *La Thessalie du sud-est au Néolithique – outillage lithique et osseaux.* Thèse présentée en vue du grade de docteur en éthnologie préhistorique. Lyon.

MULVANEY D. J. & WHITE J. P. (eds.) *Australians to 1788.* Broadway New South Wales.

OLAUSSON D., RUDEBECK E. & SÄFVESTAD U. 1981. Die südschwedischen Feuersteingruben: Ergebnisse und Probleme. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 183–204.*

OTTE M. & BEHM-BLANKE M. R. 1992. Das lithische Inventar: Rekonstrukzion technischer Verfahrensweisen. In Behm-Blanke M. R. (ed.), *Hasek Höyük: Naturwissenschaftliche Untersuchungen und lithische Industrie: 225–247.*

ÖZDOĞAN M. & BASGELEN N. 1999. *Neolithic in Turkey. The Craddle of Civilisation. New Discoveries.* Istanbul.

ÖZDOĞAN M. & GATSOV I. 1998. The Aceramic Neolithic Period in Western Turkey and the Aegean. *Anatolica XXIV: 209–232.*

PERLÈS C. 1987. Les industries du Néolithique "Précéramique" de Grèce: Nouvelles études, nouvelles interprétations. *Archaeologia Interregionalis 9: 19–39.*

1992. Systems of exchange and organisation in Neolithic Greece. *Journal of Mediterranean Archaeology 55/2 (1992): 115–164.*

PRICE T. D. 2000 (ed.). *Europe's First Farmers.* Cambridge.

PRICE T. D. & GEBAUER A. B. 1995 (eds.). *Last Hunters – First Farmers. New Perspectives on the Prehistoric Transition to Agriculture.* Santa Fe.

ROSEN A. 1983. The Canaanean blade and the Early Bronze Age. *Israel Exploration Journal 33: 1–2.*

SCHMID E. 1981. Der jungsteinzeitliche Abbau auf Silex bei Kleinkems (Baden-Württemberg). In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 141–178.*

SHERRATT A. 1997. Climatic cycles and behavioural revolutions: The emergence of modern humans and the beginning of farming. *Antiquity. Vol. 71, No. 272, June 1997: 271–287.*

SKAKUN N. N. 1993. Appendix: Results of traceological examination of flint implements from Neolithic settlements in western Bulgaria. In Gatsov I. (ed.), *Neolithic Chipped Stone Industries in western Bulgaria: 52–55.*

2000. Use-wear analysis and problems with reconstruction of palaeoeconomy. *Paper given at Symposium Semenov, Jan. 31st to Feb. 4th, 2000, in St, Petersburg.*

SMOLLA G. 1987. Prehistoric flint mining: the history of research – a review. In Sieveking G. de G. & Newcomer M. H. (eds.), *The Human Uses of Flint and Chert: Proceedings of the Fourth International Flint Symposium held at Brighton Polytechnic, 10–15 April 1983.*

SÖRENSEN S. A. 1996. *Kongemosekulturen i Sydskandinavien.* Egnsmuseet, Faergegården.

SWADLING P. 1996. *Plumes from Paradise.*

SVOBODA J., CZUDEK T., HAVLÍČEK P., LOZEK V., MACOUN J., PŘICHYSTAL A., SVOBODOVA H. & VLČEK E. 1994. *Paleolit Moravy a Slezska. Dolnevestonické studie,* svazek 1. Brno.

ŠIŠKA S. 1964. Pohrebisko Tiszapolgarskej kultúry v Tibave. *Slovenská archeológia XII–2: 293–356.*

TAFFINDER J. 1998. The Allure of the Exotic. The social use of non-local raw materials during the Stone Age in Sweden*. Aun* 25. Uppsala.

TELLENBACH M. 1983. Materialien zum präkeramischen Neolithikum in Süd-Ost-Europa. *Bericht der Römisch-Germanischen Kommission 64: 1–137.*

TODOROVA H. 1989. *Das Frühneolithikum Nordbulgariens im Kontext des Ostbalkanischen Neolithikums: Tell Karanovo und das Balkan-Neolithikum.* Salzburg.

TYKOT R. H. 1996. Obsidian procurment and distribution in the central and western Mediterranean. *Journal of Mediterranean Archaeology 9.1 (1996): 39–82.*

VANG PETERSEN P. 1993. *Flint fra Danmarks Oldtid.* Høst & Søn. København.

VERHART L. B. M. 2000. *Times Fade Away. The Neolithisation of the Southern Netherlands in an Anthropological and Geographical Perspective.* Archaeological Studies, Leiden University 6. Leiden.

WEINER A. 2000. *Inalienable Possesions.* Cambridge.

WEINER J. 1981. Eine wenig beachtete Kernsteinform aus der Umgebung von Grand Pressigny. In Weisgerber G., Slotta R. & Weiner J. (eds.), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit: 233–235.*

1992. Beobachtungen zum Hornsteinmaterial und seinem schlagtechnischen Verhalten. In Behm-Blanke M. R. (ed.), *Hasek Höyük: Naturwissenschaftliche Untersuchungen und lithische Industrie: 219–224.*

WEISGERBER G. 1987. The technological relationship between flint mining and early copper mining. In Sieveking G. de G. & Newcomer M. H. (eds.), *The Human Uses of Flint and Chert: Proceedings of the Fourth International Flint Symposium held at Brighton Polytechnic 10–15 April 1983.*

WIESSNER P. 1986. !Kung San networks in a generational perspective. In Biesele M., Gordon R. & Lee R. (eds.), *The Past and Future of !Kung Ethnography: Critical Reflections and Symbolic Perspectives Essays in Honour of Lorna Marshall: 103–136.*

ZIMMERMANN A. 1982. Zur Organisation der Herstellung von Feuersteinartefakten in bandkeramischen Siedlungen. In *Siedlungen der Kultur mit Linienbandkeramik in Europa. Internationales Kolloquium Nové Vozokany, 17.–20. November 1981: 319–323.*

UDK 903(497.4)"634":56
Documenta Praehistorica XXVIII

The Holocene vegetation dynamics and the formation of Neolithic and present-day Slovenian landscape

Maja Andrič
School of Geography and the Environment, Oxford University, UK
maja.andric@geog.ox.ac.uk
and
Department of Archaeology, University of Ljubljana, Slovenia
maja.andric@siol.net

ABSTRACT *– *This paper presents the results of palaeoecological research to investigate the Holocene vegetation development of the Slovenian landscape and the impact of the first farmers upon it. Four study sites were selected and at each site a complete Holocene sedimentary sequence was analysed by using the following techniques: loss-on-ignition, geochemistry, radiocarbon dating, pollen analysis and analysis of micro-charcoal concentration. The results of the study suggest that the Neolithic landscape was probably very dynamic and composed of small patches with different vegetation composition. This vegetation has no present-day analogues. The present-day Slovenian landscape formed only several millennia after the transition to farming.*

IZVLEČEK** – *V članku so predstavljeni rezultati paleoekološke raziskave, katere cilj je bil ugotoviti, kakšen je bil razvoj slovenske pokrajine in vegetacije v holocenu in kakšen je bil vpliv prvih kmetovalcev na okolje. Na štirih izbranih paleoekoloških najdiščih so bile izvedene sledeče analize: "loss-on-ignition", geokemična analiza, radiokarbonsko datiranje sedimenta, pelodna analiza in analiza koncentracije mikrooglja. Rezultati raziskave kažejo, da je bila neolitska pokrajina verjetno zelo dinamična in mozaična – sestavljena iz območij z različno vegetacijo. Ta vegetacija nima sodobnih analogij. Današnja slovenska pokrajina je nastala kasneje, več tisočletij po prehodu na kmetovanje.*

KEY WORDS – *palynology; Neolithic archaeology; palaeoecology; Slovenia; the Holocene vegetation developmen;, soil erosion; charcoal*

INTRODUCTION

The origins of agriculture are one of the most commonly discussed topics of the Neolithic archaeology. It is thought that the transition from predominantly hunting and gathering economy to farming economy first occurred in the Near East (in the Levant and the middle Euphrates valley) in the 9th millennium cal. BC (*Harris 1996; Bar-Yosef & Belfer-Cohen 1989; Bökönyi 1974; Garrard et al. 1996; Legge 1996; Hole 1996*) or even earlier (*Hillman et al. 2001*). The reasons why Near Eastern hunter-gatherers increased their dependence on domesticated plants and animals at the beginning of the Holocene are not clear. It has been suggested that the agriculture in the Near East either emerged because of the climatic change (*Childe 1936; COHMAP Members 1988; Wright 1993; Hole 1996; Sherratt 1997b; Hillman et al. 2001*) or population pressure (*Cohen 1977*) or a combination of both (*Bar-Yosef & Belfer-Cohen 1989; Binford 1968; Dolukhanov 1979; Hillman 1996*). However, other reasons than climatic change or population increase have also been suggested. For example, it has been argued that agricultural surpluses were produced in order to develop trade (*Runnels & van Andel 1988; Sherratt 1997a; Sherratt 1997b*).

* The paper is based on DPhil Thesis completed at the University of Oxford in September 2001.
** V članku so predstavljeni rezultati raziskave za dosego doktorata znanosti. Zagovor doktorske naloge je bil opravljen na Univerzi v Oxfordu septembra 2001.

In Europe the bulk of the first evidence for the beginning of plant cultivation is of much later date than in the Near East. It seems that in Greece domesticated plants and animals occurred simultaneously, at the beginning of the 7th millennium cal. BC (*Dolukhanov 1979; Zohary & Hopf 1993; Halstead 1996*). Elsewhere in Europe the oldest macrobotanical remains of cultivated plants are dated after *ca.* 6000 cal. BC. On the Mediterranean coast the remains of domesticated plants and animals have been discovered on sites of the Impresso culture, dated from the beginning of the 6th millennium cal. BC (*e.g. Batović 1979; Chapman & Müller 1990; Zilhão 1993; Whittle 1996*). At the same time (*ca.* 6000 cal. BC) the first evidence for the transition to farming occurs also on the early Neolithic sites of Starčevo, Körös and Criş culture in the central Balkans (*Bökönyi 1989; Zohary & Hopf 1993; Whittle 1996*). In central Europe the first agricultural villages of the Linear pottery culture are dated only after 5500 cal. BC (*Milisauskas & Kruk 1989; Whittle 1996*).

This temporal grade of macrobotanical remains – from the oldest in the Near East to the youngest in the north-western Europe – was one of the main reasons to suggest that in the early Holocene the first farming economy originated in the Near East and spread across Europe (*Ammerman & Cavalli-Sforza 1984*). The rate, direction and method of this presumable dispersal are a point of controversy, however it has been suggested, for example, that the agriculture in Europe spread together with Near Eastern farmers, who moved towards Europe, settling on territories previously uninhabited or only sparsely inhabited by the Mesolithic population (*Ammerman & Cavalli-Sforza 1971; 1984; Van Andel & Runnels 1995; Sherratt 1997a*). In contrast another group of researchers suggested that no population movement was involved in the spread of agriculture, but domesticated plants and animals arrived from the Near East (*e.g.* emmer, sheep, goat) through exchange networks and some species (possibly barley, pig and cattle) were domesticated locally (*Dennell 1983; Barker 1985; Whittle 1996; Budja 1999; Kyparissi-Apostolika 2000*). A third suggestion is a combination of the previous two, that is that there was a limited population movement in some parts of southern, south-eastern and central Europe, whereas elsewhere the local Mesolithic population gradually adopted farming (*Zvelebil & Zvelebil 1988*).

The question of why the transition to farming occurred is still highly debated and for many parts of Europe it is not known what the landscape of the late Mesolithic hunter-gatherers and early Neolithic farmers looked like. The question of when the transition to farming occurred and the impact of farmers on the landscape is also often a matter of dispute. For the south-eastern Europe, for example, it has been demonstrated that the impact of early agriculture on the vegetation was neither on a landscape scale nor in a form of a time-transgressive wave of forest clearance (*Willis & Bennett 1994; Willis 1995*).

Slovenia is an important area to study Neolithic agriculture because of its geographical position (Fig. 1, Fig. 2) It is located between the Pannonian plain and the Mediterranean, between the areas of the early Neolithic Starčevo and Impresso cultures, where the transition to farming economy presumably occurred in the early Neolithic at the beginning of the 6th millennium cal. BC. The earliest evidence for the transition to farming in Slovenia however appears much later. The oldest remains of cultivated plants, charred seeds of cereals and pulses discovered in the middle Neolithic cave site Ajdovska jama in eastern Slovenia were radiocarbon dated to the second half of the 5th millennium cal. BC (*Culiberg et al. 1992*; Tab. 1). On the Ljubljana Moor numerous charred seeds of cereals and pulses were discovered on the open air archaeological sites dated in the 4th and 3rd millennium cal. BC (*Šercelj 1975; 1981–82; Šercelj & Culiberg 1980*).

One reason why the earliest macrobotanical evidence for the transition to farming in Slovenia appears so late might be that no reliably dated early

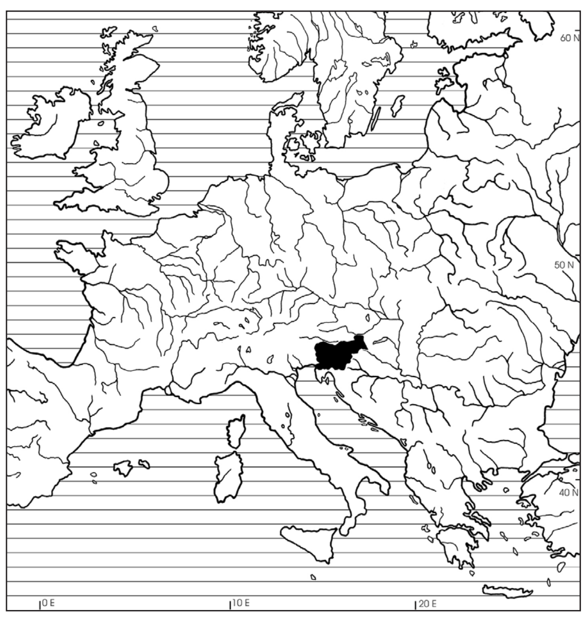


Fig. 1. Geographic position of Slovenia.

Fig. 2. Archaeological sites with first macrobotanical and bone evidence for the transition to farming in Slovenia and neighbouring countries.

Neolithic sites have been discovered so far. Several pieces of impresso pottery excavated at the end of 19th and the beginning of 20th century in Trieste karst caves near the Slovenian south-western border (*Korošec 1960a; 1960b; Leben 1967; 1973; Batović 1973; Budja 1993*) might derive from early Neolithic sites. The decoration style of this pottery is similar to the impressed ware found on the early Neolithic Impresso sites on the eastern Adriatic coast, which were radiocarbon dated in the first half of the 6th millennium cal. BC (*Batović 1979; Chapman & Müller 1990; Müller 1991*). All impresso pottery from Trieste karst was found in contexts that were not stratigraphically excavated, fine sieved or radiocarbon dated. No macrobotanical or bone remains were collected and hitherto no reliable evidence for the early Neolithic transition to farming was found.

In the vicinity of Slovenia the evidence for the early Neolithic transition to farming suggests that domesticated sheep/goats were present in Trieste karst (Edera cave, Italy) and Čičarija (Pupićina cave, Croatia) at *ca.* 5700 cal. BC (*Budja 1993; Miracle 1997; Boschin & Riedl 2000*). Macrobotanical remains of wheat, barley and legumes at the open air site Sammardenchia on the Po plain (northern Italy) were dated to *ca.* 5500–4600 cal. BC (*Pessina & Rottoli 1996; Rottoli 1999*). Therefore it is possible that in the future the remains of first domesticates of similar age will be found also in Slovenia. However, it is also possible that the situation described above is not just a consequence of the state of research (and un-

Archaeological site	Period	Radiocarbon dates	Macrobotanical remains of domesticated plants/animals	Reference
Slovenia				
Ajdovska jama	Late Neolithic, Eneolithic	5560±150 uncal. BP (6280±160 cal. BP) 4830±120 uncal. BP (5360±200 cal. BP)	*Hordeum vulgare*, *Hordeum vulgare* var. *nudum*, *Triticum monococcum*, *Triticum dicoccum*, *Triticum aestivum*, *Avena sativa*, *Vicia cracca*, *Vicia faba*, *Pisum* sp.	Šercelj & Culiberg 1984, Culiberg, Horvat & Šercelj 1992
Maharski prekop	Middle Neolithic, Eneolithic	5080–4345 uncal. BP (3880–2930 cal. BC)	*Triticum spelta*	Šercelj 1981–82, Šercelj & Culiberg 1980
Parti	Eneolithic, Bronze age(?)	4000±100 uncal. BP 3910±100 uncal. BP (ca. 2500 cal. BC)	*Hordeum* sp.	
North–Eastern Italy				
Sammardenchia	Early, middle Neolithic	5684±58 uncal. BP 6570±74 uncal. BP (ca. 5400–4500 cal. BC)	*Triticum moncoccum*, *Triticum dicoccum*, *Triticum aestivum/durum*, *Hordeum vulgare*, *Hordeum* cf. *Distichum*, *Pisum* sp., *Lens culinaris*, *Vicia faba minor*	Pessina & Rottoli 1996
Edera cave	Mesolithic	6700±140 uncal. BP (ca. 5600 cal. BC)	Domesticated sheep/goat	Boschin & Riedl 2000
North-Western Croatia				
Pupićina cave	Mesolithic	5679–5275 cal. BC	Domesticated sheep/goat	Miracle 1997

Tab. 1. Macrobotanical and bone evidence for the beginning of farming in Slovenia and neighbouring countries (for locations see Fig. 2).

favourable conditions for the preservation of paleobotanical and paleozoological material in some areas of Slovenia) and the transition to farming in Slovenia did occur later than in neighbouring countries and in the areas of early Neolithic Starčevo and Impresso cultures. This suggestion is in accordance with to date results of palynological research, which detects no human impact on the environment before 5th millennium cal. BC. In the last fifty years an extensive pollen analysis of sediments from palaeoecological sites in several regions of Slovenia has yielded a general picture of the Holocene vegetation development (*Šercelj 1996*). Most lowland study sites are concentrated on the Ljubljana Moor where archaeological sites are numerous and pollen preservation is good. It has been suggested that the impact of prehistoric populations living on the Ljubljana Moor triggered a change in the middle Holocene forest composition-an increase of oak and decline of beech and fir (*Šercelj 1988; 1996; Culiberg & Šercelj 1991; Gardner 1997*). In the Podpeško jezero palaeoecological site the decline of beech and an increase of hazel, presumably caused by small-scale agricultural activity has been radiocarbon dated to 6400 cal. BP (*ca.* 4400 cal. BC, *Gardner 1999a; 1999b*). Therefore the first changes of the environment caused by human activity appear on the pollen diagrams as early as in the middle Neolithic and seem to be contemporary with the earliest Neolithic sites on Ljubljana Moor, Resnik (dated to 5856±93 uncal. BP, 4690±93 cal. BC, *Budja 1995*) and Babna gorica (6290 cal. BP, *Mihael Budja, pers. comm., unpublished data*).

On the basis of archaeological and palaeoecological research in Slovenia and neighbouring countries, several models, explaining the process of neolithisation and transition to farming in Slovenia have been suggested. The earliest archaeological explanations for the origin of Neolithic are based on typology of material culture and do not consider economic aspects such as agricultural production. Korošec (*1960b*) defined the characteristics of Slovenian Neolithic pottery, which were formed under the influences of the Lengyel culture. He argued that the influences from the central area of the Lengyel culture located in the Danubian region reached central and north-eastern Slovenia in the middle Neolithic. There are no Lengyel pottery types in south-western Slovenia and this led Korošec (*1960a*) to suggest that the influence of Lengyel culture did not reach these areas. The earliest pottery in the Trieste Karst caves near the south-western Slovenian border was assigned to the early Neolithic. It was impressed ware, similar to that used in early Neolithic Dalmatia. These similarities led Korošec (*1960a*) to suggest that Neolithic people from Dalmatia colonised Slovenian littoral area twice – first in the early Neolithic (Impresso pottery culture) and second time in the middle Neolithic (Danilo culture).

Similarly the spread of agriculture and pottery production from Dalmatia into the Slovenian littoral area in the middle of the 6th millennium cal. BC has been suggested by Chapman and Müller (*1990*). They used radiocarbon dates from charcoal, seeds and bones, found in cultural layers of Neolithic sites along eastern Adriatic coast to demonstrate that the oldest sites are located in the south-east and the youngest sites in the north-west of the region. They have argued that the farming economy probably spread through local diffusion of agricultural techniques from the south-east and the first farmers in the Slovenian littoral area appeared only in the middle Neolithic (Vlaška group, *Chapman & Müller 1991*).

In contrast with Chapman & Müller (*1990*) and Korošec (*1960a*) predominantly 'migrationist' models, Budja (*1993*) has argued that the transition to farming economy in the northern Adriatic area began simultaneously with the other groups along the east Adriatic coast. His model is based on the pottery, palaeobotanical evidence and bones of domesticated sheep/goat found in the Mesolithic contexts of cave sites in Trieste karst (Podmol pri Kastelcu and Edera cave, dated to *ca.* 5600 cal. BC) (*Budja 1993; 1996a; 1996b*). Results from these sites have led to the suggestion that the pastoral economy was the main activity of these groups. It has been suggested that the development of nomadic pasture on the Karst Plateau was connected with the change of natural environment due to the transgression of the Adriatic sea in the middle Holocene and the loss of early Holocene freshwater marshy areas in the Trieste bay. Since the mid Holocene communities of the northern Adriatic presumably lost lowland marsh areas, they probably moved to the Karst Plateau and developed pastoral economy (*Budja 1993; 1996a; 1996b*).

The review of the palaeobotanical research suggests that there is only little evidence for the transition to farming in Slovenia. It is not known when the first domesticated plants and animals were included in the human diet. Another controversial question is whether the farming economy spread to Slovenia from one or several neighbouring countries. This study aims to address the problem of transition to farming in Slovenia using palaeoecological techniques. It does not aspire to cover all the aspects of the process of the neolithisation, associated with the transition to farming, such as changes in the archaeological settlement pattern, material culture and social structure (*e.g. Hodder 1990; Whittle 1996; Sherratt 1997a; Zvelebil 1998; Bailey 2000*). Neither it will enter into diffusionist versus indigenous origins of agriculture debate. It will rather concentrate on the biological component of the transition to farming – the appearance of first domesticated plants and animals and, in particular, human impact on the landscape. The primary aim of this study therefore is to analyse the Holocene vegetation development and the impact of the farming economy on the early postglacial landscape. It aims to investigate what the Slovenian landscape looked like in the Mesolithic and Neolithic period, which vegetation changes might have been triggered by the transition from hunting-gathering to the farming economy, when they occurred and whether the differences between several phytogeographic regions of Slovenia were significant.

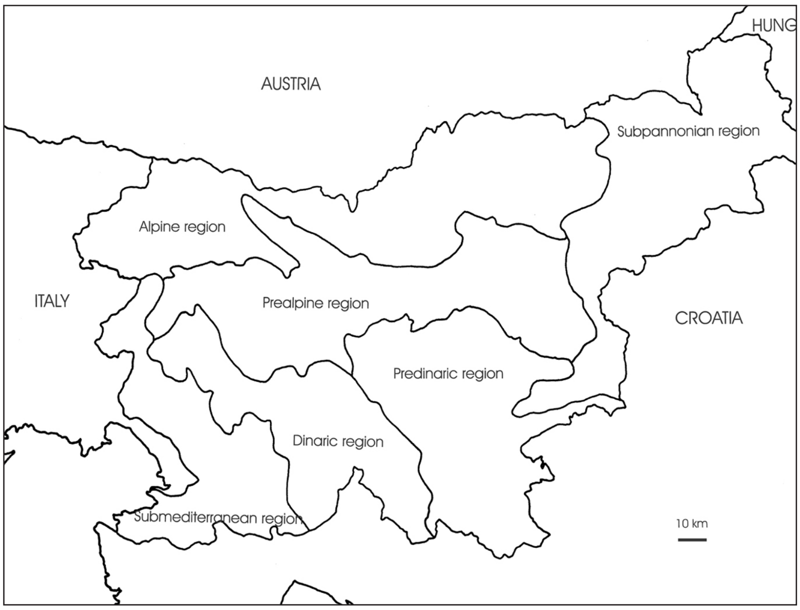


Fig. 3. Phytogeographic division of Slovenia (**after Wraber 1969*****).***

The present-day Slovenian landscape is divided into six phytogeographic regions (alpine, prealpine, submediterranean, dinaric, predinaric and subpannonian phytogeographic region) with distinctive relief, climate and vegetation (*Wraber 1969*, Fig. 3). In order to analyse the transition to farming in this wide variety of environments, nine palaeoecological sites (Fig. 4) were investigated. After preliminary pollen analysis four best sequences (in terms of pollen preservation and presence of complete Holocene sequence) were selected for further analysis. The sites selected were Prapoče, Gorenje jezero, Mlaka and Norička graba (Figs. 5–8, Tab. 2).

Each study site is located in a different phytogeographic region of Slovenia (and north-western Croatia). They form a southwest-northeast transect across Slovenia, following a climatic gradient from predominantly Mediterranean to predominantly continental climate. All study sites are small marshy areas, located in the vicinity of archaeological sites. They detect changes of the local vegetation (*Jacobson & Bradshaw 1981*) and are therefore suitable for studying presumably weak and local scale early Neolithic human impact on the environment.

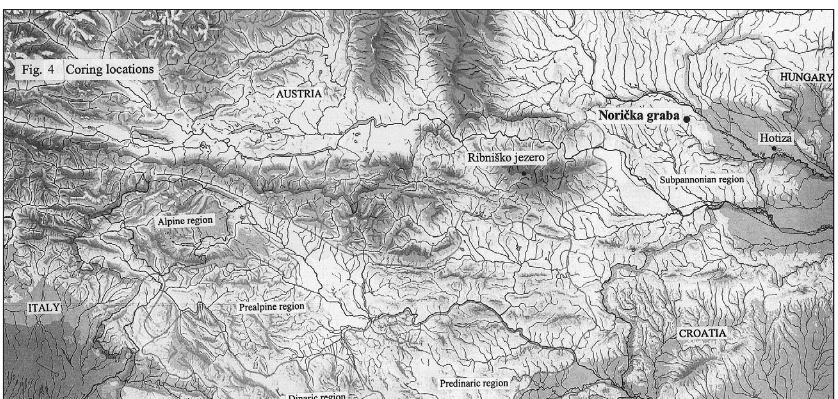


Fig. 4. Study sites.

At each study site sedimentary cores covering a complete Holocene sequence were collected and the sediment was analysed using the following techniques: loss-on-ignition, geochemistry, pollen analysis and radiocarbon dating.

Coring location	Phytogeographic region	Coordinates	Altitude
Prapoče	submediterranean	45°25'25"N, 14°04'30"E	480 m
Gorenje jezero	dinaric	45°43'40"N, 14°24'50"E	550 m
Mlaka	predinaric	45°30'10"N, 15°12'20"E	140 m
Noričká graba	subpannonian	46°37'35"N, 16°00'45"E	240 m

Tab. 2. Study sites.

The percentage of tree pollen, changes in the forest composition, microscopic charcoal concentration and presence of herb pollen, especially 'anthropogenic indicators' (*sensu Behre 1981*) on the pollen diagrams were analysed in order to detect forest clearance and burning, presumably used by prehistoric farmers to open the landscape. The results were then statistically analysed using the methods of palynological richness and principal components analysis to assess the biodiversity of the landscape (*Birks et al. 1990*) and the main direction of variance within the entire pollen dataset reflecting changes in the vegetation composition (*Birks et al. 1990; Fuller et al. 1998; Odgaard & Rasmussen 2000*). The techniques of loss-on-ignition and geochemical analysis were used to measure land degradation and soil erosion, again to assess the impact of the Neolithic farmers on the landscape.

An important aspect of the study was also the temporal and spatial scale of the analysis. This research therefore concentrated mainly on changes of the environment in a relatively short period of the Holocene (*ca.* 3000 years of the Neolithic, 6000–3000 cal. BC) and intended to detect changes perceivable on a human timescale. The temporal resolution of the analysis was high wherever the pollen preservation and sedimentation rate permitted, ranging from *ca.* 25 years (Mlaka site) to *ca.* 500 years (Noričká graba site).

This paper is divided into six sections. In the first section the present-day vegetation, climate and bedrock at each study site are presented. The information about the archaeological settlement pattern in each area was compiled from the archaeological literature and is presented on Figures 9–12. The second section outlines the methodology used and describes the fieldwork, laboratory procedures and numerical methods used in this research. Section three presents results from radiocarbon, sedimentary and pollen analysis for each site. The Holocene vegetation development for each study site is presented in the section four, where the reasons for changes of the vegetation are discussed. An attempt is made to distinguish between the changes of the vegetation caused by human activity and other factors (*e.g.* climate, internal vegetation dynamics). The fifth section addresses the question of what the Slovenian landscape looked like at the transition from hunting and gathering economy to farming. It then goes on to describe what was the human impact on the environment and possible reasons for the transition to farming. The last section draws the conclusions from the study and suggests future work.

Pollen taxonomy in the paper follows Tutin *et al.* 1964–1980. Plant taxonomy is based on Martinčič *et al.* (*1999*). All radiocarbon dates are in calibrated years before present (determined as 1950 AD, cal. BP), calibrated years BC (cal. BC) or AD. Calibration was performed using INTCAL 98 database (*Stuvier et al. 1998*) and CALIB 4.2 program (*Stuvier & Reimer 1986; 1993*).

STUDY SITES

Prapoče (Submediterranean phytogeographic region)

Prapoče study site is located in a marshy area south of the Prapoče village (480 m.a.s.l.) in Čičarija (NE Istria) and lies on an isolated flysch patch in otherwise mainly limestone region (Geological map 1: 100 000, *Ilirska Bistrica 1972*). Tertiary flysch covers the bottom of the valley, which is *ca.* 600 m wide and 4500 m long, located in NW–SE direction. Hills surrounding the valley consist of Tertiary marl and limestones (Geological map 1: 100 000, *Ilirska Bistrica 1972*). The sedimentary core was collected at the bottom of the valley, *ca.* 1000 m south of the Prapoče village (Fig. 5).

The climate of Čičarija has some mediterranean and some continental characteristics. The main mediterranean characteristic is that the precipitation maximum is in the autumn (October). The secondary precipitation maximum occurs in the spring (*Roglič 1981*) and the annual amount of precipitation in nearby Lanišče is 1664 mm (*Makjanić & Volarić 1981*).

The Čičarija has been classified in terms of its vegetation as a submediterranean region, where thermophilous forest of oak (*Quercus pubescens* Willd.) and hop hornbeam (*Ostrya carpinifolia* Scop.) prevails (*Iljanić 1981*). The vegetation at the coring location is wet meadow with meadowsweet (*Filipendula ulmaria* L.) and individual poplar (*Populus* sp.) and willow (*Salix* sp.) trees. Meadows and fields cover the bottom of the valley, whereas open, predominantly broadleaved forest (a mixture of several species of oak, hornbeam, ash, maple, lime, hazel and pine) grows on the slopes surrounding the valley.

Fig. 5. Prapoče coring location.

Data concerning archaeological sites in the area are very scarce (Fig. 9). They include a list of prehistoric (probably Bronze and Iron age) fortified settlements, which was compiled at the beginning of the 20th century.

Gorenje jezero (Dinaric phytogeographic region)

Cerkniško jezero (the lake of Cerknica) is an intermittent lake (usually flooded in the spring and autumn), lying on a karst polje in the Dinaric phytogeographic region of Slovenia, at 550 m.a.s.l. Over 80% of the bedrock in the drainage basin of Cerkniško jezero consists of permeable rocks such as Jurassic and Cretaceous limestones, which cover the entire south and southwestern part of the drainage area, whereas Triassic and Jurassic dolomites prevail on the northern slopes (Geological map 1: 100 000, *Postojna 1967; Pleničar 1953; Kunaver 1961; Kranjc 1985*). The sedimentary core was collected at the south-eastern edge of Cerkniško polje, *ca.* 50 m south of the Gorenje jezero village (Fig. 6), where previous palynological research (*Šercelj 1974*) indicated that a complete Holocene sedimentary sequence is preserved.

Cerkniško jezero has a modified continental climate with cold winters. The maximum precipitation is in the autumn, which is a characteristic of the modified Mediterranean rather than continental precipitation regime. Although Cerkniško polje has a marked temperature inversion and the annual amount of precipitation in Cerknica is 1300 mm, the influence of the Mediterranean shows as a dry summer with minimum precipitation in July and August. Warm air from the Mediterranean reaches Cerkniško polje through the Postojna gap (650 m.a.s.l.); therefore, with respect to precipitation and temperature, the climate of Cerkniško polje is transitional between the mediterranean and the continental type of climate (*Kranjc 1985*).

Fig. 6. Gorenje jezero coring location.

The slopes surrounding Cerknica lake are covered by a Dinaric beech-fir forest (*Abieti-Fagetum dinaricum*, *Zupančič 1969*). The southern slopes of Cerknica lake are covered by thermophilous vegetation, which consists mainly of oak (*Quercus pubescens* Willd.

and *Quercus petraea* (Matt.) Liebl.) and hop hornbeam (*Ostrya carpinifolia* Scop.) (*Querco-Ostryetum carpinifoliae*, *Zupančič 1969*) and has been interpreted as a remnant from the warmer early Holocene (*Wraber 1960, Zupančič 1969*). Meadows and fields, with several grassland and marshland species, cover the bottom of Cerknica polje.

Fig. 7. Mlaka coring location.

Mesolithic, Neolithic and Bronze Age sites are very rare in the Cerknica region (Fig. 10). Stone tools that could be dated in the Mesolithic have been discovered during the archaeological survey on Cerkniško jezero jezero and in test trenches in the Rakov škocjan (*Drole 1995; Schein 1993; Turk and Dirjec, unpublished report, database of Research Centre of Slovenian Academy of Science and Technology, Institute of Archaeology in Ljubljana*). The majority of fortified settlements at the northern and eastern edge of Cerkniško polje were established in the Iron Age (8th–5th century BC) and belong to the Notranjska group (*Guštin 1973*). In the Roman period the area was an important communication centre (*Urleb 1968*).

Mlaka (Predinaric phytogeographic region)

Mlaka, a swamp with diameter *ca.* 30 m lies in Bela krajina, in Predinaric phytogeographic region. It is located on Cretaceous and Jurassic limestone and dolomite bedrock, at 150 m.a.s.l., 500 m south of Mala Lahinja village (Geological map 1: 100 000, *Črnomelj 1983*). The sedimentary core was collected 5 m from the edge of the swamp, situated in a small doline. At the time of the coring the doline was covered by *ca.* 10 cm of standing water and overgrown by sedges (Fig. 7).

The climate of Bela krajina is moderate continental-subpannonian with submediterranean precipitation regime (1200–1300 mm annually in western parts) and hot summers. Primary precipitation maximum is in the autumn (November) and primary precipitation minimum is in the late winter and early spring (February). The average temperatures of the coldest month are between –3°C and 0°C and at the warmest month the average is between 15°C and 20°C. Temperatures in October are higher than in the April, which is characteristic of the continental climate (*Bernot 1984; Ogrin 1996; Plut 1985*).

Fig. 8. Noričga graba coring location.

Presently Mlaka is surrounded by meadows and fields. Woodlands of scots pine (*Pinus sylvestris* L.) and birch (*Betula pendula* Roth) with juniper (*Juniperus communis* L.) and bracken (*Pteridium aquilinum* L. Kuhn) cover acid soils. Oak (*Quercus petraea* (Matt.) Liebl.) and hornbeam (*Carpinus betulus* L.) prevail in patchy lowland woodlands of Bela krajina, whereas beech (*Fagus sylvatica* L.) forest covers

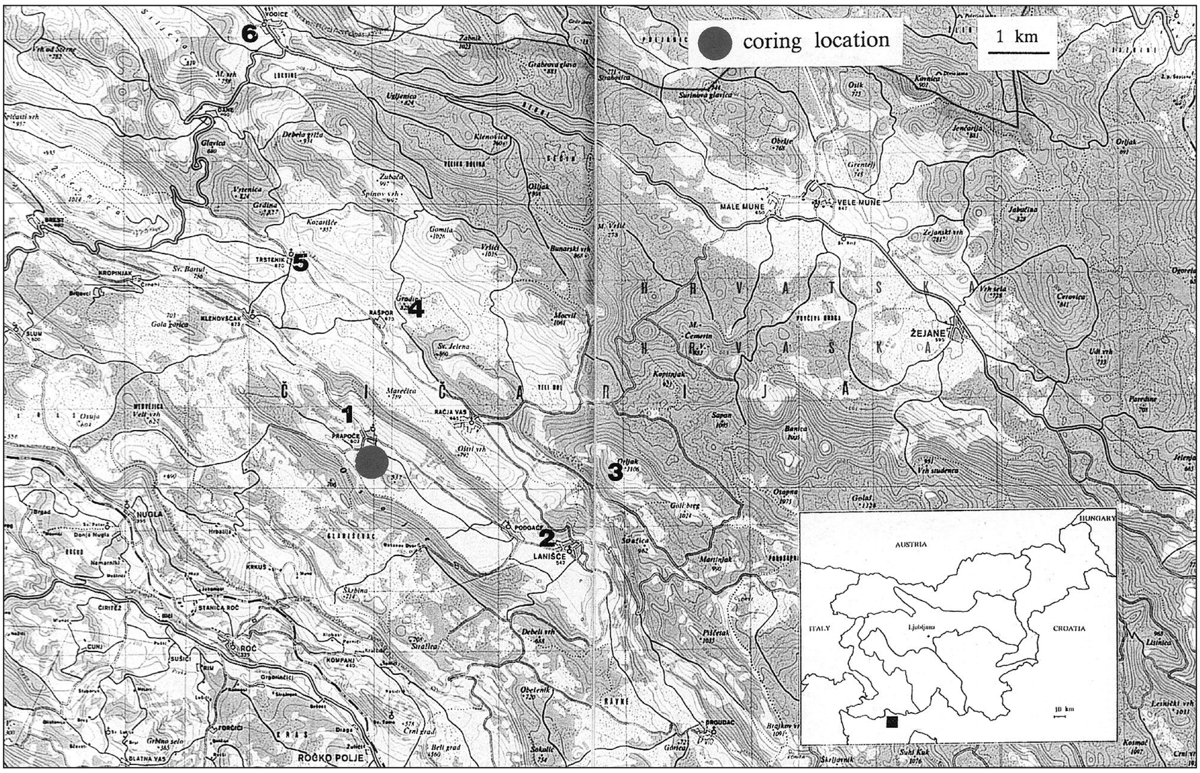


Fig. 9. Archaeological sites in the Prapoče area.[1]

higher altitudes. Therefore it has been suggested that the potential natural vegetation of the lowland Bela krajina would be oak-hornbeam forest (*Zupančič & Wraber 1989*).

Several archaeological sites lie close to Mlaka swamp (Fig. 11); the Neolithic/Eneolithic site Pusti Gradac (*Arheološka najdišča Slovenije 1975; Dular 1985*), Eneolithic site Gradinje (*Phil Mason, pers. comm. 2000*), an Iron Age cemetery Brezjece (*Dular 1985; Spitzer 1974*) and the Roman cemetery Šipek (*Arheološka najdišča Slovenije 1975; Dular 1985*) all lie less than 2 km from the coring location.

Noričká graba (Subpannonian phytogeographic region)

The coring location is situated at 240 m.a.s.l., in marshy area surrounding the spring of tributary of the Ščavnica river. The sedimentary core was taken at the edge of alder (*Alnus glutinosa* (L.) Gaertn.) wood *ca.* 500 m south of Janžev vrh (Fig. 8). The bedrock of the area is Miocene sand and sandy marl (Geological map 1: 100 000, *Čakovec*).

The climate of the subpannonian phytogeographic region is temperate-subpannonian. The annual amount of precipitation is 800–1000 mm and temperatures in April can be higher than in October. Although the precipitation maximum is in July, summers can be very dry (*Ogrin 1996*). The average temperatures of the coldest month are between –3°C and 0°C and at the warmest month the average is between 15°C and 20°C (*Ogrin 1996*).

Due to intensive human impact on the environment meadows, fields and vineyards cover most of the subpannonian region. Patchy woodlands of willow (*Salix* sp.), poplar (*Populus* sp.), hornbeam (*Carpinus betulus* L.) and oak (*Quercus robur* L.) are still growing on gleyed soils of periodically flooded lowlands, whereas many low hills, which rarely exceed 400 m.a.s.l., are covered by acid, degraded soils. Main tree taxa growing in the region are beech (*Fagus sylvatica* L.), oak (*Quercus petraea* (Matt.) Liebl.), chestnut (*Castanea sativa* Mill.) and scots pine (*Pinus sylvestris* L.) (*Wraber 1951; 1961; 1969a; Marinček & Zupančič 1984; Marinček 1987*).

Remains of supposed Neolithic settlement, Bronze Age settlement and cemetery and Iron Age cemetery have been discovered in Gornja Radgona 5 km north of the coring location (*Arheološka najdišča Slovenije 1975*, Fig. 12). Several Iron and Roman age barrows have also been found in Ščavnica valley, to the south and south-west of Norička graba (*Arheološka najdišča Slovenije 1975*).

METHODS

In June 1997 and 1998 several overlapping sedimentary cores were collected at each study site using a modified Livingstone piston corer (*Wright 1967*), mounted upon a portable drilling rig. Samples were extracted from the corer, wrapped in cling film, tin foil and plastic sheeting and transported to the laboratory where they were stored in dark at 4°C in order to prevent microbial growth.

The characteristics of the sediment were described following Troels-Smith (*1955*) and the colour of the sediment was determined by Munsell soil chart. The amount of organic material and carbonates in the sediment was determined by loss-on-ignition analysis (*Bengtsson & Ennell 1986*). 1 cm^3 of the sediment was put in a muffle furnace at 105°C, 550°C and 950°C and the loss of weight due to heating was recorded after each step. Samples for geochemical analysis were prepared by an acid digestion method (a variation of method 2 of *Bengtsson & Enell 1986, Misi Braun, pers. comm.*) using 65% HNO_3 and 30% H_2O_2. The concentration of 21 chemical elements was measured by inductively coupled plasma atomic-emission spectroscopy using Perkin Elmer Optima 3300 RL spectrometer facility at the Department of Geology, Royall Holloway, University of London, Egham.

For the pollen analysis 1 cm^3 of the sediment (or more, up to 4 cm^3 in levels with low pollen concentration) was prepared using standard laboratory procedures (method B of *Berglund & Ralska Jasiewiczowa 1986; Bennett & Willis, in press*) with the following steps: hot 7% HCl, hot 10% NaOH, sieving (sieves with 180 μm mesh), cold 7% HCl, hot 60% HF, hot 7% HCl, acetolysis, staining (0.2% aqueous

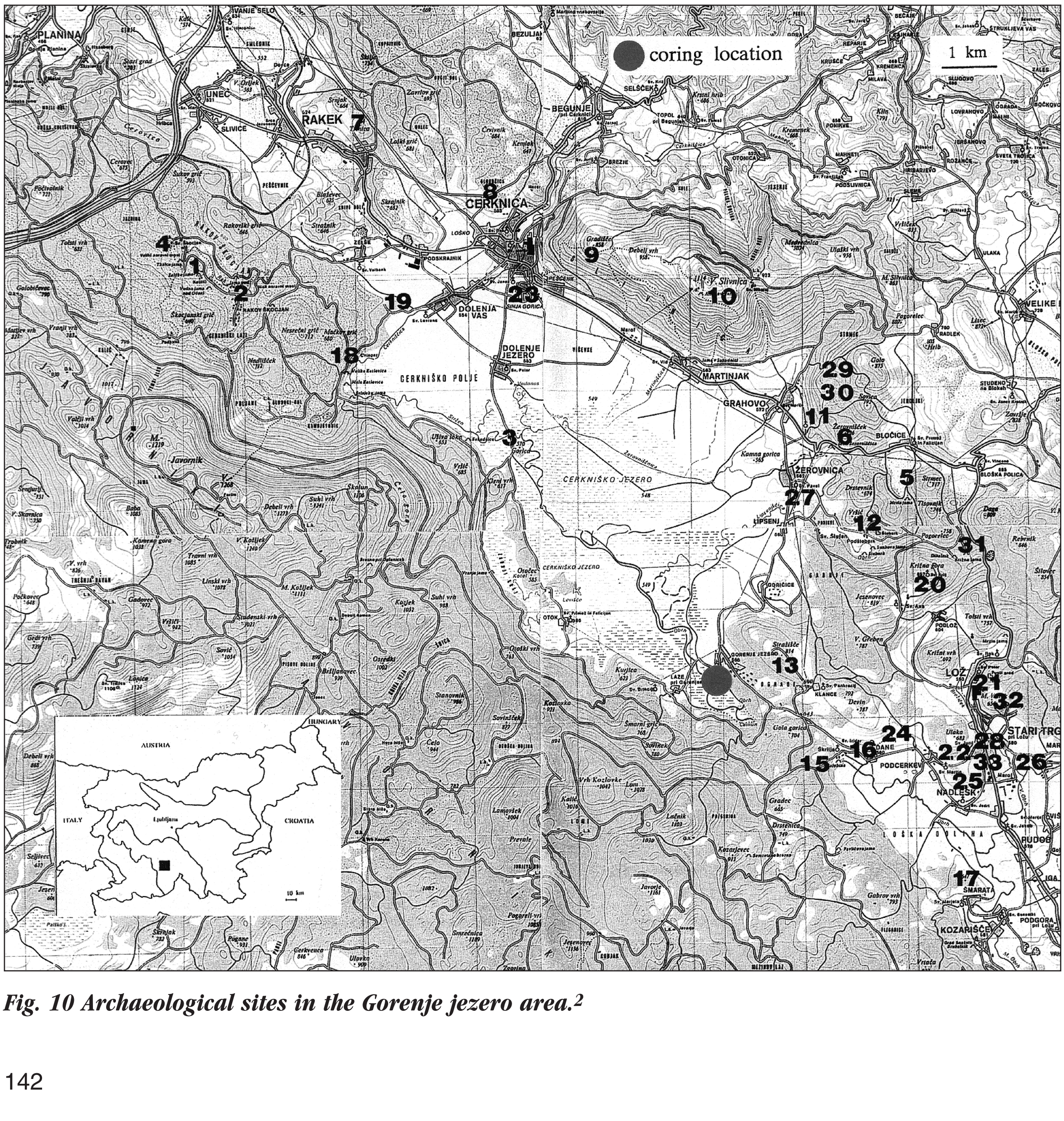


Fig. 10 Archaeological sites in the Gorenje jezero area.[2]

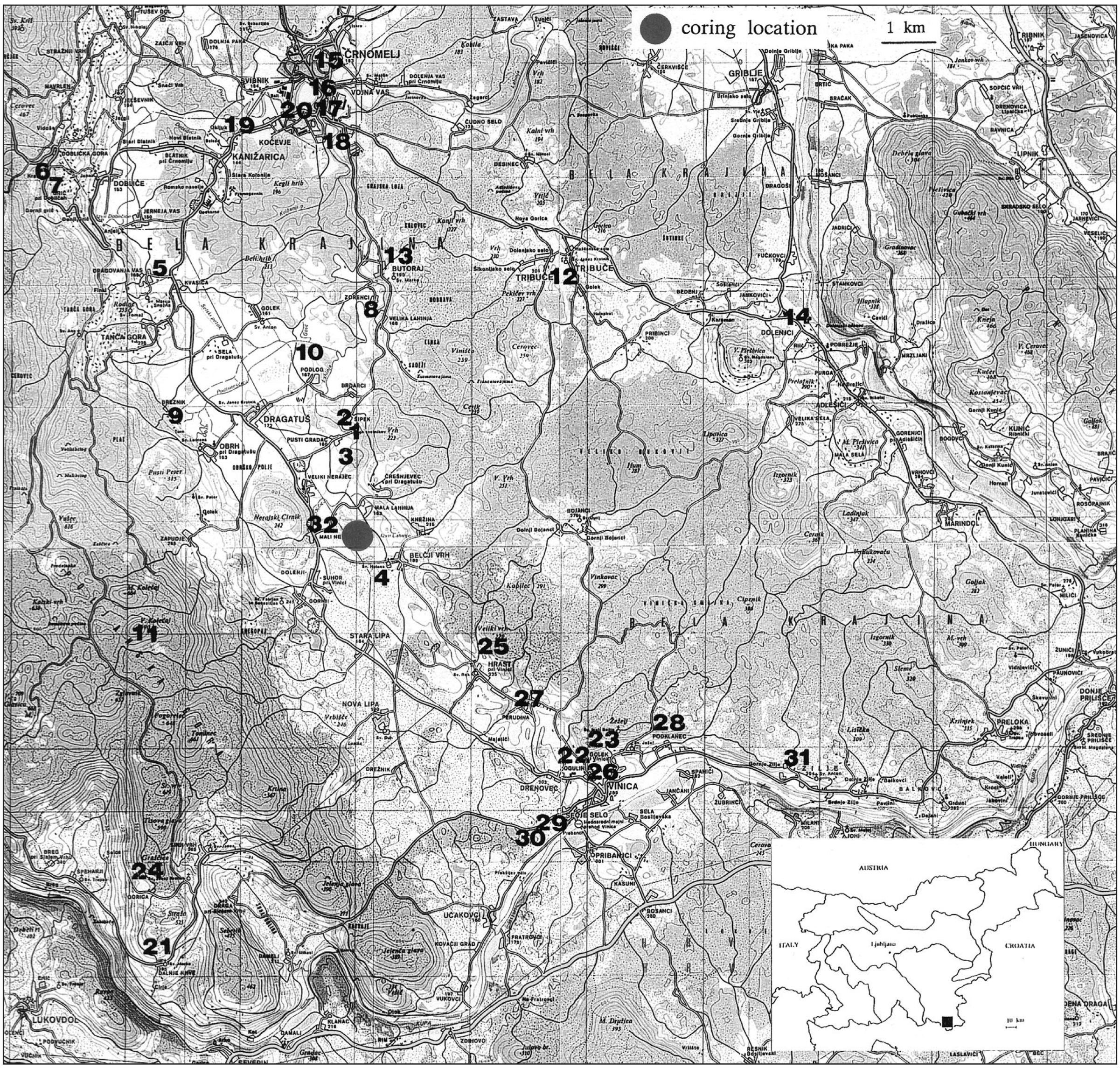


Fig. 11 Archaeological sites in the Mlaka area.[3]

safranine), tertiary butyl alcohol (TBA), silicone oil. At the beginning of pollen preparation 2 tablets with a known number of *Lycopodium* spores were added to each sample in order to determine the pollen concentration (= number of pollen grains per 1 cm^3 of the sediment). Pollen was identified using Leitz and Nikon Eclipse E400 light microscopes at 400x magnification, with the help of the following pollen keys: *Moore, Webb & Collinson 1991; Reille 1992; 1995; Punt et al. 1976–1995* and by comparison with the pollen reference collection at the Department of Geography, Oxford University. A minimum count of 600 grains of terrestrial pollen and spores (others than *Lycopodium*) per sample was made and *Lycopodium* spores were counted along the pollen to determine the pollen concentration (*Stockmarr 1971*). The abundance of microscopic charcoal in the pollen samples was established by Clark's (*1982*) point count method. The number of events when charcoal 'touched' the graticule was counted in 50 randomly selected vision fields. The number of *Lycopodium* spores in each vision field was also counted.

After preliminary pollen analysis 8–10 cm long section of the core (*ca.* 200g) near presumable Pleistocene/Holocene transition was sent to Beta Analytic Inc., Florida for radiocarbon dating. Since none of the samples yielded enough carbon for radiometric dating, AMS dating of organic carbon extracted from the sediment was carried out. To obtain more detailed chronology for the Holocene part of each core additional samples were sent for radiocarbon dating, 1 cm of the core (*ca.* 20g of the sediment) each time. Material pre-treatment included acid washes and direct atomic counting was performed using an

Fig. 12 Archaeological sites in the Noričkagraba area.[4]

accelerator mass spectrometer. The results are presented on Table 3.

The raw data were analysed by PSIMPOLL 3.00 and PSCOMB 3.01, C programs for plotting pollen diagrams and analysing pollen data (*Bennett 1998; http://www. kv.geo.uu.se/software.html/*). For the age modelling the intercept of the radiocarbon age with the calibration curve (in cal. years BP) was used and the position of these dates are plotted on each diagram. All five age models available in the PSIMPOLL 3.00 (linear interpolation, cubic spline interpolation, general line-fitting by weighted least-squares, general line-fitting by singular value decomposition and curve-fitting by Bernshtein polynomial, *Bennett 1994*) were run, and, due to rapidly changing sedimentation rate throughout all four sequences, the linear interpolation was selected. The principal components analysis (PCA) was also run with the PSIMPOLL program. During the PCA analysis of the pollen data the square root transformation of the dataset was carried out to diminish the influence of more numerous taxa (*Birks & Gordon 1985; Grimm 1987; Bennett 1998*).

The sediment description and radiocarbon dates are presented on Tables 3–7. The results of loss-on-ignition, geochemistry and pollen analysis are presented as three separate diagrams for each site. On each diagram the suggested timescale (in years cal. BP) is plotted on the far left, followed by the position of each radiocarbon date (in years cal. BP) and the results of the analysis. For geochemical analysis only the elements with highest concentration (Ca, Na, Mg, K, Fe, Al, and Mn) were plotted. The concentration of other elements (B, Ba, Cd, Co, Cr, Cu, Li, Ni, Pb, Sr, Ti, V, Y and Zn) on none of the study sites exceeded 5 mg per 1 kg of dry sediment. Similarly, only selected taxa were included in the pollen diagrams. The proportion of each taxon has been calculated as a percentage of the pollen sum of all terrestrial taxa and spores. Pollen of monolete fern spores *(Filicales)*, which is overrepresented due to an assumed local source, has been excluded from the sum.

RESULTS

Prapoče

The radiocarbon date for the bottom of the Prapoče core at 206 cm indicates that the sequence extends back to *ca.* 7500 cal. BC. Three radiocarbon dates have been obtained and the results are presented in Table 3.

Prapoče core is clay-rich throughout (Tab. 4).

The results of loss-on-ignition are presented on Figure 13. The percentage of organic material in the bottom half of the core is below 10% and slightly increases towards the top. The inorganic content of the core is 80–90%. In the section of the core dated between *ca.* 9800–7000 cal. BP (7800–5000 cal. BC) the amount of carbonates is higher (5–15%) than in the rest of the core.

The results of geochemical analysis (Fig. 14) are plotted as weight (in mg) of each element per 1kg of dry sediment. The concentration of iron (Fe) and aluminium (Al) fluctuate between approximately 20–40 $mgkg^{-1}$. The amount of magnesium (Mg) and potassium (K) stay constant throughout the whole sequence, *ca.* 10 $mgkg^{-1}$. The calcium (Ca) curve, however, is high at the bottom of the core (up to 120 $mgkg^{-1}$) and decreases after *ca.* 8000 cal. BP (6000 cal. BC).

The results of pollen analysis, presented on Figure 15 indicate that the main characteristic of the lowest section of the core (*ca.* 9500–6000 cal. BP, 7500–

Sample number	Depth	Conventional ^{14}C age	$^{13}C/^{12}C$ ratio	Intercept of radiocarbon age with calibration curve cal. BC (cal. BP)	2 sigma calibrated results
Prapoče					
Beta–145368	140	3050±40 BP	–24.5 o/oo	1310 cal. BC (3260 cal. BP)	1410–1200 cal. BC
Beta–123732	163–172	5250±60 BP	–27.7 o/oo	4035 cal. BC (4985 cal. BP)	4235–3960 cal. BC
Beta–141212	206	8360±40 BP	–25.4 o/oo	7475 cal. BC (9425 cal. BP)	7530–7330 cal. BC
Gorenje jezero 1					
Beta–145366	38	1740±40 BP	–28.9 o/oo	Cal. AD 260, 290, 320 (1690, 1660, 1630 cal. BP)	220–400 cal. AD
Beta–142232	112	7020±60 BP	–27.5 o/oo	5885 cal. BC (7835 cal. BP)	6005–5750 cal. BC
Beta–123731	128–138	20640±140 BP	–10.5 o/oo	/	/
Gorenje jezero 2					
Beta–145367	55	2670±40 BP	–28.2 o/oo	820 cal. BC (2770 cal. BP)	900–790 cal. BC
Beta–141213	77	8710±40 BP	–28.4 o/oo	7730 cal. BC (9680 cal. BP)	7915–7905 cal. BC and 7830–7605 cal. BC
Mlaka					
Beta–148848	102	1000±40 BP	–28.3 o/oo	1020 cal. AD (930 cal. BP)	980–1060 cal. AD and 1080–1150 cal. AD
Beta–141215	136	3480±40 BP	–29.2 o/oo	1765 cal. BC (3715 cal. BP)	1900–1695 cal. BC
Beta–141216	168	7350±40 BP	–27.4 o/oo	6220 cal. BC (8170 cal. BP)	6250–6090 cal. BC
Beta–124727	204–212	8720±40 BP	–26.7 o/oo	7700 cal. BC (9650 cal. BP)	7915–7590 cal. BC
Noričká graba					
Beta–141214	144	1420±30 BP	–27.1 o/oo	640 cal. AD (1310 cal. BP)	600–665 cal. AD
Beta–124725	196–204	10730±40 BP	/	10915 cal. BC (12864 cal. BP)	11012–10494 cal. BC

Tab. 3. Radiocarbon dates.

4000 cal. BC) is high percentage of pine pollen (*Pinus*, 20–40% in most levels). The other taxa present are hazel (*Corylus*, 0–45%), grasses (*Gramineae*, 0–25%), *Compositae tubuliflorae* (0–50%) and monolete fern spores (*Filicales*, 0–60%). Oak *(Quercus)*, lime *(Tilia)* and alder *(Alnus)* are present with less than 10%. In the section of the core dated 6000–3000 cal. BP (4000–1000 cal. BC) the percentage of pine declines to *ca.* 10%, whereas the other tree taxa – lime (*Tilia*, 5–10%), hazel (*Corylus*, 5–20%), alder (*Alnus*, 5–15%), fir (*Abies*, 2–10%), beech (*Fagus*, 2–5%), oak (*Quercus*, 2–10%) and hornbeam (*Carpinus betulus*, 2–5%) increase. The herb pollen *(Gramineae, Compositae liguliflorae)* increases and reaches 50%. The first appearance of Cereal type pollen grains is estimated to *ca.* 2300 cal. BC. In the top section of the core (after 3000 cal. BP, 1000 cal. BC) the percentage of tree pollen is below 10% and herbs reach *ca.* 80%. The rate of change is highest at *ca.* 1000 cal. BC, whereas palynological richness is highest at *ca.* 300–0 cal. BC and 1700–2000 AD.

The results of principal components analysis (PCA) are presented on Figure 16. The main direction of variance on the first axis is between herbaceous types *(e.g. Compositae liguliflorae, Gramineae, Compositae tubuliflorae, Centaurea)*, sedges *(Cyperaceae)*, pine *(Pinus)*, oak *(Quercus)*, charcoal and monolete fern spores *(Filicales)*, lime *(Tilia)*, fir *(Abies)*, hazel *(Corylus)*. The main direction of variance on the second axis is between pine *(Pinus)* and some herbaceous types *(Compositae liguliflorae, Geranium, Filicales)*. The sample scores have also been plotted and the points (each point on the diagram represents one sample) were connected in a chronological order (Fig. 17). The main direction of variance on the first axis is between samples from the top of the core (dated after 1000 cal. BC) and mid-Holocene samples. The main direction of variance on the second axis is between early Holocene samples and samples dated between 1000–200 cal. BC.

Gorenje jezero

The stratigraphic position and age of two cores collected at Gorenje jezero is presented on Figure 18. Three radiocarbon dates have been obtained for the core 1 and two for the core 2 (Tab. 3). The lowest section of the core 1 covers Late Glacial and early Holocene, whereas the top section of core 1 covers the vegetation development for the last 2400 years. Core 2 covers most of the Holocene. Due to a substantial difference in sedimentation rate between core 1 (Gorenje jezero 1, 1.4 cm/100 years) and core 2 (Gorenje jezero 2, 0.8cm/100 years) the results are plotted separately for each core (Figs. 19, 20, 21, 22). The bottom radiocarbon date of core 1 (Beta-123731, 20640±140 uncal. BP) is beyond a good calibration range and was not used for the age modelling.

The sediment description of cores is presented on Table 5. The sediment is clay throughout. Core 1 becomes silty and sandy below 126 cm.

In core 1 the amount of organic material increases from *ca.* 3% at the bottom to 10–20% towards the top of the sequence (Fig. 19). Carbonates decline from 20% to *ca.* 3% from bottom to the top. The

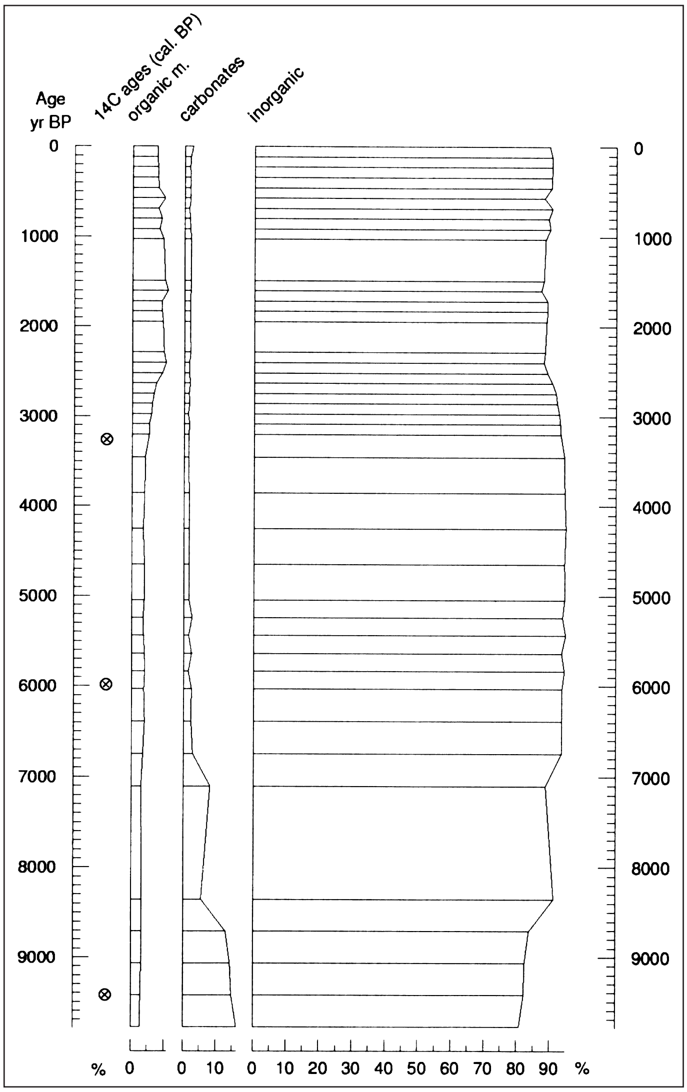


Fig. 13. Prapoče. Loss-on-ignition.

Depth (m)	Troels-Smith symbol	Colour (Munsell soil chart)
0.25–0.43	As4 (clay)	10 YR 4/2 dark greyish brown
0.43–1.00	As4 (clay)	2.5 YR 4/2 dark greyish brown
1.00–1.06	As4 (clay)	2.5 Y 3/2 very dark greyish brown
1.06–1.14	As4 (clay)	5Y 2.5/1 black
1.14–1.45	As4 (clay)	marbled, 2.5 Y 4/2 dark greyish brown
1.45–1.60	As4 (clay)	marbled, 2.5 Y 4/3 olive brown
1.60–1.90	As4 (clay)	marbled, 2.5 Y 4/4 olive brown
1.90–2.20	As4 (clay)	marbled, 2.5 Y 5/2 olive grey

Tab. 4. Prapoče. Description of the sediment follows Troels-Smith (*1955*).

amount of inorganic residue is *ca.* 70–85% throughout. Core 2 (Fig. 19) does not show major changes of sediment composition (10–20% of organic material, 70–85% of inorganic residue).

The results of geochemical analysis are plotted on Figure 20a and 20b. At the bottom of the core 1 the concentration of calcium (Ca) and magnesium (Mg) is *ca.* 70 mg and 40 mg per 1 kg of dry sediment respectively. After *ca.* 9000 cal. BP (7000 cal. BC) calcium and magnesium curves decline to 10 $mgkg^{-1}$, whereas potassium (K) and aluminium (Al) increase from 2 to 10 $mgkg^{-1}$. The concentration of elements in core 2 is similar as in the Holocene part of core 1.

On the pollen diagrams (Figs. 21, 22) the percentage of each taxon has been calculated as a percentage of the pollen sum of all terrestrial taxa and spores. *Filicales* and *Cyperaceae* (overrepresented due to an assumed local source) have been excluded from the sum. The main characteristic of the lowest section of core 1 (10 000–8800 cal. BP, 8000–6800 cal. BC) is high percentage of pine (*Pinus*, 20–70%). Other tree taxa present include spruce *(Picea)*, lime *(Tilia)*, oak *(Quercus)* and hazel *(Corylus)*. The percentage of pine and birch declines after *ca.* 8800 cal. BP (6800 cal. BC) and high percentage of alder (*Alnus*, 20–40%) and fir (*Abies*, 10–20%) is characteristic for the section of the core dated to *ca.* 8000–7000 cal. BP. The main characteristic of the top section of the core 1 is high percentage of herb pollen *(Cyperaceae, Compositae liguliflorae)*. The pollen record of core 2 is similar to core 1 – 20–60% of pine *(Pinus)* in the section dated to *ca.* 10 000–8800 cal BP (8000–6800 cal. BC), an increase of alder *(Alnus)* and fir *(Abies)* in the middle section (8800–2000 cal. BP, 6800–1 cal. BC) and high percentage of herb pollen in the top section of the core (1000–0 cal. BP, after 1000 AD). Palynological richness on both diagrams increases till the beginning of first millennium cal. BC, but starts to decline at the chord distance curve peak.

The comparison of pollen curves in the section below 8000 cal. BP (6000 cal. BC) suggests that the difference between age modelling of the cores is *ca.* 500 years. The reason for this difference is probably a rapid change in the sedimentation rate of core 1 at the Late Glacial-Holocene transition. Therefore the dating of this transition as suggested by age modelling of core 2 (*ca.* 10 000 cal. BP, 8000 cal. BC) has been accepted.

The results of principal components analysis (PCA) of the pollen data for the core Gorenje jezero 2 are presented on Figure 23. On the axis 1 the main direction of variance is between mainly tree taxa (*Alnus, Abies, Fagus, Quercus, Corylus* and charcoal) and mainly herb taxa (*Compositae liguliflorae, Cyperaceae* and *Pinus*). The main direction of variance on the second axis is between *Pinus, Filicales, Tilia, Picea* and *Cyperaceae, Abies*. The sample scores (Fig. 24) have also been plotted and the points (each point on the diagram represents one sample) were connected in a chronological order. The main direction of variance on the first axis is between the samples from the top of the core (dated after 800 AD) and mid Holocene samples (6700–5800 cal. BC). The main direction of variance on the second axis is between early Holocene samples and samples dated after 5800 cal. BC.

Mlaka

Four radiocarbon dates (Tab. 3) have been obtained from the top 212 cm of the Mlaka core. In the sec-

Depth (m)	Troels-Smith symbol	Colour (Munsell soil chart)
Gorenje jezero 1		
0–0.25	Sh2Th1As1	10 YR 2/1 black
0.25–0.44	As4 (clay)	10 YR 3/2 very dark greyish brown
1.00–1.22	As4 (clay)	10 YR 3/1 very dark grey
1.22–1.26	As4 (clay)	10 YR 4/2 dark greyish brown
1.26–1.34	As1 Ag3 (silt)	10 YR 4/2 dark greyish brown
1.34–1.38	Ag4 (silt)	2.5 YR 5/3 light olive brown
Gorenje jezero 2		
0.42–0.78	As4 (clay)	10 YR 3/2 very dark greyish brown

Tab. 5. Gorenje jezero. Description of sediments follows Troels-Smith (*1955*).

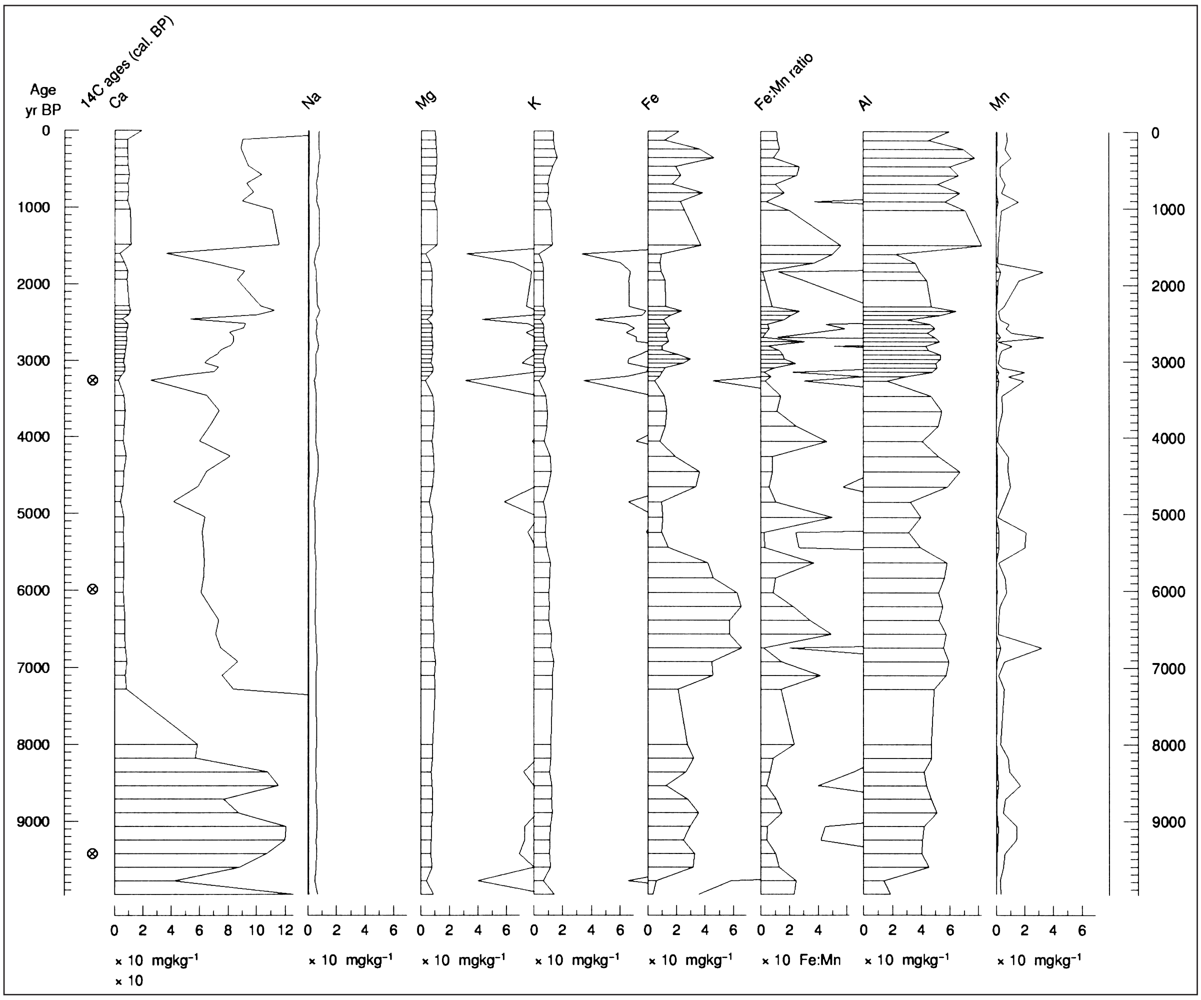


Fig. 14. Prapoče. Geochemistry (selected elements).

tion of the core below 228 cm pollen is not preserved therefore no radiocarbon dating has been carried out in the section of the core older than 7700 cal. BC.

The Mlaka core is clay rich (Tab. 6), with a distinctive organic layer in the middle of the core (0.75-1.35 cm)

Loss-on-ignition (Fig. 25) reveals that the amount of organic material (25–50%) is especially high in the section dated 4000–1000 cal. BP (2000 cal. BC – 1000 AD) and in the top 10 cm of the core.

Results of geochemical analysis for Mlaka are presented on Figure 26. Sediment is rich in calcium (Ca, 5–30 mgkg^{-1}), sodium (Na, 5 mgkg^{-1}), magnesium (Mg, 10 mgkg^{-1}), potassium (K, 10mgkg^{-1}), iron (Fe, 5–20 mgkg^{-1}) and aluminium (Al, 10–70 mgkg^{-1}). The concentration of Ca is highest in the section dated 4000–1000 cal. BP (2000cal. BC–10 00AD, 10–20 mgkg^{-1}), whereas the concentration of Fe and Al is highest in the section of the core dated after 5000 cal. BP (3000 cal. BC, *ca.* 10 mgkg^{-1} and 20–60 mgkg^{-1} respectively).

Pollen data is presented as a percentage of the sum of terrestrial pollen and spores (Fig. 27). Pollen of monolete fern spores *(Filicales)*, which is overrepresented due to an assumed local source, has been excluded from the sum. High percentage of lime (*Tilia*, 5–60%) is characteristic for the bottom section of the core (10 400–8900 cal. BP, 8400–6900 cal. BC). The other tree taxa present are hazel *(Corylus)*, oak *(Quercus)*, beech *(Fagus)*, and alder *(Alnus)*. The pollen record drastically changes at 8900 cal BP (6900 cal. BC), when the amount of beech *(Fagus)* pollen suddenly increases (30–50%). At *ca.* 7500 cal. BP (5500 cal. BC) the pollen composition changes again. All tree taxa decline and the percentage of beech pollen declines to only 10%. This beech decline is followed by an increase of hazel, oak and hornbeam at *ca.* 6800–6000 cal. BP (4800–4000 cal. BC). Later beech increases again, but only for a

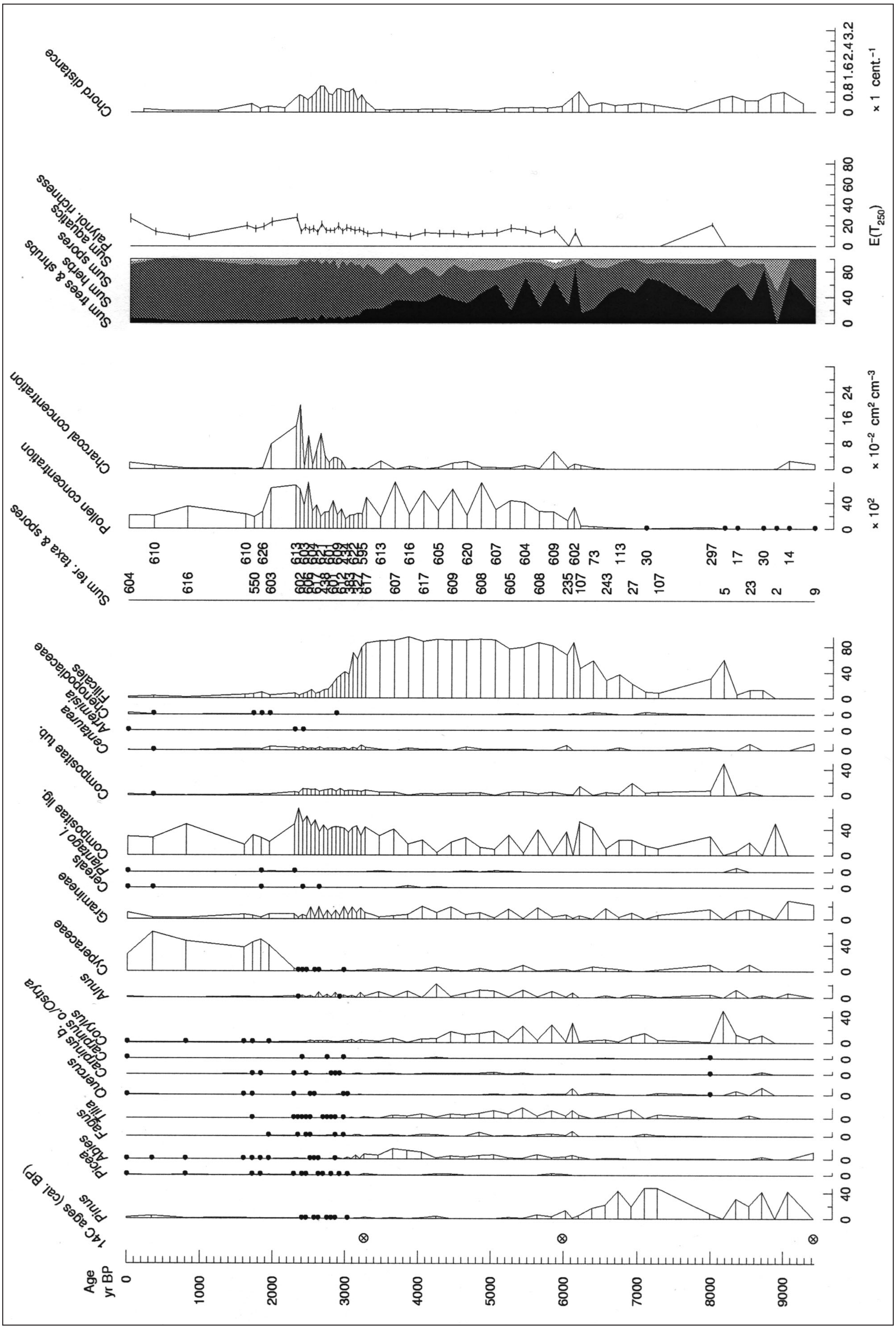


Fig. 15. Prapoče. Percentage pollen diagram (selected taxa).

short period (5300–4300 cal. BP, 3300–2300 cal. BC) Its decline is followed by an increase of fir at 4000–2100 cal. BP (2000 cal. BC – 1100 AD). At 1200 BP (800 AD) the abundance of tree pollen starts to decline for the last time and the main characteristic of the pollen record after 800 cal. BP (1200 AD) is low percentage of tree pollen (10–20%). *Compositae liguliflorae* (*ca.* 20%), *Cyperaceae* (*ca.* 20%) and *Gramineae* (*ca.* 5%) are the most abundant among herb pollen, whereas pine *(Pinus)* increases at the top of the sequence. Palynological richness increases throughout the Holocene, whereas the chord distance curve has two peaks – at *ca.* 8900–8300 cal. BP (6900–6300 cal. BC) and 1100 AD.

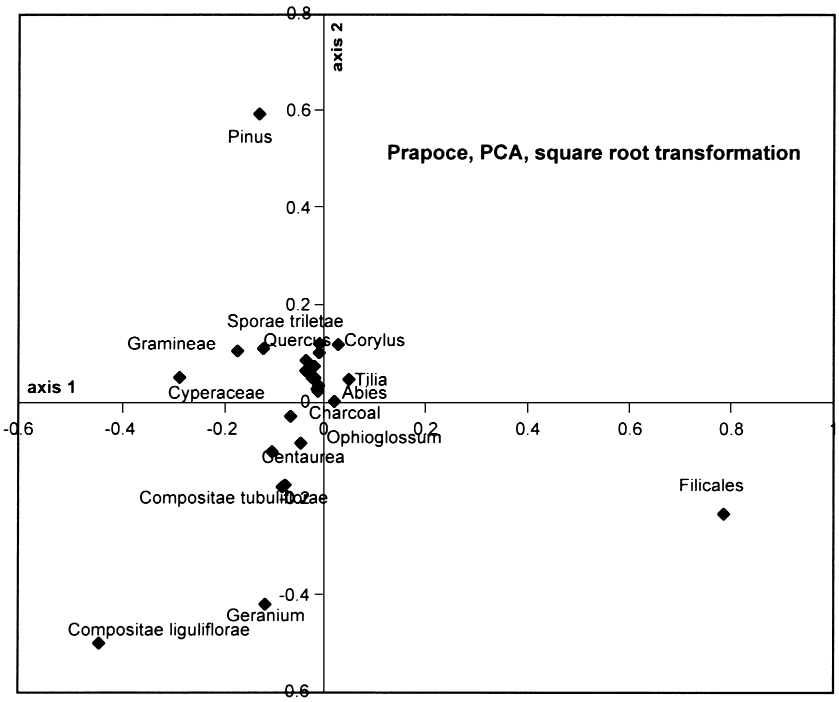


Fig. 16. Prapoče. PCA. Taxa scores.

The results of principal components analysis are presented on Figure 28. The main direction of variance on the first axis is between predominantly tree taxa (*Fagus, Corylus, Tilia, Carpinus betulus, Quercus, Abies* and *Filicales*) and herbs (*Compositae liguliflorae, Cyperaceae, Gramineae, Centaurea, Pinus*, charcoal). The main direction of variance on the second axis is between *Filicales, Tilia* and *Carpinus betulus, Corylus.* The sample scores have also been plotted (Fig. 29) and the points (each point on the diagram represents one sample) were connected in a chronological order. The main direction of variance on the first axis is between the samples from the top of the core (younger than 1200 AD) and mid Holocene samples (8900–8400 cal. BP, 6900–6400 cal. BC). The main direction of variance on the second axis is between most early Holocene samples (dated before 6900 cal. BC) and some mid Holocene samples (dated 7200–1200 cal. BP, 5200 cal. BC–800 AD).

The results of loss-on-ignition analysis are presented on Figure 30. The percentage of organic material is low (below 10%) throughout the sequence, being slightly higher only at the bottom (14 500–10 500 cal. BP, 12 500–8500 cal. BC) and top section (after 4000 cal. BP, 2000 cal. BC). The inorganic content of the core is 80–95%.

The results of geochemical analysis, presented on Figure 31 indicate that the the concentration of calcium (Ca), sodium (Na), magnesium (Mg) and potassium (K) does not exceed 10 mg per 1 kg of dry sediment and does not vary much throughout the Holocene section of the core. Iron (Fe) and aluminium (Al) are more abundant, especially in sections 14 500–10 000 cal. BP (12 500–8000 cal. BC) and 500–0 BP (1500–1950 AD), with concentrations of *ca.* 30 $mgkg^{-1}$ and 40 $mgkg^{-1}$ respectively.

Pollen diagram of selected taxa (Fig. 32) shows the proportion of each taxon, calculated as a percentage

Norička graba

Two radiocarbon dates have been obtained from the Holocene section of the core and the results are presented on Table 3.

Norička graba core alternates between being clay and silt rich (Tab. 7).

Depth (m)	Troels-Smith symbol	Colour (Munsell soil chart)
0–0.13	Ld4 (organic material)	10 YR 3/3 dark brown
0.13–0.75	As4 (clay)	10 YR 3/3 dark brown
0.75–1.10	Ld4 (organic material)	10 YR 2/1 black
1.10–1.35	As1Ld4 (organic m., clay)	10 YR 3/1 very dark grey
1.35–2.77	As4 (clay)	2.5 Y 4/2 dark greyish brown

Tab. 6. Mlaka. Description of sediments follows Troels-Smith (1955).

of the pollen sum of all terrestrial taxa and spores. Pollen of monolete fern spores *(Filicales)*, which is overrepresented due to an assumed local source, has been excluded from the sum. In the section of the core with an estimated age of 14 500–10 000 cal. BP (12 500–8000 cal. BC) the main tree taxa present are pine (*Pinus*, 10–60%), spruce (*Picea*, 10–15%), lime *(Tilia)*, oak *(Quercus)*, hazel *(Corylus)* and alder *(Alnus)*. The percentage of herb pollen is high (20–50%) and the main herb types present are *Compositae liguliflorae* and *Gramineae*. In the section dated to *ca.* 9500–7000 cal. BP (7500–5000 cal. BC) the pollen curves for lime *(Tilia)*, oak *(Quercus)* and hazel *(Corylus)* increase up to 30%, 5% and 10% respectively. Short-term peaks of alder, pine, beech and *Compositae liguliflorae* follow their decline. In the uppermost section (600–0 cal. BP, 1400–1950 AD) the percentage of herb taxa is 30–60% (*Compositae liguliflorae*, 25–60% of the pollen sum) and the main tree taxon is pine (*Pinus*, 2–35%). Chord distance is highest at 800–1000 AD.

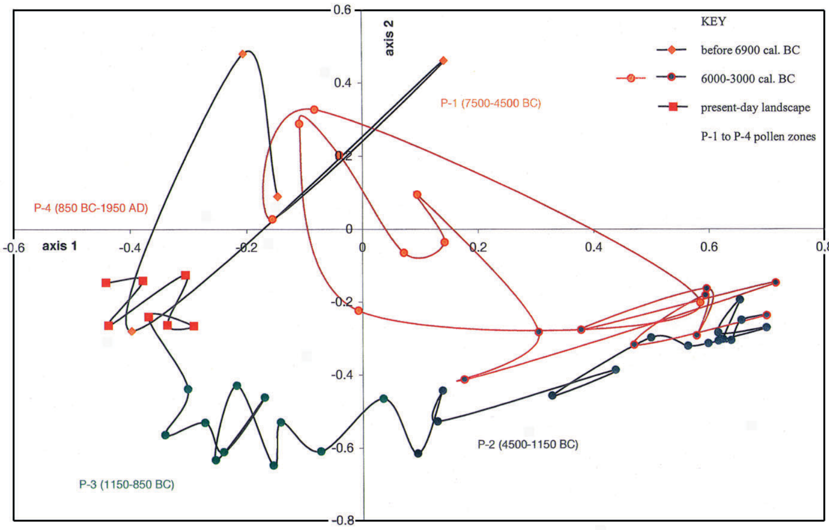


Fig. 17. Prapoče. PCA. Sample scores.

The results of principal components analysis (PCA) are presented on Figure 33. The main direction of variance on the first axis is between predominantly tree taxa (*Tilia, Alnus, Corylus, Fagus* and *Filicales*) and mainly herbs (*Compositae liguliflorae, Cyperaceae, Pinus* and charcoal). The main direction of variance on the second axis is between *Pinus, Filicales, Tilia, Picea* and *Alnus, Sporae triletae*. The sample scores have also been plotted and the points (each point on the diagram represents one sample) were connected in a chronological order (Fig. 34). The main direction of variance on the first axis is between the samples from the top of the core (dated *ca.* 1800 AD) and some of the mid Holocene samples. The main direction of variance on the second axis is between some early and mid Holocene samples.

Depth (m)	Troels-Smith symbol	Colour (Munsell soil chart)
0–0.22	Sh2Th1As1	10 YR 2/2 very dark brown
0.22– 0.80	As4 (clay)	2.5 Y 4/2 dark greyish brown
0.80–0.96	As3Ag1 (silty clay)	5 Y 4/2 olive grey
0.96–1.11	As2Ag2 (silty clay)	5 Y 4/2 olive grey
1.11–1.40	As3Ag1 (silty clay)	5 Y 3/2 dark olive grey
1.40–1.46	As4 (clay)	5 Y 4/1 olive grey
1.46–1.80	As1Ag2Ga1 (silt)	5 Y 4/1 dark grey
1.80–2.08	As4 (clay)	5 Y 3/1 very dark grey

Tab. 7. Noričk*a graba. Description of sediments follows (**Troels-Smith 1955**).

THE HOLOCENE VEGETATION DEVELOPMENT

The results of pollen analysis suggest that vegetation history at each study site was different; although the maximum distance between any two sites does not exceed 200 km. Therefore the vegetation development for each study site will be presented first.

Prapoče

Pollen record for Prapoče suggests that in the early Holocene (9500–6500 cal. BP, 7500–4500 cal. BC) woodland of pine, oak and hazel was probably growing in the region. Due to low pollen concentration (in most levels below 500 pollen grains per 1 cm^3 of sediment) and high percentage of degraded pollen grains (10–60%) it is difficult to estimate whether pollen record reflects the real vegetation composition or was it changed due to a selective degradation. Since pollen sum in most levels does not exceed 250 (and therefore confidence intervals for pollen counts are wide), the vegetation composition cannot be discussed in detail.

The reason for low pollen survival might be in dry, aerobic conditions and high microbial activity in the sediment (*Moore et al. 1991*) triggered by presumably warm and dry climate. Loss-on-ignition and geochemical results support this suggestion. The concentration of calcium (Ca) in the sediment depends on the temperature (*Cole 1979; Williams et al. 1998*). Increased temperature and progressive evaporation of the lake water could cause the precipitation of calcium carbonate into the sediment. In the section of the core dated between *ca.* 10 000–7500 cal. BP (8000–5500 cal. BC) the concentration of carbonate (10–20% of the sediment dry weight, Fig. 13) and calcium (60–120 $mgkg^{-1}$, Fig. 14) is higher than in the upper part of the core and might indicate arid climate before 7500 cal. BP (5500 cal. BC). An increase of iron (Fe), which followed at *ca.* 7000–6500 cal. BP (5000–4500 cal. BC) was probably caused by changes of redox conditions in both, the catchment and marsh area. Iron has, similarly as manganese (Mn) very low solubility under oxidising conditions, but becomes mobile under reducing conditions. Reducing conditions in the catchment can be caused by waterlogging or build-up of raw humus on the soil surface (*Mackereth 1966; Engstrom & Wright 1984*) Therefore slightly higher iron at *ca.* 5000 cal. BC might suggest that the climate either became wetter or the basin became waterlogged.

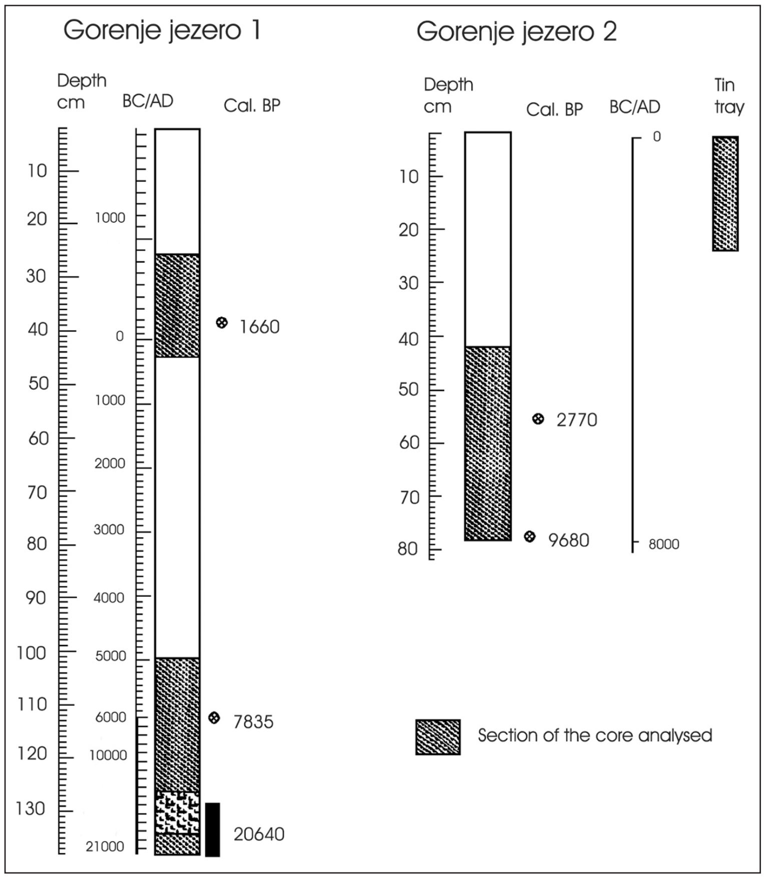


Fig. 18. Gorenje jezero. Stratigraphic position of cores 1 and 2.

In the section of the core dated after 6500 cal. BP (4500 cal. BC) the percentage of degraded pollen grains declines and pollen concentration increases to 2000–6000 grains per $1 cm^3$ of the sediment. This indicates that the pollen record in this section of the core is reliable and pollen composition was probably not changed due to a selective preservation. Still rather low pollen concentration is most likely a consequence of sedimentation rate and vegetation composition.

The vegetation growing in the Prapoče area between 6500 and 4000 cal. BP (4500–2000 cal. BC) was probably open forest of lime, oak, beech, fir, hornbeam, hop hornbeam and hazel. Alder and willow were growing in the marshy areas in the bottom of the valley. High percentage of hazel (5–25%) and herb pollen (20–60%) suggests that open areas, presumably meadows and fields were located in the vicinity of the coring location. Several lines of evidence suggest that human activity in the area might be the reason for this forest thinning. Charcoal record detects regular small-scale burning of the landscape and several 'anthropogenic indicators' *(Plantago l., Centaurea, Artemisia, Chenopodiaceae)* appear on the pollen diagram. The poor pollen preservation at the bottom of the core does not allow to see how open was the landscape before 4500 cal. BC and whether these 'anthropogenic indicators' were actually growing also in the 'natural' early and mid Holocene landscape. Present-day habitats of many species from *Chenopodiaceae*, *Centaurea* and *Artemisia* family are dry, rocky places in the Submediterranean region (*Martinčič et al. 1999*) and it is possible that they were growing in similar habitats also in the middle Holocene. The first cereal type pollen grains appear at *ca.* 4300 cal. BP (2300 cal. BC). The cereal pollen production is low and pollen does not spread far from the plant (*Behre 1988; Rösch 2000*), therefore they indicate that fields and Eneolithic/Bronze Age site must have been located in the vicinity of the coring location. Since the beginning of the second millennium cal. BC the human pressure on the environment started to increase. The amount of tree pollen declined and a change in forest composition occurred at 4000–3500 cal. BP

(2000–1500 cal. BC) when fir became more numerous. The reason for this increase of fir might be climatic (increased precipitation, similar increase of fir appears on the Mlaka site between 2000 and 100 cal. BC) and/or development of metallurgy (more beech was cut for fuel, similarly as suggested for Hungary, *Willis et al. 1998*). Despite this change in the forest composition the areas covered by forest diminished and the present-day landscape formed already at *ca.* 1000 cal. BC.

Gorenje jezero

In the Late Glacial (before *ca.* 10 000 cal. BP, 8000 cal. BC) mixed woodland of pine, birch, spruce, lime, oak, hazel ash and elm was growing in the Gorenje jezero region. Geochemical record suggests that the landscape was not stable. Increased inorganic input and high concentration of calcium (Ca) and magnesium (Mg) indicate that erosion probably occurred due to open vegetation and low temperatures.

In the early Holocene (10 000–8900 cal. BP, 8000–6900 cal. BC) broadleaved taxa (beech, lime, oak, hazel) and spruce replaced pine and birch. At *ca.* 8900 cal. BP (6900 cal. BC) the composition of forest growing in the Gorenje jezero area changed. The amount of spruce declined, whereas fir became more numerous. Alder, growing on the floodplain also increased, probably because of the change in the hydrology of the basin. Cerkniško jezero is a karst field, usually flooded in spring and autumn. The extent and duration of the floods is connected with the amount of precipitation in its watershed (*Kranjc 1985*). Therefore it is possible that the observed change of vegetation (an increase of alder and fir) was triggered by an increase in precipitation.

At *ca.* 8900 cal. BC (6900 cal. BC) alder and fir started to grow around Gorenje jezero site and by 7000 cal. BP (5000 cal. BC) fir became the most common tree in the region. Alder, which was probably growing in the floodplain, suddenly declined at 5000 cal. BC. Two reasons could be suggested for this decline: change of the hydrology in the basin or human impact (the first cereal type pollen grains appear on the diagram at this point). Although no Neolithic or Eneolithic sites have been found in the area, it is possible that Neolithic populations were clearing and burning forest on the floodplain.

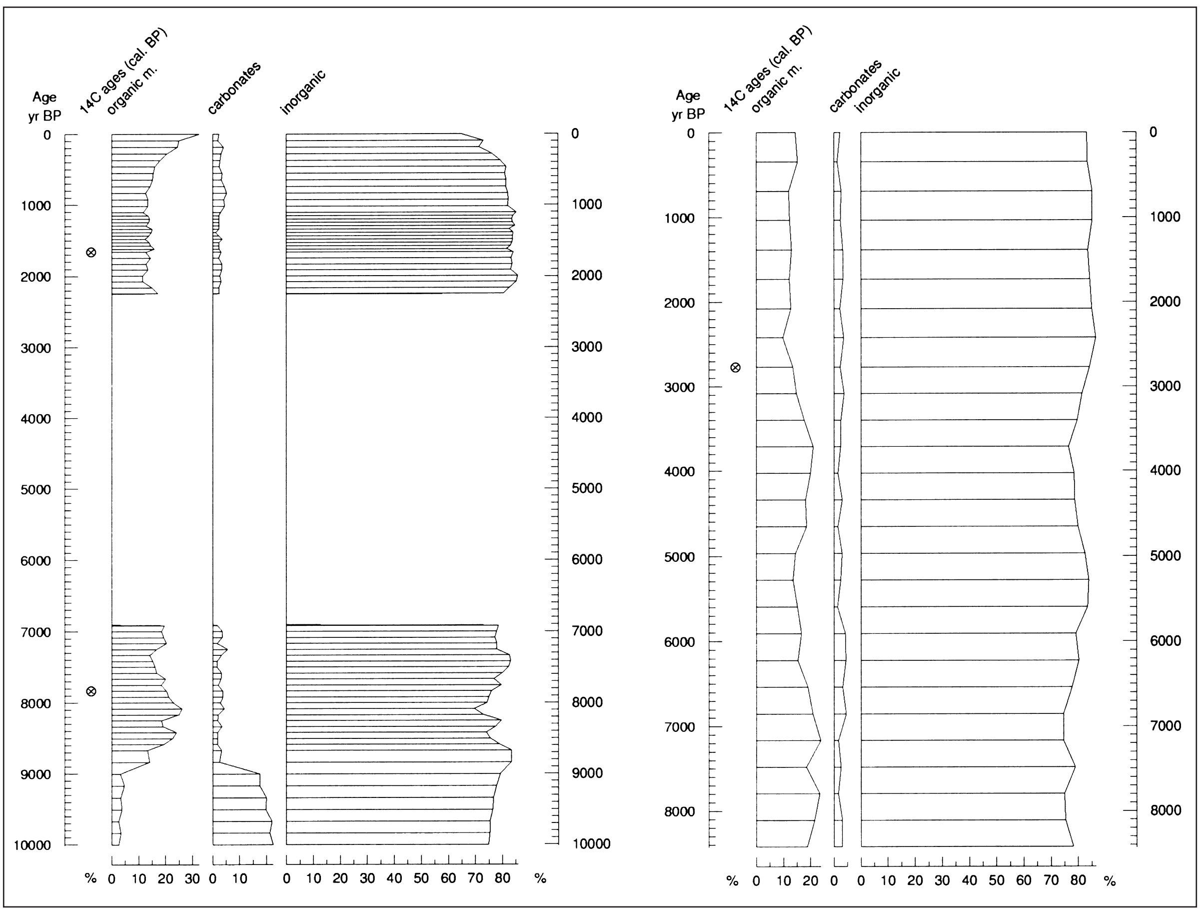


Fig. 19. Gorenje jezero 1 and 2. Loss-on-ignition.

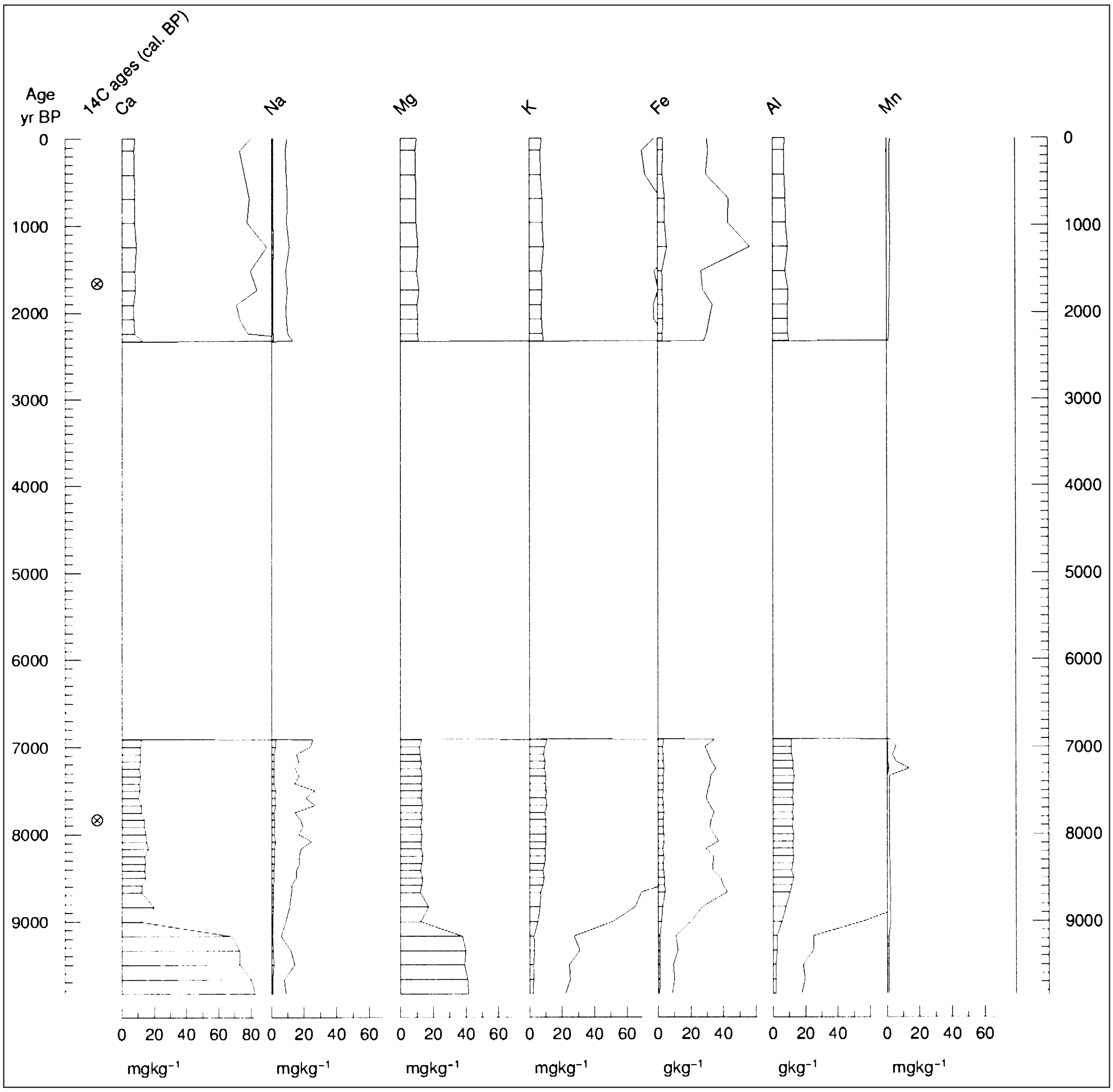


Fig. 20a. Gorenje jezero 1. Geochemistry (selected elements).

In contrast to Neolithic/Eneolithic settlement pattern, the Bronze and Iron Age sites in the area are numerous. Most Iron Age fortified settlements and cemeteries are located on the northern edge of the Cerknica polje (*Arheološka najdišča Slovenije 1975*). A presumable late Bronze and/or early Iron Age site in Gorenje jezero village was located *ca.* 200 m from the coring location. On the basis of several pieces of potsherds found in the village during the construction of a pipeline, the site was dated into 9th/8th century BC (*Alma Bavdek, pers. comm., 1999*). Pollen record for this period shows a decline of fir dated *ca.* 3000 cal. BP (1000 cal. BC). Alder started to decline again, whereas herbs were increasing. These changes suggest that the landscape was gradually becoming more open and present-day landscape with meadows and fields at the bottom of Cerknica polje formed already in the Roman period at *ca.* 300 AD. Input of geochemical elements has remained stable throughout the Holocene suggesting that no soil erosion occurred.

Mlaka

In the early Holocene (10 600–8900 cal. BP, 8600–6900 cal. BC) Mlaka swamp was surrounded by broad-leaved forest in which lime dominated. The other tree taxa also growing in the region were hazel, oak, hornbeam, hop hornbeam, maple, fir, spruce, birch, pine, elm, alder and willow.

At 8900 cal. BP (6900 cal. BC) thick beech forest replaced predominantly lime woodland within only a hundred years. Fir, although probably growing in

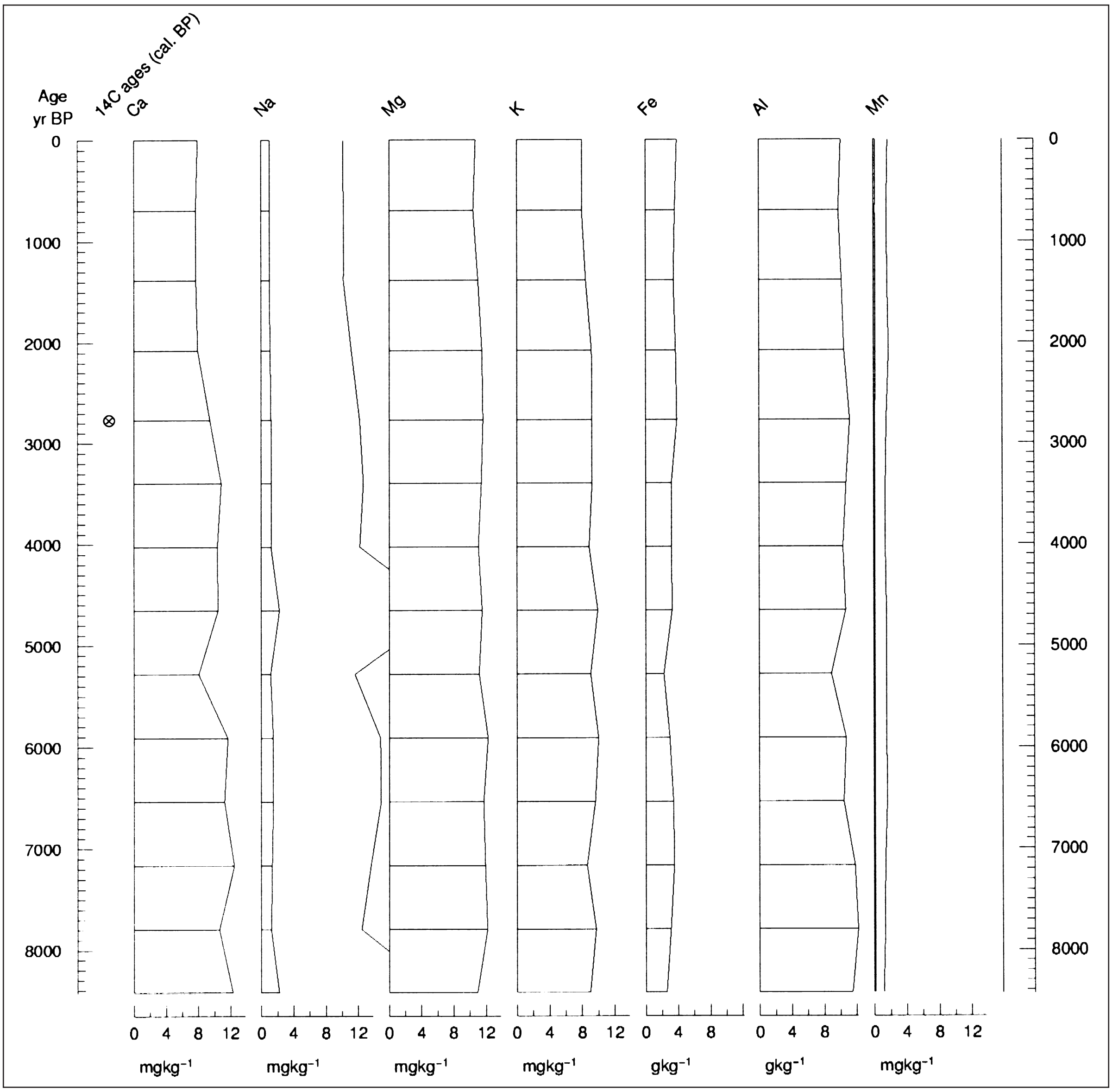


Fig. 20b. Gorenje jezero 2. Geochemistry (selected elements).

the area, was not very numerous. The reason for this vegetation change was probably, similarly as in other regions of Slovenia, climatic. Maybe the increase of precipitation was intensive enough to allow the spread of beech, but summers were still too dry for fir expansion. Another factor that limited the spread of fir might have been burning of the forest. Fir has been classified as fire-intolerant tree taxon (*Tinner et al. 2000*) and in the southern Switzerland, for example, the results of palaeoecological research have suggested that high fire incidence was responsible for the extinction of fir from Swiss lowland forests (*Tinner et al. 1999*). The charcoal record at Mlaka suggests that regular burning of the landscape occurred throughout the Holoceme. The fluctuation of beech curve and relatively high percentage of lime and hazel pollen suggests that occasional small-scale openings of the canopy did occur between 8900 and 8000 cal. BP (6900–6000 cal. BC). It is difficult to estimate what was the role of the Mesolithic population in shaping the landscape (forest burning) since to date no Mesolithic sites have been discovered in the area.

At 8200 cal. BP (6200 cal. BC) the amount of beech growing around Mlaka swamp started to decline and by 7500 cal. BP (5500 cal. BC) the landscape became very open again. The vegetation composition at 5500 cal. BC was similar as in the early Holocene with lime being the most important tree taxon. What was the reason for this drastic change of vegetation? Two possible explanations will be discussed – climatic change and human impact on the environment.

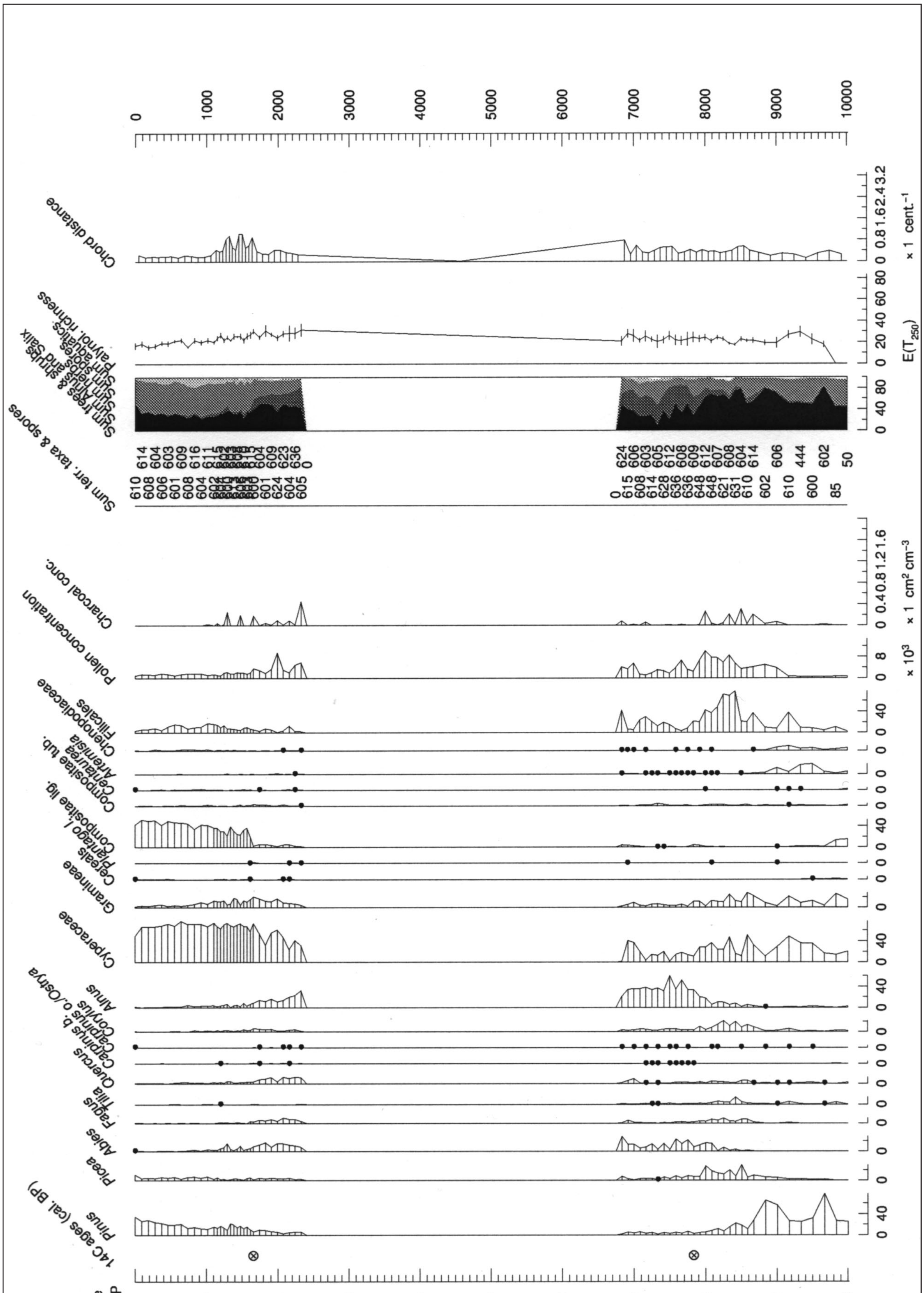


Fig. 21. Gorenje jezero 1. Percentage pollen diagram (selected taxa).

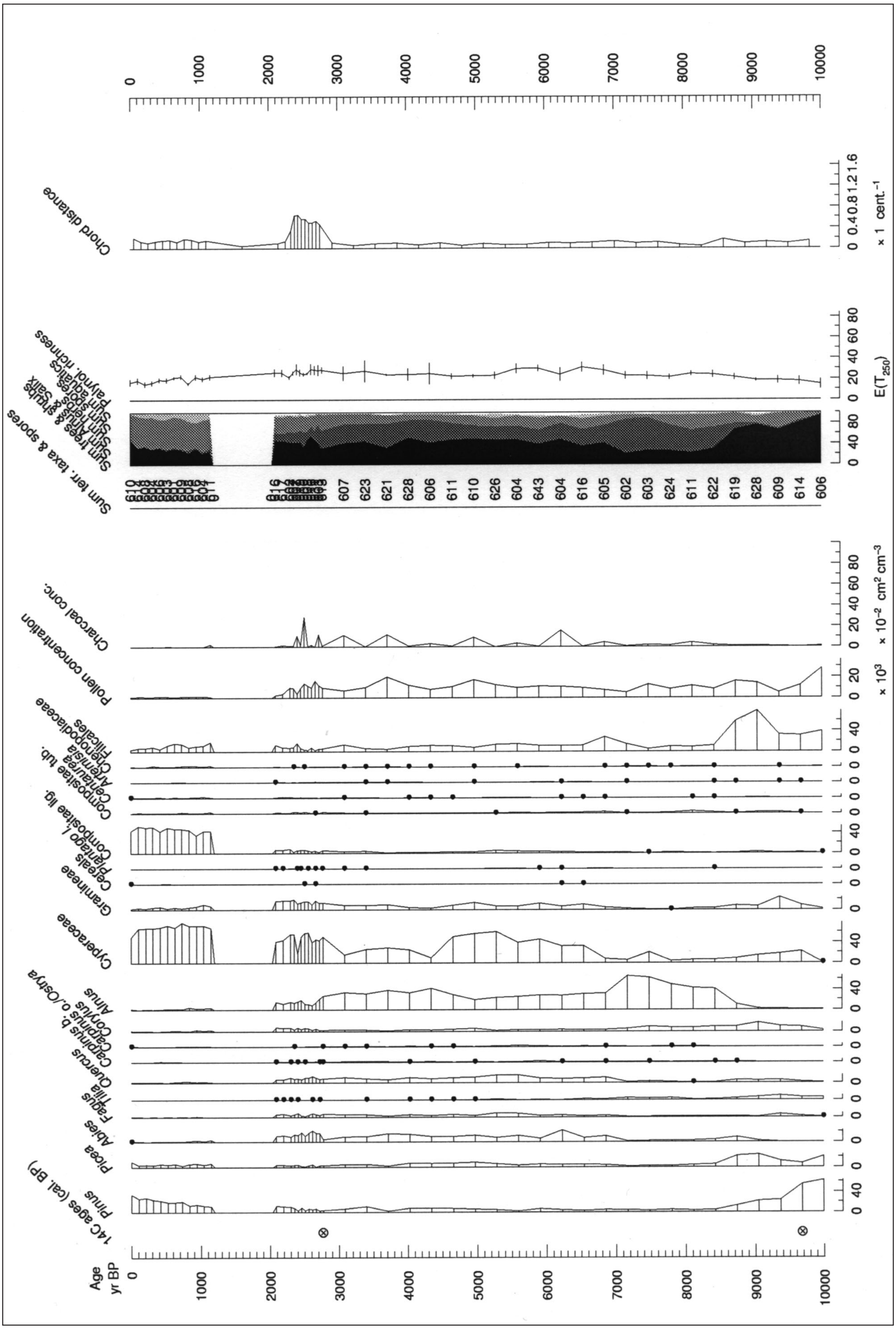


Fig. 22. Gorenje jezero 2. Percentage pollen diagram (selected taxa)

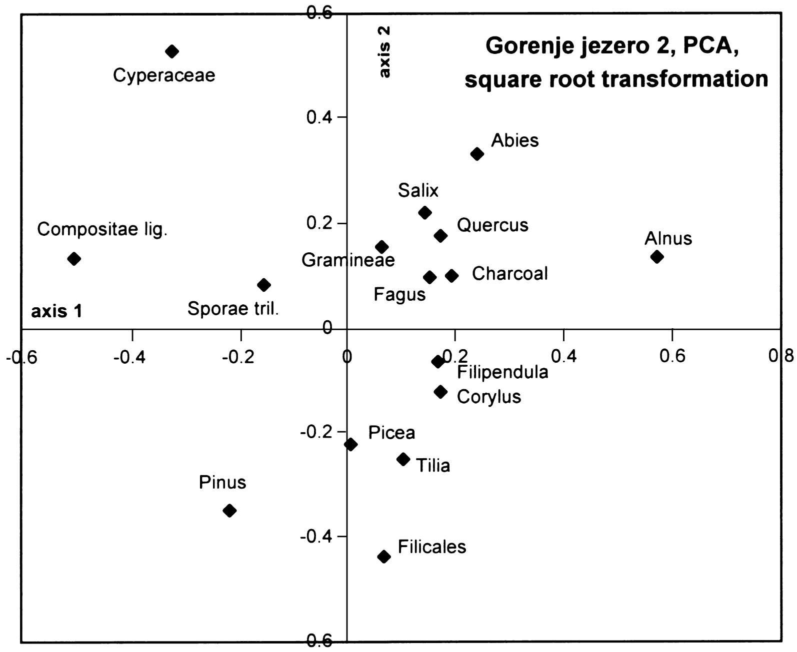


Fig. 23. Gorenje jezero 2. PCA. Taxa scores.

Since the vegetation composition at 6200–5500 cal. BC was similar as in the early Holocene, it could be argued that it was caused by similar climate – presumably warm and dry summers and cold winters (*Kutzbach et al. 1998*). The beech decline at Mlaka also coincides with cold period detected in the Greenland ice cores and Swiss palaeoecological record. The main difference between Greenland and Swiss palaeoecological record is that the former was interpreted as "cold and dry" event (*Alley et al. 1993; Meese et al. 1994*), whereas the latter has been reported as "cold and humid phase", which might include a drier episode recorded in the lowlands only (*Haas et al. 1998*). The problem with the climatic explanation for the vegetation change at Mlaka is that such a drastic change in vegetation composition does not occur anywhere else in Slovenia, which suggests that the presumable climatic change was neither intensive nor widespread.

Therefore the other option – human impact on the environment – should also be considered. Mlaka is small swamp with diameter 30 m and the pollen source area for such small sites is mainly local. Most of the pollen derives from plants growing less than 300 m from the site (*Jacobson & Bradshaw 1981*). An individual, small-scale forest clearance in the vicinity of Mlaka would cause a major change of local vegetation and pollen record. It is possible that forest clearance and burning opened the landscape to an extent when it was not only more attractive to the herbivores, but also allowed cereal cultivation and pasture of domestic animals. The most intensive pressure on the vegetation lasted for *ca.* 700 years. Afterwards, at 5500 cal. BC, forest started to regenerate through a phase of hazel, oak and hornbeam. Predominantly hornbeam forest was growing around Mlaka between 4500 and 3800 cal. BC. It seems that the hornbeam forest was maintained by coppicing and burning, which prevented beech to regenerate. Long coppice rotation and wood pasture might increase the proportion of hornbeam against other trees and it is possible that it was grown for firewood (*Rackham 1980; Ellenberg 1988*).

At 3800 cal. BC the hornbeam forest was cleared and an increase of ash and pine suggests that the landscape became very open again. An increase of grass and herb pollen *(e.g. Centaurea, Plantago l., Compositae liguliflorae)* and cereal type pollen indicates that meadows and fields were located in the vicinity of the Mlaka site. Between 3300 and 2500 cal. BC some of these fields were abandoned and thick beech forest spread again. The spread of forest was interrupted for a short period only at *ca.* 2800 cal. BC, when beech declined an geochemical record (an increase of Fe:organic and Al:organic ratio) suggests that forest clearance and burning caused soil erosion.

For the Neolithic and Eneolithic period the archaeological settlement pattern in the area is very well known – most Neolithic sites are located in river meanders and bends in the lowland Bela krajina (*Dular 1985; Budja 1989; 1992 (1995); Mason 1995*). Yet no early Neolithic sites have been discovered in the Bela krajina so far and the oldest, mid Neolithic levels of Moverna vas site, were radiocarbon dated to 4904–4874 cal. BC (*Budja 1989; 1992; 1993*). The Pusti Gradac site, located 2 km north of Mlaka, has been, on the basis of pottery, which is similar to the pottery discovered in the Moverna vas, dated in the 5th, 4th and 3rd millennium BC (*Arheološka najdišča Slovenije 1975; Dular 1985; Budja 1989*). Therefore the forest clearance detected in the palynological record of Mlaka site pre-dates the earliest Neolithic site in the area for *ca.* 1000 years and suggests that the first farmers were probably living in Bela krajina in the Early Neolithic, but their sites still need to be discovered. The first soil erosion, which followed forest clearance at *ca.* 2800 cal. BC was probably associated with a recently discovered Eneolithic site Gradinje, located just 300 m west of the coring location (*Phil Mason, pers. comm., 2000*).

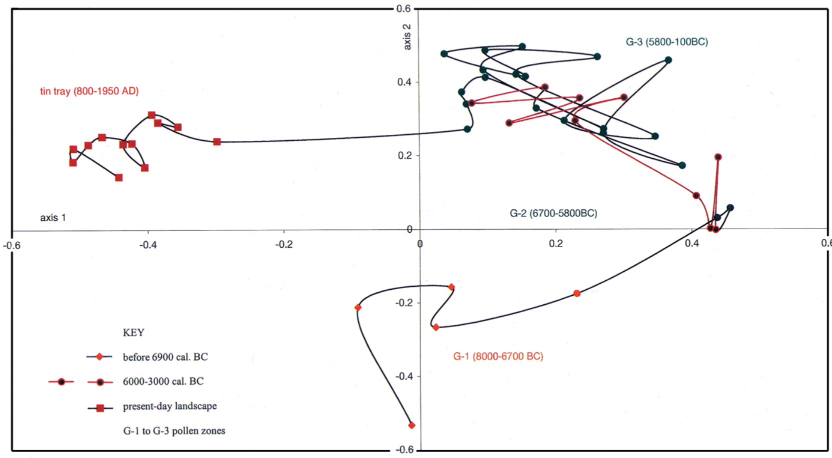


Fig. 24. Gorenje jezero 2. PCA. Sample scores.

At 2000 cal. BC beech declined again. The sediment of Mlaka core became organic and more fir started to grow in the area. This change in the sediment composition and an increase of fir could be a consequence of climatic changes (increased precipitation). Intensive metallurgy could also favour fir since more beech was probably cut for the fuel (*similarly as suggested for Hungary, Willis et al. 1998*). An increase of pine and herb pollen suggests that human pressure on the environment was gradually increasing until *ca.* 1000 AD when the present-day landscape with patchy woodlands and extensive meadows and fields formed. Geochemical record suggests that soil erosion occurred again with the formation of the present-day landscape.

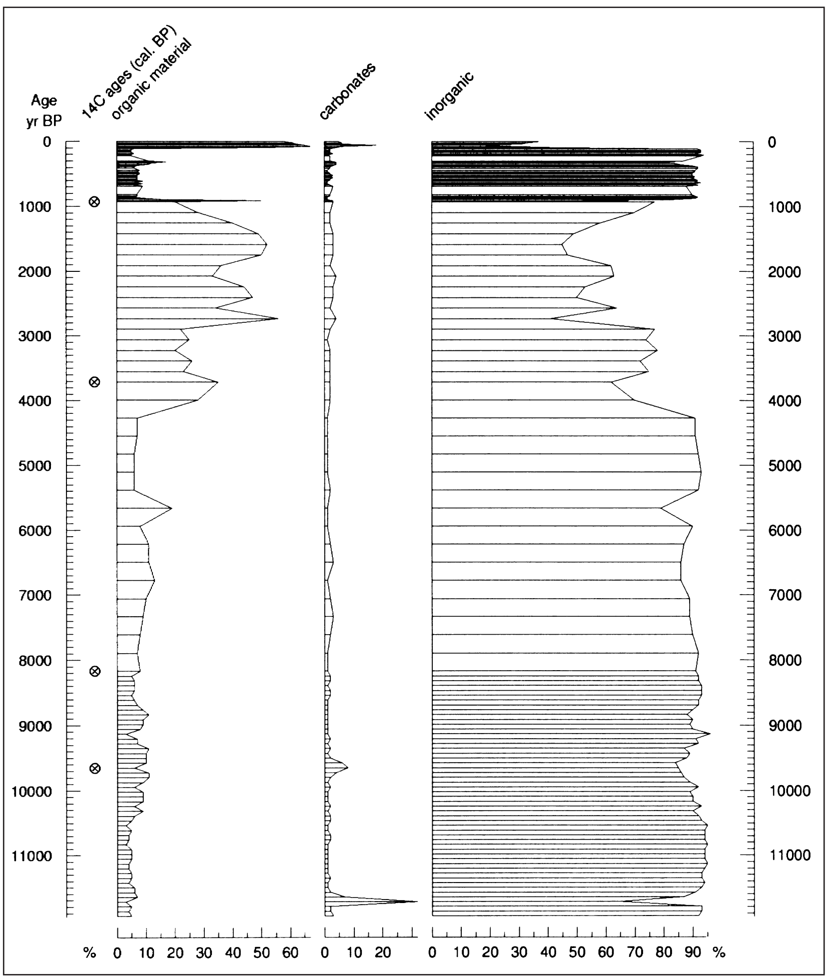


Fig. 25. Mlaka Loss-on-ignition.

Norička graba

In the Late Glacial (14 500–10 000 cal. BP, 12 500–8000 cal. BC) predominantly pine-birch-spruce woodland was growing around Norička graba. High percentage of herb pollen and high charcoal concentration suggests that woodland in the Late Glacial and Early Holocene was very open due to a high incidence of natural fires. This open landscape was not very stable and high concentration of iron and aluminium (the concentration of Ca, Mg and Mn is also slightly higher) probably indicates catchment erosion.

In the early Holocene (*ca.* 10 000–8900 cal. BP, 8000–6900 cal. BC) broad-leaved taxa (mainly lime and oak) gradually replaced pine-birch-spruce woodland. Spread of lime-dominated forest is dated to 9000–7000 cal. BP (7000–5000 cal. BC). It seems that beech and fir were never important taxa in the Norička graba region. Due to very low pollen concentration (and therefore low pollen sums and low resolution) in the section of the core between 8000 cal. BP (6000 cal. BC) and 1300 AD

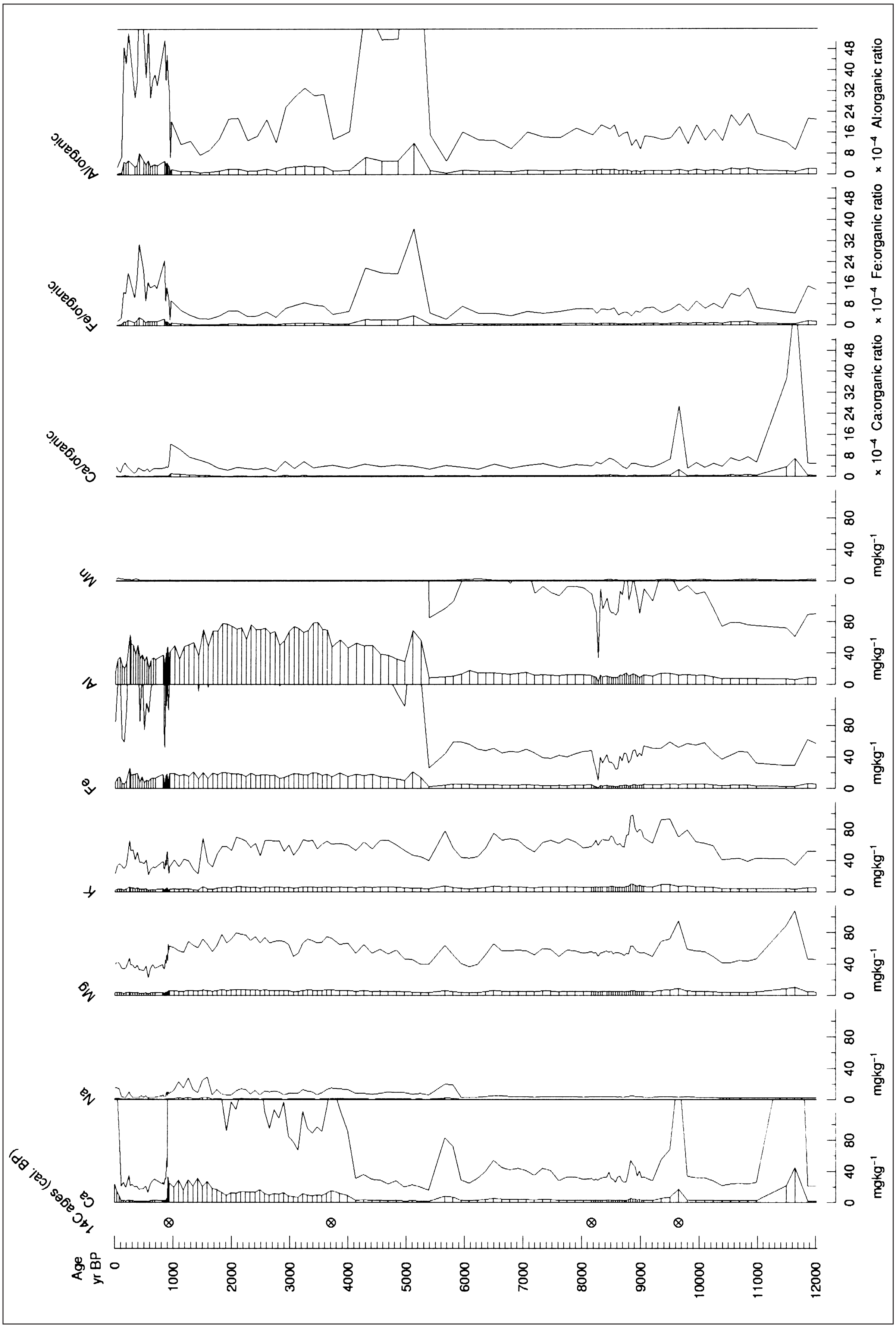


Fig. 26. Mlaka. Geochemistry (selected elements).

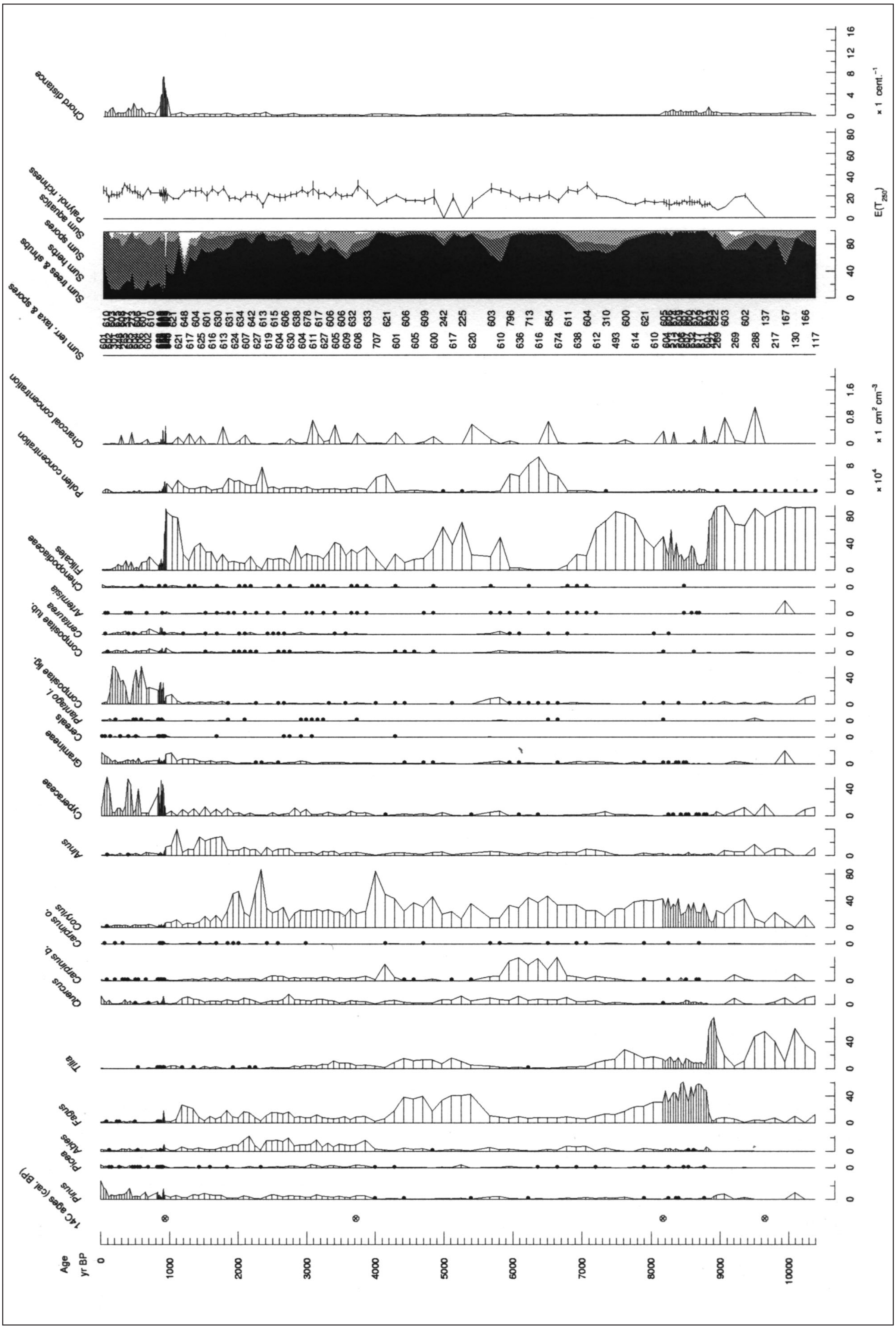


Fig. 27. Mlaka. Percentage pollen diagram (selected taxa).

it is difficult to estimate when the present-day landscape appeared. The lime decline (*ca.* 7000 cal. BP, 5000 cal. BC), the appearance of cereal type pollen grains and soil erosion that followed at 6000 cal. BP (4000 cal. BC) indicate human activity. Herb pollen curves however suggest that the present-day landscape might not form before 1400 AD, when soil erosion occurred again.

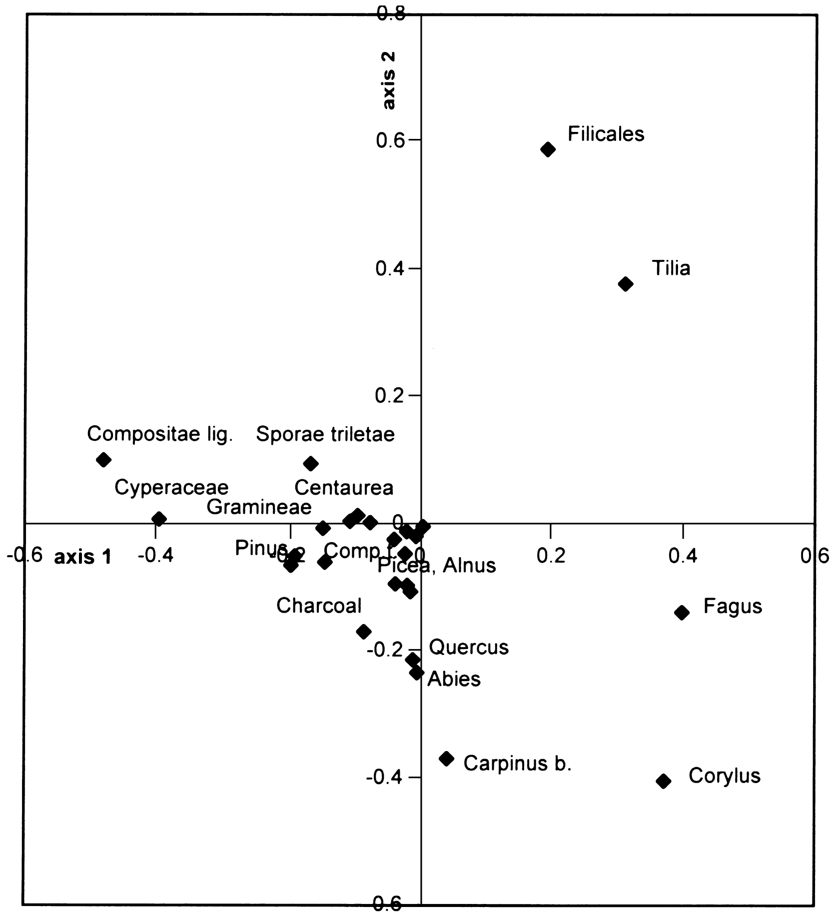


Fig. 28. Mlaka. PCA. Taxa scores.

THE NEOLITHIC TRANSITION TO FARMING

Archaeological research suggests that major changes in the Neolithic settlement pattern, economy and material culture in the south-eastern Europe occurred at 6500 cal. BC. Changes included the construction of more permanent settlements, pottery production and domestication of plants and animals (*Hodder 1990; Whittle 1996; Sherratt 1997a; Zvelebil 1998; Bailey 2000*). Some of these changes reached the central and western Europe only after 5500 cal. BC (*Whittle 1996*). Slovenia is situated between south-eastern and central Europe. Studies of Slovenian Neolitic pottery style have suggested contacts with two major farming Neolithic cultural complexes: Impresso-Cardium/Danilo/Hvar culture in the Mediterranean and Starčevo-Körös-Criş/Vinča/LBK in the Balkans and central Europe (*Korošec 1960a; 1960b; Bregant 1974; Batović 1973; Budja 1983; Tomaž 1999 and references therein*). The oldest stratigraphically excavated and radiocarbon dated Neolithic levels in Slovenia are dated in the middle Neolithic (Moverna vas: 4904–4874 cal. BC, *Budja 1993*). No reliably dated early Neolithic sites have been discovered and the nature of the Neolithic transition to farming is not very well known. This section aims to ask what did the Slovenian landscape look like in this transitional period, what was the human impact on the environment and what might be the reasons for the transition to farming?

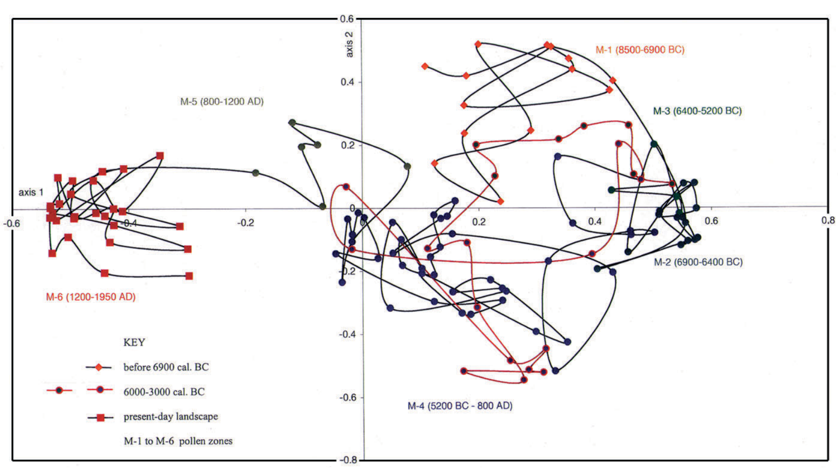


Fig. 29. Mlaka. PCA. Sample scores.

The Late Quaternary vegetation development in Slovenia was very dynamic. In the Late Glacial the landscape was covered by predominantly pine-birch woodland. At the beginning of the Holocene lime, oak, elm and hazel replaced pine and birch. At 6900 cal. BC – several centuries before presumable transition to farming –

a major change of vegetation occurred throughout Slovenia. Shade-tolerant trees (such as beech and fir) started to dominate. Distinctive phytogeographic regions appeared: beech-fir forest spread in the Dinaric region, the main tree taxon in the Predinaric region became beech, whereas predominantly lime forest became established in the Subpannonian and Submediterranean regions. The reasons for this simultaneous change of vegetation were presumably climatic, an increase of precipitation.

The results from this study suggest that in Slovenia Mesolithic and Neolithic landscapes were different. During the Mesolithic the dominant vegetation in all study regions was open woodland of lime, oak and hazel. A sudden change of forest composition occurred with the spread of shade-tolerant trees at 6900 cal. BC and several regional 'Neolithic landscapes' formed.

These results open several questions and at the present state of research only some of them can be addressed. The first question is what were the consequences of this vegetation change for the hunter-gatherer subsistence? Did the change of vegetation trigger a change in the fauna composition? Did supposed change in fauna (loss of grazers?), associated with the forest change prompt the transition to farming? How did hunter-gatherers adapt to a change in the variety of plant food available? Did the 'last' hunter-gatherers and 'first' farmers fight against thicker forest by cutting trees and burning forest? And, finally, did they change their settlement pattern after 6900 cal. BC?

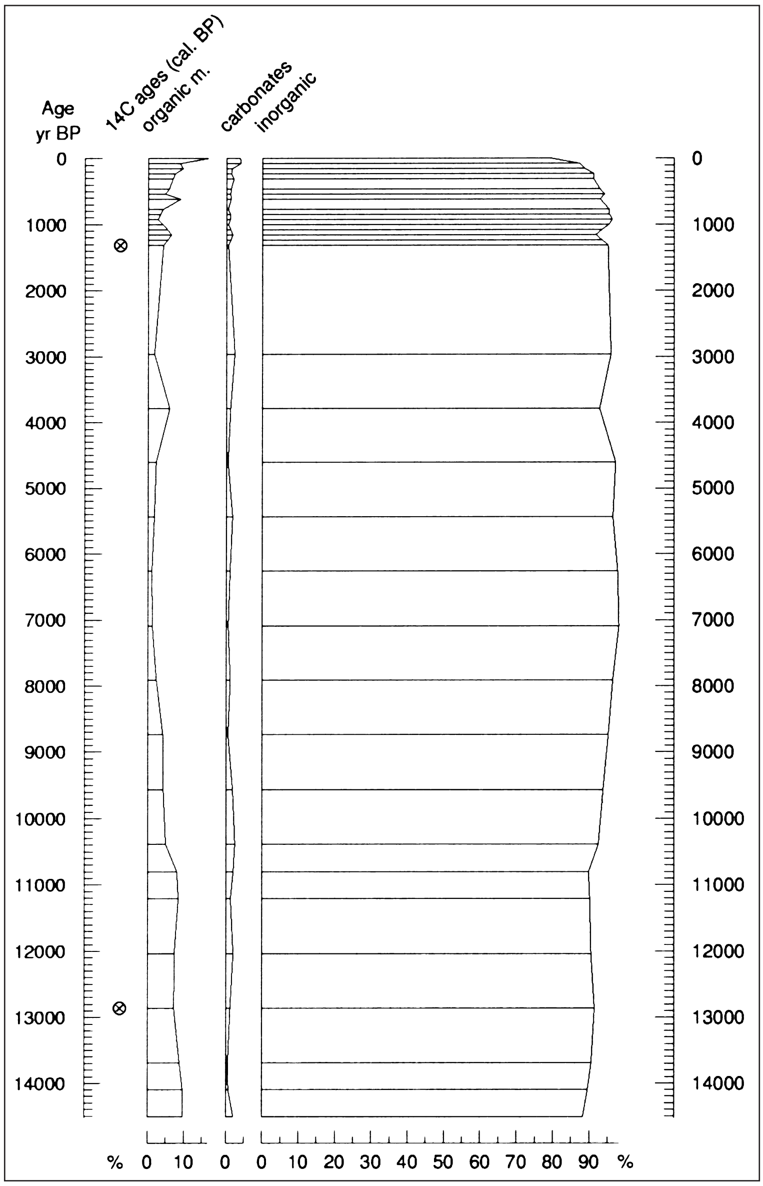


***Fig. 30. Noričk**a graba. Loss-on-ignition.*

The results from this study, combined with the archaeological research, can be used to address the last two questions. High resolution pollen analysis at Mlaka site suggests that small-scale openings of the beech canopy occurred after 6900 cal. BC. Some of these canopy gaps coincide with the charcoal peaks. It is possible that these subtle fluctuations of the forest composition were caused by a small-scale forest burning of the local Mesolithic populations. Admittedly, fire regimes can be climatically driven and since charcoal analysis cannot be used to distinguish whether individual fire events were natural or anthropogenic, the possibility that the Mesolithic populations were using fire to manipulate the environment cannot either be confirmed or ruled out. Never the less, the Mlaka area has a good prospect to study Mesolithic settlement pattern and the transition to farming. In the Prapoče area, where the Mesolithic settlement pattern has been studied in detail, radiocarbon dates from six cave sites range from 9500 to 7000 cal. BP (*Miracle & Fornbaher 2000*). In the levels dated after 7000 cal. BC archaeological finds are scarce. This suggests that after 7000 cal. BC the archaeological settlement pattern changed and caves were not visited very frequently any more.

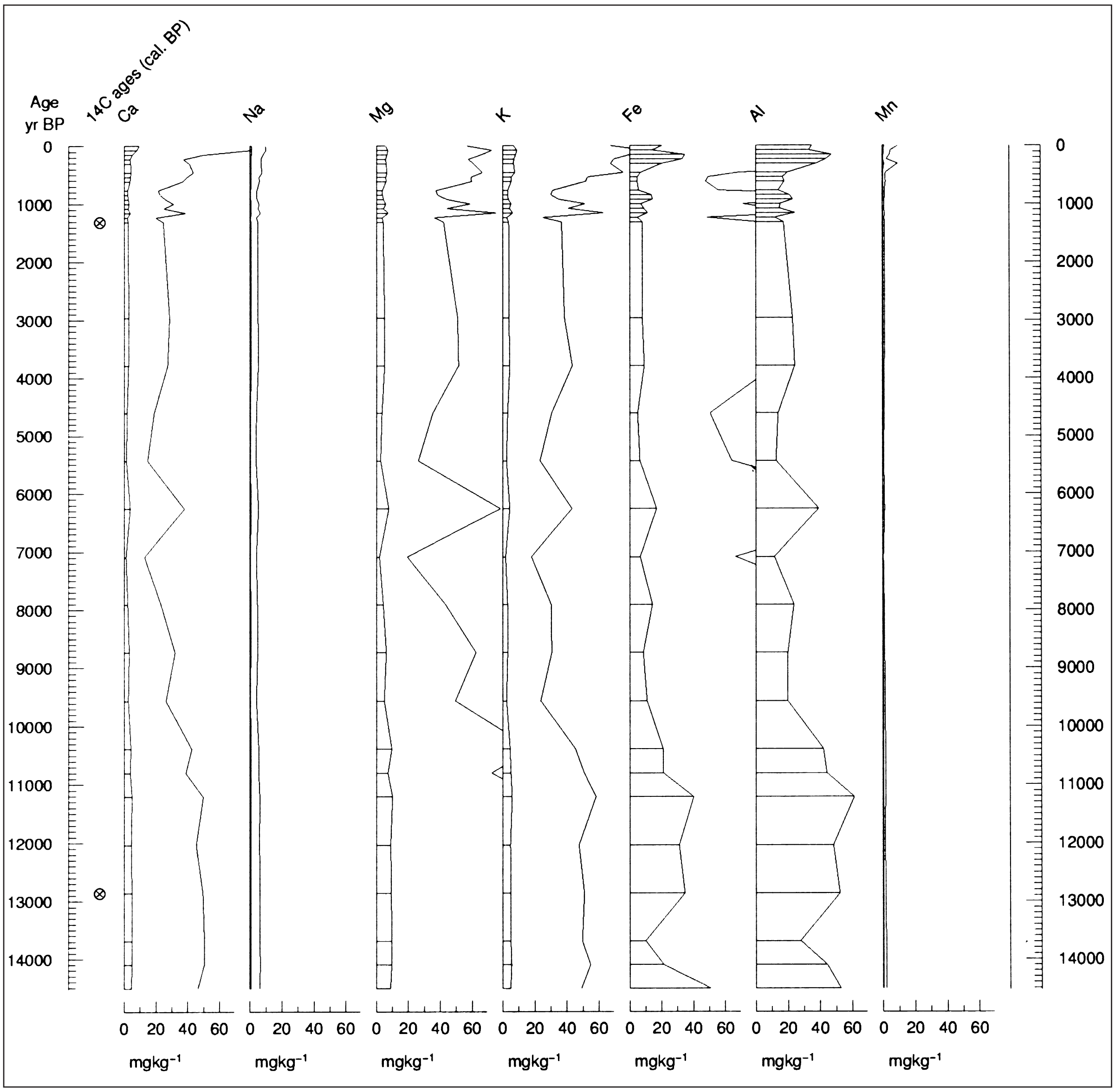


Fig. 31. Noriĉka graba. Geochemistry (selected elements).

These two examples suggest that the Mesolithic people might be involved in small-scale forest clearance and/or burning and that in some regions a change in vegetation composition at *ca.* 6900 cal. BC was possibly followed by a change in the archaeological settlement pattern.

Previous research suggested that no major (landscape scale) forest clearance occurred at the transition to farming in the south-eastern Europe (*Willis & Bennett 1994; Gardner 1999a; 1999b*). The results of this study are in agreement with previous research – in Slovenia there seems to be no signs of significant pressure on the environment connected with major population movement and the introduction of agricultural economy. In that sense, there seems that no time-transgressive spread of agriculture to Slovenia took place. Major forest clearance at all four study sites occurred only at the formation of the present-day landscape which ranged in date from 1000 cal. BC to 1400 AD. Although no major Neolithic forest clearance was carried out on the regional level, pollen record indicates that small-scale forest clearance, burning and coppicing can be detected with high resolution pollen analysis of small sites.

The forested Neolithic landscape was never the less, very dynamic and varied in time and space. The results of principal components analysis (PCA, Figs. 17, 24, 29 and 34) indicate that three distinctive phases of vegetation development, early Holocene (8000–6900 cal. BC), middle Holocene (after 6900 cal. BC) and the formation of the present-day land-

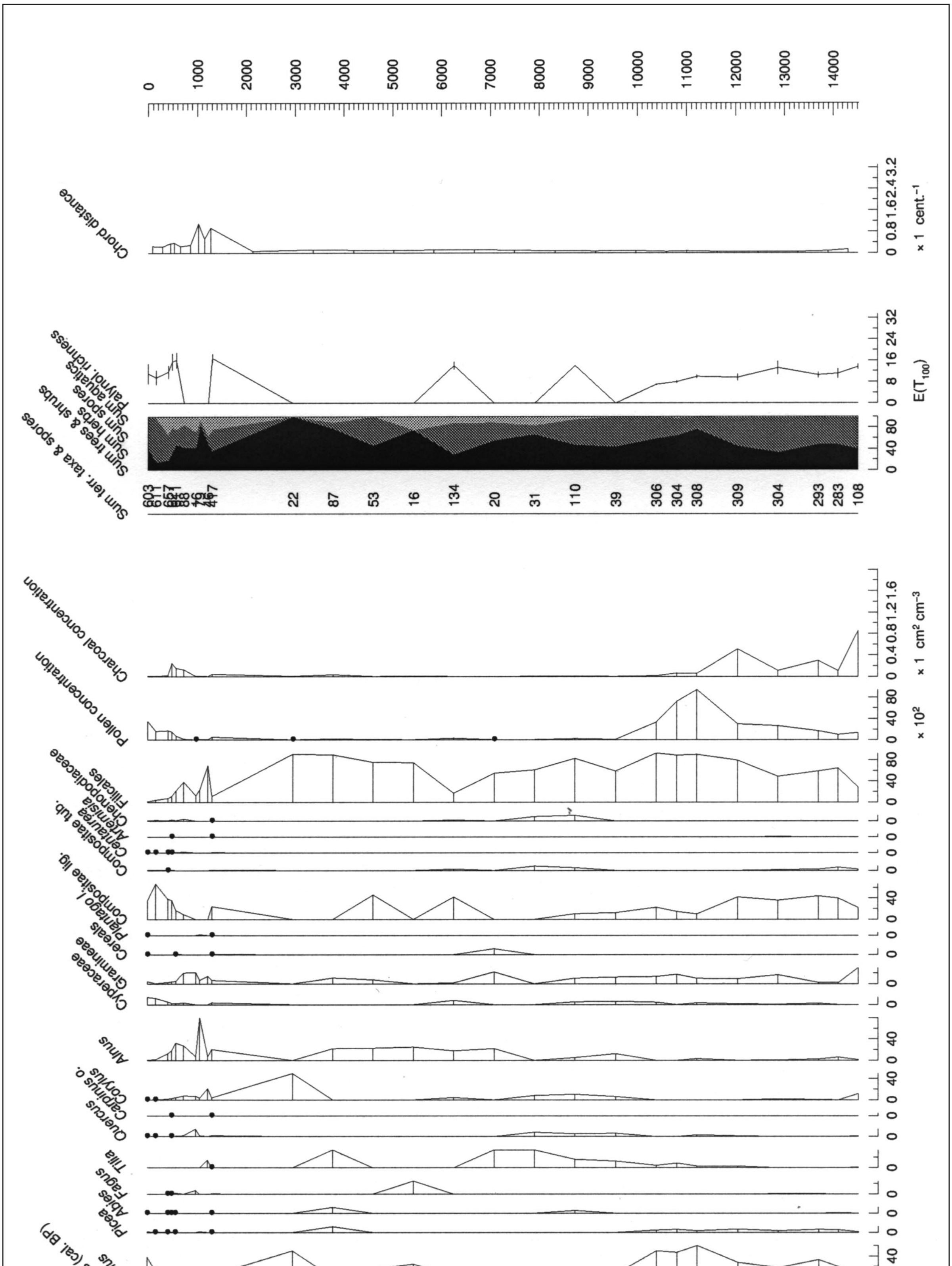


Fig. 32. Noričk a graba. Parcentage pollen diagram (selected taxa).

scape can be distinguished on each study site. Both, early and middle Holocene vegetation were very specific and have no present-day analogues. In particular, no analogues for the Neolithic vegetation exist today. Although the vegetation composition in the middle Holocene occasionally 'swung' towards the present state, the formation of the present-day landscape was a sudden event. It was an irreversible change and once human pressure passed the threshold, the modern landscape formed. PCA of the pollen data (Fig. 29) also shows that between 6000 and 3000 cal. BC the vegetation of Mlaka site, for example, changed from beech forest to open landscape (similar to early Holocene woodland), hornbeam forest, very open landscape again (similar to landscape at *ca.* 500 AD) and back to the beech forest. The main direction of vegetation change at Gorenje jezero (Fig. 24) between 6000 and 3000 cal. BC was from predominantly alder forest to fir-beech forest and more open landscape. The results of PCA (Figs. 17, 24, 29 and 34) also show that the landscape was most dynamic between 6000 cal. BC and the formation of the present-day landscape.

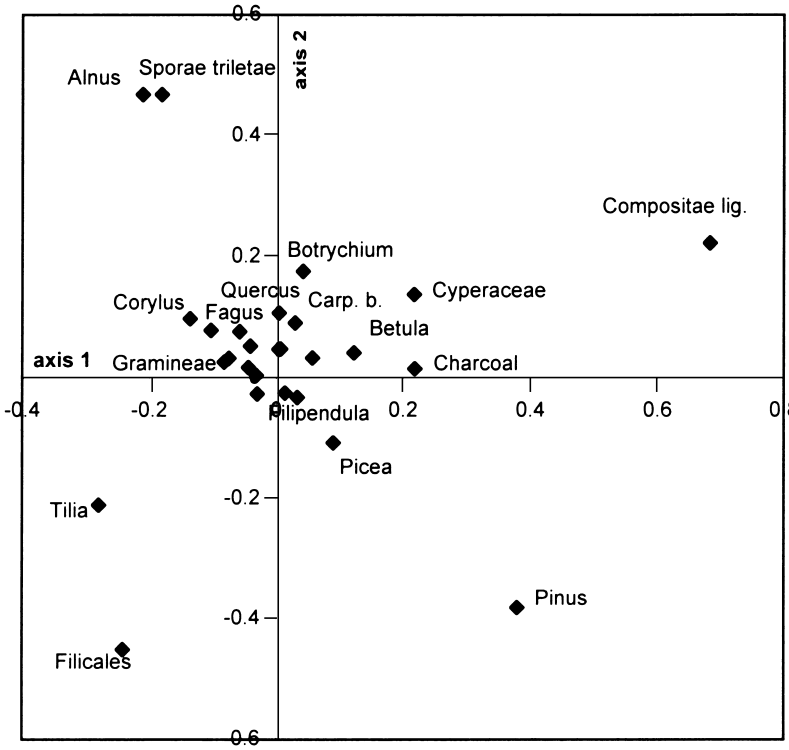


Fig. 33. Noričkagraba. PCA. Taxa scores.

This landscape dynamics possibly reflects human activity. The small-scale forest clearance, burning and coppicing probably created a mosaic landscape, composed of patches with different vegetation. Biodiversity of this environment was high and increased with human impact (*Birks 1990; Birks et al. 1990*). An increase of palynological richness detected on all pollen diagrams can probably be connected with the Neolithic transition to farming. Palynological richness at four study sites shows some similar general trends. It increases by *ca.* 5000 cal. BC and then it stays constant (Gorenje jezero, Fig. 22) or slightly increases (Mlaka, Fig. 27). At Prapoče the palynological richness is highest after 1300 cal. BC (especially at 300–1 cal. BC), in the period when charcoal record suggests burning of the landscape. This is in accordance with ecological studies suggesting that fire disturbance increases biodiversity (*Whelan 1995*). Palynological richness decreases with or after the formation of the present-day landscape (Prapoče after ca. 1 cal. BC, Gorenje jezero after 300 AD, Norička graba at 1400 AD), probably because the human impact was very intensive and habitat diversity declined.

CONCLUSIONS

The results from this study indicate that the impact of the first farmers on the Slovenian landscape (small-scale forest clearance, burning and coppicing) can be detected by high resolution pollen analysis of small palaeoecological sites. Human activity in the Neolithic probably

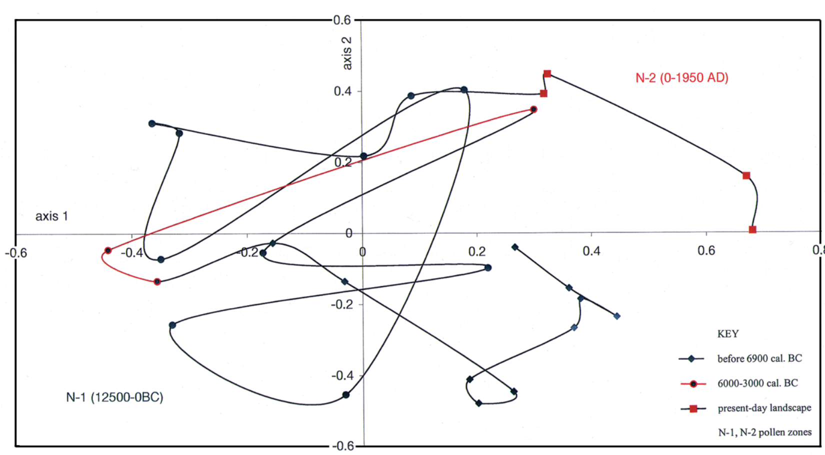


Fig. 34. Norička graba. PCA. Sample scores.

led to the formation of mosaic landscape. The present-day Slovenian landscape however formed only several millennia after the transition to farming.

The archaeological implications from this research are that in several study regions hitherto undiscovered archaeological sites are probably located in the vicinity of the coring locations (*e.g.* Eneolithic/ Bronze Age site at Prapoče and Neolithic sites at Gorenje jezero and Mlaka). The forest clearance at Mlaka site at *ca.* 6000 cal. BC pre-dates the earliest Neolithic site in the area (Moverna vas) for *ca.* 1000 years and suggests that it is possible that hunter-gatherers and early farmers lived in Bela krajina, but their sites have not been discovered yet. Further archaeological and palaeoecological research at Mlaka and in other parts of Bela krajina will help us to better understand the process of transition to farming.

ACKNOWLEDGEMENTS

First of all, I would like to thank Kathy Willis for her supervision, constant support and guidance throughout this research project. I am extremely grateful for her constructive criticism and the endless energy, which she has invested into this thesis.
I would also like to express my deepest gratitude to Mihael Budja, who enabled this research project. I would like to thank him for his constant support, guidance and numerous discussions over the years.
I must also thank Keith Bennett for his help and support. He promptly replied to all my ignorant queries concerning "Psimpoll" and numerical methods. I am grateful to Andrew Sherratt who read individual chapters in a draft form and drew my attention to several articles. I am also obliged to Preston Miracle who helped at fieldwork and with the information about Prapoče study area. I am grateful to Tone Wraber, Nataša Vidic and Lindsey Gillson, who read individual chapters in a draft form.
Alva Hobom, Jill Dye and Julie Temple-Smith helped me to learn laboratory techniques. I am obliged to Adam Gardner for the help with geochemistry, computing and English language.
I would also like to thank Ivan Turk, Janez Dirjec, Alma Bavdek, Phil Mason, Mihael Budja, Will Fletcher and Preston Miracle for the permission to cite their unpublished data.
Geochemical analysis was performed using the ICP AES facilities at Geology Department, Royal Holloway (University of London). I would like to express my deep gratitude to Nikki Paige, Sarah James and Nick Walsh, who helped me with the measurements.
This research was funded by Slovenian Ministry for Science and Technology, Dulverton Trust, scholarship from ORS award scheme, St. Hugh's College (Oxford) and Selwyn College (Cambridge).
The funding for the costs of radiocarbon dates was provided by K. J. Willis (Oxford University), M. Budja (University of Ljubljana), Dulverton Trust and Marjorie Clerk Scholarship (St. Hugh's College, Oxford).
The fieldwork was funded by Worts Travelling Fund, Selwyn College Cott Fund, Soulby Fund Grant, Geokal d.o.o. and P. T. Miracle (Cambridge University). It could not have been carried out without invaluable help of Kathy Willis (Oxford University), Keith Bennett (Uppsala University), Alva Hobom (Cambridge University), Tomo Andrič (Horjul), Dražen Brajković (INA – Industrija nafte d.d. Zagreb), Preston Miracle (Cambridge University), Mlinarič family (Janžev vrh), Grbec and Kalanj (Geokal d.o.o.) families (Maribor), Metod Končan (Horjul), Danilo from Brezovica and friendly people from Veliki Nerajac. For assistance in searching for suitable coring locations I would like to thank Vera Vardjan (Veliki Nerajac), Phil Mason (Zavod za varstvo naravne in kulturne dediščine Novo mesto), Mihael Budja (University of Ljubljana), Preston Miracle (Cambridge University), Andrej Mihevc (Inštitut za raziskovanje krasa, ZRC SAZU), Milan Lovenjak (University of Ljubljana), Irena Šavel (Pokrajinski muzej Murska Sobota).
I would also like to thank to "Institute for protection of natural and cultural heritage Novo mesto" and "Institute for protection of natural and cultural heritage Maribor" for the permission to core the locations Mlaka and Ribniško jezero.
For a generous contribution towards the costs of presenting this work at several conferences I would like to thank to School of Geography and the Environment (Oxford University), St. Hugh's College (Oxford), Quaternary Research Association, Cambridge Philosophical Society and Committee for Graduate Studies (Oxford University).
Last, but not least, I would like to thank many people working at School of Geography and the Environment (Oxford University), Department of Plant Sciences (Cambridge University), Godwin Lab (Cambridge University), Department of Archaeology (University of Ljubljana) and Institute of Archaeology (Ljubljana), as well as all friendly librarians and documentalists in Ljubljana, Cambridge and Oxford.
I am obliged to my family for their continuous support and to Lindsey, who had to bear with me during the last few months of thesis writing.

REFERENCES

ALLEY R. B., MEESE D. A., SHUMAN C. A., GOW A. J., TAYLOR K. C., GROOTES P. M., WHITE J. W. C., RAM M., WADDINGTON E. D., MAYEWSKI P. A. and ZIELINSKI G. A. 1993. Abrupt Increase in Greenland Snow Accumulation at the End of the Younger Dryas Event. *Nature 362: 527–529*.

AMMERMAN A. J. & CAVALLI-SFORZA L. L. 1971. Measuring the Rate of Spread of Early Farming in Europe. *Man 6: 674–688*.

1984. *The Neolithic Transition and the Genetics of Populations in Europe*. Princeton: Princeton University Press.

ARHEOLOŠKA NAJDIŠČA SLOVENIJE 1975. Ljubljana: SAZU, Inštitut za arheologijo.

BAILEY D. W. 2000. *Balkan Prehistory (Exclusion, Incorporation and Identity)*. London: Routledge.

BARKER G. 1985. *Prehistoric Farming in Europe*. Cambridge: Cambridge University Press.

BAR-YOSEF O. & BELFER-COHEN A. 1989. The Origins of Sedentism and Farming Communities in the Levant. *Journal of World Prehistory 3(4): 447–498*.

BATOVIĆ Š. 1973. Odnos Jadranskog primorja prema području jugoistočnih Alpa u neolitu i eneolitu. *Arheološki vestnik 24: 62–127*.

1979. Jadranska zona. *Praistorija Jugoslavenskih zemalja II*. Sarajevo: Akademija nauka i umetnosti Bosne i Hercegovine. Centar za balkanološka ispitivanja.

BEHRE K.-E. 1981. The Interpretation of Anthropogenic Indicators in Pollen Diagrams. *Pollen et spores 23: 225–245*.

1988. The Role of Man in European Vegetation History. In B. Huntley and T. Webb III. (eds.), *Vegetation History: 633–672*.

BENGTSSON L. & ENELL M. 1986. Chemical Analysis. In B. E. Berglund (ed.), *Handbook of Holocene Palaeoecology and Palaeohydrology: 423–451*.

BENNETT K. D. 1994. Confidence Intervals for Age Estimates and Deposition Times in Late-Quaternary Sediment Sequences. *The Holocene 4(4): 337–348*.

1998. Documentation for PSIMPOLL 3.00 and PSCOMB 1.03: C Programs for Plotting Pollen Diagrams and Analysing Pollen Data. Cambridge. http://www.kv.geo.uu.se/software.html

BENNETT K. D. & WILLIS K. J. in press. Pollen. In J. P. Smol, H. J. B. Birks & W. M. Last (eds.), *Tracking Environmental Changes in Lake Sediments: Biological Techniques and Indicators*.

BERGLUND B. E. & RALSKA-JASIEWICZOWA M. 1986. Pollen Analysis and Pollen Diagrams. In B. E. Berglund (ed.), *Handbook of Holocene Palaeoecology and Palaeohydrology: 455–484*.

BERNOT F. 1984. Opis klimatskih razmer občin Trebnje, Novo mesto, Metlika in Črnomelj. In D. Plut and M. Ravbar (eds.), *Dolenjska in Bela krajina (Prispevki za 13. zborovanje slovenskih geografov v Dolenjskih Toplicah od 12.–14. oktobra 1984): 89–98*.

BINFORD L. R. 1968. Post-Pleistocene Adaptations. In L. R. Binford and S. R. Binford (eds.), *New Perspectives in Archaeology: 313–341*.

BIRKS H. J. B. 1990. Introduction. In H. H. Birks, H. J. B. Birks, P. E. Kaland and D. Moe (eds.), *The Cultural Landscape – Past, Present and Future: 179–187*.

BIRKS H. J. B. & GORDON A. D. 1985. *Numerical Methods in Quaternary Pollen Analysis*. London: Academic Press.

BIRKS H. J. B., LINE J. M. and PERSSON T. 1990. Quantitative Estimation of Human Impact on Cultural Landscape Development. In H. H. Birks, H. J. B. Birks, P. E. Kaland and D. Moe. (eds.), *The Cultural Landscape – Past, Present and Future: 229–240*.

BÖKÖNYI S. 1974. *History of Domestic Mammals in Central and Eastern Europe*. Budapest: Akadémiai Kiadó.

1989. Animal Husbandry of the Körös-Starčevo Complex: Its Origin and Development. In S. Bökönyi (ed.), *Neolithic of Southeastern Europe and its Near Eastern Connections: 13–16*.

BOSCHIN F. & RIEDL A. 2000. The Late Mesolithic and Neolithic Fauna of the Edera Cave (Aurisina, Trieste Karst): a Preliminary Report. *Società per la preistoria e protostoria della regione Friuli-Venezia Giulia 8: 73–90*.

BREGANT T. 1974. Elementi jadransko mediteranske kulturne skuipine v alpskem faciesu lengyelske kulture. *Situla 14/15: 35–44*.

BUDJA M. 1983. Tri desetletja razvoja teorij o poznem neolitu in eneolitu severozahodne Jugoslavije. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 11: 73–82*.

1989. Arheološki zapisi na površju, palimpsesti preteklih stanj. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 17: 83–102*.

1992. Pečatniki v slovenskih neolitskih kontekstih. (Lehmstempel in dem slowenischen neolitischen Siedlungskontexten). *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 20: 95–109*.

1992 (1995). Neolithic and Eneolithic Settlement Patterns in the Bela krajina Region of Slovenia. Mem. *Museo civ. St. Nat. Verona. Sez. Scienze Uomo 4: 119–127*.

1993. Neolitizacija Evrope. Slovenska perspektiva. (The Neolithisation of Europe. Slovenian aspect). *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 21: 163–193*.

1995. Spreminjanje naravne in kulturne krajine v neolitiku in eneolitiku na Ljubljanskem barju I (Landscape Changes in the Neolithic and Eneolithic in Slovenia. Case Study: Ljubljansko barje I). *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 22: 163–181*.

1996a. Neolitizacija na področju Caput Adriae: med Herodotom in Cavalli-Sforzo. (Neolithisation in the Caput Adriae region: between Herodotus and Cavalli-Sforza.) *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 23: 61–76*.

1996b. Neolitizacija Evrope. Slovenska perspektiva. Prispevek k diskusiji. (The Neolithisation of Europe. Slovenian Aspect. Contribution to the Discussion.) *Arheološki vestnik 47: 323–329*.

1999. The Transition to Farming in Mediterranean Europe – an Indigenous Response. In M. Budja (ed.), *Documenta Praehistorica 26: 119–141*.

CHAPMAN J. & MÜLLER J. 1990. Early Farmers in the Mediterranean Basin: The Dalmatian evidence. *Antiquity 64: 127–134*.

CHILDE V. G. 1936. *Man Makes Himself*. London: Watts.

CLARK R. L. 1982. Point Count Estimation of Charcoal in Pollen Preparations and Thin Sections of Sediments. *Pollen et spores 24: 523–532*.

COHEN N. M. 1977. *The Food Crisis in Prehistory*. New Haven: Yale University Press.

COLE G. A. 1979. *Textbook of Limnology*. St. Louis: The C. V. Mosby Company.

COHMAP Members. 1988. Climatic Changes of the Last 18 000 Years: Observations and Model Stimulations. *Science 241: 1043–1052*.

CULIBERG M., HORVAT M. and ŠERCELJ A. 1992. Karpološke in antrakotomske analize rastlinskih ostankov iz neolitske jamske nekropole Ajdovska jama. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 20: 111–126*.

CULIBERG M. & ŠERCELJ A. 1991. Razlike v rezultatih raziskav makroskopskih rastlinskih ostankov s kolišč na Ljubljanskem barju in pelodnih analiz – dokaz človekovega vpliva na gozd. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 19: 249–256*.

DENNELL R. 1983. *European Economic Prehistory (A New Approach)*. London: Academic Press.

DOLUKHANOV P. M. 1979. *Ecology and Economy in Neolithic Eastern Europe*. London: General Duckworth & Co. Ltd.

DROLE F. 1995. Rakov škocjan. *Varstvo spomenikov 35: 140*.

DULAR J. 1985. *Arheološka topografija Slovenije. Topografsko področje XI (Bela krajina)*. Ljubljana: SAZU.

ELLENBERG H. 1988. *Vegetation Ecology of Central Europe (4th Edition)*. Cambridge University Press.

ENGSTROM D. R. & WRIGHT Jr. H. E. 1984. Chemical Stratigraphy of Lake Sediments as a Record of Environmental Change. In E. Y. Haworth and J. W. G. Lund (eds.), *Lake Sediments and Environmental History: 11–67*.

FULLER J. D., FOSTER R., MCLACHLAN J. S. and DRAKE N. 1998. Impact of Human Activity on Regional Forest Composition and Dynamics in Central New England. *Ecosystems 1: 76–95*.

GARDNER A. 1997. Biotic Response to Early Holocene Human Activity: Results from Palaeoenvironmental Analyses of Sediments from Podpeško jezero. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 24: 63–77*.

1999a. *The Impact of Neolithic Agriculture on the Environments of South-East Europe*. DPhil Thesis. University of Cambridge

1999b. The Ecology of the Neolithic Environmental Impacts – Re-evaluation of Existing Theory Using Case Studies from Hungary & Slovenia. In M. Budja (ed.), *Documenta Praehistorica 26: 163–183*.

GARRARD A., COLLEDGE S. and MARTIN L. 1996. The Emergence of Crop Cultivation and Carpine Herding in the "Marginal Zone" of the Southern Levant. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 204–226*.

GRIMM E. C. 1987. CONISS: a FORTRAN 77 Program for Stratigraphically Constrained Cluster Analysis by the Methods of Incremental Sum of Squares. *Computers & Geoscience 13: 13–35*.

GUŠTIN M. 1973. Kronologija notranjske skupine. *Arheološki vestnik 24: 461–506*.

HAAS J. N., RICHOZ I., TINNER W. and WICK L. 1998. Synchronous Holocene Climatic Oscillations Recorded on the Swiss Plateau and at Timberline in the Alps. *The Holocene 8(3): 301–309*.

HALSTEAD P. 1996. The Development of Agriculture and Pastoralism in Greece: When, How, Who and What? In D. R. Harris. (ed), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 296–309*.

HARRIS D. R. 1996. The Origins and Spread of Agriculture and Pastoralism in Eurasia: an Overview. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 552–573*.

HILLMAN G. 1996. Late Pleistocene Changes in Wild Plant Foods Available to Hunter-Gatherers of the Northern Fertile Crescent: Possible Preludes to Cereal Cultivation. In D. R. Harris (ed), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 159–203*.

HILLMAN G., HEDGES R., MOORE A., COLLEDGE S. and PETTIT P. 2001. New Evidence of Lateglacial Cereal Cultivation at Abu Hureyra on the Euphrates. *The Holocene 11(4): 383–393*.

HODDER I. 1990. *The Domestication of Europe*. Oxford: Blackwell.

HOLE F. 1996. The Context of Caprine Domestication in the Zagros Region. In D. R. Harris (ed), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 263–281*.

ILJANIĆ L. 1981. Florističke značajke Istre. In *Prirodna podloga Istre: 158–167*.

JACOBSON G. L. & BRADSHAW R. H. W. 1981. The Selection of Sites for Palaeovegetational Studies. *Quaternary Research 16: 80–96*.

KOROŠEC J. 1960a. Neolit na Krasu in v Slovenskem primorju. *Zgodovinski časopis 14: 5–34*.

1960b. Drulovka. *Zbornik FF III/4. Ljubljana.*

KRANJC A. 1985. Cerkniško jezero in njegove poplave (The Lake of Cerknica and its Floods). *Geografski zbornik 25: 71–123*.

KUNAVER P. 1961. *Cerkniško jezero*. Ljubljana: Mladinska knjiga.

KUTZBACH J., GALLIMORE R., HARRISON S., BEHLING P., SELIN R., LAARIF F. 1998. Climate and Biome Simulations for the past 21 000 Years. *Quaternary Science Reviews 17: 473–506*.

KYPARISSI-APOSTOLIKA N. 2000. The Mesolithic/Neolithic Transition in Greece as Evidenced by the Data at Theopetra Cave in Thessaly. In M. Budja (ed.), *Documenta praehistorica 27: 133–140*.

LEBEN F. 1967. Stratigrafija in časovna uvrstitev jamskih najdb na Tržaškem krasu. *Arheološki vestnik 18: 43–109*.

1973. Opredelitev neolitske in eneolitske keramike iz jamskih najdišč jugovzhodnega alpskega prostora. *Arheološki vestnik 24: 145–160*.

LEGGE T. 1996. The Beginning of Carpine Domestication in Southern Asia. In D. R. Harris (ed.), *The Origins and Spread of Agriculture and Pastoralism in Eurasia: 263–281*.

MACKERETH F. J. H. 1966. *Some Chemical Observations on Post-Glacial Lake Sediments*. Philosophical Transactions of the Royal Society of London, Series B 250.

MAKJANIĆ B. & VOLARIĆ B. 1981. Kratki pregled klime Istre. In *Prirodna podloga Istre: 91–102*.

MARINČEK L. 1987. *Bukovi gozdovi na Slovenskem*. Ljubljana: Delavska enotnost.

MARINČEK L. and ZUPANČIČ M. 1984. Carpinetum subpannonicum ass. nova. *Razprave 4. Razreda SAZU 25(3): 135–159*.

MARTINČIČ A., WRABER T., JOGAN N., RAVNIK V., PODOBNIK A., TURK B. and VREŠ B. 1999. *Mala flora Slovenije (Ključ za določanje praprotnic in semenk)*. Ljubljana: Tehniška založba Slovenije.

MASON P. 1995. Neolitska in eneolitska naselja v Beli krajini: naselje v Gradcu in izraba prostora v času od 5. do 3. tisočletja BC. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 25: 183–199*.

MEESE D. A., GOW A. J., GROOTES P., MAYEWSKI P. A., RAM M., STUVIER M., TAYLOR K. C., WADDINGTON E. D. and ZIELINSKI G. A. 1994. The Accumulation Record from the GISP2 core as an Indicator of Climate Change throughout the Holocene. *Science 266: 1680–1682*.

MILISAUSKAS S. & KRUK J. 1989. Neolithic Economy in Central Europe. *Journal of World Prehistory 3(4): 403–446*.

MIRACLE P. 1997. Early Holocene Foragers in the Karst of Northern Istria. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 24: 43–61*.

MIRACLE P. & FORENBAHER S. 2000. Pupićina Cave Project: Brief Summary of the 1998 Season. *Histria Archaeologica 29 (1998): 27–48*.

MOORE P. D., WEBB J. A. and COLLINSON M. E. 1991. *Pollen Analysis (Second Edition)*. Oxford: Blackwell Science.

MÜLLER J. 1991. Die ostadriatische Impresso-kultur, Zeitliche Gliederung und kulturelle Einbindung. *Germania 69/2: 311–358*.

ODGAARD B. V. & RASMUSSEN P. 2000. Origin and Temporal Development of Macro-scale Vegetation Patterns in the Cultural Landscape of Denmark. *Journal of Ecology 88: 733–748*.

OGRIN D. 1996. Podnebni tipi v Sloveniji. *Geografski vestnik 68: 39–56*.

PESSINA A. & ROTTOLI M. 1996. New Evidence on the Earliest Farming Cultures in Northern Italy: Archaeological and Palaeobotanical Data. (Novi dokazi o prvih kmetovalskih kulturah v Severni Italiji: arheološki in paleobotanični podatki.) *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 23: 77–103*.

PLENIČAR M. 1953. Prispevek h geologiji Cerkniškega polja. *Geologija 1: 111–119*.

PLUT D. 1985. Pokrajinske (prirodoslovno-geografske) poteze Bele krajine. In J. Dular *Arheološka topografija Slovenije. Topografsko področje XI. Bela krajina: 13–15*.

PUNT W., CLARKE G. C. S., BLACKMORE S. and HOEN P. P. (eds.) 1976–1995. *The Northwest European Pollen Flora. I–VII.* Amsterdam: Elsevier Scientific Publishing Company.

RACKHAM O. 1980. *Ancient Woodland (Its History, Vegetation and Uses in England).* London: Edward Arnold.

REILLE M. 1992. *Pollen et Spores d'Europe et d'Afrique du Nord.* Marseille: Laboratoire de botanique historique et palynologie URA CNRS.

1995. *Pollen et Spores d'Europe et d'Afrique du Nord (Supplement).* Marseille: Laboratoire de botanique historique et palynologie URA CNRS.

ROGLIČ J. 1981. Geografski aspekt na tribut o podlogu Istre. In *Prirodna podloga Istre: 29–34*.

ROTTOLI M. 1999. I resti vegetali di Sammardenchia-Cûeis (Udine), insediamento del neolitico antico. In

A. Ferrari, A. Pessina (eds.), *Sammardenchia-Cûeis (Contributi per la conoscenza di una communità del primo neolitico): 307–326*.

RÖSCH M. 2000. Long-Term Human Impact as Registered in an Upland Pollen Profile from the Southern Black Forest, South-Western Germany. *Vegetation History and Archaeobotany 9: 205–218*.

RUNNELS C. & VAN ANDEL T. 1988. Trade and the Origins of Agriculture in the Eastern Mediterranean. *Journal of Mediterranean Archaeology 1: 83–109*.

SCHEIN T. 1993. Poročilo arheološke skupine. Ekološko-raziskovalni tabor "Cerkniško jezero 93".

SHERRATT A. G. 1997a. *Economy and Society in Prehistoric Europe*. Edinburgh University Press.

1997b. Climatic Cycles and Behavioural Revolutions: the Emergence of Modern Humans and the Beginning of Farming. *Antiquity 71: 271–287*.

SPITZER G. 1974. Ein Hallstattzeitlicher tumulus von Dragatuš. *Arheološki vestnik 24: 780–830*.

STOCKMARR J. 1971. Tablets with Spores used in Absolute Pollen Analysis. *Pollen et spores 13: 615–621*.

STUVIER M. & REIMER P. J. 1986. A Computer Program for Radiocarbon Age Calibration. *Radiocarbon 28: 1022–1030*.

1993. Extended ^{14}C Data Base and Revised CALIB 3.0 ^{14}C Age Calibration Program. *Radiocarbon 35(1): 215–230*.

STUVIER M., REIMER P. J., BARD E., BECK J. W., BURR G. S., HUGHEN K. A., KROMER B., MCCORMAC F. G., v. d. PLICHT J. and SPURK M. 1998. INTCAL98 Radiocarbon Age Calibration 24,000 – 0 cal BP. *Radiocarbon 40: 1041–1083*.

ŠERCELJ A. 1974. Paleovegetacijske raziskave sedimentov Cerkniškega jezera (Palaeovegetational Investigation of the Sediments of Cerkniško jezero (Lake of Cerknica)). *Acta Carsologica (Krasoslovni zbornik) VI/16:233–240*.

1975. Analize makroskopskih in mikroskopskih rastlinskih ostankov iz kolišča ob Maharskem prekopu, izkopavanja leta 1973 in 1974. *Poročilo o raziskovanju neolita in eneolita v Sloveniji 4: 115–122*.

1981–82. Pomen botaničnih raziskav na koliščih Ljubljanskega barja. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 9–10*.

1974. Paleovegetacijske raziskave sedimentov Cerkniškega jezera (Palaeovegetational Investigations of the Sediments of Cerkniško jezero (Lake of Cerknica)). *Acta Carsologica (Krasoslovni zbornik) VI/16: 233–240*.

1988. Palynological Evidence of Human Impact on the Forests in Slovenia. In F. Salbitano (ed.), *Human Influence on Forest Ecosystems Development in Europe: 49–57*.

1996. *Začetki in razvoj gozdov v Sloveniji. The Origins and Development of Forests in Slovenia.* Dela SAZU IV/35. Ljubljana: SAZU.

ŠERCELJ A. & CULIBERG M. 1980. Paleobotanične raziskave kolišča na Partih (Izkopavanja 1978). *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 8: 83–88*.

1984. Rastlinski ostanki iz Ajdovske jame pri Nemški vasi. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 12: 33–37*.

TINNER W., HUBSCHMID P., WEHRLI M., AMMANN B. and CONDERA M. 1999. Long-Term Forest Fire Ecology and Dynamics in Southern Switzerland. *Journal of Ecology 87: 273–289*.

TINNER W., CONDERA M., GOBET E., HUBESCHMID P., WEHRLI M. and AMMANN B. 2000. A Palaeoecological Attempt to Classify Fire Sensitivity of Trees in the Southern Alps. *The Holocene 10(5): 565–574*.

TOMAŽ A. 1999. *Časovna in prostorska strukturiranost neolitskega lončarstve: Bela krajina, Ljubljansko barje, Dinarski Kras. Magistrsko delo*. Univerza v Ljubljani. Unpublished MA thesis.

TROELS-SMITH J. 1955. Karakterising af løse jordater. (Characterisation of unconsolidated sediments). *Geological Survey of Denmark IV. series 3/10: 1–73*.

TUTIN T. G., HEYWORD V. H., BURGES N. A., MOORE D. M., VALENTINE D. H., WALTERS S. M. and WEBB D. A. (eds.) 1964–1980. *Flora Europaea* (5 volumes). Cambridge: Cambridge University Press.

URLEB M. 1968. Križna gora in okolica v antiki. *Arheološki vestnik 19: 473–484*.

VAN ANDEL T. H. & RUNNELS C. N. 1995. The Earliest Farmers in Europe. *Antiquity 69: 481–500.*

WHELAN R. J. 1995. *The Ecology of Fire*. Cambridge: Cambridge University Press.

WHITTLE A. 1996. *Europe in the Neolithic (The Creation of New Worlds)*. Cambridge: Cambridge University Press.

WILLIAMS M., DUNKERLY D., DECKKER P. D. E., KERSHAW P. and CHAPELL J. (eds.) 1998. *Quaternary Environments. 2nd edition*. London: Arnold.

WILLIS K. J. 1995. The Pollen-Sedimentological Evidence for the Beginning of Agriculture in Southeastern Europe and Anatolia. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 22: 9–24.*

WILLIS K. J. & BENNETT K. D. 1994. The Neolithic Transition – Fact or Fiction? Palaeoecological Evidence from the Balkans. *The Holocene 4(3): 326–330.*

WILLIS K. J., SÜMEGI P., BRAUN M., BENNET K. D., TOTH A. 1998. Prehistoric Land Degradation in Hungary: Who, How and Why? *Antiquity 72: 101–113.*

WRABER M. 1951. Gozdna vegetacijska slika in gozdnogojitveni problemi Prekmurja. *Geografski vestnik 23: 1–47.*

1960. Fitosociološka razčlenitev gozdne vegetacije v Sloveniji. *Ad annum Horti botanici Labacensis solemnem: 49–96.*

1961. Gozdna vegetacija Slovenskih goric. *Biološki vestnik 9: 55–57.*

1969. Pflanzengeographische Stellung und Gliederung Sloweniens. *Vegetatio 17: 167–199.*

1969a. Die Bodensauern Rotföhrenwälder des Slowenischen Pannonischen Randgebietes. *Acta Botanica Croatica 28: 401–409.*

WRIGHT H. E. 1967. A Square-Rod Piston Sampler for Lake Sediments. *Journal of Sedimentary Petrology 37: 975–976.*

1993. Environmental Determinism in Near Eastern Prehistory. *Current Anthropology 34 (4): 458–469.*

ZILHÃO J. 1993. The Spread of Agro-Pastoral Economies across Mediterranean Europe: A View from the Far West. *Journal of Mediterranean Archaeology 6/1: 5–63.*

ZOHARY D. & HOPF M. 1993. *Domestication of Plants in the Old World (Second Edition)*. Oxford: Oxford University Press.

ZUPANČIČ M. 1969. Vegetacijska podoba okolice Cerkniškega jezera. *3. mednarodni mladinski raziskovalni tabor Cerknica: 93–101.*

ZUPANČIČ M. & WRABER T. 1989. *Fitogeografija*. Enciklopedija Slovenije 3: 118-119. Ljubljana: Mladinska knjiga.

ZVELEBIL M. & ZVELEBIL K. V. 1988. Agricultural Transition and Indo-European Dispersals. *Antiquity 62: 574–583.*

ZVELEBIL M. 1998. Agricultural Frontiers, Neolithic Origins and the Transition to Farming in the Baltic Basin. In M. Zvelebil, R. Dennell, L. Domanska (eds.), *Harvesting the Sea, Farming the Forest: 9–27.*

1 List of archaeological sites that lie ca. 15 km around all coring locations is based on information derived from the database of Research centre of Slovenian Academy of Science and Technology, Institut of Archaeology in Ljubljana and the database of Dr. P. Miracle, Department of Archaeology, University of Cambridge. For the literature published before 1975 see "Arheološka najdišča Slovenije. Ljubljana. 1975": 1.Prapoče, prehistoric hillfort (Marchesetti 1903.109; Calafati 1903); 2. Nilinum (Gradina di Lanischie), prehistoric hillfort (Benussi 1927–28.267); 3. Orljak iznad Lanišča, prehistoric and Roman hillfort (Marchesetti 1903.96; De Franceschi 1964); 3. Rašpor, prehistoric hillfort (Marchesetti 1903.109; Calafati 1903; Benussi 1927–28); 4. Trstenik, site of unknown age (Benussi 1927–28.269); 5. S. Martin kod Vodica, site of unknown age (Marchesetti 1903.109; Calafati 1903); Benussi, B. 1927–28. Dalle annotazioni di Alberte Puschi per la carta archeologica dell'Istria. Arch. Triest. Ser. III, 14, 267; Calafati, A. 1903. Il Tourista 1–4. Trst; De Franceschi, C. 1964. Storia documentata della Dantea di Pisino, AMSI. 10–12; Marchesetti, C. 1903. Castellieri della Venezia, Biulia. Trieste.

2 List of archaeological sites: 1. Farovka, Mesolithic, Neolithic and Eneolithic (?) open air settlement (Drole 1995, 140); 2. Srednje njive, prehistoric pottery and stone tools found, (Schein 1993, 45); 3. Gorica, prehistoric (?) pottery and stone tools found, (topographic notes of J. and B. Dirjec); 4. Sv. Kancijan, prehistoric fortified settlement (Bronze Age, Roman and Medieval finds) (Schein 1993.41–45); 5. Turščeva skedenica,

cave, Early Bronze Age site; 6. Žerunček (Žerovinšček), prehistoric hillfort (Schein 1988, Teržan 1995.127); 7. Peskovec, Tičnica, prehistoric fortified settlement (Schein 1988); 8. Kamna gorica, Iron Age settlement (Schein 1988); 9. Gradišče and Casermanov laz, Iron Age settlement and cemetery (Schein 1985.212; Slabe 1981.224; Guštin 1978.Tab. 36; Schein 1988); 10. Velika Slivnica, prehistoric settlement (Schein 1988, Slabe 1983.278; Guštin 1979.Tab. 3); 11. Lijevka (Tomšičeva jama, jama nad Grahovim), Iron Age site (Leben 1978.14); 12. Šteberk, prehistoric fortified settlement; 13. Stražišče (Gorenje jezero), fortified prehistoric settlement (Schein 1988); 14. Markovski grič, prehistoric settlement; 15. Gradec, Dane, prehistoric fortified settlement (Schein 1988); 16. Dane, Iron Age site (Kim 1978.10, 33); 17. Šmaraški vrh, Ušenična, Iron Age settlement, prehistoric and Roman graves (Schein 1988); 18. Cvinger, Iron Age and Roman settlement (Urleb 1981.179–194); 19. Tržišče, Iron Age and Roman settlement, Iron Age cemetery (Guštin 1978; Schein 1988); 20. Križna gora, prehistoric, Roman and Medieval settlement, late Bronze Age, Iron Age and Medieval cemetery (Guštin 1978; Urleb 1977; Ciglenečki 1987); 21. Janeževa hiša, Lož, Iron Age and Roman site; 22. Ulaka, Stari trg pri Ložu, Prehistoric and Roman settlement (Slabe 1983.215–216; Urleb 1977; Guštin 1978; Schein 1988.VS 25, 215); 23. Svinja gorica, Roman cemetery (Urleb 1981; Rešena...1980; Urleb 1983; Urleb 1979; Urleb 1981a); 24. Dane, pod češnjo, Roman grave (Slabe 1974.417–423; Slabe 1974a.195); 25. Nadleški grič, Roman site; 26. Gradišče, Stari trg pri Ložu, Roman villa; 27. Sv. Pavel, medieval cemetery (VS 1979; Arheološki... 1977); 28. Sv. Jurij, medieval cemetery (Urleb 1977); 29. Špiček, fortified settlement of unknown age; 30. Zajčji grič, fortified settlement of unknown age; 31. Križna jama, prehistoric cave site (Schein 1988); 32. Mali vrhek, Iron Age and Roman settlement (?), (Urleb 1977); 33. Podcerkev, cemetery of unknown age.

REFERENCES

CIGLENEČKI S. 1987. Dela SAZU 31. Ljubljana. 875; DROLE F. 1995. Rakov škocjan. Varstvo spomenikov 35. 140, št. 244; GUŠTIN M. 1978. Notranjska. Katalogi in monografije 17. Ljubljana; LEBEN F. 1978. Arheološki vestnik 29. 14; REŠENA ARHEOLOŠKA DEDIŠČINA SLOVENIJE 1945–1980 (Katalog razstave). 1980. Ljubljana; SCHEIN T. 1985. Gradišče na Slivnici. Varstvo spomenikov 27; SCHEIN T. 1988. Arheološka topografija gradišč v Cerkniški občini. Diplomska naloga; SCHEIN T. 1993. Poročilo arheološke skupine. Ekološko-raziskovalni tabor "Cerkniško jezero 93". Ljubljana. 45; SLABE M. 1981. Cerknica. Varstvo spomenikov 23: 224; SLABE M. 1983. Varstvo spomenikov 25: 278; TERŽAN B. (ed.) 1995. Depojske in posamezne kovinske najdbe bakrene in bronaste dobe na Slovenskem I (Hoards and Individual Metal Finds from the Eneolithic and Bronze Ages in Slovenia). Katalogi in monografije 29. Ljubljana: Narodni muzej Ljubljana; URLEB M. 1977. Loška dolina in okolica v davnini. Notranjski listi I: 16–30 Stari trg pri Ložu; URLEB M. 1977a. Stari trg pri Ložu. Varstvo spomenikov 21: 320–321; URLEB M. 1979. Cerknica – rimsko grobišče. Arheološki pregled 20: 90. Beograd; URLEB M. 1981. Cerknica in okolica v davnini. Notranjski listi II: 179–194. Cerknica. 192–194; URLEB M. 1981a. Cerknica. Varstvo spomenikov 23: 234; URLEB M. 1984. Antično grobišče v Cerknici. Arheološki vestnik 34 (1983): 298–346.

3 List of archaeological sites: 1. Pusti gradac, Neolithic/Eneolithic, Bronze Age and Roman settlement, Medieval castle (Teržan 1995.86; Dular 1985.67–68); 2. Šipek, Roman cemetery (Dular 1985.68–69); 3. Veliki Nerajac – Brezjece, Iron Age cemetery (Dular 1985.69–70); 4. Belčji vrh – Pečni vrh, settlement and cemetery of unknown age (Dular 1985.66); 5. Dragovanja vas, Eneolithic (?) site (Dular 1985.66–67); 6. Doblička gora, Eneolthic (?) site (Dular 1985.58–59); 7. Dobliče – Vrti, Prehistoric (?) site (Dular 1985.58); 8. Zorenci, Neolithic, Eneolithic and Bronze Age site (Dular 1985.65); 9. Breznik, site of unknown age (Dular 1985.66); 10. Golek, Medieval settlement (Dular 1985.67; Ciglenečki 1978); 11. Veliki Koležaj, late Roman settlement (Dular 1985, 70–71); 12. Tribuče, Roman cemetery (Dular 1985, 64–65); 13. Butoraj, Bronze Age and Roman cemetery (Dular 1985, 56); 14. Dolenjci, Eneolthic (?) site (Dular 1985, 55); 15. Črnomelj, Sadež, Bronze Age, Iron Age, Roman and Medieval cemetery (Dular 1985, 57; Mason 1998); 16. Črnomelj – župna cerkev, Bronze Age and Iron Age settlement, Medieval cemetery (Dular 1985, 58); 17. Črnomelj – Sv. Duh, late Roman settlement and cemetery; 18. Loka pri Črnomlju – Grajska cesta, Iron Age cemetery (Dular 1985, 59–60); 19. Loka pri Črnomlju – Okljuk, Roman settlement and cemetery (Dular 1985, 60); 20. Loka pri Črnomlju – Rdeči hrib, Eneolthic (?) site (Dular 1985, 61); 21. Daljne njive, cemetery of unknown age (Dular 1985, 105); 22. Drenovec, Iron Age site (Dular 1985, 105–106); 23. Golek pri Vinici, Iron Age settlement, Iron Age and Latene cemetery (Dular 1985, 106); 24. Gorica, Iron Age settlement (Dular 1985, 108); 25. Hrast pri Vinici, site of unknown age (Dular 1985, 108–109); 26. Ogulin, Roman site (Dular 1985, 109); 27. Perudina, Roman (?) site (Dular 1985, 109–110); 28. Podklanec, Roman cemetery (Dular 1985, 110); 29. Sečje selo – Učakovske stene, site of unknown age (Dular 1985, 111); 30. Sečje selo – Veliki zjot, Eneolithic and Bronze Age site (Dular 1985, 111; Leben 1991); 31. Zilje, Roman grave (Dular 1985, 112–113); 32. Gradinje, Eneolithic settlement and Roman cemetery (Phil Mason, pers. comm. 2000).

REFERENCES

CIGLENEČKI S. 1978. K problemu kulturne in časovne opredelitve nekaterih utrjenih prostorov v Sloveniji. Arheološki vestnik 29: 582–494; DULAR J. 1985. Arheološka topografija Slovenije. Topografsko področje XI (Bela krajina). Ljubljana; LEBEN F. 1991. Veliki zjot, bakreno- in bronastodobno jamsko bivališče v Beli krajini. Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 19: 169–189. Ljubljana; MASON P. 1998. Late Roman Črnomelj and Bela krajina. Arheološki vestnik 49: 285–313. Ljubljana; TERŽAN B. (ed.) 1995. Depojske in posamezne kovinske najdbe bakrene in bronaste dobe na Slovenskem I (Hoards and Individual Metal Finds from the Eneolithic and Bronze Ages in Slovenia). Katalogi in monografije 29. Ljubljana: Narodni muzej Ljubljana.

4 List of archaeological sites: 1. Plitvica, Roman cemetery; 2. Črešnjevci, cemetery of unknown age; 3. Gornja Radgona, presumably Neolithic settlement, Bronze Age, Iron Age and Latene settlement, Iron Age and Roman cemetery (Šavel 1980; Šavel 1987; Tušek 1989; Tušek 1990; Tušek 1995; Horvat-Šavel 1981; Teržan 1995, 52); 4. Hercegovščak, Bronze Age site and Roman cemetery; 5. Lastomerci, Roman cemetery; 6. Spodnja Ščavnica, cemetery of unknown age; 7. Boračeva, cemetery of unknown age; 8. Hrastje – Mota, cemetery of unknown age; 9. Kapelski vrh, Neolithic (?) site, Roman (?) site; 10. Murski vrh, Roman site; 11. Ptujska cesta, Roman (?) cemetery; 12. Radenci, Roman (?) cemetery, Neolithic (?) site;

13. Radenski vrh, Eneolithic (?) site; 14. Rihtarovci, Roman (?) cemetery; 15. Sp. Kocjan, Bronze Age, Roman and Medieval site; 16. Berkovci, site of unknown age; 17. Biserjane, Neolithic (?), Bronze and Iron Age site; 18. Blaguš, Roman (?) cemetery; 19. Dragotinci, Roman cemetery; 20. Galušak, Eneolithic (?) site; 21. Jamna, Roman settlement; 22. Okoslavci, Eneolithic (?) site; 23. Selišči, Eneolithic (?) site; 24. Slaptinci, Roman cemetery; 25. Stanetinci, Eneolithic (?) site; 26. Stara gora, Roman cemetery; 27. Terbegovci, Bronze Age (?) settlement; 28. Videm, Neolithic (?) settlement; 29. Ženik, Iron Age site; 30. Gornji Ivanjci, cemetery of unknown age; 31. Grabonoš, Roman cemetery; 32. Kunova, Eneolithic (?) site; 33. Negova, Eneolithic (?), Bronze Age and Roman site; 34. Očeslavci, Neolithic (?) site; 35. Spodnji Ivanjci, Roman cemetery; 36. Stavešinci, Roman cemetery; 37. Osek, Eneolithic site.

REFERENCES

HORVAT-ŠAVEL I. 1981. Rezultati sondiranj prazgodovinskega naselja v Gornji Radgoni. Arheološki vestnik 32: 291–310; PAHIČ S. 1967. Radenci pri Gornji Radgoni. Varstvo spomenikov 12 (1967):82. Ljubljana; ŠAVEL I. 1980. Gornja Radgona, Murska Sobota – prazgodovinska naselbina. Arheološki pregled 21: 57–58. Beograd; ŠAVEL I. 1987. Gornja Radgona. Varstvo spomenikov 29: 237–238. Ljubljana; TUŠEK I. 1989. Gornja Radgona. Varstvo spomenikov 31: 206–207. Ljubljana; TUŠEK I. 1990. Gornja Radgona. Varstvo spomenikov 32: 149–150. Ljubljana; TUŠEK I. 1995. Gornja Radgona. Varstvo spomenikov 35: 97. Ljubljana.

UDK 903'1(4-924.6)"632/633":56
Documenta Praehistorica XXVIII

Feast or famine? Epipalaeolithic subsistence in the northern Adriatic basin

Preston Miracle
Department of Archaeology, University of Cambridge, UK
ptm21@cam.ac.uk

ABSTRACT – *In this paper I use a late glacial-early postglacial archaeological case study from Istria, Croatia, to develop methods for inferring the social contexts of food consumption from animal remains. A number of lines of evidence are suggestive of an increase over time in the diversity and scale of food consumption at Pupićina Cave. At the scale of the region, these data are consistent with subsistence intensification in response to shortfalls in food resources. At the scale of the site, however, these data can be interpreted as remains from "celebratory" feasts. This paper addresses the gap between theory and method in the identification of prehistoric feasts.*

IZVLEČEK – *S pomočjo živalskih ostankov, najdenih na poznoglacialno-zgodnje postglacialnem najdišču v Istri na Hrvaškem, razvijemo metode za ugotavljanje družbenega konteksta uživanja hrane. Številni dokazi kažejo, da sta se v jami Pupićina sčasoma povečala tako raznolikost kot tudi obseg uživanja hrane. V regionalnem merilu se ti podatki časovno ujemajo z zaostrenimi pogoji preživljanja zaradi pomanjkanja virov hrane. V okviru najdišča lahko te podatke razložimo kot ostanke "prazničnih" pojedin. V članku usmerimo pozornost tudi na razkorak med teorijo in metodo pri identifikaciji prazgodovinskih pojedin.*

KEY WORDS – *Mesolithic; Upper Palaeolithic; zooarchaeology; feast; hunter-gatherer; Europe*

INTRODUCTION

There has been considerable interest in dietary changes across the Pleistocene-Holocene transition in the Old World, especially since Flannery's (*1969*) proposal of a "broad spectrum revolution" as a precursor to the emergence of agriculture. This dietary shift was generalised and popularised as "The Food Crisis in Prehistory" by Cohen (*1977*). Cohen, along with many other archaeologists in the 1970s and 1980s, followed Boserup's (*1965*) lead and focused on population pressure as the prime mover behind these dietary changes. In the last 15 years archaeologists have made great strides in understanding foragers' changing diets and subsistence strategies by using predictive models such as optimal foraging theory (*e.g. Bettinger 1991; Kelly 1995*). Archaeological applications have ranged from relatively coarse studies of taxonomic diversity (*e.g. Neely & Clark 1993; Miracle 1996*) to more complex models of prey choice (*Miracle 1995*) and sophisticated simulations of predator-prey interactions (*Belovsky 1988; Winterhalder et al. 1988; Stiner et al. 2000*). The common thread running through all of these studies is that people change their strategies in response to resource/population imbalances. In plain language, people take action when their plates are empty, whatever the cause may be.

Resource procurement, distribution, and consumption have certainly played a pivotal role in human evolution, and feeding strategies have been and are under strong selective pressure. There is much more, however, to the consumption of food than the simple conversion of ingested calories into energy for somatic maintenance, growth, and reproduction. Food plays an "active" role in the creation of sociocultural contexts and the negotiations of power enacted therein. Food cannot be understood divorced from the social and cultural contexts in which it is produced and consumed. It is as much material culture as are pots and projectile points.

Food and its consumption have often been studied anthropologically in terms of cuisine and feasts (*e.g. Appadurai 1981; Douglas 1972; 1984; Goody 1982; Lévi-Strauss 1969; 1978; Wiessner & Schiefenhövel 1996*). "Cuisine" commonly refers to food preparation, cooking, "recipes", food presentation, and the food itself. Feasts have been defined as "public ritual events ... [that] provide an arena for the highly condensed symbolic representation of social relations" (*Dietler 1996.89*). Archaeologists, particularly prehistorians, have been relatively uninterested in food, cuisine, and feasting until recently (*e.g. Dietler 1996; Gosden & Hather 1999; Gummerman 1997; Hayden 1996; Samuel 1996*). Food procurement and consumption are widely recognised as key elements of hominid adaptations and strategies during the Palaeolithic and Mesolithic periods. While there has been considerable theoretical work (*e.g. Hawkes 1992; 1993; Hill & Kaplan 1993; Wiessner 1996; Winterhalder 1986*) and a few archaeological studies of food sharing (*e.g. Enloe & David 1989*), scant consideration has been given to the social contexts and meanings associated with and created by food consumption (see discussion of Mesolithic cuisine in *Miracle 2001*). A significant exception is Brian Hayden, who has been arguing over the last decade for the importance of the social contexts of food consumption and feasting to two of the "big issues" in the human past, namely the development of food production (*Hayden 1990*) and emergence of social inequality (*Hayden 1995*). The goal of this paper is to explore methods for inferring contexts of consumption from food waste in prehistoric hunter-gatherer sites, particularly with reference to faunal assemblages from the Late Upper Palaeolithic and Mesolithic periods in Pupićina Cave, Istria, Croatia.

Ethnographic evidence of feasting among human foragers has been summarised and discussed by Hayden (*1996*), who proposed that there are three basic types of feast: celebratory, mutual aid, and commensal. The first two types of feast serve functions of social bonding and risk buffering, and are widely known among hunter-gatherers, whether "simple" (immediate-return) or "complex" (delayed-return). Celebratory and mutual-aid feasts are treated as by-products of seasonal aggregations of mobile and dispersed populations; the primary functions of these population aggregations are thought to be exchanges of people (marriages), items (raw materials and artefacts), and information (rituals, resource availability). Ethnographically and archaeologically, most interest has been in the associated exchanges rather than in the feasts themselves, even though the labour and food requirements associated with such feasts were often substantial. In this vein, Conkey (*1991*) suggests that aggregation sites would have been places of increased social activity and fluidity, with many social relationships in a state of flux and/or up for negotiation.

In contrast to celebratory and mutual-aid feasts, commensal feasts are characterised by diacritical display, control over labour, and economic gain. Food and the social contexts of its consumption are central to commensal feasts; ethnographic accounts of the "potlatch" of the Kwakiutl and other American Northwest Coast cultures (*e.g. Boas 1966; Codere 1950*) figure prominently in the definition of commensal feasts. The labour of kin and non-kin was mobilised and in all probability "exploited" to prepare a commensal feast. Among other things, there was a short-term accumulation of food and goods to be consumed, exchanged, given, and/or destroyed at the feast. These commensal feasts often, if not always, provided arenas for competition among so-called "Triple A" personalities (aggrandisers, accumulators, acquisators) who manipulated these "competitive feasts" for personal gain. Such competitive feasts thus helped create and maintain social inequalities, and much of the interest in competitive feasting has been in looking at it as a mechanism for the emergence of social inequality (*Arnold 1993; Hayden 1995*).

IDENTIFYING FEASTS AND FEASTING BEHAVIOUR IN THE ARCHAEOLOGICAL RECORD

Two major classes of data have been used to identify feasting from archaeological remains. The first is the artefacts used in food preparation, presentation, and consumption, along with the contexts of their production, use, and disposal (*e.g. Dietler 1996*). In pre-ceramic archaeological contexts, more generally those contexts that lack evidence of containers, evidence of food preparation and presentation is limited to site furniture (features) for storage and cooking. Even so, the identification of these practices from pits, postholes, and hearths/ovens is still quite problematic. As such, the artefacts and features used to manipulate food can rarely be used in studies of the Palaeolithic and Mesolithic, although they are an extremely valuable source of information for studying food from later periods. Other indirect evidence of celebratory and mutual-aid feast might come from "aggregation sites", identified from variables such as site size and location (*Butzer 1982*) and/or artefact diversity (*Conkey 1980; 1991*). The second major class of data is the food itself. I focus on these data in my analysis of feasting during the Mesolithic at Pupićina Cave.

The few studies to date of archaeological signatures of feasting among hunter-gatherers have focussed on competitive feasts at which people "fought with food". Hayden (*1996.137*) suggests that competitive feasts might be recognised archaeologically on the basis of the following 6 characteristics:

❶ abundant resource base capable of providing surpluses;
❷ special foods used for feasting;
❸ special vessels used for serving feast foods (could include carved wooden bowls and gourds);
❹ the use of prestige items into which feast foods could be converted;
❺ the occurrence of special grounds or structures at which feasting events could be held;
❻ the occurrence of Triple A individuals having more wealth and influence than others in the community.

While there has been some interest in identifying competitive feasts and understanding the commensal politics that accompanied them (*Dietler 1996*), almost no attention has been given to celebratory and mutual-aid feasts. The focus on competitive feasts is understandable since the scale and regularity of such practices should make them more prominent in the archaeological record than celebratory and mutual-aid feasts. Another reason for the growing interest in competitive feasts is that they play a key rôle in some models of the emergence of social inequality (*e.g. Hayden 1995*).

The scale at which different foods were procured and consumed at relatively short-term events (duration of days to weeks) is one important distinction between feasts and every-day food consumption. The amount and density of food waste and/or its state of preservation/fragmentation should relate to the organisation and scale of food preparation and consumption. Although food storage is not necessary for competitive feasts, as shown by the Calusa of Florida, storage aids the accumulation of a surplus needed to underwrite feasts of any kind (*Hayden 1996*). Soffer (*1989*) and Rowley-Conwy & Zvelebil (*1989*) have reviewed evidence of the storage in the European Upper Palaeolithic and Mesolithic. As discussed briefly above with respect to food preparation and presentation, evidence of underground and above ground storage from the Palaeolithic/Mesolithic is for the most part fragmentary. Nevertheless, dried meat may have buffered subsistence risk and provided for feasts in addition to constituting a major form of wealth, along with buckskin during the Upper Palaeolithic (*Hayden 1981*). The production of both dried storable meat and buckskin would have required much labour. Thus, evidence of a feast might come from "copius food leftovers and much greater wastage than usual ... for example animal bones often are not completely broken up for marrow, and may not even be completely disarticulated, ... [since] feasting refuse tends to occur in considerable quantities in single deposits" (*Hayden 1996. 138*). Other than Hayden's suggestions about the value of dried meat and the ways in which carcass disarticulation and bone breakage might indicate unusual food waste, there have been relatively few attempts to identify feasting from food remains, regardless of whether those feasts were competitive, celebratory, or for mutual aid. The case study that follows is used to develop techniques for the identification of feasting from food remains as well as to explore the visibility of non-competitive feasting among prehistoric hunter-gatherers.

In summary, common characteristics of a feast include the scale and context of consumption. With a feast one expects the participation of consumers beyond the usual (local?) social group, including a range of relatives, visitors, and the like. Feasts often include a larger consumptive group, and in particular the consumption of a large amount of food in a relatively short period of time. There should thus be a larger scale of consumption than during regular meals. With a larger scale of consumption, one might expect economies of scale in the processing of food (resulting from much food being processed and consumed at once) and evidence of the provisioning of food. There might also be greater waste – owing to limitations on the amount that people could eat. Also, there might be greater selectivity for particular food items. There might also be a greater representation of exotic items and unusual foods, both for diversity but more importantly to demonstrate the ability to mobilise resources from a wide range of areas, through trading links, or through the work effort of a large support group. Some of these practices use food to promote position and create prestige.

FEASTING AT PUPIĆINA CAVE

Pleistocene-Holocene Transition at Pupićina Cave

Our topic requires high-resolution contextual data on food remains. The Pupićina Cave Project has been producing results that meet these stringent criteria of resolution and context. The Pupićina Cave Project is investigating prehistoric food management and mobility strategies within their palaeoenvironmental contexts in the northern Adriatic Basin, with particular reference to the northeastern portion of the Istrian Peninsula[1]. The overall goals of the project have already been summarised in a number of other places (*Miracle 1997; 2001; Miracle et al. 2000; Miracle & Forenbaher 2000*), and the interested reader is referred to these publications for details of site location, size, excavation strategy, and other basic information.

The focus of the current study is on temporal changes in faunal assemblages excavated in 1995–1996 at Pupićina Cave. Pupićina is a large (25 m wide at the entrance and 30 m deep), south-east-facing cave located in a narrow, limestone canyon at an elevation of 220 metres above sea level. The detailed analyses presented below are based on 3.8 m^3 of sediment excavated over an area of 6.5 m^2 in 1995–96 (Fig. 1)[2].

The lowest levels (36, 36A–C, 37, 38) are massive, yellow-brown, silty-clays with very few clasts (Fig. 1). These levels were devoid of finds other than small, terrestrial gastropods. Radiocarbon dates from overlying levels confirm a late glacial age (Fig. 2). Relatively thin lenses (2–10 cm thick) of animal bones, lithic artefacts, and charcoal mark two "cultural" levels (35, 32), the latter of which is associated with a hearth (Level 33). The matrix is still a silty-clay. Between these lenses the silty-clays are virtually "clean" of clasts other than small land snails. The most reliable absolute date on the middle cultural layer is 10 150±60 bp (Beta–131626), an AMS ^{14}C date on pine charcoal from hearth Level 33 (Tab. 1, Fig. 2)[3]. This date suggests deposition of these silty-clays at the very end of the Younger Dryas, and takes precedence over the date of 10 610±200 bp (Z–2574) on combined charcoal from Levels 31–34. The date 10 020±180 bp (Z–2631) on combined

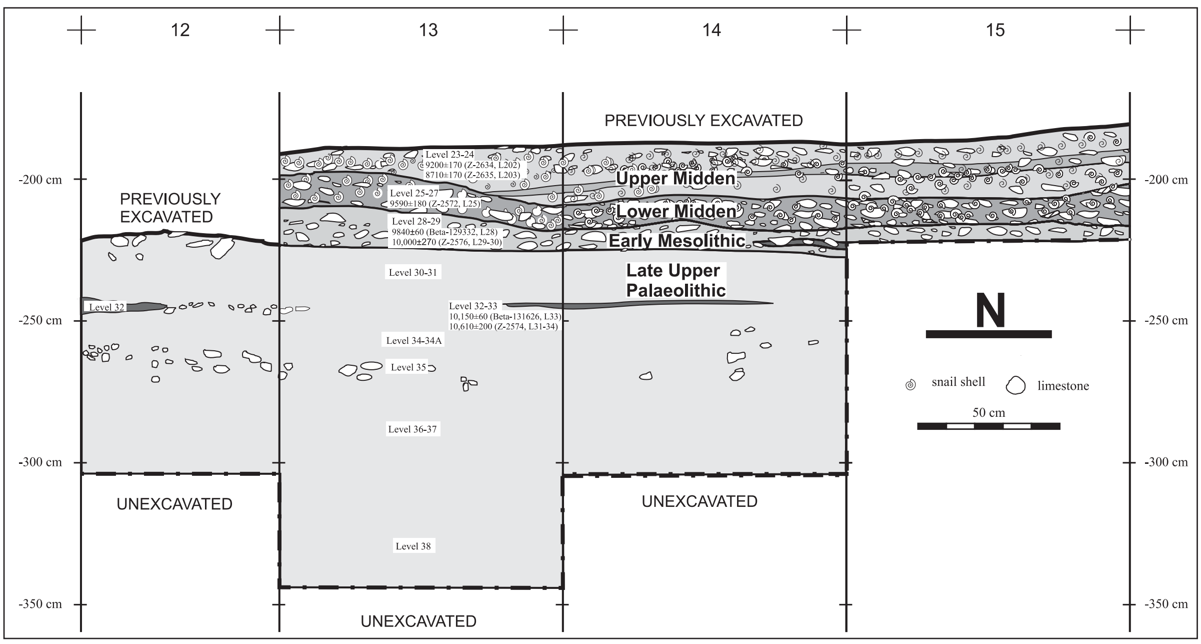


Fig. 1. Profile along N/O line in Pupićina Cave, showing Late Upper Palaeolithic and Mesolithic horizons, excavated levels, and ^{14}C dates.

1 The Pupićina Cave Project is a collaboration involving the following institutions: Cambridge University (Department of Archaeology), Zagreb University (Department of Archaeology), Archaeological Museum of Istria, and Croatian Academy of Sciences and Arts (Institute for Quaternary Geology and Palaeontology).

2 Excavation levels followed the natural stratigraphy, with units thicker than 10 cm subdivided using artificial spits. All sediments were dry-sieved using a 6-mm mesh in 1995 and a 3-mm mesh in 1996; a flotation sample (volume of 4 litres in 1995, 8 litres in 1996) was systematically taken from each square (1 m^2) excavated in a level.

3 All dates were calibrated using OxCal 3.3.0.2.

Phase	Excavation levels	¹⁴C Dates (lab, level)	Calendar Age BC (at 1 σ)	Excavated volume (m³)
Upper Midden (Mesolithic)	24, 202, 202+203, 203	9200±170 (Z–2634, L 202) 8710±170 (Z–2635, L 203)	8690–8240 8200–7550	0.764
Upper Silts (Mesolithic)	204, 205			0.175
Lower Midden (Mesolithic)	25, 26, 27, 203A, 206	9590±180 (Z–2572, L 25) 8770±310 (Z–2578, L 27)	9220–8740	0.553
Early Mesolithic	28, 29, 207, 208	**9840±60 (Beta–129332, L 28)** 10 000±270 (Z–2576, L 29–30) **11 160±270 (Z–2636, L 207)**	9310–9225 10 200–9200 11 500–10 950	0.387
Late Upper Palaeolithic	30, 30+31, 31, 32, 32+34, 33, 34, 34A, 35, 36, 36A, 36B, 36C, 37, 38	*10 150±60 (Beta–131626, L 33)* *10 610±200 (Z–2574, L 31–34)* 10 020±180 (Z–2631, L 35)	10 050–9450 11 000–10 200 10 150–9300	1.802

Tab. 1. Stratigraphic phases, absolute dates, and volume of sediment excavated at Pupićina Cave in 1995–96. Dates in bold are AMS determinations. Dates in italics are rejected (see text).

charcoal from Level 35 completely overlaps with the overlying date on Level 33 when both dates are calibrated. The similarity of these dates is probably owing to the effects of the radiocarbon plateau associated with the Younger Dryas as well as what appears to have been relatively rapid sedimentation at the site at this time. These three radiocarbon dates are consistent in dating what appear to have been very brief and ephemeral occupations at the site to the very end of the Pleistocene.

Above the "clean" silty-clays of Level 30, the frequency of limestone debris and organic material (wood charcoal and ash) in the silty-clay matrix increases dramatically; sediment colour also changes to grey-brown. The date of 10 000±270 bp (Z-2576) on Levels 29-30 suggests that this shift in depositional regime marks the Pleistocene-Holocene boundary at Pupićina (Tab. 1)[4]. An early Holocene date of deposition is confirmed by an AMS ^{14}C date of 9840±60 bp (Beta-129332) on pine charcoal. The date of 11 160±270 bp (Z-2636) on combined charcoal from Level 207 is rejected as too old. A small hearth (Level 208) was preserved in the surface of Level 207. The cave appears to have been occupied more frequently during the initial Holocene than during the late Pleistocene, although the intensity of occupation was not great enough to obliterate features like hearths.

Moving into the overlying levels, the sedimentary matrix becomes much ashier in the areas of the "midden". This "midden" was identified on the basis of the extremely high density of finds, especially animal bones and large land snail shells, as well as wood charcoal, frequent limestone clasts, and what appear to be fire-cracked rocks. Two major components of the midden were identified, a "lower midden" that covered the entire area and contained a relatively high density of animal bones, and an "upper midden" that contained a relatively high density of *Helix* snail shells. These broad horizons contained multiple, discrete episodes of ash dumping and hearth cleaning that have created a complex horizontal as well as vertical stratigraphy; it was impossible to identify most of these episodes in excavation and profile. While a series of radiocarbon dates firmly date this midden to between about

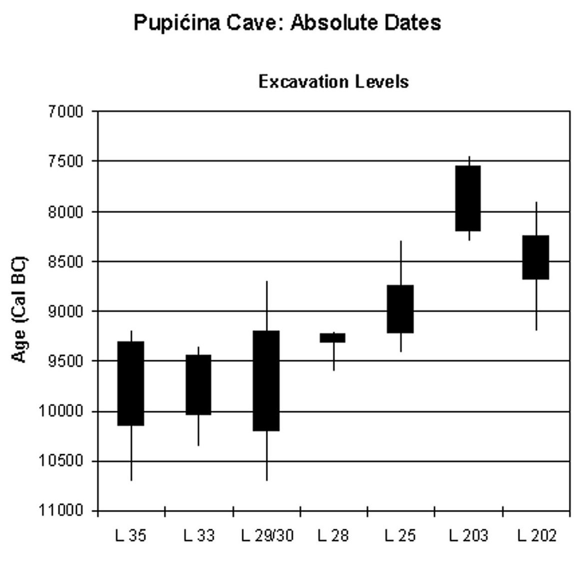


Fig. 2. Calibrated radiocarbon dates from late glacial and early postglacial excavation levels at Pupićina Cave.

4 Most of the wood charcoal from level 30 came from the uppermost part of the level, and is most likely associated with a hearth (feature 1) and overlying cultural layer (level 29).

8700–9600 bp (Fig. 2), several reversals indicate the complex and potentially mixed nature of these sediments. The "upper silts" contained a silty-clay matrix with some limestone clasts, yet little ash. They overlay the "lower midden". They appear to have been deposited at roughly the same time as the "upper midden". Although still undated, the "upper silts" are treated as temporally equivalent and spatially distinct to the ash lenses of the "upper midden". The uppermost Mesolithic level, which was capped by a hard-packed crust, was treated as a potentially disturbed level and excavated as an arbitrary ca. 5-cm spit. This uppermost "Mesolithic surface" appears to have been a trampled surface, but will not be discussed further.

The correspondence of different excavation levels to the phases described above is presented in Table 1. The archaeological record from Pupićina Cave will be analysed using these broad phases, in part owing to the small sample sizes of many of the excavated levels. Although this gives a somewhat homogenised view of practices at any point in time, these phases capture the general changes in depositional regimes over time as well as giving a hint of some of the spatial contrasts between the "upper midden" and "upper silts".

Mammal assemblage composition at Pupićina Cave

The main taxa throughout the Late Upper Palaeolithic-Mesolithic sequence are red deer, roe deer, and wild boar (Tab. 2). Red deer varies in relative frequency from 23.9–51.7%, while roe deer fluctuates between 10.0–15.7%; neither taxa shows a temporal trend. Wild boar, in contrast, decreases from 18.6% during the LUP to 6.7% in the Upper Midden. Species richness increases from 7 taxa in the Late Upper Palaeolithic to 16 taxa in the Upper Midden. Taxonomic diversity increases significantly over time, with a major inflection between the Early Mesolithic and Lower Midden. The Total NISP identified in each phase also increases significantly over time, from NISP=274 in the Late Upper Palaeolithic to NISP=1966 in the Upper Midden (Tab. 2). Thus, the change in taxonomic diversity closely correlates with an increase in Total NISP. Although changing species diversity is strongly conditioned by sample size, it is important to note that much of this increase in taxonomic diversity is achieved through the addition of relatively small-sized carnivores (e.g. marten, wild cat, badger, fox), hare, beaver, and hedgehog (Tab. 2). Cut marks indicate that at least some of these species were procured for skins and/or meat. Measured as a percent of Total NISP, small game doubles in frequency between the Early Mesolithic to Lower Midden (from 2.1% to 5.3%), and then doubles again to 9.6% in the Upper Midden. Although the Upper Silts have the smallest Total NISP, they have the highest frequency of small game at 17.4%. This increase in the frequency of small game appears to reflect more than just changing assemblage size. This diversification of resource use is consistent with models of subsistence intensification owing to local factors of duration of occupation (*Miracle 1997*) and/or regional changes in ecological abundance and variability (*Miracle 1996; Miracle & O'Brien 1998*), although it would be overstating the case to call this increase in small game frequency evidence of "famine".

Species	Late Upper Palaeolithic	Early Mesolithic	Lower Midden	Upper Silts	Upper Midden
% Red deer	37.1	36.4	51.7	23.9	29.5
% Roe deer	15.7	12.0	11.5	10.0	13.3
% Wild boar	18.6	22.8	14.2	9.0	6.7
% Small ungulate	10.0	9.5	5.2	8.0	12.3
% Medium ungulate	14.3	15.3	11.2	29.9	21.6
% Small game[1]	2.6	2.1	5.3	17.4	9.6
% Other	1.7	2.0	0.9	2.0	7.0
Total NISP	274	517	2493	201	1966
% Identifiable	14.9	18.3	25.1	27.9	39.1
N Taxa	7	7	13	9	16
N shaft fragments	406	844	1855	231	1251
N articular ends & cancellous bone	157	242	1632	86	672
Total faunal remains	1845	2824	9916	720	5029

1 Includes: *Castor fiber, Erinaceus europaeus, Felis silvestris, Lepus europaeus, Lepus sp., Martes sp., Meles meles, Vulpes vulpes*, small animal, small-medium sized carnivore

Tab. 2. Relative frequency of major mammal taxa by stratigraphic phase at Pupićina Cave.

Land Snail Taphonomy and Consumption

Land snails are ubiquitous in the Late Upper Palaeolithic and Mesolithic deposits at Pupićina Cave (*Mi-*

racle 1997). Their taphonomy is usually complex since many species live in or near karstic caves, and a number of small carnivores (hedgehog, fox, mole etc.) eat snails and could collect their shells in caves and rockshelters. Stiner (*1994; 1999*) has remarked on several modifications of snail shells that point to non-human accumulators, in particular the presence of small punctures on otherwise undamaged shells. She has also remarked on the small size of many of the land snails from the Italian sites she has analysed.

The Pupićina land snail assemblage is divided into two components. The first includes relatively small-sized species, many of which are found in the entrance to Pupićina Cave today. The shells of these small land snails are mostly complete and preliminary analysis suggests that burning is very rare. These small land snails are most common during the LUP phase at Pupićina Cave. Their geometric density drops by a factor of 7 from the LUP (116 MNI/m^3) to the Early Mesolithic (16 MNI/m^3) and later levels (Tab. 3, Fig. 3). Interestingly, the density of these inedible land snails also increases in the Upper Silts relative to other phases of the Mesolithic. These small land snails are most frequent at the site when evidence of human occupation is sparsest.[5] Although a detailed taphonomic study of these snails remains to be done, the contextual evidence convincingly argues for non-human agents of accumulation and modification. We agree with Stiner (*1994; 1999*) that this component of the mollusc assemblage most likely reflects the activities of non-human accumulators.

The second component of the Pupićina land snail assemblage is the large-sized "edible" snail (*Helix secernendra* and *Helix* sp.) that is known from many late glacial to early postglacial contexts around the Mediterranean (*Lubell et al. 1976; Miracle 1995*). There is general agreement that *Helix* shells associated with fire-cracked rock and settlement debris in Capsian sites of North Africa reflect food waste (*Lubell et al. 1976; Stiner 1999*). *Helix* shells are present in very low quantities during the LUP at Pupićina. The geometric density of *Helix* shells increase by a degree of magnitude from the LUP (9 MNI/m^3) to the Early Mesolithic (88 MNI/m^3), with a similarly dramatic increase occurring between the Early Mesolithic and Lower Midden (to 1504 MNI/m^3, Tab. 3, Fig. 3). The frequency of *Helix* remains high in the Upper Midden of the Mesolithic, although it is much lower (325 MNI/m^3) in the Upper Silts. The frequency of *Helix* is the mirror image of the small land snails (Fig. 3). The high frequency of *Helix* is associated with ashy deposits that appear to have been dumped from hearths and roasting pits, a depositional context very similar to those at the open-air and clearly anthropogenic escargotières of the Capsian Culture of North Africa (*Lubell et al. 1976*). I suggest that the *Helix* land snails were prepared and eaten by people, although this interpretation remains preliminary until taphonomic studies are completed.

	Late Upper Palaeolithic	Early Mesolithic	Lower Midden	Upper Silts	Upper Midden
Red deer & medium ungulate					
NISP	89	267	1569	108	1063
Weight (g)	903	1714	16706	794	11781
Weight per fragment (g)	10.1	6.4	10.6	7.3	11.1
Roe deer & small ungulate					
NISP	82	111	417	36	503
Weight (g)	155.9	265.1	1034	90.8	1714
Weight per fragment (g)	1.9	2.4	2.5	2.5	3.4
Helix MNI	16	34	831	57	1139
Mytilus hinges	6	13	20	14	26
Inedible landsnail MNI	209	6	9	7	15
Geometric Density (count/m^3)					
Red deer & medium ungulate	49	691	2840	616	1391
Roe deer & small ungulate	46	287	755	205	658
Helix	9	88	1504	325	1491
Mytilus	3	34	36	80	34
Inedible landsnail	116	16	16	40	20

Tab. 3. Frequency of main ungulates and molluscs by stratigraphic phase at Pupićina Cave.

Land snails would have been a low-ranked resource when compared to the returns provided by ungulate hunts and any other gathered resource (*Miracle 1995*). The dramatic increase over time in land snail collecting

5 This relationship is even clearer if one compares "occupation" and "sterile" layers within the LUP phase. The frequency of small land snails varies inversely with other evidence of human use at this much finer stratigraphic resolution.

thus provides some of the strongest indirect evidence of increasing resource stress during the Mesolithic at Pupićina – people broadened their diet to include lowly land snails in response to the depletion of higher-ranked resources in the vicinity of the site and/or within the wider region (*Miracle 1997*). These changes in early Holocene dietary composition may also reflect a longer period of occupation at the site, in addition to changes in group composition (particularly the presence of children) and/or individual strategies (*Miracle 1997*).

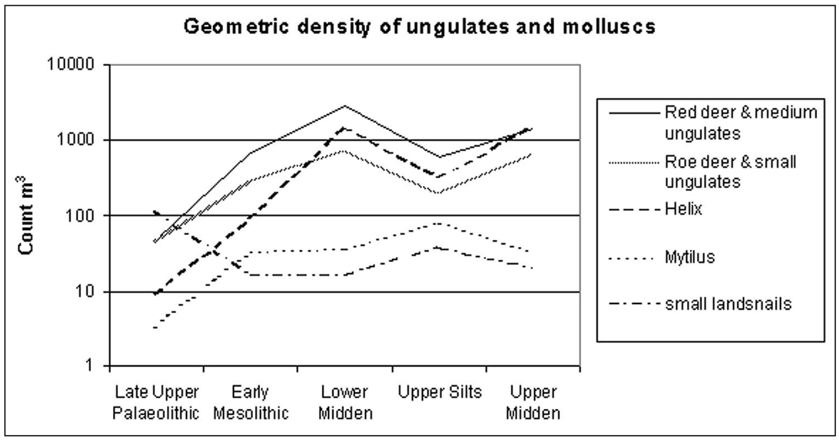


Fig. 3. Stratigraphic changes in geometric density of major ungulates (NISP/m³), land snails (MNI/m³) and marine molluscs (hinges/m³) at Pupićina Cave.

What I would like to suggest here is that the increase in *Helix* may also reflect a shift towards more feasting. Land snails can be collected in fairly large quantities. They can also be "stored" alive for a short time prior to consumption. Such "storage on the hoof" is practised today to improve the taste and reduce the toxicity of snails. The Romans "preseasoned" snails by feeding them milk, grain, and other delicacies prior to consumption (*Renfrew 1996*). One important aspect of a feast is being able to collect and store foodstuffs in preparation for the feast. *Helix* land snails may have been selected for collecting for those reasons. One potential drawback of collecting *Helix* is that it is relatively easy to overexploit a population, and it can take several years (or longer) for a population to bounce back from overpredation. At times when *Helix* was hyperabundant, people could have collected them in large quantities with relatively greater efficiency. People would have then had to lay off snails for a period of several years until local populations recovered.

Marine Foods in the Hinterland

Marine molluscs are present in the late glacial and early postglacial deposits at Pupićina. The mussel, *Mytilus galloprovincialis*, it the most common marine bivalve. These mussels must have been transported at least 20 km from the coast, and their presence at Pupićina provides tantalising evidence about the directionality and timing of contacts between coastal and inland areas (*Miracle 1997*). Most of the mussel shells are highly fragmented. I interpret these *Mytilus* shells as food waste. The geometric density of *Mytilus* increases ten-fold from the LUP to Early Mesolithic, rising from 3 to 34 hinges/m³ (Tab. 3, Fig. 3). The frequency of *Mytilus* remains more or less constant in the Lower and Upper Middens of the Mesolithic, only to rise to 80 hinges/m³ in the Upper Silts. The significance of this contrast between the midden deposits and the Upper Silts is still not clear, although it is interesting that the Upper Silts also had the highest frequency of small game.

The presence of *Mytilus* shells in the LUP phase at the very end of the Pleistocene suggests that water in the Kvarner Gulf and eastern coast of Istria was already sufficiently saline to support this species. This is not unexpected since comparison to global sea level curves suggests that the Kvarner Gulf may have flooded sometime between 11 500 and 11 000 Cal BC (*Miracle 1995*). Therefore, the increase in marine molluscs at Pupićina does not appear to be a simple function of proximity to the coast. The potential significance of these marine mussels for cooking techniques and "cuisine" is discussed elsewhere (*Miracle 2001*). Marine mussels are too rare to have been a significant food item, whether during good or bad times. It is difficult to interpret marine mussels as a "famine food" and their increasing frequency over time as indicative of subsistence stress. On the other hand, these seafoods would have been clearly "exotic" in comparison to the terrestrial game (mostly red deer, roe deer, and boar). In this hinterland context, marine mussels may have been "special foods" because of their origin from the sea. One might imagine taboos against the mixing of marine and terrestrial foods, and ingestion of mussels may have pyscho-socially transformed the consumer in various ways. Although the specific meanings associated with mussel consumption are not currently accessible (and may never be), it seems quite likely that they were a marked or special food used for feasting (*Hayden 1996*).

Deer Feasts at Pupićina Cave

The larger ungulate fauna at Pupićina provides clear evidence of shifts in the scale of consumption and processing practices. For this analysis I have treated red deer and medium ungulate together, while roe deer and small ungulate are treated together (Tab. 3)[6]. Quantification using geometric density brings out a major contrast between the LUP and Early Mesolithic phases, with a 14-fold increase in red deer/medium ungulate density and a 6-fold increase in roe deer/small ungulate frequency. The frequency of both taxa increases again from the Early Mesolithic to Lower Midden, with a more marked increase in the larger-sized red deer/medium ungulates than in the smaller-sized roe deer/small ungulates (Tab. 3). These comparisons of geometric density are predicated on the assumption that deposition rates were constant. Unfortunately absolute dates from the site are not adequate for precisely determining the length of stratigraphic phases. Even so, the LUP phase appears to correspond with the "Younger Dryas", while the three Mesolithic phases may well fit within the "Preboreal". The contrasts in geometric density among these phases are unlikely to disappear when we correct for the rate of sediment deposition. If anything, the time span covered by the LUP is likely to be greater than that for the three Mesolithic phases, making the contrast between these phases even more dramatic. The spatial contrast between the Upper Midden and Upper Silts is extremely informative. The geometric density of red deer/medium ungulate remains in the latter deposit is only 44% of that from the former deposit. Similarly, the geometric density of roe deer/small ungulate remains in the latter deposit is only 31% of that from the former deposit. The midden deposits form discrete and distinctive contexts both temporally and spatially.

The relative frequency of different body parts can provide valuable information about food management and processing. Skeletal elements have been grouped into a series of carcass units as defined in Table 4. These carcass units are similar to those used by Stiner (*1994*) and Gamble (*1997*), although there are some differences. NISP counts in Tables 5 and 6 have been "corrected" by dividing NISP for each carcass unit by the number of elements present in the carcass unit in a complete deer skeleton. Note that not all elements are included for each carcass unit.

Carcass unit	Elements Included	Correction Factor	Mean MGUI (rank)[a]	Mean volume density (rank)[b]
antler	antler (base, beam, tine, other)	8	1.0 (9)	
head	frontal, maxilla, nasal, occipital, petrous, premaxilla, temporal, zygomatic, mandible	18	19.5 (5)	0.57 (5)
upper teeth	upper dp2–4/P2–4, M1–3	12		
lower teeth	lower dp2–4/P2–4, M1–3	12		
neck	hyoid, atlas, axis, cervical vertebra	*8*	18.4 (6)	0.20 (8)
back	thoracic vertebra, lumbar vertebra, ribs	*45*		
pelvis	innominate, sacrum	3	47.9 (2)	0.23 (7)
upper front	scapula, humerus, radius, ulna	8	34.5 (3)	0.60 (4)
lower front	carpals, metacarpal	12	12.7 (8)	0.72 (1)
upper hind	femur, patella, tibia, (fibula)	6	78.8 (1)	0.66 (3)
lower hind	astragalus, calcaneus, metatarsal	12	29.8 (4)	0.66 (2)
feet	phalanges	24	13.7 (7)	0.39 (6)
other	sesamoids, accessory phalanges (digits I, II, V), accessory metapodials, other teeth, other tarsals, sternum, costal cartilage			

a Calculated from data in Binford (*1978.Table 2.7*).
b Calculated from data in Lyman (*1994.Table 7.6*). Scan sites are head: DN4; neck: AT3, AX1, CE1; pelvis: AC1, SC1; upper front: SP2, HU4, RA3; lower front: MC3; upper hind: FE4, TI3; lower hind: AS3, CA2, MR3; feet: P13, P23, P31.

Tab. 4. Definition of carcass units and correction factors used to study body part representation. Teeth and back (correction factor written in italics) are excluded from further comparisons.

6 The wild boar is left out of these comparisons.

Carcass	Late Upper Palaeo.			Early Mesolithic			Lower Midden			Upper Silts			Upper Midden		
unit	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM
antler	1	0.0	0.0	25	12.0	0.0	57	12.3	22.8	6	50.0	0.0	86	11.6	22.1
head	10	0.0	0.0	39	7.7	0.0	275	4.4	1.1	16	0.0	0.0	97	5.2	7.2
upper teeth	4	0.0	0.0	15	6.7	0.0	100	1.0	0.0	4	0.0	0.0	23	0.0	0.0
lower teeth	5	0.0	0.0	10	0.0	0.0	77	2.6	0.0	1	0.0	0.0	38	0.0	0.0
neck	8	0.0	0.0	6	33.3	0.0	69	4.3	17.4	4	0.0	0.0	47	2.1	17.0
back	12	8.3	0.0	27	7.4	0.0	93	4.3	3.2	20	5.0	15.0	166	3.6	9.0
pelvis	2	0.0	0.0	5	0.0	0.0	62	3.2	11.3	2	0.0	0.0	30	3.3	13.3
upper front	13	0.0	15.4	20	5.0	0.0	148	5.4	10.8	9	0.0	11.1	84	14.3	9.5
lower front	2	0.0	50.0	14	14.3	14.3	86	10.5	10.5	4	0.0	0.0	51	9.8	7.8
upper hind	8	12.5	0.0	13	15.4	7.7	91	11.0	5.5	5	0.0	20.0	87	16.1	6.9
lower hind	4	25.0	0.0	17	5.9	23.5	163	9.8	10.4	10	20.0	20.0	78	11.5	10.3
feet	10	0.0	10.0	34	17.6	0.0	169	9.5	0.6	5	0.0	0.0	108	5.6	4.6
other	10	10.0	0.0	42	11.9	2.4	179	9.5	3.9	22	0.0	9.1	168	11.9	1.8
Total NISP	89	4.5	4.5	267	10.5	3.0	1569	6.8	5.9	108	5.6	8.3	1063	8.4	8.2

Tab. 5. Red deer and medium ungulates: frequency of body parts and bone modification at Pupićina Cave.

For example, only a limited number of head bones were systematically recorded; only these bones were used to determine the correction factor. The main contrast in my usage to that of Gamble is in how I treat teeth. While a deer over its lifetime possesses 36 cheek teeth (18 upper and 18 lower), it would only rarely ever have all 36 in its mouth, and even then it is likely that no more than 24 (12 upper and 12 lower) would be in active use. This comes from the simple fact that deciduous teeth are exfoliated and lost with maturation, while permanent premolars are rarely visible (and hence not coded separately) in juvenile animals. Use of the correction factors makes the different carcass units equivalent to one another in their relative frequency in a deer skeleton. Corrected NISP for carcass units was then standardised to 100% by dividing values by the highest corrected NISP; calculation is identical to %MNI and %MAU used by other workers with the exception that corrected NISP is the basis for quantification[7]. Although NISP counts are presented for upper teeth, lower teeth, and back, these carcass units have not been corrected and included in further comparisons. Teeth are excluded since they are much denser than bone. Elements of the back are excluded since they are often underrepresented relative to other elements of the skeleton. The MGUI (*Binford 1978*) and volume density (*Lyman 1984;*

Carcass	Late Upper Palaeo.			Early Mesolithic			Lower Midden			Upper Silts			Upper Midden		
unit	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM	NISP	% Burn	% CM
antler	0			0			6	0.0	0.0				27	33.3	0.0
head	12	25.0	8.3	18	5.6	0	62	1.6	3.2	5	0.0	0.0	97	5.2	7.2
upper teeth	7	0.0	14.3	5	0.0	0	30	0.0	0.0	1	0.0	0.0	23	0.0	0.0
lower teeth	6	50.0	0	0			35	0.0	0.0				38	0.0	0.0
neck	5	20.0	0	2	0.0	0	16	0.0	0.0	3	0.0	0.0	47	2.1	17.0
back	12	8.3	0	14	0.0	0	34	2.9	5.9	5	0.0	0.0	166	3.6	9.0
pelvis	1	0.0	0	3	0.0	0	14	0.0	0.0	1	0.0	0.0	30	3.3	13.3
upper front	5	20.0	40	16	12.5	6.3	45	4.4	2.2	4	0.0	0.0	84	14.3	9.5
lower front	6	0.0	0	6	0.0	0	22	9.1	9.1	2	0.0	0.0	51	9.8	7.8
upper hind	8	12.5	0	9	11.1	11.1	41	2.4	2.4	5	0.0	40.0	87	16.1	6.9
lower hind	4	25.0	0	11	27.3	9.1	37	5.4	8.1	7	0.0	14.3	78	11.5	10.3
feet	1	0.0	0	8	12.5	12.5	24	16.7	8.3	1	0.0	0.0	108	5.6	4.6
other	15	0.0	0	19	15.8	0	51	3.9	2.0	2	0.0	0.0	168	11.9	1.8
Total NISP	82	13.4	4.9	111	9.9	3.6	417	3.6	3.4	36	0.0	8.3	1004	8.8	6.8

Tab. 6. Roe deer and small ungulates: frequency of body parts and bone modification at Pupićina Cave.

7 NISP is used instead of MNE. The latter has not yet been calculated because analyses are still ongoing.

1994) are used as predictive models of carcass unit selection. Mean MGUI and Density were calculated by averaging values for the different elements included in each carcass unit[8]. Relationships between these variables and carcass unit frequency were assessed using scatter plots and nonparametric statistical measures of correlation (Spearman's r).

Mean MGUI and volume density are not significantly correlated (Spearman's r = 0.02, p = 0.955, 6 degrees of freedom). Carcass unit frequency is not significantly correlated with volume density in any of the phases for either red deer/medium ungulates or roe deer/small ungulates; Spearman's r ranges from –0.40 to 0.14. Density-mediated destruction of bones has not significantly patterned body part frequency in these assemblages.

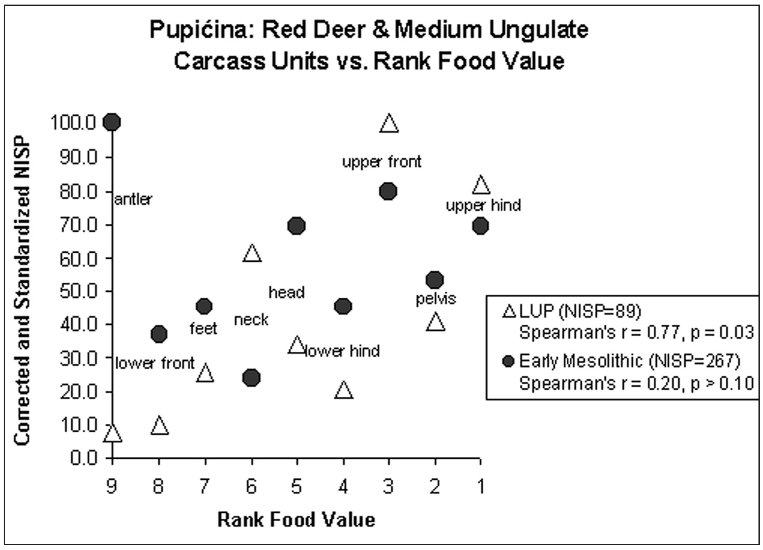


Fig. 4. Carcass unit frequency vs. rank food utility for red deer and medium ungulates from LUP and Early Mesolithic phases at Pupićina Cave.

In contrast to volume density, there are strong positive correlations between food utility, as measured by the mean MGUI, and carcass unit frequency. Looking first at red deer and medium ungulates (Figs. 4–5), mean MGUI and carcass unit frequency are positively correlated in the LUP (Spearman's r = 0.77, p = 0.03, 7 d.f.), but not in the Early Mesolithic (Spearman's r = 0.20). If one removes antler from the analysis, then there is a strong positive correlation for the Early Mesolithic (Spearman's r = 0.68, p = 0.06, 6 d.f.), while that for the LUP becomes weaker (Spearman's r = 0.67, p = 0.07, 6 d.f.). In upper case the midden deposits of the Mesolithic correlations between food utility and carcass unit frequency are extremely high and positive in the Lower Midden (Spearman's r = 0.82, p = 0.01, 7 d.f.) and also in the Upper Midden if one removes antler from the analysis (Spearman's r = 95, p < 0.001, 6 d.f.). There is not a clear relationship between carcass unit frequency and food value in the Upper Silts, regardless of whether one includes antler in the analysis. There was clearly a very strong selection for the meatiest parts of the red deer (and medium ungulate) carcass during the midden phases of the Mesolithic (Fig. 5). All parts of the carcass were being brought to Pupićina during the different phases of occupation. There was a shift over time, however, towards a selection for the meatiest carcass

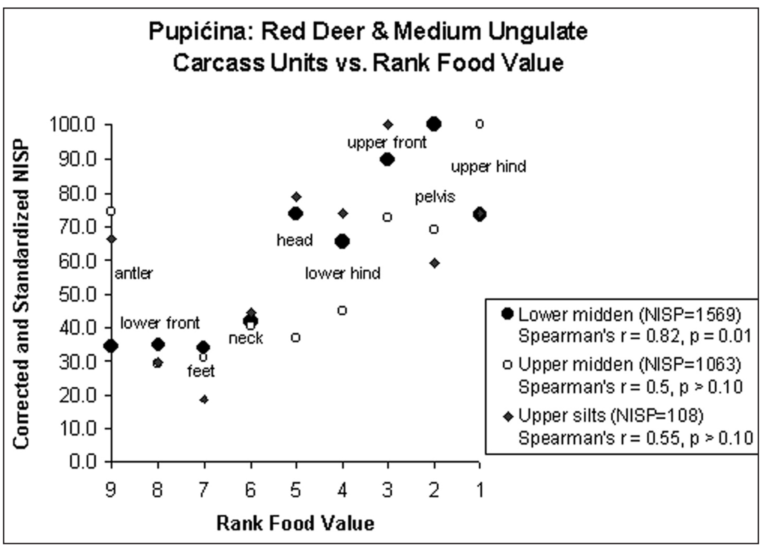


Fig. 5. Carcass unit frequency vs. rank food utility for red deer and medium ungulates from Lower Midden and Upper Midden Mesolithic phases at Pupićina Cave.

8 The maximum volume density has been used for each element, which in the case of the limbs comes from the shaft. Limb shafts were identified to element and body size based on nutrient foramina and other diagnostic anatomical features. This use of volume density is appropriate since I am examining the relative frequency of different carcass parts rather than differential survivorship within individual bones. This assumes, of course, that limbs were initially transported and manipulated whole rather than in pieces, i.e. disarticulation was between bones rather than through them.

parts so that there was a surplus of high utility elements relative to the rest of the carcass during the midden phases of the Mesolithic. Antler was also collected during the Early Mesolithic and Upper Midden phases, probably for use as a raw material for manufacturing antler tools. The interpretation I favour is of people provisioning Pupićina with the meaty upper limbs of red deer carcasses during the Mesolithic.

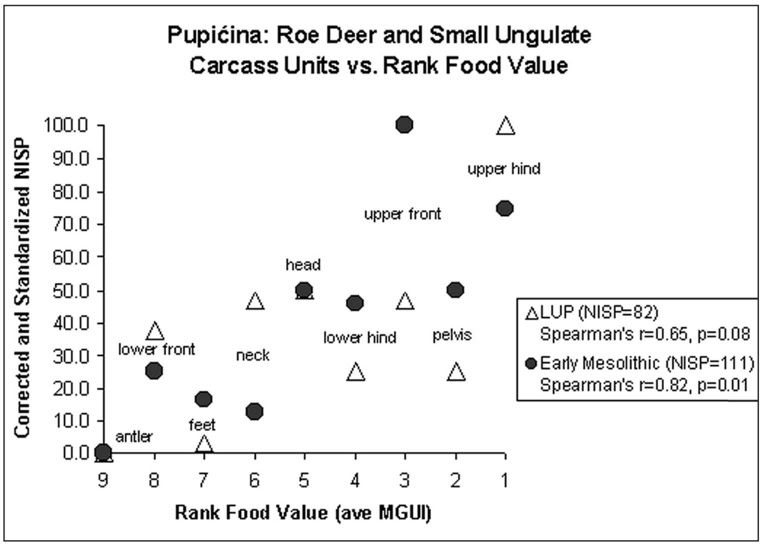


Fig. 6. Carcass unit frequency vs. rank food utility for roe deer and small ungulates from LUP and Early Mesolithic phases at Pupićina Cave.

Turning to the roe deer and small ungulates, we again find significant correlations between food utility and carcass unit frequency (Figs. 6–7). Carcass unit frequency is not significantly correlated with food utility in the LUP (Spearman's r = 0.65, p = 0.08, 7 d.f.). In the Early Mesolithic through Upper Midden, however, food utility is significantly correlated with food utility, with rank correlation coefficients ranging from r = 0.82 to r = 0.94 (Figs. 6–7). The assemblage from the Upper Silts is not included owing to its small sample size. As with the red deer and medium ungulates, the shift from LUP to Mesolithic is not simply a matter of sample size – sample sizes in the LUP and Early Mesolithic are very similar. This suggests a deliberate provisioning of the site with the meatier elements of roe deer and small ungulates during the Mesolithic occupations of the site.

Further evidence of the differential provisioning of Pupićina with meaty carcass parts during the Midden phases of the Mesolithic comes from the differential representation of bones from the right versus left side of the animal. The only incidence of bias for a particular side in red deer and medium ungulates is in the upper front limb from the Lower Midden, with NISP = 45 for left side and NISP = 87 for right side ($\chi^2 = 13.4$, $p < 0.001$, 1 d.f.). In the roe deer and small ungulates there appears to be a preferential selection for upper hind limbs in the Early Mesolithic (NISP = 4 for left side compared to NISP = 0 for right side, $\chi^2 = 4.0$, p = 0.045, 1 d.f.) and Lower Midden (NISP = 23 for left side compared to NISP = 12 for right side, $\chi^2 = 3.46$, p = 0.063, 1 d.f.), although the latter relationship is not statistically significant. It is quite interesting that evidence of a bias for a particular side of the body appears only in the meaty parts of the carcass as opposed to the rest of the carcass, and mostly comes from the Lower Midden. These data complement evidence of a selective transport of higher utility elements to the site during the Midden phases of occupation.

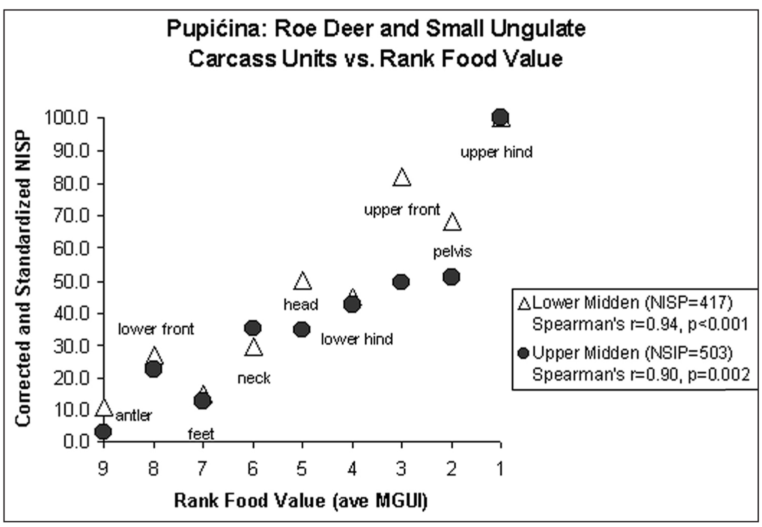


Fig. 7. Carcass unit frequency vs. rank food utility for roe deer and small ungulates from Lower Midden and Upper Midden Mesolithic phases at Pupićina Cave.

Evidence of further processing is more difficult to interpret. The frequency (% of NISP) with which different carcass units are burned and cut is presented in Tables 5 and 6. The interpretation of burning data is far from clear (*Kent 1993*) since burning may have little to do with food preparation and consumption, and may be postdepositional in origin (*Stiner et al. 1995*). Likewise, as numerous authors have noted, nicking bone dulls a sharp edge. Cut mark frequency and location are strongly conditioned by an animal's anatomy, including the location and attachment of major muscles and tendons, as well as in the ease with which bone can be avoided during skinning, carcass disarticulation, and defleshing. On the other hand, there is anecdotal evidence that cultural differences also contribute to distinctive butchery styles (*Langenwalter 1980; Lyman 1987; Yellen 1977*). With reference to the faunal remains from Pupićina, my question is what the burning and cut mark data might be revealing about the scale at which butchery and consumption was occurring. In particular, are there changes in burning and cut mark frequency that might be interpreted in terms of feasting?

Bones were coded as burned when they were at least partially charred dark brown to black in colour. The category of "burned bone" thus includes bones that have been charred and calcined; it excludes bones that may have been only lightly burned. Burning frequency in red deer and medium ungulates ranges from 4.5% to 10.5% of NISP (Tab. 5). The frequency of burning increases from the Late Upper Palaeolithic to Mesolithic phases, with the highest frequency of burning in the Early Mesolithic. There is even greater variability among phases in the distribution of burning within the skeleton. To give a better sense of bone burning relative to anatomy, burning frequency by carcass unit is represented on schematic drawings of a deer carcass (Figs. 8–11). These schematic drawings show that burning is not distributed at random on the different carcass parts. In fact, in most cases burning frequency is relatively similar among neighbouring carcass units (e.g. axial skeleton in Figures 10 and 11)[9]. Carcass units with similar burning frequencies are likely to have been burned together, whether as part of food preparation/discard or owing to postdepositional fires. From this perspective, a major difference in burning frequency between adjacent carcass units is important in that it suggests that burning occurred after disarticulation/dispersion of skeletal elements. In the LUP red deer/medium ungulates, the upper and lower hind limb are relatively more burned than the adjacent pelvis and feet (Fig. 8). Many carcass units were not burned at all, including some of the relatively meaty portions like upper fore limb and pelvis. These parts may have been filleted and discarded at Pupićina with consumption occurring elsewhere. The sample size is admittedly small and results are preliminary, but the overall impression is that red deer and medium ungulate carcasses had already been disarticulated prior to burning. Much of this burning may have been incidental or resulted from the disposal of bone waste into fires following consumption. It will certainly be informative to study the spatial distribution of bone burning in these late glacial levels, particularly with respect to the placement of hearths. In the Early Mesolithic burning frequency is consistently higher on all carcass units compared to the LUP, although there is a similar pattern of discrepancies between adjacent carcass parts (Fig. 9). The relatively high frequency of burning on antler may be related to tool manufacture, while the sharp contrast in bone burning between the head and neck is good evidence that the head had been removed from the neck prior to burning. Red deer heads may have been processed/disposed in a different manner from the rest of the body. Perhaps they were roasted with hide and flesh still attached, or they may have been boiled/stewed. They may have been deposited away from fires due to respect to the animals. A more specific interpretation of the heads is not possible at this point in time, although the pattern is striking. The rest of the carcass shows consistent burning frequencies, excepting a discrepancy between the pelvis and upper hind limb. This pattern of burning may not be what one would expect if carcasses were roasted whole. We still lack adequate baselines for interpreting this kind of burning data. In the Lower Midden antler is more frequently burned than the head, and the upper hind limb is much more frequently burned than the pelvis and back (Fig. 10). As mentioned above, the high frequency of antler burning may be related to its use as a raw material for tool manufacture. The evidence of the upper hind leg suggests that it had already been disarticulated from the pelvis prior to burning. In general, I also note that the axial skeleton is uniformly burned to a slight degree, while limbs are more heavily burned. This may suggest that limbs were separated from the trunk prior to cooking. This certainly fits with other evidence of upper limbs being introduced to the site; these limbs may have been treated separately from other parts of the carcass, perhaps for preparation/cooking on a larger scale as part of a feast. Finally, in the Upper Midden

9 Treatment of feet on these drawings is somewhat problematic. It is very difficult to distinguish between phalanges of the fore and hind limb, particularly when complete phalanges are rare as at Pupićina. Thus, in presenting these data I have assumed the burning was equally distributed among fore and hind phalanges.

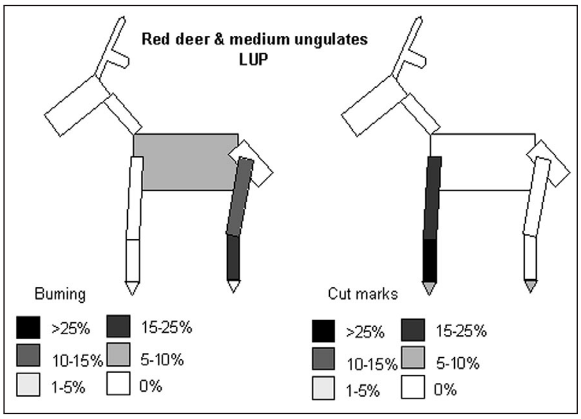


Fig. 8. Frequency of burning and cut marks (% of NISP) on carcass parts of red deer and medium ungulates in the LUP phase at Pupićina Cave.

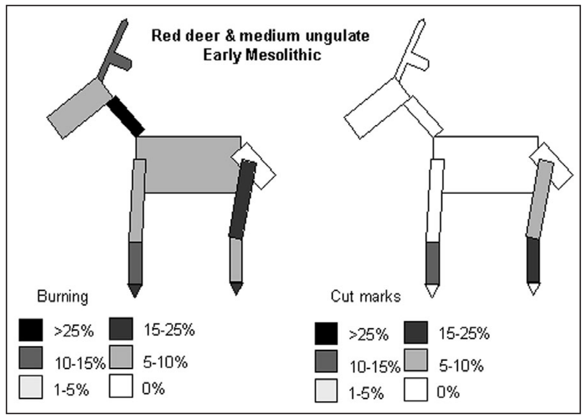


Fig. 9. Frequency of burning and cut marks (% of NISP) on carcass parts of red deer and medium ungulates in the Early Mesolithic phase at Pupićina Cave.

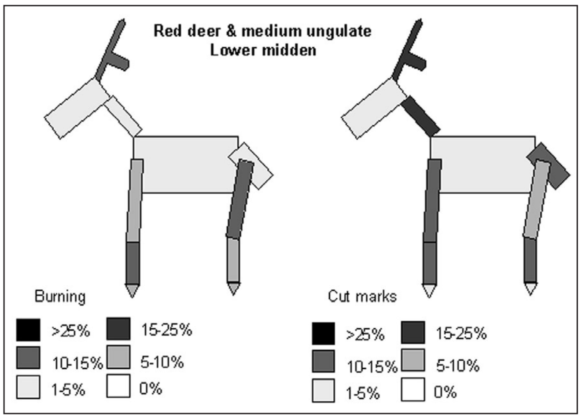


Fig. 10. Frequency of burning and cut marks (% of NISP) on carcass parts of red deer and medium ungulates in the Lower Midden phase at Pupićina Cave.

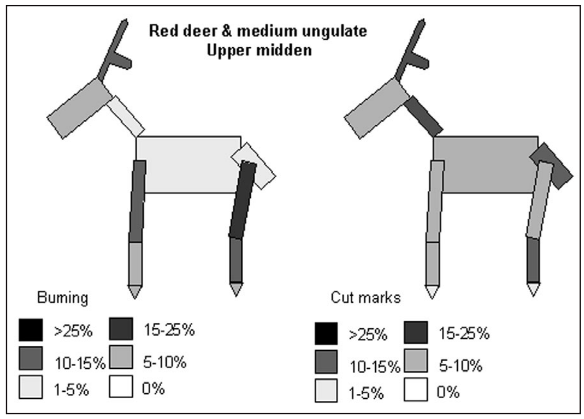


Fig. 11. Frequency of burning and cut marks (% of NISP) on carcass parts of red deer and medium ungulates in the Upper Midden phase at Pupićina Cave.

antler is again much more frequently burned than the head, while now both the upper fore and hind limbs are much more frequently burned than the back and pelvis (Fig. 11). The contrast between the Upper Midden and Upper Silts is also evident in the much lower frequency of burning in the latter compared to the former context. My interpretation of these patterns is much as it was for the Lower Midden, with the exception that evidence for a differential treatment of limbs versus the trunk is even stronger. While keeping in mind the shortcomings that come from a lack of interpretative baselines, I suggest that this evidence is consistent with preparing and cooking red deer at a larger scale. This may be evidence of feasting.

Anatomical data on cut mark frequency is presented in the same way as the data on bone burning (Figs. 8–11). The overall frequency of cut marks ranges from 3.0–8.3 % of NISP; in contrast to bone burning, cut mark frequency increases from the earliest to latest phases under consideration (Tab. 5). While we have some interpretative baselines for the position and form of cut marks on bones (*e.g. Binford 1981; Noe-Nygaard 1989; Lyman 1994*), little is known about the factors that affect the overall frequency of cut marks on bones. Intuitively, it seems likely that an increase in the range and kind of butchering practices will cause an increase in cut mark frequency. Likewise, the frequency of "mistakes" must increase with the overall intensity of skinning, disarticulation, and filleting. I suggest that the increase in cut mark frequency from the LUP to Upper Midden reflects both an increase in the range of butchery practices and a more intensive butchery of carcasses. The latter could have resulted from carcasses being divided into relatively smaller portions, perhaps related to the transport of already butchered parts to the site as well as a wider or more extensive sharing of meat at the site. Turning to the distribution of cut marks on red deer carcasses, cut marks are limited to the fore limb and feet during the LUP (Fig. 8) and to the hind limb and lower fore limb during the Early Mesolithic (Fig. 9). Cut marks are more widely distributed on carcasses in the Lower Midden (Fig. 10) and Upper Midden (Fig. 11). The relatively high frequency of cut marks on antler in the Lower Midden may be related to tool production. On the other hand, the relatively high frequency of cut marks on the neck and pelvis in both Lower and Upper Middens is probably related to dismemberment. Overall, red deer carcasses appear to have been more thoroughly dismembered and filleted during the Midden phases relative to the LUP and Early Mesolithic. The link between this pattern and consumption of food at a larger scale and feasting remains to be established, although this pattern is not incongruent with such an interpretation.

Roe deer and small ungulates show a similar degree of burning and cut marks as found on red deer and medium ungulates. Burning frequency ranges from 0.0–13.4% of NISP, while cut mark frequency ranges from 3.4–8.3% of NISP (Tab. 6). There are not any clear stratigraphic trends in these data. The anatomical distribution of bone burning shows a pattern similar to that observed in red deer and medium ungulates. In the LUP and Early Mesolithic, adjacent carcass units show very different degrees of burning, suggesting burning after major disarticulation/dispersion, while burning is more evenly distributed among carcass units in the Lower and Upper Midden (Tab. 6). Cut marks are rare or missing from the neck and pelvis in contrast to red deer and medium ungulates; units of butchery may have included more carcass parts in roe deer than in the larger-sized red deer. Cut marks on feet in the Early Mesolithic and Lower Midden are probably from skinning; much of the initial carcass butchery and processing appears to have occurred at Pupićina. Cut marks are very localised, primarily on limbs, in the LUP and Early Mesolithic; they are more evenly distributed across the carcass in the Lower Midden and Upper Midden. Some of this contrast may be owing to the increase in sample size in the later phases; as with the red deer and medium ungulates, links between cut mark distribution and patterns of food consumption remain to be established.

The intensity of carcass processing may give another indication of feasting. A feast involves the consumption of relatively large quantities of food over a restricted period of time. This may lead to the generation of not only large amounts of food waste, but also the wasting of large amounts of food. The operationalisation of these observations in most archaeological contexts, however, is quite difficult. One indicator would be the deposition of incompletely butchered and processed carcasses among food waste. Anecdotal observations at Pupićina suggest that partially articulated limbs and vertebral columns are more frequent in the Midden phases than during the LUP. These partial articulations are mixed among the rest of the faunal remains in the deposits; nothing sets apart these remains as having come from "structured" deposition.

Another indication of wasting food might be a less intensive processing of carcasses for bone grease and marrow; this would also suggest that other sources of animal fat were available. The identification of processing intensity from faunal remains comes with other problems (*see Miracle 1995*), in particular the distinction between human food preparation/consumption practices and post-depositional fragmentation caused by a range of agents. The frequency of teeth relative to bony parts of heads gives one indication of post depositional fragmentation. Since teeth are much denser than bones, a relative increase in the former relative to the latter should indicate greater postdepositional destruction. Comparison of teeth to heads is also very useful since they are likely to move together (leaving out pierced teeth used as ornaments); therefore the relative frequency of teeth to heads should indicate *in situ* destruction rather than differential transport of heads relative to other parts of the carcass. Using data in Tables 5 and 6, we can see that the ratio of NISP teeth/NISP head varies from 0.32–0.90 in red deer and medium ungulates, while in roe deer and small ungulates it ranges from 0.20–1.08. None of these assemblages are dominated by teeth in a fashion that one might expect if there had been extremely postdepositional fragmentation. Likewise, there are not any clear stratigraphic trends in these parameters. As noted in the previous discussion of food utility, there are not clear relationships between bone density and carcass unit frequency.

Another approach to postdepositional fragmentation is to examine the fragmentation of relatively small, dense bones without marrow (*Marean 1991; Miracle 1995*). These bones are unlikely to have been fractured by people in butchery or processing. Their completeness, coded from a minimum of 10% complete to a maximum of 100% complete (unbroken) should give a rough indicator of fragmentation by non-human agents. In particular this would be postdepositional fragmentation since there is little for a carnivore to gain from them, and carnivores tend to swallow them whole rather than gnawing them into pieces (*Marean 1991*). The completeness of carpals, tarsals (excepting calcaneus), sesamoids, accessory phalanxes and accessory metapodials is summarised by phase in Table 7. Red deer and medium ungulates show an increase in mean completeness from 85% in the Early Mesolithic to 91.7% in the Upper Midden; the sample size (N=1) from the Late Upper Palaeolithic is too small for a comparison. The slight differences in completeness within the Mesolithic phases are not statistically significant (two-tailed t-tests for samples with unequal variance). Roe deer and small ungulates show a slight decrease over time in mean completeness from 95.8% to 88.8% (excluding the single bone from the Upper Silts). Again differences are not statistically significant and sample sizes from the earlier phases are quite small. These data suggest that the effects of postdepositional fragmentation did not change dramatically over time. While postdepositional fragmentation has certainly had important effects on the faunal assemblages from Pupićina, alone it does not account for the stratigraphic changes that I will now discuss.

One crude yet effective measure of fragmentation is the percent of remains identifiable to species and/or skeletal element. Among other factors, the ease and possibility of identification of remains is a function of completeness; identifiability decreases as fragmentation increases. This "%Identifiable" is calculated as the NISP/N faunal remains (Tab. 2). While this parameter has been shown in some contexts to be strongly dependent on sample size (*Grayson 1984*), graphic comparison of %Identifiable vs. sample size (from individual excavation units) shows that there is no relationship between these variables (Fig. 12). The percentage of identifiable remains ranged from 14.9–39.1% and showed a clear stratigraphic trend towards greater identifiability in the later phases. There is also a spatial distinction, with less fragmentation in the Upper Midden (39.1%) than in the Upper Silts (27.9%). Bone fragmentation decreased from the LUP to the Upper Midden.

Another measure of fragmentation is mean fragment weight (NISP/wt). In red deer and medium ungulates, the average weight per fragment increases slightly from 10.1–11.1 g from the LUP to the Upper Midden (Tab. 3). The roe deer and small ungulates show a similar trend, from 1.9 to 3.4 g from the LUP to the Upper Midden. As with identifiability, mean fragment weight of both small and medium-sized ungulates is less in the Upper Silts than the Upper Midden. As discussed above, a change in postdepositional fragmentation does not account for this trend in fragment weight. These trends coarsely indicate a temporal shift from more to less intensive bone fragmentation, and by inference carcass processing, from the Late Upper Palaeolithic to Upper Midden.

Zooarchaeologists often compare fragmentation rates among skeletal elements to study carcass processing in greater detail. Unbroken bones were clearly not used for marrow or grease. At Pupićina, almost all marrow-bearing bones have been broken, and many show clear evidence of impact scars indicating that they were cracked for marrow extraction. Only two out of 227 red deer and medium ungulate first and second phalanxes were unbroken, while all of the 49 roe deer and small ungulate first and second phalanxes were broken. There are not any temporal trends in these data. From these results one might conclude that people at Pupićina were constantly making maximal use of all potential food sources from a carcass, and hence were under dietary stress. On the other hand, the cracking of phalanxes for marrow may have been something done to pass the time while telling stories around the fire (*Gamble 1997*).

Instead of focussing on variation in fragmentation among elements, I will examine the differential preservation of different parts of individual elements. My point of departure is Binford's (*1978*) observations among the Nunamiut that the frequency of long bone shaft fragments to articular ends was indicative of the intensity with which bones were pro-

	Red deer & medium ungulates			Roe deer & small ungulates		
Phase	Mean completeness	S.D.	N	Mean completeness	SD	N
Upper Midden	90.5	21.0	44	88.8	16.4	12
Upper Silts	91.7	14.4	3	100.0	N/A	1
Lower Midden	89.2	25.1	97	82.1	28.0	12
Early Mesolithic	85.0	33.5	11	65.0	33.5	5
Late Upper Palaeolithic	10.0	N/A	1	95.8	10.2	6

Tab. 7. Mean completeness (100 maximum) of carpals, tarsals, sesamoids, accessory phalanxes, and accessory metapodials in red deer & medium ungulates and roe deer & small ungulates at Pupićina Cave.

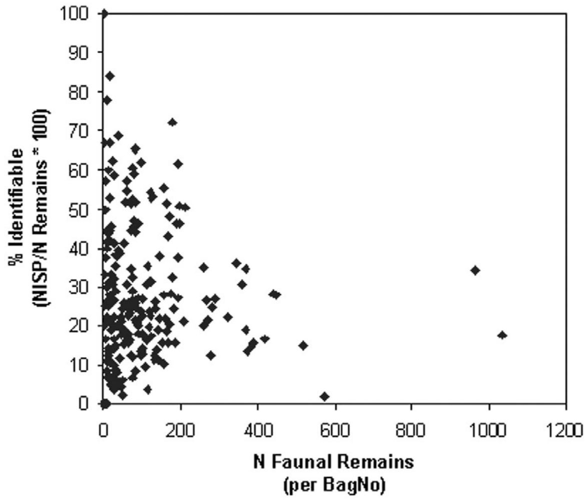


Fig. 12. %Identifiable versus sample size by excavation lot (BagNo) at Pupićina Cave.

cessed for marrow, bone juice, and/or grease extraction. Enloe (*1993*) has further studied some of these ethnoarchaeological assemblages to develop criteria for the identification of marrow extraction. Rather than trying to use these data to identify specific practices, I simply note that one expects the ratio of shaft fragments to articular ends to increase as bones are more intensively processed, owing to the higher susceptibility of ends to destruction, their higher grease content relative to shafts, and the need to break up articular ends to help free grease. The frequencies of long bone shafts (including small splinters and chips not identifiable to body size) and long bone ends (including unidentifiable cancellous bone)[10] for different phases are presented in Table 2. The ratio of long bone shafts to articular ends calculated using data in Table 2 is relatively high in the LUP (2.59) and Early Mesolithic (3.49); it drops substantially in the Lower Midden (1.14), only to rise again slightly in the Upper Midden (1.86). The ratio of shafts to ends is much higher in the Upper Silts (2.68) than in the Upper Midden. These data suggest that long bones were more intensively processed, perhaps by crushing articular ends for bone juice and/or grease, during the LUP, Early Mesolithic, and Upper Silts relative to the later phases of the Midden. Not only did fragmentation decrease over time, but also the pattern of fragmentation shifted from the articular ends to the shafts of long bones. These preliminary interpretations suggest a shift in the importance being placed on the extraction of lipids from bones. An increase in the processing of bone grease over time would fit interpretations of increasing dietary stress (*Miracle 1995*). Bone grease may have also been produced in preparation for a feast; the consumption of large amounts of animal oil/fat was a key component of ethnographically documented feasts (*e.g. Boas 1966; Codere 1950*).

DISCUSSION

Several lines of evidence indicate an increase over time in the scale of animal food consumption at Pupićina Cave. These changes are manifest in the following ways:

- the range and kind of species collected, in particular an increasing emphasis on edible land snails and marine molluscs;
- the amount of food refuse deposited on site;
- the provisioning of the site with carcass parts high in food value;
- patterns of burning and cut marks indicating a more systematic and intensive use of entire carcasses at once;
- decreased bone fragmentation and less intensive use of carcasses in later phases.

Results from these different analyses are not uniformly strong, and some of the suggested links with feasting need further comparative study. Nonetheless, the redundancy of patterning in independent lines of evidence gives credibility to the suggestion that there was a shift in food consumption practices, with feasting more important in early postglacial than late glacial phases of site use. These new food consumption practices are accompanied at the site by other changes in material culture, namely the appearance of pierced tooth and shell ornaments and occasional human remains. These later data still await detailed analysis, but reinforce the interpretation put forward here that changes were qualitative as well as quantitative. The record of food consumption at Pupićina suggests that Dietler's (*1996.102*) pessimistic assessment of "our ability to detect feasts in the [Mesolithic] archaeological record" was premature.

The presence of feasting raises interesting possibilities about commensal politics and the basis of leadership and power in Mesolithic societies in the northern Adriatic basin. Dietler (*1996*) and Hayden (*1996*) have both suggested that commensal politics may have started to become important during the Meso-

10 Some of this cancellous bone may be from vertebral centra. Hence, ratios of shaft fragments/ends may be slightly depressed compared to the actual values.

lithic in Europe. In particular, Hayden (*1996.141–142*) has argued "on the basis of analogies with American Northwest Coast cultures ... that competitive feasting systems also were operating in the rich coastal and riverine environments of Mesolithic Europe". While Pupićina is not on the coast, it was clearly part of a settlement system that included the coast. Environmental richness is more difficult to evaluate, but the region seems to have supported diverse and probably abundant natural resources. At Pupićina the appearance of human remains in the midden intermixed with feasting refuse raises the possibility that the manipulation of human relics (including symbolic consumption of flesh?) were important components of feasts. A presencing of ancestors might be accompanied by group affirmation and social bonding, and would better fit Hayden's definition of a "celebratory feast" rather than a commensal or competitive feast. On the other hand, the involvement of ancestors may have served to highlight social distinctions among feast participants and could thus have contributed to commensal politics. With only preliminary results available, it would be unwise to push interpretations of the Pupićina data in a particular direction; results of analyses of other classes of data will shed further light about the structure and nature of feasts at the site.

Categorical contrasts like "feast-famine" can be useful analytical and rhetorical devices. As shown above, however, many of the temporal trends and patterns in the data fit interpretations of dietary stress as well as feasting. Scale is certainly an important issue. People could have periodically held feasts (short-term events) during a period of declining resource availability (long-term trend). Likewise, consumption events (i.e. feasts) that bring together different local groups might act to buffer subsistence risk over the longer term. Thus while "feast-famine" is helpful in that it highlights some of the different dimensions of variation in food practices, these terms are not useful when used in opposition. Similar points have been made innumerable times with regard to ecological/social, nature/nurture, and so on.

Although the archaeological record of the Palaeolithic and Mesolithic imposes significant constraints on interpretative possibilities, much of the invisibility of food in these periods also reflects limitations of our theoretical and analytical approaches. Several researchers working with Late Upper Palaeolithic faunal assemblages have started to develop methods for examining the sociality of food consumption (*e.g. Audouze and Enloe 1991; Gamble 1997*). The current study of feasting at Pupićina Cave builds on these methods and provides other routes for interpretations of the archaeology of consumption during the Mesolithic, although the motives and strategies behind these Mesolithic feasts at Pupićina Cave remain obscure.

ACKNOWLEDGEMENTS

The 1995–1996 excavations at Pupićina Cave were supported by travel grants from IREX. Kristina Mihovilić and the Archaeological Museum of Istria and Ružica Vlašić provided logistical support. Special thanks also go to Stašo Forenbaher and Snježana Vrdoljak for assistance in the field. Laura Pugsley helped with the coding of faunal data from the 1996 season. The late Marija Poje identified the molluscs.

∴

REFERENCES

APPADURAI A. 1981. Gastro-politics in Hindu south Asia. *American Ethnologist 8: 494–511.*

ARNOLD J. E. 1993. Labor and the rise of complex hunter-gatherers. *Journal of Anthropological Archaeology 12: 75–119.*

AUDOUZE F. & ENLOE J. 1991. Subsistence strategies and economy in the Magdalenian of the Paris Basin, France. In N. Barton, A. J. Roberts & D. A. Roe (eds.), *The Late Glacial in North-West Europe: Human Adaptation and Environmental Change at the End of the Pleistocene, (Council for British Archaeology Research Report 77.) London: Council for British Archaeology, 63–71.*

BELOVSKY G. E. 1988. An optimal foraging-based model of hunter-gatherer population dynamics. *Journal of Anthropological Archaeology 7: 329–372.*

BETTINGER R. L. 1991. *Hunter-Gatherers: Archaeological and Evolutionary Theory.* New York (NY): Plenum Press.

BINFORD L. R. 1978. *Nunamiut Ethnoarchaeology.* New York (NY): Academic Press.

1981. *Bones: Ancient Men and Modern Myths.* New York (NY): Academic Press.

BOAS F. 1966. *Kwakiutl Ethnography.* H. Codere (ed.). Chicago (IL): University of Chicago Press.

BOSERUP E. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure.* Chicago (IL): Aldine.

BUTZER K. W. 1982. *Archaeology as Human Ecology.* Cambridge: Cambridge University Press.

CODERE H. 1950. *Fighting with Property: A Study of Kwakiutl Potlatching and Warfare, 1792–1930.* Seattle (WA): University of Washington Press.

COHEN M. N. 1977. *The Food Crisis in Prehistory.* New Haven (CT): Yale University Press.

CONKEY M. 1980. The identification of prehistoric hunter-gatherer aggregation sites: the case of Altamira. *Current Anthropology 21: 609–30.*

1991. Contexts of action, contexts for power: material culture and gender in the Magdalenian. In J. M. Gero & M. W. Conkey (eds.), *Engendering Archaeology: Women and Prehistory: 57–92.*

DIETLER M. 1996. Feasts and commensal politics in the political economy. Food, power and status in prehistoric Europe. In P. Wiessner & W. Schiefenhövel (eds.), *Food and the Status Quest, an Interdisciplinary Perspective: 87–125.*

DOUGLAS M. 1972. Deciphering a meal. *Deadalus 101: 61–82.*

1984. *Food and the Social Order.* New York (NY): Russell Sage Foundation.

ENLOE J. G. 1993. Ethnoarchaeology of marrow cracking: implications for the recognition of prehistoric subsistence organization. In J. Hudson (ed.), *From Bones to Behavior: Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains, (Center for Archaeological Investigations Occasional Paper No. 21): 82–97.*

ENLOE J. G. & F. DAVID 1989. Le remontage des os par individus: le partage du renne chez les Magdaléniens de Pincevent (La Grande Paroisse, Seine-et-Marne). *Bulletin de la Société Préhistorique Française 86: 275–81.*

FLANNERY K. V. 1969. Origins and ecological effects of early domestication in Iran and the Near East. In P. J. Ucko & G. W. Dimbleby (eds.), *The Domestication and Exploitation of Plants and Animals: 73–100.*

GAMBLE C. 1997. The animal bones from Klithi. In G. Bailey (ed.), *Klithi: Palaeolithic settlement and Quaternary landscapes in northwest Greece. Vol. 1: Excavation and intra-site analysis at Klithi: 207–44.*

GOODY J. 1982. *Cooking, cuisine and class. A study in comparative sociology.* Cambridge: Cambridge University Press.

GOSDEN C. & J. HATHER (eds.), 1999. *The Prehistory of Food. Appetites for change.* London: Routledge.

GRAYSON D. K. 1984. *Quantitative Zooarchaeology.* New York (NY): Academic Press.

GUMMERMAN G. IV. 1997. Food and complex societies. *Journal of Archaeological Method and Theory 4: 105–39.*

HAWKES K. 1992. Sharing and collective action. In E. A. Smith & B. Winterhalder (eds.), *Evolutionary Ecology and Human Behavior: 269–300.*

1993. Why hunter-gatherers work. An ancient version of the problem of public goods. *Current Anthropology 34: 341–61.*

HAYDEN B. 1981. Research and development in the stone age: technological transitions among hunter/gatherers. *Current Anthropology 22: 519–48.*

1990. Nimrods, piscators, pluckers, and planters: the emergence of food production. *Journal of Anthropological Archaeology 9: 31–69.*

1995. Pathways to power: principles for creating socioeconomic inequalities. In T. D. Price & G. M.

Feinman (eds.), *Foundations of Social Inequality: 15–86*.

1996. Feasting in prehistoric and traditional societies. In P. Wiessner & W. Schiefenhövel (eds.), *Food and the Status Quest, an Interdisciplinary Perspective: 127–47*.

HILL K. & KAPLAN H. 1993. On why male foragers hunt and share food. *Current Anthropology 34: 701–706*.

KELLY R. L. 1995. *The Foraging Spectrum*. Washington (DC): Smithsonian Institution Press.

KENT S. 1993. Variability in faunal assemblages: the influence of hunting skill, sharing, dogs, and mode of cooking on faunal remains at a sedentary Kalahari community. *Journal of Anthropological Archaeology 12: 323–85*.

LANGENWALTER P E. II 1980. The archaeology of 19th Century Chinese subsistence at the Lower China Store, Madera County, California. In R. L. Schuyler (ed.), *Archaeological Perspectives of Ethnicity in America: 102–112*.

LÉVI-STRAUSS C. 1969. *The Raw and the Cooked*. London: Jonathan Cape.

1978. *The Origin of Table Manners: Introduction to a Science of Mythology, Volume 3*. London: Jonathan Cape.

LUBELL D., HASSAN F. A., GAUTIER A. & BALLAIS J.-L. 1976. The Capsian escargotières. *Science 191: 910–20*.

LYMAN R. L. 1984. Bone density and differential survivorship of fossil classes. *Journal of Anthropological Archaeology 3: 259–299*.

1987. Archaeofaunas and butchery studies: a taphonomic perspective. In M. B. Schiffer (ed.), *Advances in Archaeological Method and Theory, Vol. 10: 249–337*.

1994. *Vertebrate Taphonomy*. Cambridge: Cambridge University Press.

MAREAN C. W. 1991. Measuring the postdepositional destruction of bone in archaeological assemblages. *Journal of Archaeological Science 18: 677–94*.

MIRACLE P. T. 1995. *Broad-Spectrum Adaptations Re-examined: Hunter-Gatherer Responses to Late-Glacial Environmental Changes in the Eastern Adriatic*. Ph.D. Dissertation. University of Michigan. University Microfilms, Ann Arbor, MI.

1996. Diversification in Epipaleolithic subsistence strategies along the eastern Adriatic coast: a simulation approach applied to zooarchaeological assemblages. *Atti del Museo Civico di Storia Naturale, Trieste IX(1994–1995): 33–62*.

1997. Early Holocene foragers in the karst of northern Istria. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji XXIV: 43–61*.

2001. Mesolithic Meals from Mesolithic Middens. In Miracle P. T. & N. Milner (eds.), *Consuming Passions and Patterns of Consumption (in press)*.

MIRACLE P. T. & FORENBAHER S. 2000. Pupićina Cave Project: Brief Summary of the 1998 season. *Histria Archaeologica 29(1998): 27–48*.

MIRACLE P. T., GALANIDOU N. & FORENBAHER S. 2000. Pioneers in the hills: early Mesolithic foragers at Šebrn Abri (Istria, Croatia). *European Journal of Archaeology 3: 293–329*.

MIRACLE P. T. & O'BRIEN C. J. 1998. Seasonality of resource use and site occupation at Badanj, Bosnia-Herzegovina: subsistence stress in an increasingly seasonal environment. In T. Rocek & O. Bar-Yosef (eds.), *Seasonality and Sedentism: Archaeological Perspectives from Old and New World Sites, (Peabody Museum Bulletin 6): 41–74*.

NEELEY M. P. & CLARK G. A. 1993. The human food niche in the Levant over the past 150 000 years. In G. L. Peterkin, H. M. Bricker & P. Mellars (eds.), *Hunting and Animal Exploitation in the Later Palaeolithic and Mesolithic of Eurasia. Archaeological Papers of the American Anthropological Association No. 4: 221–240*.

NOE-NYGAARD N. 1989. Man-made trace fossils on bones. *Human Evolution 4: 461–91*.

RENFREW J. 1996. Roman Britain. In M. Black (ed.), *A Taste of History: 10,000 Years of Food in Britain: 51-93*.

ROWLEY-CONWY P. & ZVELEBIL M. 1989. Saving it for later: storage by prehistoric hunter-gatherers in

Europe. In P. Halstead & J. O'Shea (eds.), *Bad Year Economics: Cultural Responses to Risk and Uncertainty: 40–56*.

SAMUEL D. 1996. Approaches to the archaeology of food. *Petits Propos Culinaires 54: 12–21*.

SOFFER O. 1989. Storage, sedentism and the Eurasian Palaeolithic record. *Antiquity 63: 719–32*.

STINER M. C. 1994. *Honor Among Thieves: A Zooarchaeological Study of Neandertal Ecology*, Princeton (NJ): Princeton University Press.

1999. Palaeolithic mollusc exploitation at Riparo Mochi (Balzi Rossi, Italy): food and ornaments from the Aurignacian through Epigravettian. *Antiquity 73: 735–54*.

STINER M. C., KUHN S. L., WEINER S. & BAR-YOSEF O. 1995. Differential burning, recrystallization, and fragmentation of archaeological bone. *Journal of Archaeological Science 22: 223–37*.

STINER M. C., MUNRO N. D. & SUROVELL T. A. 2000. The tortoise and the hare: small-game use, the broad-spectrum revolution, and Palaeolithic demography. *Current Anthropology 41: 39–73*.

WIESSNER P. 1996. Leveling the hunter. Constraints on the status quest in foraging societies. In P. Wiessner & W. Schiefenhövel (eds.), *Food and the Status Quest, an Interdisciplinary Perspective: 171–91*.

WIESSNER P. & SCHIEFENHÖVEL W. (eds.), 1996. *Food and the Status Quest, an Interdisciplinary Perspective*, Providence (RI): Berghahn.

WINTERHALDER B. 1986. Diet choice, risk, and food sharing in a stochastic environment. *Journal of Anthropological Archaeology 5: 369–392*.

WINTERHALDER B., BAILLARGEON W., CAPPELLETTO F., DANIEL I. R. Jr. and PRESCOTT C. 1988. The population ecology of hunter-gatherers and their prey. *Journal of Anthropological Archaeology 7: 289–328*.

YELLEN J. E. 1977. Cultural patterning in faunal remains: evidence from the !Kung Bushmen. In D. Ingersoll, J. E. Yellen & W. Macdonald (eds.), *Experimental Archaeology: 271–331*.

UDK 903.4(497.5)"634"
Documenta Praehistorica XXVIII

The architecture of Early and Middle Neolithic settlements of the Starčevo culture in Northern Croatia

Kornelija Minichreiter
Institut of Archaeology, Zagreb, Croatia
kornelija.minichreiter@IARH.tel.hr

ABSTRACT – *In southeastern Europe, in the region of northern Croatia (between the Drava, Sava, and Danube Rivers), which geographically belongs to southern Pannonia, the first Neolithic settlements developed during the early and middle Neolithic, ca. 6000–4800 BC. Numerous archaeological excavations in the last 25 years have enabled an overview of the development of Starčevo Culture settlements (the earliest Neolithic culture in this region), from the first phases to the end of its development.*

IZVLEČEK – *V jugovzhodni Evropi na severnem Hrvaškem (med Dravo, Savo in Donavo), ki geografsko pripada južni Panoniji, so prve neolitske naselbine nastale v zgodnjem in srednjem neolitiku okoli 6000 do 4800 BC. Številna arheološka izkopavanja v zadnjih 25-ih letih nam omogočajo pregled razvoja naselbin kulture Starčevo (najzgodnej{a neolitska kultura v regiji) od prvih faz do konca njenega razvoja.*

KEY WORDS – *southeastern Europe; southern Pannonia; Croatia; early and middle Neolithic; Starčevo Culture; settlements; architecture*

INTRODUCTION

The first agricultural and pottery-using cultures developed during the early and middle Neolithic in the southeastern European region as parts of the common Starčevo Cultural complex, basically related in terms of material and spiritual culture, but nonetheless different in the cultural and territorial senses. The Starčevo Culture received its name from the village of Starčevo, on the left bank of the Danube, near Pančevo in Vojvodina (Yugoslavia), where the first major excavations were undertaken in 1931/1932. Settlements of the Starčevo Culture have been discovered in southern Hungary, northern Croatia, Vojvodina, Serbia proper, Kosovo, eastern Bosnia and northern Macedonia. The Starčevo cultural complex also includes the Körös Culture in eastern Hungary, the Cris Culture in Romania, the Čavdar-Kremikovci-Karanovo Culture in Bulgaria, and Anzabegovo-Vršnik in Macedonia. It extends throughout the early and middle Neolithic during the early Stone Age (Fig. 1).

In terms of its geographical position, Croatia is culturally oriented and attached to various regions. This was reflected as a major advantage in the luxuriant development of prehistoric cultures and their connections to the surrounding European regions. The region of northern Croatia was permanently integrated into the life and culture of the Pannonian plain and the southeastern Alpine region. Its northern and eastern part, Slavonia, Syrmia, and Baranja, is an area through which influences were spread from southeastern Europe and further from the region of Asia Minor, but also from the east, from the Trans-Caucasus and the Russian-Ukrainian steppe. Along with all these varied cultural connections, each of the cited Croatian regions was to retain its own autochthonous line of cultural development, ideas, and artistic expression.

To the present, 66 sites of the Starčevo Culture, belonging to the early and middle Neolithic, have been

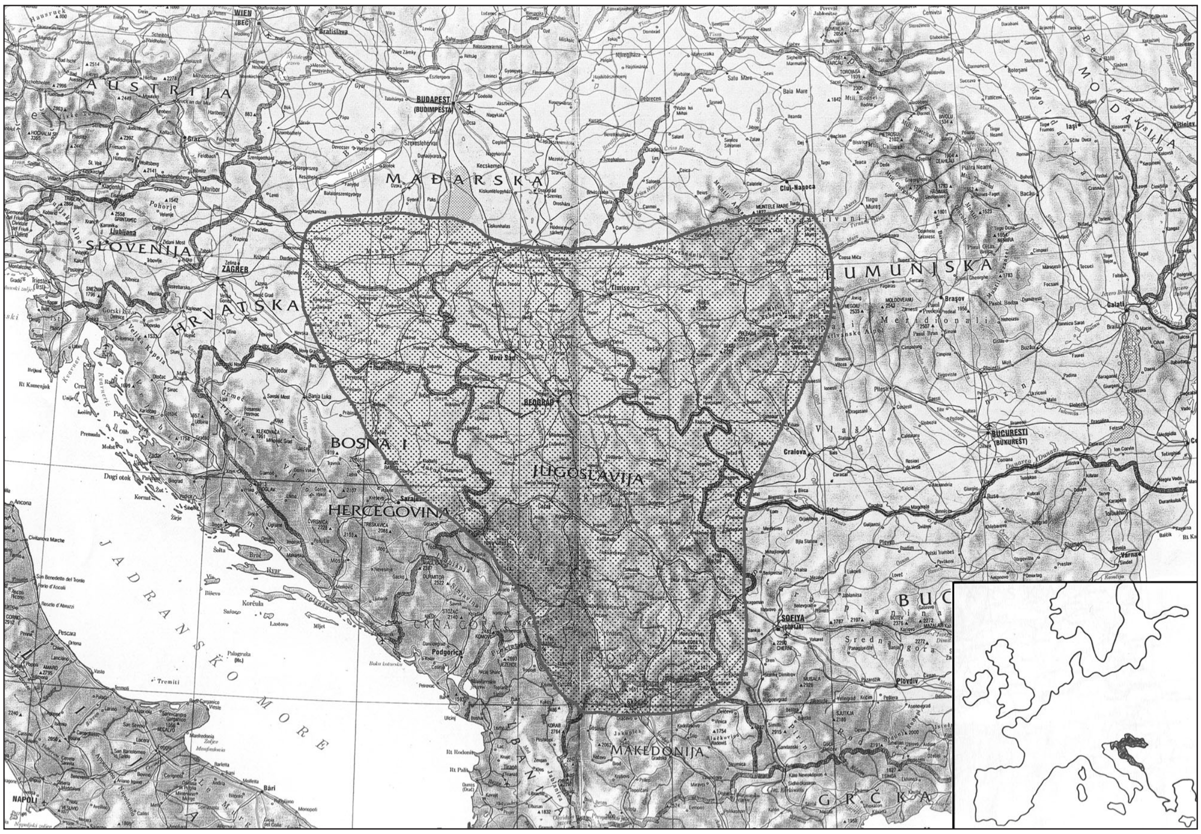


Fig. 1. Distribution map of Starčevo Culture in Southeast Europe.

documented in northern Croatia (*Minichreiter 1997*), and they are dated from the Linear A phase to the end of Spiraloid B (Fig. 2).

THE CHRONOLOGICAL DIVISION OF THE STARČEVO CULTURE

The problems of a unified chronological system for the Starčevo Culture have still not been solved. The broad distribution and, primarily, single layered settlements, mean that 4 chronological systems are currently in use (Milojčić, Garašanin, Dimitrijević, and Srejović), each of which can be applied to a certain geographical region. Of the above authors, S. Dimitrijević was most involved with the Starčevo Culture and its relations to neighboring cultures (*Dimitrijević 1969; 1974; 1979*), and he divided it (according to the stylistic traits of finds in southern Pannonia) into 7 phases: monochrome, Linear A, Linear B, Garlandoid, Spiraloid A, Spiraloid B, and a final phase.

Through a comparison of these four chronological systems, a division of the Starčevo Culture can be coordinated in the following manner (Fig. 3): the beginning developmental phases were named by the authors as Starčevo I (*Milojčić 1950.109–111*), Starčevo I and IIa (*Arandelović-Garašanin 1954.131–141*), the Monochrome and Linear A phases (*Dimitrijević 1970.237–252*), and Proto-Starčevo I and II (*Srejović 1969.173–178*).

The two beginning developmental phases were designated by S. Dimitrijević as the pre-classic Starčevo Culture, which differs from the classic developmental stages in that the vessels lack decoration with channeled barbotine. The decoration of coarse ware with channeled barbotine begins only in the following Linear B phase, denoting the beginning of the classic Starčevo Culture and the period of the middle Neolithic (*Dimitrijević 1979.242–243*). The characteristics of the Linear A phase of the early Neolithic have been confirmed entirely by the numerous examples of pottery discovered in 1989–1990 in the rescue excavations of the Starčevo settlement at Zadubravlje (*Minichreiter 1992.29, 37, 41–43*), and the systematic excavations of the Starčevo settlement with a ritual-burial area at Slavonski Brod (*Minichreiter 1998; 1999; 2000*), which do not contain a single example of decoration with channeled barbotine. The painted motifs are linear, and the vessel shapes rounded, with no bi-conical forms. The classic developmental phase of the Starčevo Culture begins in the period of the middle Neolithic (the Linear

B according to S. Dimitrijević), with the widespread use of barbotine decoration on pottery vessels, which remains to the end of this culture, to the end of the Spiraloid B phase. The classic Starčevo Culture, in addition to linear painting, also contains painting of garlands (the Garlandoid phase), and in the final stages of Spiraloid A and B, spiral decorations also appear on the painted pottery.

Archaeological excavation in northern Croatia after 1985 has confirmed the chronological system of S. Dimitrijević for this region. Settlements of the Linear A stage were discovered at Zadubravlje and Slavonski Brod (Fig. 2), and 20 years earlier S. Dimitrijević had only hypothetically suggested the existence of a Linear A phase within his chronological division. A supplement and minor correction to the chronological system of S. Minichreiter was published in 1985, after the excavations at Pelana, whose archaeological material was placed by K. Minichreiter into a newly defined Linear C phase (*Minichreiter 1990; 1992*). Additionally, we consider that the other sites in western Slavonia (Stara Rača, Cernička Šagovina, and Ždralovi) can be placed in the Linear C stage, and not the final phase of the Starčevo Culture as defined by S. Dimitrijević.

THE TOPOGRAPHICAL CHARACTERISTICS OF THE SETTLEMENTS – THE EARLIEST WATER-BASED ROUTES OF THE NEOLITHIC

The topographical traits of the 66 documented settlements of the Starčevo Culture in northern Croatia indicate certain regularities in the choice of sites for settlements (*Minichreiter 1997*). The main conditions were the possibilities for sustenance: the cultivation of land, hunting areas, gathering fruits and nuts, and stock raising. Other fundamental conditions for life, because of which all Starčevo settlements were built along major or minor bodies of water, were drinkable water, irrigation, fishing, a large choice of river stones for making stone tools, and the possibility of trade connections along navigable routes. As a rule, one of three possibilities depending on terrain was chosen during the construction of a settlement along a water course:

- the high terraces along the banks of the Sava Drava, and Danube Rivers;
- low, sunny hills that gradually descend into small river valleys (for example, western Slavonia: a series of 5 settlements were discovered along with Pepelana in the Breznica River valley);

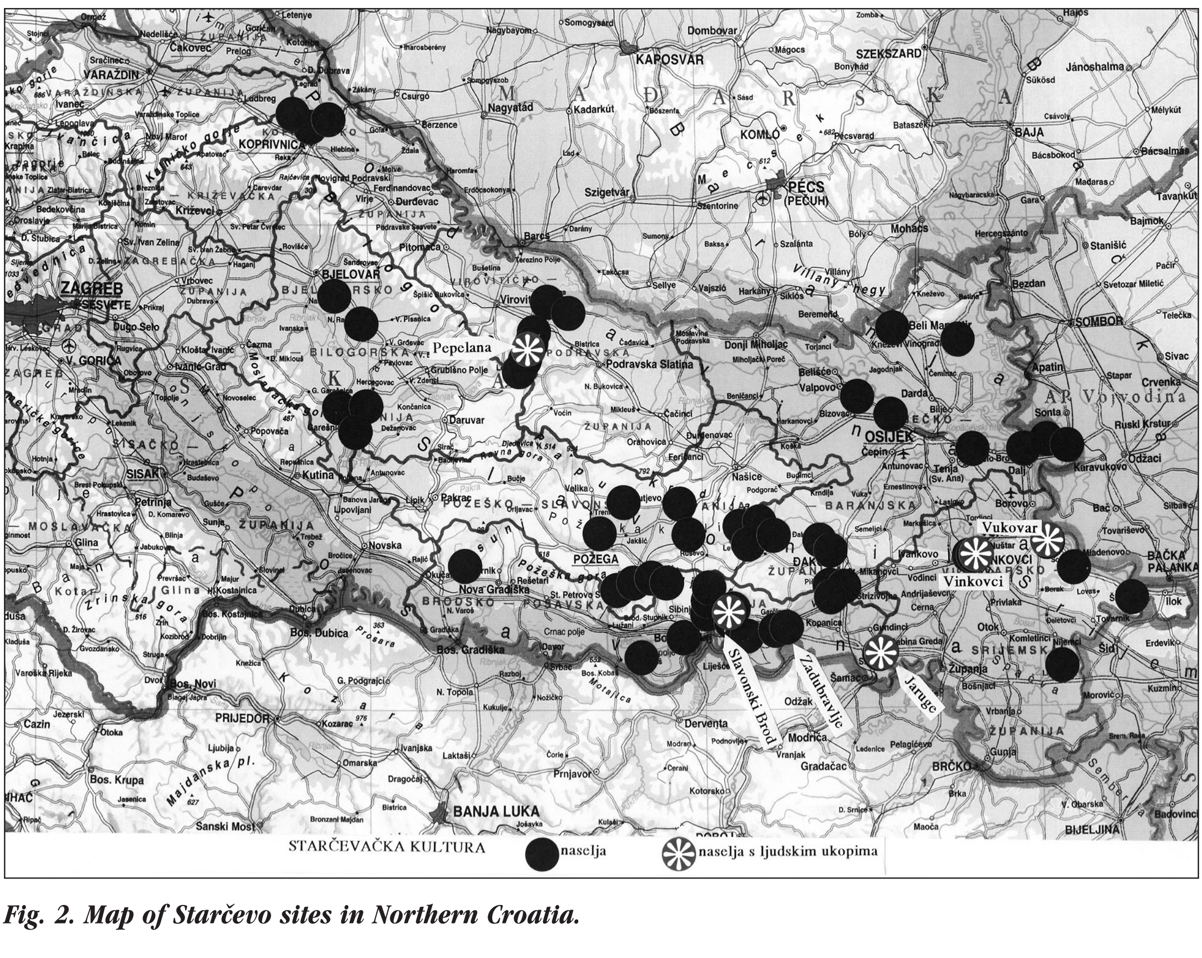


Fig. 2. Map of Starčevo sites in Northern Croatia.

- gently raised, well-drained land; a crest or extension of a hill into a plain along former water courses.

Milojčić	Garašanin	Dimitrijević	Srejović	Neolithik
Starčevo I	Starčevo I	monohrom	Protostarčevo I	rani
	Starčevo IIa	Linear A	Protostarčevo II	
Starčevo II		Lin. B/Girlandoid	Starčevo I	srednji
Starčevo III	Starčevo IIb	Spiraloid A	Starčevo II	
Starčevo IV	Starčevo III	Spiraloid B	Starčevo III	

Fig. 3. The chronological division of the Starčevo Culture.

The Starčevo settlements were never isolated and far from one another (a distance of 3-5 km), but were grouped in a row, in broads stream or river valleys, along water routes. More than half of the documented settlements were discovered in the past 10 years, and only now can they be mapped so as to enable the tracing of the earliest natural routes in northern Croatia. The wide rivers of the Danube, Sava, and Drava, characterized by their slow passage through plains, connected northern Croatia with the other Pannonian regions of this part of Europe. Their tributaries are equally important, which as the only possible natural routes, enabled the Neolithic population to penetrate deeply into the interior of the Slavonian highlands. The waters had a much greater volume of water during the Neolithic, and were navigable, while today, these are small rivers, streams, or even dry beds. The find of two canoes dated to the Neolithic (each made from a single piece of wood) in the Biđ River, into which the Brezna Stream flows (running by the settlement at Zadubravlje), confirms the use of water courses for communication by the Neolithic inhabitants (*Minichreiter 1997a*).

THE ARCHITECTURE: TYPES OF PIT STRUCTURE IN STARČEVO CULTURE SETTLEMENTS

The archaeological excavation of large surface areas of Starčevo Culture settlements at Vinkovci, Pepelana, Zadubravlje, and Slavonski Brod have enabled us to distinguish four basic types of pit structure (*Minichreiter 1992b; 1993*): small pits (working pits or storage pits), medium sized structures (working pits with hearths or kilns, pit-dwellings with one or more rooms), and large pit-dwellings (residential and ritual-burial), and deep pits (wells).

- Small structures: working pits (pit-dwellings) or storage pits; circular, ellipsoid, or kidney-shaped in section, 2-3 m in diameter, 50-70 cm in depth, served as working pits, while pits of the same form, but dug deeper, 1-1.5 m) were very probably storage pits.

At Zadubravlje, pits 19, 20, 21 (Fig. 4) were located in a workshop for producing stone tools. Pit 19 (an irregular rectangular form: 5 x 3.5 m, depth 50 cm) contained around 2000 artifacts: microliths, cores, flakes, chips, whetstones, and unfinished tools, and it is presumed that this was a workshop for the production of stone tools. Pit 20 (an irregular circular form, 2 x 2.5 m, depth 20 cm) and pit 21 (an elongated trefoil form, 3 x 1.2 m, depth 50 cm), not far from pit 19, were probably auxiliary working areas.

At Pepelana, pits 22 and 23 (Fig. 16, upper right corner) were shallow-dug into a plateau northeast of a large pit-dwelling. Given their kidney-shaped forms (2.2 x 1 m, depth 40 cm, and 1.5 x .70, depth 40 cm), they could have served as working pits. Similar pits, only somewhat later in dating, were discovered at the Sopot Culture site of Gornji Brezovljani, cited by S. Dimitrijević as working areas (*Dimitrijević 1978.81-83*, Fig. 16). Deep pits (Fig. 15) were dug into the edge sections of pit-dwellings, such as pit 10 (of ellipsoid form, 1.7 x 0.90 m, depth 1.2 m), which served as storage and refuse pits.

At the "Cibalae Banka" site in Vinkovci, a group of pits (Fig. 18) were discovered (mostly circular, 3-5 m in diameter, depth 50-70 cm), which most probably served as working areas (*Iskra-Janošić 1984. 143*).

- Medium sized structures (4-8 m in diameter with a base dug to 1 m in depth) were working pits with kilns (pottery workshops), and pit-dwellings with one or more rooms, with the rooms arranged according to purpose. The entrance in almost all pit-dwellings was over one or two steps on the eastern, sheltered side, as during the Neolithic period in these regions there were strong prevailing westerly winds (as a rule, drifts of loose prehistoric humus were found on the western side inside the pit-dwellings, indicating strong westerly winds). The edges of the pit-dwellings were formed into so-called "banks" or benches (Vinkovci), which served to support the roof structure, as seating, or for storing household items. The somewhat wider benches on the edges of the pit-dwellings could also have been used for everyday tasks, and they probably also served for sleeping.

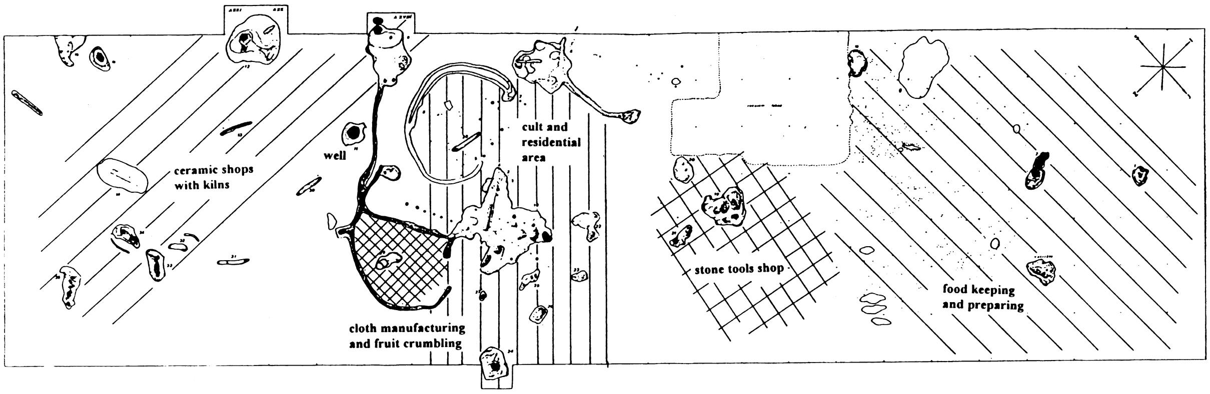


Fig. 4. Zadubravlje, plan of the Starčevo settlement.

Working pits with hearths, ovens, and kilns for various purposes (pits 9 and 12 with an oven for bread and a kiln for pottery) were discovered in the settlement at Zadubravlje (*Minichreiter 1992c*). In the western part of the settlement, where the pottery workshops were located, working pit 9 was built, in an ellipsoid form, 4.5 x 6.5 m, dug to a depth of ca. 60 cm from the surface of the settlement (Fig. 5). The base of the pit was almost flat over the entire area, and the sides were perpendicular except on the northeast, where there was a small entrance or access platform. A pothole from a perpendicular wooden beam (30 x 30 cm, depth 10 cm) was found in the northern part of the pit, probably serving as support for the roof structure. The pit was dug so that it had an undivided large working area in the central and northern area, while there were two ovens for baking bread (with hemispherical domes), and two (cylindrical) kilns for firing large pottery vessels in the southern part along the edge of the pit (*Minichreiter 1992c.40–41*). A shallow pit (50 cm x 60 cm, depth 20 cm) was dug into the floor in the northern part of the working pit, and opposite it, outside the working pit, was an identical small pit (80 x 70 cm, depth 40 cm). These small pits were probably used during the production process, or served for setting aside clay vessels. The western part of the working pit was full of a loose prehistoric humus that had accumulated because of the prevailing westerly winds, and a deposit of greasy gray ashy soil was found in the northwestern section, probably remnants of ash from the ovens and kilns temporarily deposited here. The settlement also contained several small pits in which only ashes from the ovens and kilns were placed (*Minichreiter 1992.31, 32*). Charcoal samples from the southwestern part of the working pit were dated by ^{14}C analysis to the period from 5720–5530 BC (6705 ± 95 BP).

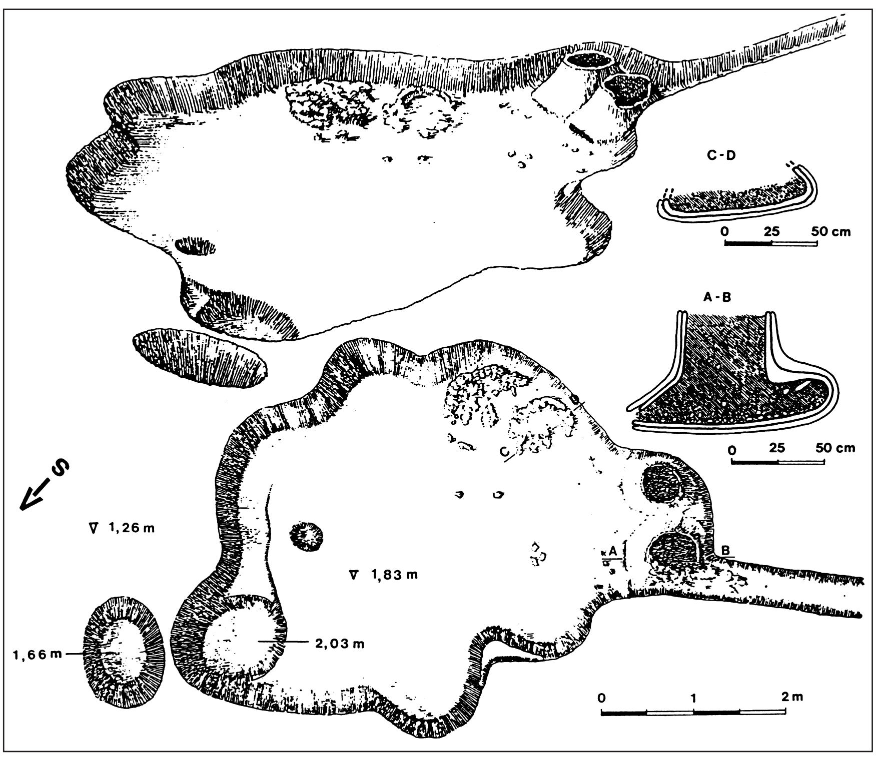


Fig. 5. Zadubravlje, working pit 9, pottery workshop with kilns, plan and perspective (drawing: Miljenko Gregl).

To the west of working pit no. 9, another working pit (no. 12) was discovered, with kilns for firing pottery (Fig. 6). The working pit had an irregular circular shape, with dimensions of 5 x 5.5 m, with a dug out floor on two levels: the northern part was dug 30 cm from the edge of the pit, and the southern part was 30 cm deeper, i.e. 60 cm from the edge of the pit. The entrance to the working pit was probably on the eastern side in the upper (northern) part of the pit, where on the flat floor there was a cigar-shaped kiln for firing small fine vessels and small vessels with painted decoration (*Minichreiter 1992c:42*). The even southern surface of the working pit had a domed kiln with a horseshoe shaped foundation, which probably also served for firing clay objects. This kiln was badly damaged, and its form could not be reconstructed with certainty. The western part of the working pit contained two smaller pits (dug to a depth of 50 cm), on whose edges the potters could sit and control the vents and fuel during the firing period, and vessels could be set aside on the flat surfaces around both kilns during the production process. Charcoal samples from the southern section of the working pit were dated by ^{14}C analysis to the period 5370–5040 BC (6260 ± 130 BP).

One of the most attractive examples of a dwelling structure is pit-dwelling 10 at Zadubravlje (Fig. 7). It was built in the central part of the settlement, southeast of the entrance to the central enclosed area (*Minichreiter 1992. 29–35*). It was shaped like a quatrefoil with a fourth narrower side (6 x 8 m, dug in from 0.20 to 1.00 m), and was the largest structure in the settlement in terms of dimensions. Because of its size, it had both a main and secondary entrance. The main entrance was on the eastern side, with one step and a row of perpendicular pots 3 m in length, which held up the beam over the entrance (Fig. 8). The secondary entrance was in the southwestern part of the structure, in fact a passage from the structure into a large courtyard (11 x 8 m), which was enclosed by a wooden fence. The northern part of the fence was straight in plan, while the southern part of the fence was semicircular, with an entrance from the settlement on the southeastern side. The courtyard was used for producing fabric (a find of 37 clay weights from a vertical loom) and for crushing grain and other foods (20 fragments of stone querns). On the northwestern side of pit-dwelling 10, a row extended of 6 regularly arranged vertical wooden beams (postholes 25 cm in diameter), which were placed parallel to the northern fence of the courtyard. These wooden beams probably supported a slanted roof – an overhanging eave, the southern side of which leant on the courtyard fence. The open

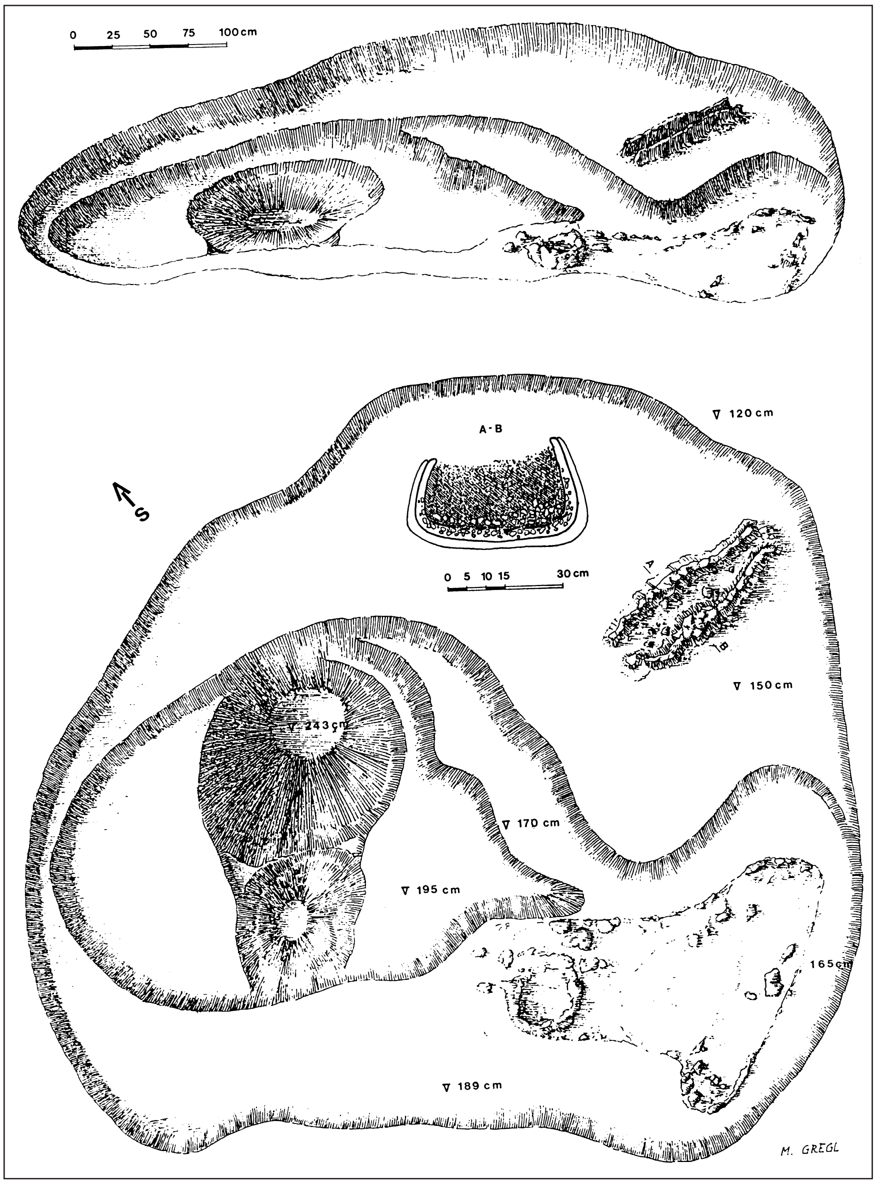


Fig. 6. Zadubravlje, working pit 12, pottery workshop with kilns, plan and perspektive (drawing: Miljenko Gregl).

side of the 'eave-arcade' looked to the north, into the central, circular fenced area. Food for animals could have been kept, or everyday tasks could have been performed under this eave. The interior of pit-dwelling 10 (Fig. 8) was divided into 4 rooms: eastern, southern, western, and northern, the eastern (the first beyond the main entrance) being the largest, measuring 6 x 4 m. Numerous pottery fragments and pieces of bone were found in this room, and cult objects were prominent (*Minichreiter 1992a.7–10*), which is logical, given its size and the possibility of gathering a large number of the inhabitants inside. A narrow pit was found between the eastern and western rooms (an identical area in pit-dwelling 6), which contained traces of densely arranged vertical posts, supported at the base with packed clay extending to a height of 45 cm. The purpose of these structures remain merely conjecture, that is, that this could have been a household shrine. Pits of identical shape in plan, empty or with animal sacrifices, were found in Neolithic settlements at Branč (*Vladar-Lichardus 1968.273–283*) and at Endröd (*Makkay 1992.131–132, Pl. 37/1,2; 39/1–4; 40/1–4*), but those at Zadubravlje are the oldest among them according to the chronological sequence. Pits of similar form have been found at Starčevo settlements in Croatia at Pepelana (*Minichreiter 1990.18*), Černička Šagovina (*Minichreiter 1992. 12*), Vinkovci "Tržnica" (*Dimitrijević 1966.39–42*), and Kneževi Vinogradi, in Baranja (*Šimić 1989.40*), but we still lack sufficient elements for a definite evaluation of their purpose. Complete pots and the remains of animal bones were found in the western room, and a cattle horn was found buried in the floor below them. A similar example was found in the center of a large pit-dwelling with human burial at Slavonski Brod (*Minichreiter 1999.12*), and at the Obre I site in Bosnia and Herzegovina, where the bones of cattle and sheep were found under house K–1, which were suggested by A. Benac to have been the remains of animal sacrifices made during the construction of this dwelling structure (*Benac 1973. 16*). An analysis of a charcoal sample using the ^{14}C method has dated the southeastern part of the pit-dwelling to 5990–5740 BC (6995 ± 115 BP).

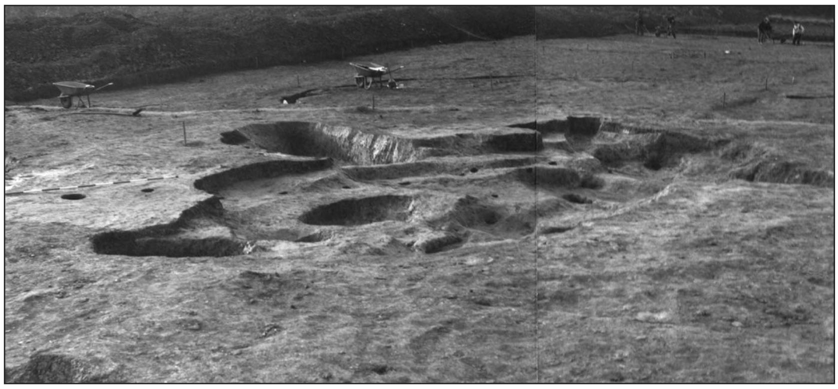


Fig. 7. Zadubravlje, residential pit-dwelling 10, during archaeological excavations (photo: K. Minichreiter).

● The third type of structures were large pit-dwellings used both for habitation and ritual-burial purposes (15 x 7 m, 12.5 x 6.5 m, and 11 x 4 m) discovered at Vinkovci, Pepelana, and Slavonski Brod. At the Starčevo settlement at Pepelana, at site IIA (*Minichreiter 1990.18*), part of a large multi-roomed pit-dwelling was excavated to a length of 25 m and a width of 10 m (Fig. 17). The pit-dwelling could not be excavated entirely (because of the limited possibilities of excavating along the gas-pipeline), so the actual dimensions could not be established. The pit-dwelling was in the shape of a cross or inverted letter "T", with a wide southern and central area, and eastern, northern and western arms. A passageway, 5 m in length and 1.5 m in width, was formed in the eastern part of the central area. The passageway connected the southern, lower part of the pit-dwelling like a ground-floor level to the northern higher section of the "first floor" (with a height difference of around 1 m because of the inclination of the land). The eastern arm of the pit-dwelling was entered from the central part of the passageway over one step, while three steps at the end of the passageway (Fig. 7) led to the northern arm, which again, via a platform in the central section, was connected to the western arm of the pit-dwelling. The exterior edge of the large pit-dwelling was straight, while the edges of the smaller rooms had a step-like form ("bench"). Refuse pits were not found in the central section and its arms, while part of pit 10 (Fig. 15) in the southern section most probably served this purpose. In the "ground floor" of the pit-dwelling, its southern area, a large hearth was uncovered, with a circular plan, 1.5m in diameter, and 30 cm thick, formed in a special niche along the eastern edge of the pit-dwelling. Very poorly preserved remains of human bones, i.e. the lower part of a leg in a contracted position, were discovered in a small niche opposite the hearth. In several places in the northern and central parts of the pit-dwelling (the "first floor"), postholes of perpendicular wooden beams were discovered which held up the over-ground roof structure. The western arm of the large pit-dwelling contained an elongated narrow pit (3.1 m in length, 25 cm in width, and 20 cm in depth), with no pottery finds. An identical pit was discovered west of this, but its purpose remains unknown.

An elongated pit-dwelling with several rooms (12.5 x 6.5 m) was discovered in the northern zone of excavation at the Starčevo settlement at the "NAMA" site in Vinkovci (*Dimitrijević 1979.240*).

Two large pit-dwellings (15 m in length, 7 and 5 m in width, dug to a depth of 1 m) were discovered at Slavonski Brod during excavations of the Starčevo settlement, one of which was for habitation within the settlement, and the other with human burials in a separate and enclosed ritual-burial area (*Minichreiter 1998; 1999; 2000*). The pit-dwelling was damaged on the northeastern side by uncontrolled excavation on the part of a brickworks (by extracting soil from this land to make bricks), so it is only hypothesized that the pit-dwelling had an entrance section on the eastern side. The pit-dwelling contained rows of postholes from perpendicular wooden beams and posts that supported the roof construction (Fig. 11). The usual household belongings were found within the pit-dwelling: numerous pottery vessels, parts of querns, stone tools, and the remains of animal bones. To the south, alongside the large pit-dwelling, two small refuse pits (2 m in diameter) had been dug.

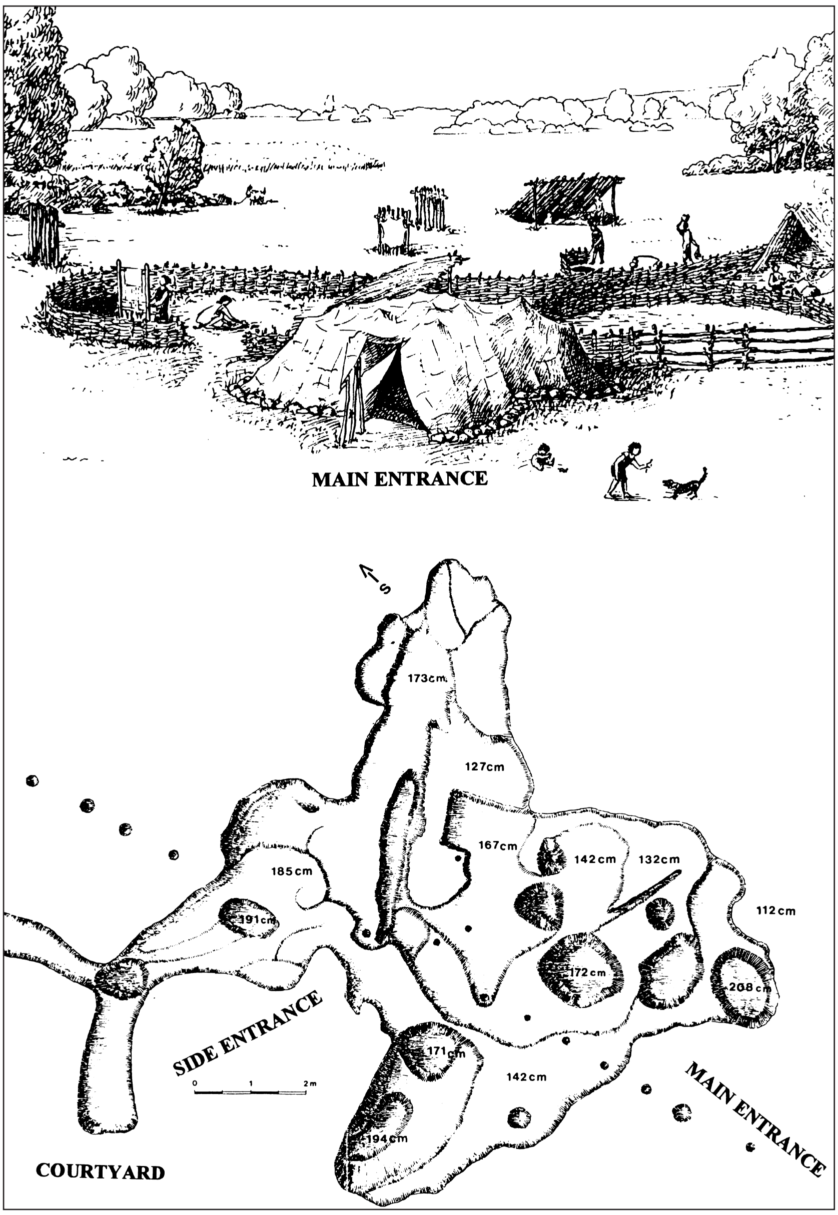


Fig. 8. Zadubravlje, residential pit-dwelling 10 with fenced courtyard, plan and perspective (drawing: Miljenko Gregl).

Another large pit structure, which was similar in form and dimensions to the pit-dwelling, was discovered at the same site within the separated and enclosed ritual-burial area (Fig. 12). The entrance to the large pit-dwelling was via two steps on the eastern side into the central section. Two "cigar" shaped ovens were discovered in the northern room along the outside edge, and it is hypothesized that they served only for ritual purposes (no remains of pottery vessels were found in them as at Zabubravlje, where the kilns, additionally, had fuel sources from a semi-subterraneous structure). Between these two sources, in the inner part of the pit-dwelling, the remains of two human skeletons in a contracted position were discovered (one missing the skull). The central part of the pit-dwelling (the geometrical center of the structure), not far from the entrance stairs, contained a group of pottery vessels, fragments of animal bones, and stone tools, including pieces of burnt earth with a smooth

Fig. 9. Zadubravlje, the well during the excavations (photo: K. Minichreiter).

surface on one side, considered to have been parts of "altar tables". Below all this, a large cattle horn (Fig. 13) was buried in a cult manner in the subsoil, for which analogies exist at Zadubravlje in pit-dwelling 10 (*Minichreiter 1992b.19*), and Obre in Bosnia (*Benac 1973.16*). The southern section of the pit-dwelling contained three groups (each group contained pottery vessels, stone tools, and animal bones), which were arranged in equally spaced intervals. Between them were buried the remains of headless human skeletons, on whose northern side were placed a miniature altar in the form of an animal with a pack on its back and a lump of ocher (*Minichreiter 1998*). This large pit structure did not have the usual roof construction of a pit-dwelling, as postholes were not found from vertical beams. It is hypothesized that only those sections of pit structure with buried human skeletons were covered with horizontally placed wooden logs. The northern and southern sections of the pit structure had edges shaped like a giant step ("bench"), where horizontal or slightly angled wooden logs could be rested. The central part of the pit structure could have been uncovered, as the inhabitants were probably present in this structure only under certain circumstances during special ceremonies, or while offering sacrifices in honor of the deceased who had been buried here. A charcoal sample from the northern part of the pit structure was dated by ^{14}C analysis to 5810–5620 BC (6835 ± 110 BP).

● The fourth type of structure in settlements was deep pits – wells – discovered in the Starčevo settlement at Zadubravlje (*Minichreiter 1992.35; 1993.101–102; 1998a.25–31*). A well was discovered in the western part of the settlement, west of the wooden fence connecting northern working pit no. 9 and southern dwelling pit no. 10, and which protected the central part of the settlement on the western side. The well in its uppermost section had a widened plateau (2.5 m in diameter), with thin posts lined up as a protective fence on the western side, which is logical, as only from this side could people or animals fall into the well. No enclosure was necessary on the eastern side, as the main central area of the settlement, fenced off in a large circle, was not far from the well. In the eastern part of the well plateau, a dug out step was found, on which a thick wooden beam was probably placed to aid in drawing water (Fig. 9). The southern side of the platform had a small access plateau, and only from this side could one stand next to the well. The well had a diameter of 1.5 m, and at a depth of 4.9 meter water appeared during investigations. The well was probably even deeper when it was in use. Several pottery fragments and stone tools were found inside, the finest find being a jug with four lugs and a high cylindrical neck, used for drawing water. Charcoal samples from the bottom of the well have been dated by ^{14}C analysis to 6610–6340 BC (7620±140 BP).

URBANISM: THE ARRANGEMENT AND PURPOSE OF PIT STRUCTURES IN STARČEVO SETTLEMENT STRUCTURES

Archaeological excavations undertaken during the last 30 years in northern Croatia have led to new knowledge about the "urbanism" (the arrangement and purpose of pit structures) of the earliest Neolithic settlements in southern Pannonia through all the developmental phases of the Starčevo Culture.

Zadubravlje: "The Craft Settlement" – The Linear A Phase (Fig. 10)

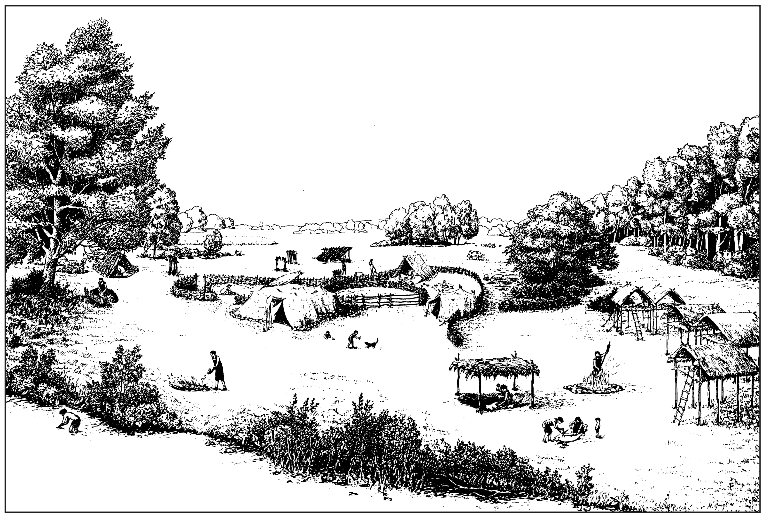


Fig. 10. Zadubravlje, the probable appearance of settlement of Early Starčevo Culture reconstructed on the basis of finds from Zadubravlje by K. Minichreiter (drawing: Miljenko Gregl).

An early Neolithic "craft settlement" of one tribal community was discovered at Zadubravlje during 1989–1990, with an excavated surface area of 6200 m² (*Minichreiter 1992; 1992b; 1992c; 1993; 1997a*). Certain sections of the settlement had strictly determined purposes: an area for storing and preparing food, a workshop for producing stone tools, cult and dwelling areas, courtyards for weaving fabric and grinding grain, pottery workshops with pits for extracting clay, and kilns for firing small and large pottery vessels and clay objects (Fig. 5, 6).

In the easternmost part of the settlement, postholes were uncovered of perpendicular beams probably used to support an above ground storage area for food, with a large open hearth next to it, where food was prepared for the population of the entire settlement (hearths were not found in the pit-dwellings, making this the only hearth in the settlement). Further towards the center of the settlement was a group of working pits: workshops for the production of stone tools and weapons. The central area of the settlement contained two pit-dwellings (northern no. 6 and southern no. 10) with sacrificial pits, with a circular enclosed area of unknown purpose between them. It probably served as a gathering point for the population during certain rites, or perhaps was used for penning stock. The southern pit-dwelling had a semicircular, enclosed courtyard where fabric was produced (weights from a vertical loom were found along the southern fence, where the loom was probably supported), and numerous remains of stone querns indicate the grinding of grain and other foodstuffs and food preparation for the entire community. The central area of the settlement was protected on the western side from animal intrusion by a wooden fence, which also connected the northwestern working pit with the kilns and ovens and the southern pit-dwelling. Beyond the fence, on the western side, a well was dug (depth ca. 5 m), with a system for extracting water (a horizontally placed wooden log), and a small protective fence on the western side. The western part of the settlement contained pottery workshops with kilns (working pits no. 9, 12, 14) and working pits for the extraction and treatment of clay (pits 32, 33, 34, 35). Working pit 9 contained a double kiln (cylindrical) for firing large

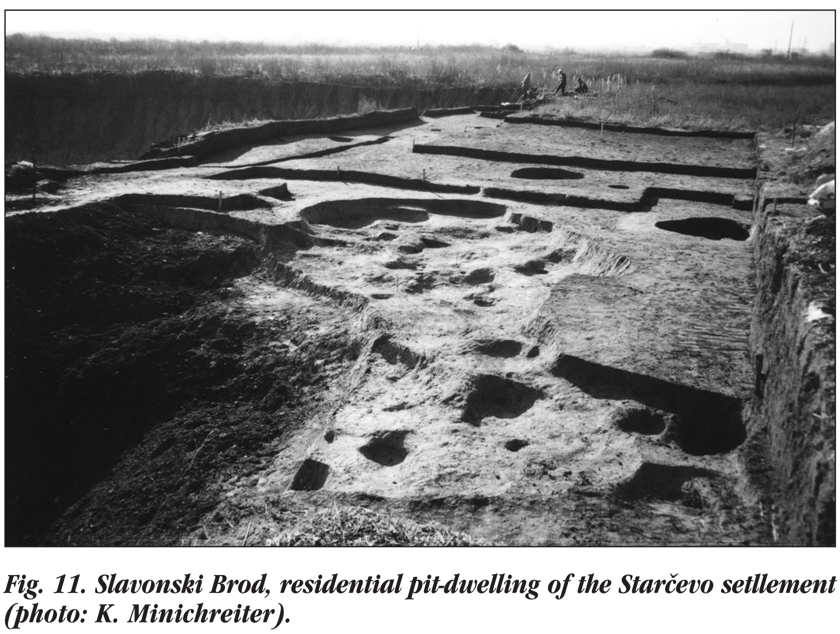


Fig. 11. Slavonski Brod, residential pit-dwelling of the Starčevo settlement (photo: K. Minichreiter).

Fig. 12. Slavonski Brod, pit-dwelling in the Starčevo ceremonial and burial area site (photo: K. Minichreiter).

vessels, and two bread ovens (hemispherical forms). Working pit no. 12 contained two kilns: one quite damaged (horseshoe-shaped in plan), and another, of "cigar" shape, for firing fine and painted pottery. Working pit no. 14 contained another "cigar" kiln, of somewhat greater dimensions than the kiln in pit 12. This part of the settlement also had pits for the extraction and working of clay, as semicircular wooden fences were found next to the pits that contained packed clay used in the preparations for making pottery vessels. On the basis of material found during excavations, a reconstruction (on paper) was carried out for the first time in this part of Europe of an early Neolithic "craft" settlement of the Starčevo Culture, as discovered in northern Croatia.

Slavonski Brod: The Settlement and the Ritual-Burial Area – The Linear A Phase

From 1997, systematic archaeological excavation was undertaken in Slavonski Brod at a large settlement of the Starčevo Culture, where a specially separated ritual-burial area was discovered with the buried remains of selected members of this tribal community (*Minichreiter 1998; 1999; 2000*). A surface area of 1500 m^2 has been excavated, and excavations still continue. A cult-burial area was separated and enclosed by a semicircular wooden fence, in which one large and one small pit were found (Fig. 14). The large pit-dwelling (15 x 7 m) had an entrance on the eastern side, and a clump of pottery in its center, beneath which a cattle horn had been ceremonially buried. The northern part of the pit-dwelling contained two "cigar" shaped kilns, which had fuel sources on the exterior side of the pit structure, and which probably served only for ritual purposes. Two human skeletons (one headless) were buried near the kilns in the pit-dwelling, in a contracted position, covered with soil mixed with pieces of pottery and stone tools. Three groups of pottery vessels were discovered in the southern section of the pit-dwelling (special rites probably took place here in honor of the deceased), as well as one human burial, in a contracted position, and lacking a head. The pit-dwelling did not have a large roof construction, and it was probably only partly covered by a low cover of horizontally placed wooden logs. To the west of the large pit-dwelling, a small pit-dwelling was discovered (5 x 5 m, dug to a depth of 1 m), with an entrance stair on the northern side. To the east of the entrance, a large group stone axes and minor tools was discovered, while in the western section, human skeletons having only the rear portion of the skull buried in a contracted position.

Fig. 13. Slavonski Brod, a group of ceramic pottery above the cattle horn in the middle of the pit-dwelling in the Starčevo ceremonial and burial area site (photo: K. Minichreiter).

The skeleton was buried under soil mixed with pottery fragments, tiny stone tools, clay discs, and parts of zoomorphic religious sculptures (duck heads). Postholes from small poles were found on the edges of the pit-dwelling, and around the pit-dwelling there were holes of perpendicular wooden beams (30–40 cm in diameter) arranged in rows, so that a wide arcade existed above the entrance section of the dwelling, indicating the special formal character of this pit-dwelling, where, probably, a prominent member of the tribal community was buried. On the northwestern side, the ritual-burial area was enclosed by a semicircular wooden fence, and on the southwestern side by a free-standing double semicircular fence, whose purpose is not entirely clear at present. The western section contained rows of postholes from large wooden columns that could have held up an eave above the "western gates" – the passage from the settlement into the ritual-burial area. Beyond the fence and further to the west, the settlement continued, where to date two pit-dwellings and several refuse pits in their vicinity have been excavated. One pit-dwelling was large (15 x 5 m), in form, size, and orientation very similar to the one in the ritual-burial area, except this pit-dwelling had rows of postholes from wooden beams that supported a roof above it. The entrance to this pit-dwelling was most probably on the eastern side, but this could not be confirmed, as this part of the structure was destroyed by extraction for the brickworks. Archaeological excavations will continue at this site, which will enable an overview of the arrangement of structures at what is so far the largest settlement from the early phases of development of the Starčevo Culture not merely in Croatia, but also in the broader region of southern Pannonia.

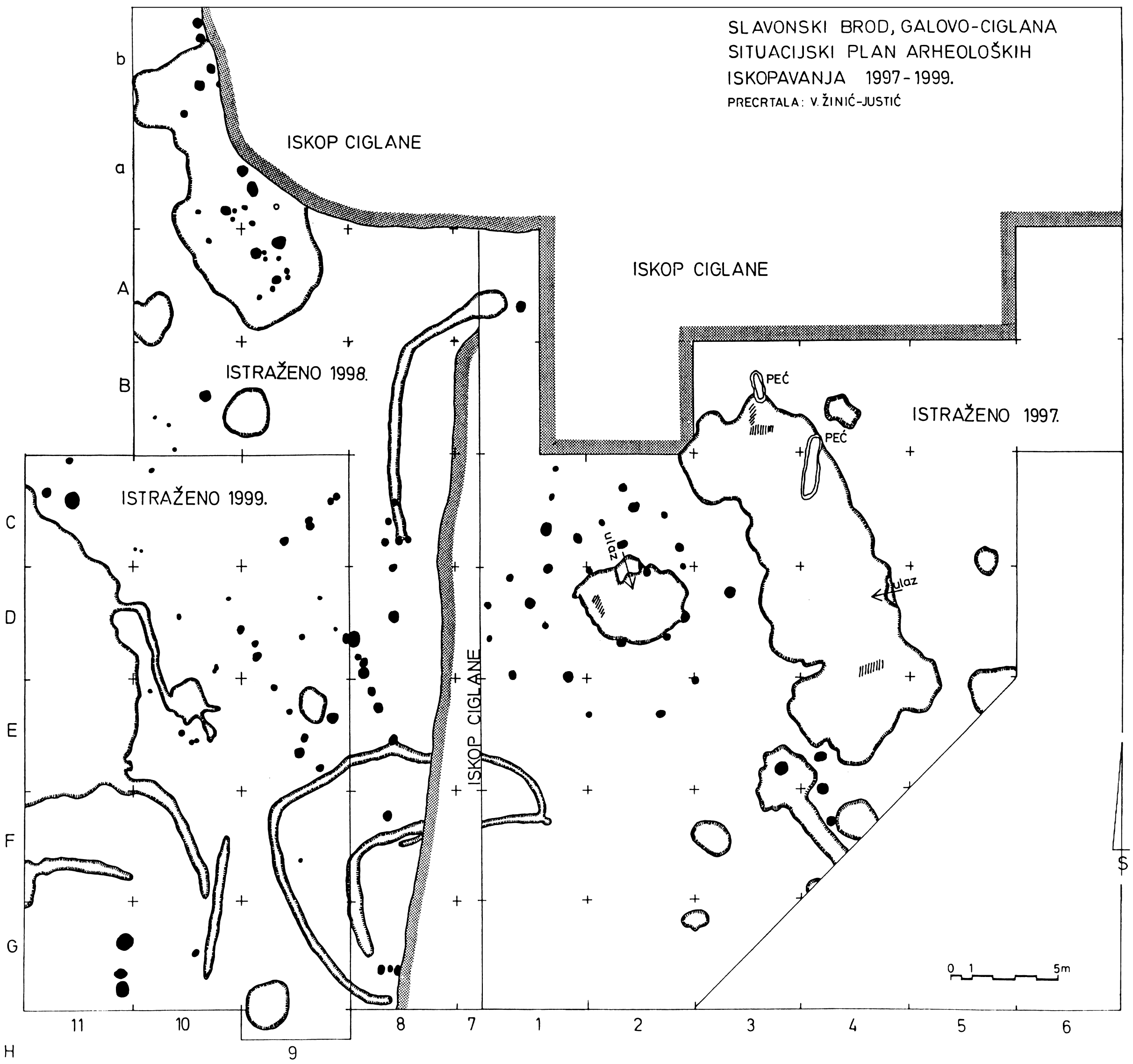


Fig. 14. Slavonski Brod, the situational scheme of archaeological field research in 1997, 1998 and 1999.

Pepelana: The Neolithic and Eneolithic Settlement – The Linear C Phase

A rescue excavation was carried out in 1985 on the route of the gas pipeline from Pepelana to Suhopolje, where a surface area of 400 m^2 was investigated to an average depth of 1 m. The site extends over an area of 800 x 1000 m. The archaeological complex is composed of a large tell, 90 x 90 m, by 4 m in height, and two elongated hills that gently descend to the banks of the Brežnica River (*Minichreiter 1992.17–20*). As the extent of the excavation was limited, only one large pit-dwelling on a hill was investigated, with a length of 25 m and width of 10 m (Fig. 17). The pit-dwelling was shaped like a reversed letter "T" with a wide southern and central area, and eastern, northern, and western arms. The eastern section of the central area contained a passageway 5 m long and 1.5 m wide that connected the southern, lower part of the "ground floor" of the pit-dwelling, and the upper "first floor". From the central part of the passageway, one step led to the eastern arm of the pit-dwelling, while across three steps the northern arm was reached, which was connected to the western arm of the pit-dwelling across a platform in the central section. The southern section of the pit-dwelling had a deeper dug pit for refuse, which contained discarded pottery fragments. A large hearth was also discovered in the southern area, 1.5 m in diameter and 30 cm thick, and opposite this, the remains of a human skeleton in a contracted position were buried. The northern and central part of the pit-dwelling contained postholes from large perpendicular columns that held up the above-ground roof construction. Two small working pits were discovered northeast of the pit-dwelling. The relatively limited area excavated at Pepelana meant that the arrangement of the structures in the settlement could not be determined, but the excavated pit-dwelling showed a previously unknown form of construction on two levels ("ground floor and first floor").

Fig. 15. Pepelana, refuse – pit 10 (photo: K. Minichreiter).

Vinkovci: a multi-strata settlement of the Starčevo Culture – Linear B to Spiraloid B Phase (Fig. 18)

In the southern part of the town of Vinkovci, on the elevated bank of the Bosut River, a multi-strata settlement from the late developmental phases of the Starčevo Culture was found at several scattered sites in rescue excavations (*Dimitrijević 1979.238–240; Iskra-Janošič 1984.143–151; Minichreiter 1992.24–28*). At the "Tržnice" (Market) site, a micro-unit of the Starčevo settlement was found, and this in the northern and southern zones, while the empty central area contained only several fragments of pot-

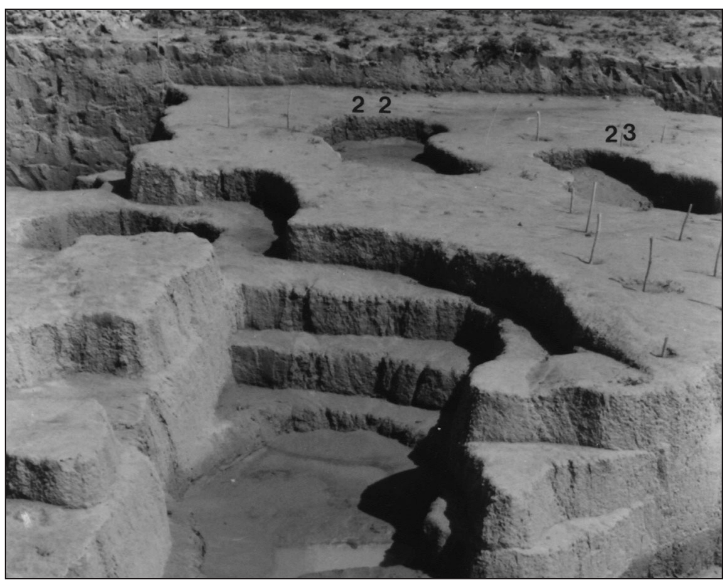


Fig. 16. Pepelana, working pit 22 and 23 (photo: K. Minichreiter).

tery. Subterranean dwellings with several rooms were discovered in the southern zone of "Tržnice". One of the pit-dwellings had a trefoil shape, and another trapezoidal. The pit-dwellings had an entranceway, and on its edges on the exterior and interior sides, postholes were found from the wooden beams that supported the roof. Along the steep sides of the pit-dwelling, support posts were inserted (oblique or horizontal), which strengthened the interior row of bearing beams. An oven of some type, with an arched covering, most probably a kiln used for firing pottery, was discovered north of the pit-dwelling. Shallow excavated pits, which were probably working areas, were discovered in the northern zone of the "Tržnice" site. At the site of "Cibalae Banka" (Jugobanka), part of the Starčevo settlement was discovered with densely dug, small working and refuse pits (Fig. 18), and two groups of structures were discovered at the "Nama" department store site. The northern zone contained two pit-dwellings of medium size (12.5 x 6.5 and 9.7 x 5.5), and seven smaller pits (probably for refuse) that surrounded it in a horseshoe shape. One of these pit-dwellings contained the buried remains of 7 human skeletons in a contracted position. Six pit structures were found in the southern part of the "Nama" site: one large pit-dwelling (11 x 4 m) and three medium ones (5 x 4 m, 6 x 4 m, and 6 x 4.5 m), and two small refuse pits. A grouping of dwelling structures with empty areas between them, was noted at all the Vinkovci sites.

Fig. 17. Pepelana, residential pit-dwelling with a passage in upper level, the Classical phases – Linear C of the Starčevo Culture (photo: K. Minichreiter).

The numerous archaeological excavations in the past 25 years in northern Croatia have enabled a review of the development of Starčevo Culture settlement (the earliest Neolithic culture in this region) from its beginnings to the final stage of its development. The results of research up to the present have enabled us to identify the basic elements of the "urban" growth of these settlements, and the arrangement, form, and purpose of the pit structures in them; this will serve as fundamental material for the further investigation of the very first cultures in these areas, and the process of the spread of the Neolithic throughout southern Europe.

Fig. 18. Vinkovci, Cibalae banka (Jugobanka), Starčevo horizon of production and refuse pits – the Classical phases Linear B and Spiral B (photo: K. Minichreiter).

REFERENCES

ARANĐELOVIĆ-GARAŠANIN D. 1954. *Starčevačka kultura,* Ljubljana: 1–151

BENAC A. 1973. Obre I. *Glasnik Zemaljskog muzeja Bosne i Hercegovine u Sarajevu n.s. vol. XXVII/XXVIII.*

DIMITRIJEVIĆ S. 1966. Rezultati arheoloških iskopavanja na području vinkovačkog muzeja od 1957. do 1965.g. *20 godina Muzeja Vinkovci: 35–99.*

1969. Starčevačka kultura u slavonsko-srijemskom prostoru i problem prijelaza starijeg u srednji neolit u srpskom i hrvatskom Podunavlju, (Die Starčevo-kultur im Slawonisch-Syrmischen Raum und das Problem des übergangs vom Älteren zum Mittleren Neolithikum im Serbischen und Kroatischen Donaugebietet), *Neolit i eneolit u Slavoniji: 1–96.*

1974. Problem stupnjevanja starčevačke kulture s posebnim obzirom na doprinos južnopanonskih nalazišta rješavanju ovog problema (Das Problem der Gliederung der Starčevo-kultur mit Besonderer Rücksicht auf den Beitrag der Südpannonischen Fundstellen zur Lösung dieses Problems). *Počeci ranih zemljoradničkih kultura u Vojvodini i srpskom Podunavlju, Materijali X: 59–121.*

1978. Neolit u sjeverozapadnoj Hrvatskoj – Pregled stanja istraživanja do 1975. godine, (Das Neolithikum in Nordwestkroatien – Überblick über den Stand der Forschung bis 1975), *Arheološka istraživanja u sjeverozapadnoj Hrvatskoj, Izdanje Hrvatskog arheološkog društva, band 2: 71–128.*

1979. Sjeverna zona. *Praistorija jugoslavenskih zemalja II, Neolit: 229–362.*

ISKRA-JANOŠIĆ I. 1984. Arheološka istraživanja na području općine Vinkovci (Archäologische Forschungen im Gebiet der Gemeinde Vinkovci), *Arheološka istraživanja u istočnoj Slavoniji i Baranji, Izdanje Hrvatskog arheološkog društva band. 9: 143–151.*

MAKKAY J. 1992. Excavations at the Körös culture settlement of Endröd – Oregszölög 119 in 1986–1989, *Cultural and Landscape Changes in South-East Hungary I, Reports on the Gyomaendrod Projekt.*

MILOJČIĆ V. 1950. Körös – Starčevo – Vinča, *Reinecke Festschrift: 108–120.*

MINICHREITER K. 1990. Starčevačko naselje u Pepelanama kod Virovitice (Eine Ansiedlung der Starčevo kultur in Pepelane bei Virovitica), *Vjesnik Arheološkog muzeja u Zagrebu, 3 serija – vol. XXIII: 17–40.*

1992. *Starčevačka kultura u sjevernoj Hrvatskoj (The Starčevo Culture in Northern Croatia):* 1–104.

1992a. Kultni predmeti starčevačke kulture u sjevernoj Hrvatskoj (Kultgegenstände der Starčevo-kultur in Nordkroatien). *Prilozi Instituta za arheologiju u Zagrebu, vol. 9/1992: 7–22.*

1992b, Ranoneolitička arhitektura sjeverne Hrvatske (Frühneolithische Architectur Nordkroatiens). *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji XX: 17–25.*

1992c. Peći u starčevačkom naselju kod Zadubravlja (Öfen in der Starčevo Kultur Stammenden Siedlung bei Zadubravlje), *Opvscvla archaeologica vol. 16: 37–49.*

1993. Arhitektura starčevačkog naselja kod Zadubravlja (The arhitecture of the Starčevo settlement at Zadubravlje near Slavonski Brod). *Arheološka istraživanja u Slavonskom Brodu i Brodskom Posavlju, Izdanje Hrvatskog arheološkog društva vol. 16/1991: 97–111.*

1997. Otkriče u Lukaču i Požegi kao prilog poznavanju topografije naselja starčevačke kulture u sjevernoj Hrvatskoj (Entdeckung in Lukač und Požega als ein Beitrag zur Kenntnis der Topographie der Siedlungen der Starčevo-Kultur in Nordkroatien). *Prilozi Instituta za arheologiju u Zagrebu, vol. 11–12/1994–1995: 7–36.*

1997a. Otkriče najstarijeg bunara na tlu Hrvatske u arheološkim istraživanjima kod Slavonskog Broda (Discovery of the Oldest Well on the Territory of Croatia during Archaeological Investigations in the Area of Slavonski Brod). *Hrvatske vode vol. 5, number 20: 215–221.*

1998. Zoomorfna idoloplastika obredno-ukopnog prostora starčevačkog lokaliteta na Galovu u Slavonskom Brodu (Zoomorphic Idols on the Starčevo Ceremonial and Burial Area Site at Galovo, Slavonski Brod). *Prilozi Instituta za arheologiju u Zagrebu, vol. 13-14/1996-1997: 7-22*.

1998a. The Oldest Neolithic Water-Well in Croatia from the Early Starčevo Settlement near Slavonski Brod. *Brunnen der Jungsteinzeit, Internationales Symposium in Erkelenz 27. bis 29. October 1997, Materialien zur Bodendenkmalpflege im Reinland 11: 25-31*.

1999. Ranoneolitički ukopi i pogrebni običaji u naseljima starčevačkog kulturnog kompleksa (Early Neolithic Burials and Funerary Customs in Settlements of the Starčevo Culture Complex). *Prilozi Instituta za arheologiju u Zagrebu, vol. 15-16/1998-1999: 5-20*.

2000. Reljefni prikaz ženskog lika na posudama starčevačke kulture (Relief Images of Female Figures on Starčevo Culture Vessels). *Prilozi Instituta za arheologiju u Zagrebu, vol. 17/2000: 5-15*.

SREJOVIĆ D. 1969. Naslednici (Les Heritiers). *Lepenski Vir, nova praistorijska kultura u Podunavlju: 1-328*.

ŠIMIĆ J. 1989. Kneževi Vinogradi/Osnovna škola, Neolitsko naselje (Kneževi Vinogradi/Primary school, Neolithic Settlement). *Arheološki pregled 28, Archaeological Reports 1987: 40*.

VLADAR J., LICHARDUS J. 1968. Erforschung der Frühaneolithischen Siedlung in Branč. *Slovenska Archeologia XVI-2.*

UDK 903.2(497.5)"636":529.3
Documenta Praehistorica XXVIII

Celestial symbolism in the Vučedol culture

Aleksandar Durman
Department of Archaeology, University of Zagreb, Croatia

ABSTRACT – *The article presents the Vučedol Culture conception of the world, as shown on their vessels, particularly the terrines and the vessels developed from them – referred to as censers. They had more of a ritual than a practical role. Particular attention is drawn to the pot with the calendar image.*

IZVLEČEK – *V članku obravnavamo pojmovanje sveta v kontekstu Vučedolske kulture, kot se kaže na njihovih posodah, še posebej na terinah in posodah, ki so se razvile iz njih – takoimenovanih kadilnicah. Te posode so imele bolj ritualen kot praktičen pomen. Posebno pozornost namenjamo posodi s sliko koledarja.*

KEY WORDS – *Vučedol; pottery; calendar*

INTRODUCTION

The right bank of the Danube River in eastern Croatia was settled by members of the Vučedol Culture at the beginning of the third millennium BC. This predominant cultural phenomenon (in the period between 2900–2400 BC) had a great influence on other contemporary cultures, and it also left behind considerable traces in the European heritage as a whole. Its high standards were first achieved through an economy related to stock-raising, and in later phases on mining and copper metallurgy based on a new revolutionary technological process – mass casting. The need for copper resulted in the expansion of the Vučedol Culture from its homeland of Slavonia into the broader region of central and southeastern Europe. Society became stratified, as is shown by the rich princely graves. It is increasingly clear that the inhabitants of Vučedol were not merely of Indo-Europeanised proto-Mediterranean ancestry, instead being the direct descendants of the Indo-Europeans.

The eponymous site of Vučedol has to date given the greatest contribution to reconstruction of the entire Vučedol Culture, but other important information has been offered by the finds from several sites in Vinkovci (*Hotel*, *Zvijezda*), and from Damić Gradina at Stari Mikanovci and Sarvaš near Osijek.

This article wishes to present the Vučedol Culture conception of the world, as shown on their vessels, particularly the terrines and the vessels developed from them – referred to as censers. They had more of a ritual than a practical role. The decoration on them is sometimes paralleled by that on smaller vessels. Shallow bowls sometimes also bear certain messages, but as a rule they present only part of the symbolism of the others. Chalices with a short pedestal are particularly interesting, most often decorated inside and outside, but with a completely different conceptual idea. They increasingly replaced the terrine form at the end of the Vučedol Culture. The terrines first lost their evolved ancient form (a long banded handle in place of a tunnel-shaped one, and this connecting the rim of the vessel with a rounded body in place of the usual sharply biconical edge), and soon afterwards their characteristic decoration.

The decoration on the vessels was made with grooved incisions, which is technically close to a slanted continuous slicing made by a large thorn (up to 3 mm in diameter) as an instrument. The incisions must have represented recognizable and clear symbols, as the empty spaces were carefully filled after firing with the crushed shells of snails or river shellfish, mixed in a base of natural resins.

It is interesting that the earliest pottery of the Vučedol Culture, discovered in several refuse pits at Vučedol itself, bears no traces of encrustation, and the first terrines have a continuously incised horizontal line immediately above the biconical break on the body of the vessel (Fig. 1).

At almost the same time, shallow or somewhat more emphasized contours appear above this line, such as could be used in elementary form of art to evoke some actual outlines on a horizon – isolated heights or mountains (Fig. 2, 3).

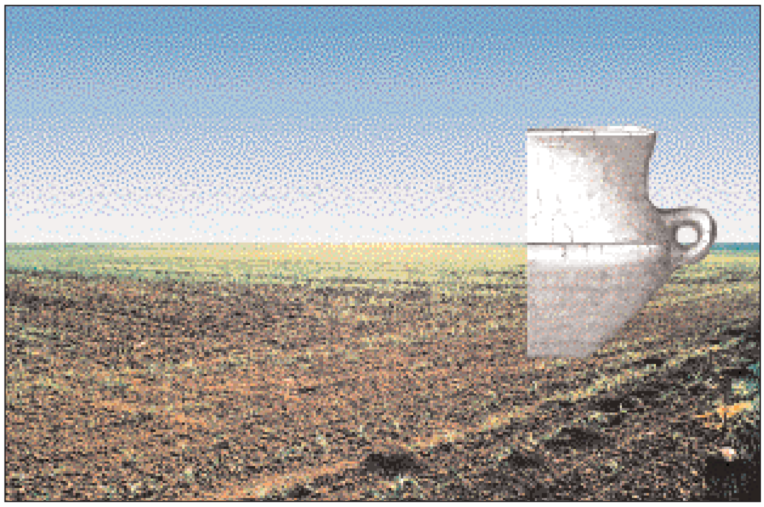


Fig. 1.

And God said: "Let the water under the heavens gather into one place and let the land appear!"...."
The Holy Bible, Genesis, 1, 9.

It seems like the first horizontal line denoted the lucid idea of delineating a horizon. This "pattern" was an interpretation or image of the world presented on pottery, where the widest part of the vessel – the biconical edge of the body – represented a division between the visible and invisible worlds, thus that section crying out for attention.

"Then running round the shield-rim, triple ply, he pictured all the might of the Ocean stream."
The Iliad, 18, 607–608

The visible part of the horizon was soon "canonized" into the classic Vučedol Culture, and was filled with a centimetre wide horizontal band with incised lattice-like lines, whether zigzag, oblique, or with impressed circles (Fig. 4, 5).

The incrustation itself often covered the actual decoration in this horizontal band, as was discovered only when an external layer simply fell apart after cleaning a vessel removed from an archaeological layer. Even today, this decoration cannot be seen under certain encrusted sections. It is as if the incised decoration in this band was not of any particular importance, having already served primarily as a foundation onto which the encrustation could be applied.

Those pottery fragments recovered from greater depths, or those found under conditions meaning that they had not been exposed to constant freezing, preserved a red border along the white encrustation.

In the ancient Indo-European religion, and thus in many others, the idea is preserved of the Earth floating on the Ocean.

"... beyond famed Oceanus at the world's edge hard by Night"
Hesiod, Theogony, 275–276

In southern Mesopotamia they believed that all the springs, wells, streams, rivers and lakes received their water from an ocean of fresh water lying be-

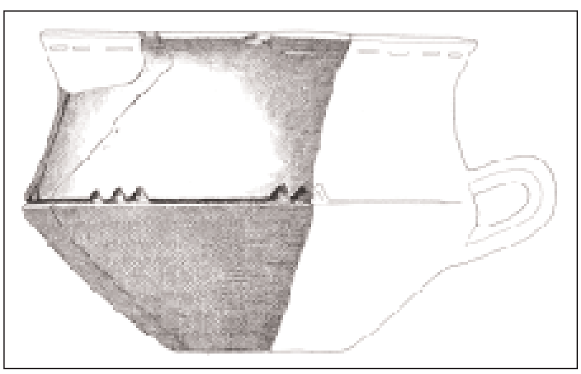


Fig. 2.

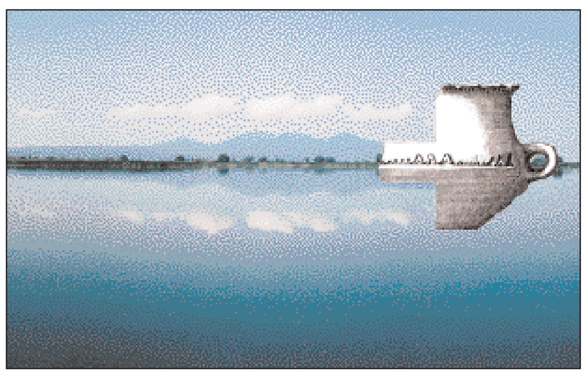


Fig. 3.

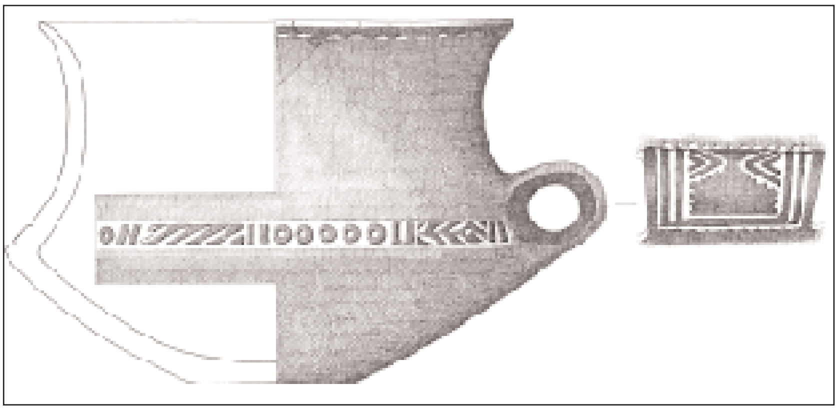


Fig. 4.

low the land (Abzu or Apsu). The land was surrounded by the salty ocean – Tiamat.

(Black, 1992, 27).

Nonetheless the principle of the “canonized band”, which is only a millimeter or at most two above the biconical, widest part of the vessel, could be replaced only by two symbols that (in their actual and religious importance) exceed the contour of the horizon.

The first symbol that negates the horizon is an image of the Sun. It is always placed so that its centre lies on the biconical point (Fig. 6, 7). On small terrines, four suns are placed symmetrically as a rule. This position symbolically denotes the sun’s rise from the depths of the sea, where it was during the night. Dawn is the most important moment of the entire day, the moment when the darkness of night is overcome.

“The sun dipped, and all the ways grew dark upon the fathomless unresting sea. By night our ship ran onward toward the Ocean’s bourne, the realm and region of the Men of Winter, hidden in mist and cloud. Never the flaming eye of Helios lights on those men at morning, when he climbs the sky of stars, nor in descending earthward out of heaven; ruinous night being rove over those wretches.

Odyssey, 11, 13–19

But while such a depiction of the sun can be seen to represent the daily battle of light and dark, where the Sun arising from the Ocean (Fig. 8) overcomes the dark (death), the next symbol representing the constellation of Orion undoubtedly refers to the annual battle between light and dark.

Orion (Fig. 9, 10), shown with five stars, is incised on the biconical edge of the vessels, where the central one is always placed (it is depicted as larger, as three smaller stars from the belt of Orion are incorporated in it). Orion is the most dominant constellation of the winter sky, and its belt (in Croatian known as “the Reapers”) fell below the horizon exactly at the spring equinox in 2800 BC. The disappearance of Orion (specifically the belt) from the heavens marked the end of winter, and the previously mentioned solar symbol on the horizon is celebrated the same day, but as the first day of spring. This day was the main annual visual clue for determining the year of Vučedol, more precisely representing the beginning of the New Year for the inhabitants of Vučedol.

The find from Vučedol that many interpret as a worshipper, is the only known graphic image of a human figure in the Vučedol Culture (Fig. 11). This figure is undeniably an anthropomorphous representation of Orion. The most important aspect of this is the conclusion that the inhabitants of Vučedol (like the Egyptian, the Greeks, etc.) perceived Orion as a human figure.

Fig. 5.

The part of a terrine that descends from the body and narrows towards the base was never decorated with incision and encrustation in the classical Vučedol Culture. But the jugs and the low chalices that developed from the terrines in the later phase of the culture were filled in the lower narrow section with exclusively zigzag or wavy lines, which in primitive painting always designate water or the mythic ocean in which the world floats (Fig. 12, 13). The depths of these waters are unknown to man, who knows only the flickering surface, but can only be conjectured in fear.

Fig. 6.

According to the cosmogony of Heliopolis (Egypt), the Sun evolved through its own power from Nun, the fluid and immobile, languid chaos.

Under the surface, in the depths of the ocean, was the void in which man definitely lost firm land under his feet and where he fell into a bottomless abyss – the realm of water, but also death.

The decoration on the low chalices on a single widened pedestal was made in a special way (Fig. 14). The upper edge of the vessel always denotes the horizon, as a series of wavy or zigzag decorations are often incised on its narrow rim. On the outside, the vessel as a rule is decorated with large zigzag line in negative, extending from the rim to the base, which at first glance look like some kind of flower with five or six petals. When the vessel stands on its pedestal, this exterior part displays the water on which the Earth floats. The inner part of the vessel was filled with variously organized symbols that stand independently or in specially marked fields. They most commonly bear a recognizable symbolism of the Sun, its daily or yearly rotation, and we can hypothesize that this was the natural position of the vessel in which the firmament was reflected. But when the vessel is turned over as a lid, the vault of heaven is denied to the viewer, and the decoration of water or the ocean dominates on the outside. As the wavy line on the rim of the vessel shows the boundary of the visible horizon, it can perhaps be suggested that the horizon was reversed here, and that only with the vessel that it covered did it perhaps form a unit. Very frequently the pedestal of the chalice was made like a classic cross or a cross was incised and encrusted on the underside of its circular base (Fig. 15). This was a perception of the Sun in the moment when it is entirely covered, under the horizon at the bottom of the Ocean, at night or in winter, or in the reversed position, as a lid, at the zenith of the diurnal or summer sky.

"Where is Surya now (after sunset) and which celestial region his rays now illumine?

Rig-Veda I, 35, 7

"The nether waters formed not only the home of the evil spirits and the scene of fights with them, but that it was the place which Surya, Agni, Vishnu, the Ashvins and Trita had all to visit during a portion of the year."

Tilak, 1903, 306

Fig. 7.

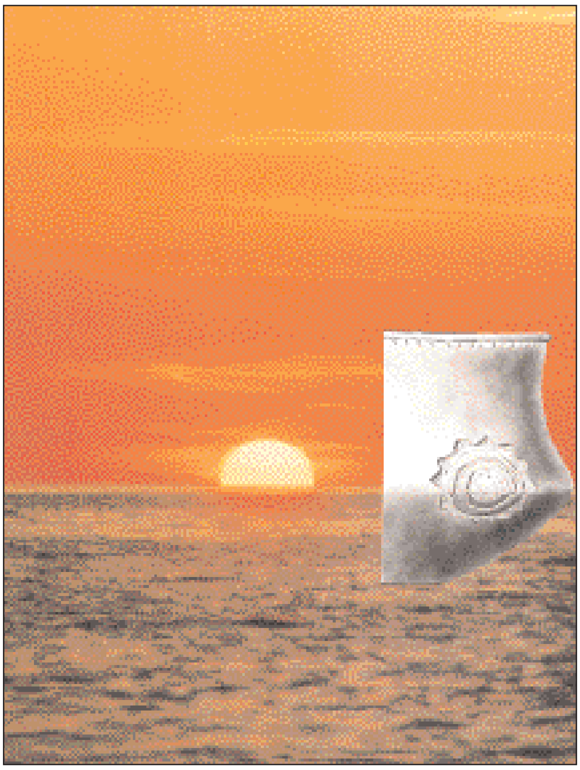


Fig. 8.

These vessels because of their decoration and symbolism of ornamentation were certainly used both as chalices and as lids, but they then served in converse ritual purposes.

"The nether world or world of waters was conceived like an the inverted hemisphere or tub, so that anyone going there was said to go to the region of endless darkness or bottomless waters."
Tilak, 1903, 306

The terrines were most often up to 15 cm height, and were mainly decorated in the previously described manner. However, terrines beyond this size can be found, and even over 30 cm in diameter, which for a vessel with a single tunnel-like handle is entirely absurd. These large terrines as a rule are more richly decorated (Fig. 16). Most often seven or nine suns are drawn at the biconical break, but not evenly spaced, instead in groups (2+3+2 or 3+3+3). This marking of the Sun seven or nine times most probably described the number of sun months in a year.

"The sun drives in a carriage with seven wheels."
Rig-Veda (I, 50, 8)

Dawn in a moderate climate belt, such as at Vučedol, is visible only for a short time in the east before it is replaced by the brilliance of the rising Sun.

"One year to a mortal is one day and one night to the gods: the day corresponds to the route of the Sun to the north, and the night its route to the south."
Manu, I. 67

Dawn is a mortal, as is god of the spring equinox, and the decoration on the vessels can be interpreted as an annual human visual clue, or calendar. But just as the sun rises at dawn, at the end of the day it sets, which could be shown in the same manner – at the halfway point of the horizon.

"The sun is carried by the current of the heavenly waters towards their destination, i.e. towards the Ocean."
Rig-Veda, VII, 49, 2

"Water and light come from the same source, and run in the same bed", as is cited by J. Darmesteter in a note about Zend-Avesta, as the heavenly water awakens the heavenly bodies to movements, something like what would happen to a boat or any other object carried by the current of some river. The results of damming these waters would be quite serious, and the entire world would be thrown into darkness, into a winter fettered in ice.

Above the incised line on the body of the Vučedol terrine is the world horizon of living man. Numerous symbols are incorporated in this, which repre-

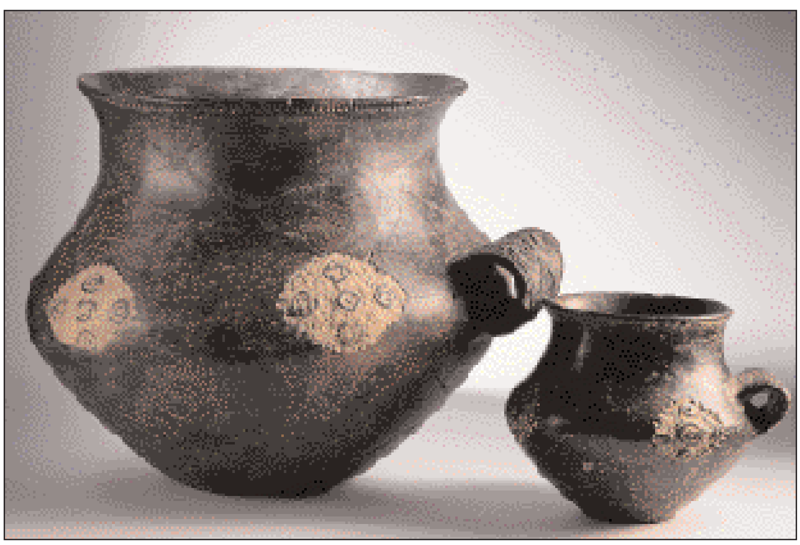


Fig. 9.

sent a firm orientation for man finding his way in time and space.

And God said, "Let there be a firmament in the midst of the waters, and let it separate the waters from the waters." And God made the firmament and separated the waters which were under the firmament from the waters which were above the firmament. And it was so. And God called the firmament Heaven.

The Holy Bible, Genesis 1, 6–8

And God said, "Let there be lights in the firmament of the heavens to separate the day from the night; and let them be for signs and for seasons and for days and years, and let them be lights in the firmament of the heavens to give light upon the earth."

The Holy Bible, Genesis 1, 14–15

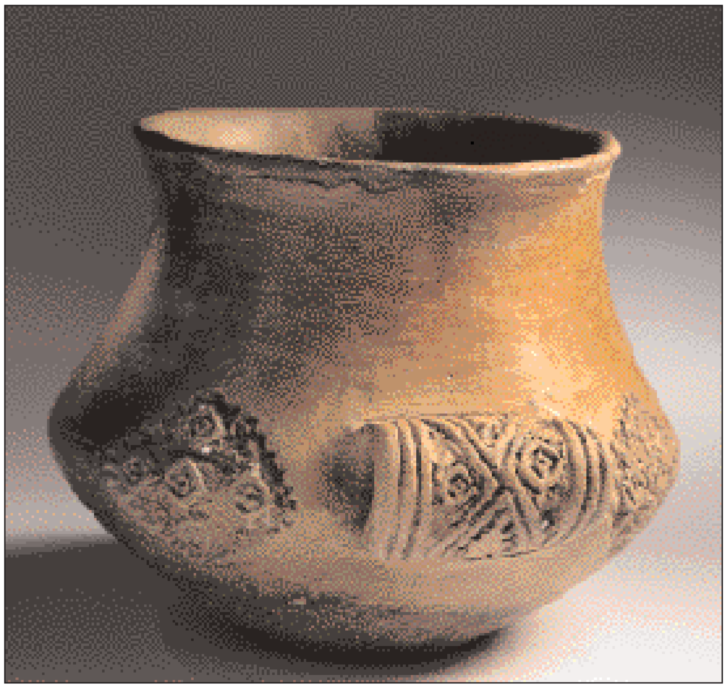


Fig. 10.

On the large Vučedol terrines, a zone with a depiction of the heavens extends from the horizon to the upper rim of the vessel (Fig. 17). This is divided by vertical boundaries (usually two parallel lines) into 4 or 6 fields. Constellations are most often shown in these fields. Orion was present in almost all combinations, and the Pleiades, Cassiopeia, and some planetary symbols also appear. The terrines with such a decoration offer their illustrated message of an individual story about the fate of the deceased next to which they were usually placed. Although it is not something that is easy to admit, the decoration on them is closely related to views of the situation in the graves in which they are most often found, including human victims. In this manner the heavenly drama was equalized with the human fate.

The determination of the seasons can best be perceived in the positions and relations between certain symbols that undoubtedly mark the constellations significant for individual parts of the year.

In comparison with the Sumerian-Babylonian, Egyptian, Chinese, Indian, and other ancient calendars, the constellations can be clearly defined, and the zones or belts into which some vessels are divided exhibit larger annual units. The constellations that denote individual seasons were shown at the moment of twilight, as the first landmarks of the evening sky (Orion, Gemini, Pegasus, the Pleiades, Cassiopeia, Cygnus). Naturally, the very common symbolism of the Sun (without a single depiction of the Moon) shows the complete displacement of lunar symbolism, which is an Indo-European trait.

Fig. 11.

Particular attention is drawn to a low pot with a gentle profile in an S-shape, found in 1978 during excavations at the Vinkovci-Hotel site, in a pit of the late classic Vučedol Culture (Fig. 18). It was quite damaged on one side, and the ancient break indicated that it had had a role even in a broken state, as the pit

Fig. 12.

was mainly filled with unbroken vessels. It was divided into four horizontal fields, and the lower one was preserved in its entire extent, containing 12 equal squares. They are clearly delineated, and every other one has an incised and encrusted, precisely formed mark (Fig. 19).

In the first, upper zone, which is proportionally worse damaged, squares can be recognized in the following sequence.

❶ Empty square, the Sun, empty square, Orion, empty square, the Sun, empty square... This belt undoubtedly evokes **spring**, according to the previously mentioned terrines that bore the Sun or Orion on the horizon. This is the beginning of the season when the Sun, on the 21st of March 2800 BC set around 5:27 PM, and the Belt of Orion – in Croatia known as "Reapers", in Upper Germany it has been often the Magy or the Three Kings (*Allen 1963.316*) – set with the first twilight. This is the only zone on this pot where the Sun appears, as it was necessary to emphasize particularly that Orion was passing, visible in the very fact that the Sun is shown. This is more a depiction of the triumph of the arrival of the first day of spring – the equinox – than spring itself.

The year at Vučedol began with the spring equinox, when the Sun symbolically supplanted the most important winter constellation of Orion. To be more exact, that night Orion's Belt appeared a short while for the last time in the winter sky, disappearing for several months. This chance circumstance, noted by the inhabitants of Vučedol, today no longer exists because of the course of time (precession), helped them in determining the first day of the new year, but also in coordinating the number of days in their year (unknown to us) with the actual number of days of the yearly revolution of the Earth around the Sun.

The second, lower belt shows **summer**, without too many dominant stars.

❷ Empty square, the Pleiades, empty square, Cygnus, empty square, Cassiopeia, empty square, the Pleiades... Cassiopeia in the form of the letter W is particularly interesting. In this period it was not a circumpolar constellation, and at the summer solstice it rose at the setting of the Sun, at 8 PM. Cygnus (like the cross of St. Andrew) is high above the eastern horizon. The circular symbol is not typical for several stars (6) in the Pleiades, but it is difficult to record them all in such a small space, so it is most likely, as was the case in Babylonian (*Gossmann 1950.279*) and Vedic astronomy (*Santillana 1969.157*) that Mars was their planetary representative. The Pleiades appeared only at 1 AM in the morning.

"When the Pleiades born of Atlas rise before the sun, begin the reaping; the ploughing, when they set."

Hesiod, Works and Days, 383–384

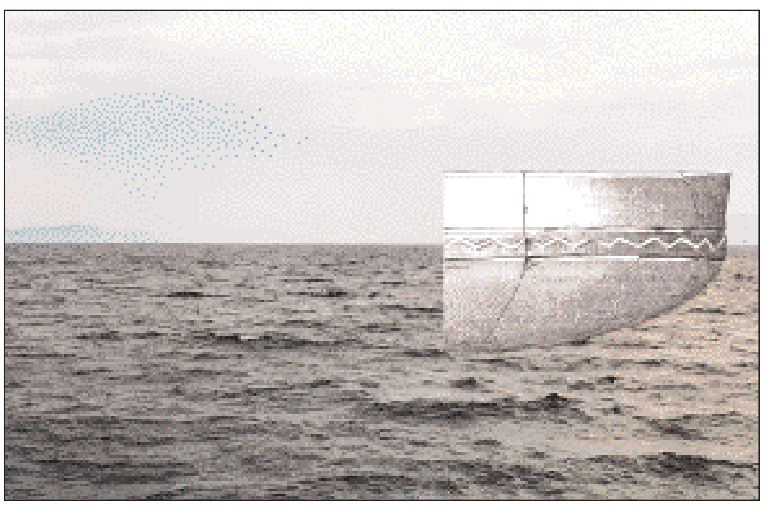


Fig. 13.

Autumn is shown in the third belt.

❸ The Pleiades, empty square, Gemini, empty square, the Pleiades, empty square, Pegasus/Pisces, empty square, the Pleiades... In 3000 BC, the Pleiades rose at 7 PM, and Gemini (two diagonally placed stars) around 8:30 PM. The large constellation that is today divided into two, Pisces and Pegasus, was most often depicted on the Vučedol vessels as two diagonally overlapping squares, although there are also other artistic variants (checkerboard). Examples for this analogy can be found in Santillana (*1969.434*), including Sumer and Babylonia, Roman Zodiac of Dendera (Egypt), as well as rather recent drawings from the Guinea Coast in Africa, Sumatra, and the New World. This constellation at 8 PM was high in the heavens and practically at its culmination.

Fig. 14.

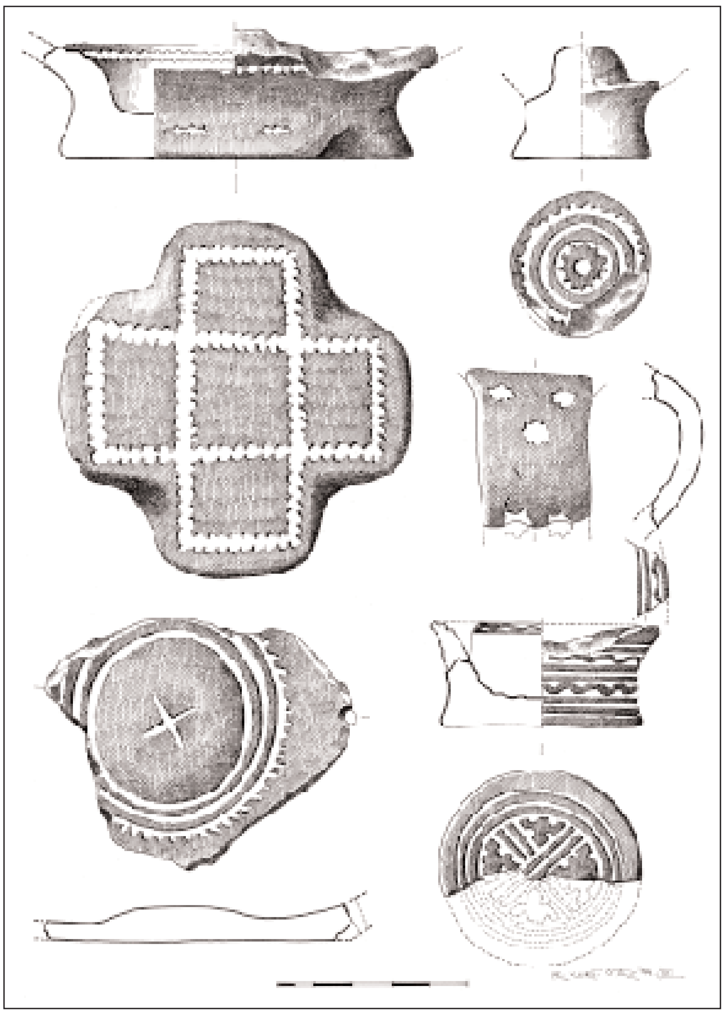


Fig. 15.

The **winter** sky in the lowest belt is particularly interesting. This is not merely because of the fact that the vessel in this section was entirely preserved with 12 squares, but also because of the separate constellations of the especially attractive winter firmament.

❹ Empty square, Cassiopeia, empty square, Pegasus/Pisces, empty square, Orion, empty square, the Pleiades, empty square, Pegasus/Pisces, empty square, Gemini. It is extremely interesting that in the depiction of the winter sky, Pegasus/Pisces is shown twice, but Orion, as the dominant constellation of the winter sky and practically its symbol, only once. Pegasus/Pisces set at 9 PM on the 21st of December in 3000 BC. Cassiopeia can be seen in winter in a perpendicular position in comparison to its summer appearance. The already well-known constellation of the Pleiades was directly above the heads of the inhabitants of Vučedol.

It is especially significant that not a single season contained the particularly conspicuous constellation of the northern sky, Ursa Major (the Great Bear, the Big Dipper), not even when certain sym-

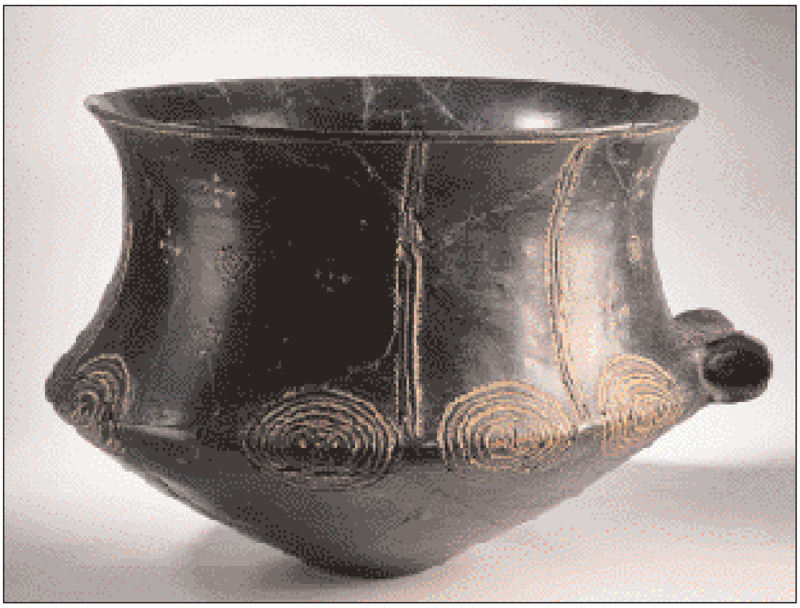


Fig. 16.

another annual super-control, and that was the setting of Orion's Belt on the horizon at the spring equinox, when a yearly correction to the calendar could be performed.

It has already been mentioned that on the varied vessels of the Vučedol Culture, the decoration was conceived in different ways. There are vessels entirely filled with only one astral sign (such as Orion, Cygnus, Pegasus, Cassiopeia), or a combination of two symbols. But it is not unusual to find several artistic solutions for a single sign, even on the same vessel. Orion, in addition to the usual rhombus with five stars, with the central the largest (but not necessarily), also appears as a clepsydra or hourglass figure.

bols are repeated in the same row. The reason most of all must lie in the fact that this constellation was permanently in the skies throughout the entire year (circumpolar), and thus it was not significant to the people of Vučedol in terms of the calendar, although they probably knew of it.

This calendar recognized four seasons and 12 possible weeks within them, i.e. three months. There was space in the upper belts for 13 squares, but this space was probably occupied by a small protrusion. In any long-term observation of the phases of the moon, the ancient peoples concluded that they take somewhat longer than 29.5 days. Thus it can be hypothesized that the month, like that of the Egyptians, would have had 30 days. We could attempt to prove this with the explanation that one month was divided into two decorated fields (theoretically each 8 days) and two undecorated (each 7 days). Thus a year would have 360 days, and it would be necessary to add days, just as in the early Egyptian system, to the full so-called tropical year. Perhaps somewhere around the hypothesized protrusion was something used to add a certain number of days, but we can only guess at this. Nonetheless. There was yet

Along with the pot with the calendar image, yet another exceptionally interesting vessel was found – a "censer-rattle" (Fig. 20). This is another typical Vučedol terrine surmounted with a shallow vessel. During the first washing after its discovery, one section of its completely closed lower section came apart, and three stone balls were found within the hollow section. They meant that this "censer" was at the same time a rattle.

The lower part of the vessel was undecorated except for symmetrically arranged perforated holes. Through the entire series of these small circular openings in the closed lower section, scented grasses and herbs could be lit and inserted, to smoke or burn after oil and a wick were added to the upper section, as this upper part bears all the characteristics of a lamp.

Above the biconical break (horizon) is an encrusted band filled with zigzag lines and 8 vertical hourglass shaped figures. Above this horizontal band, in the

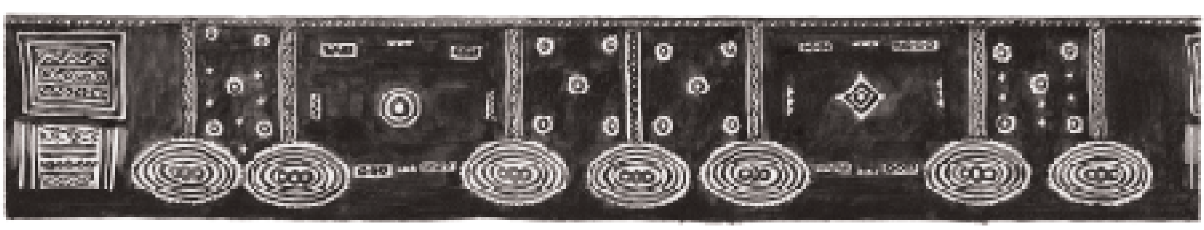


Fig. 17.

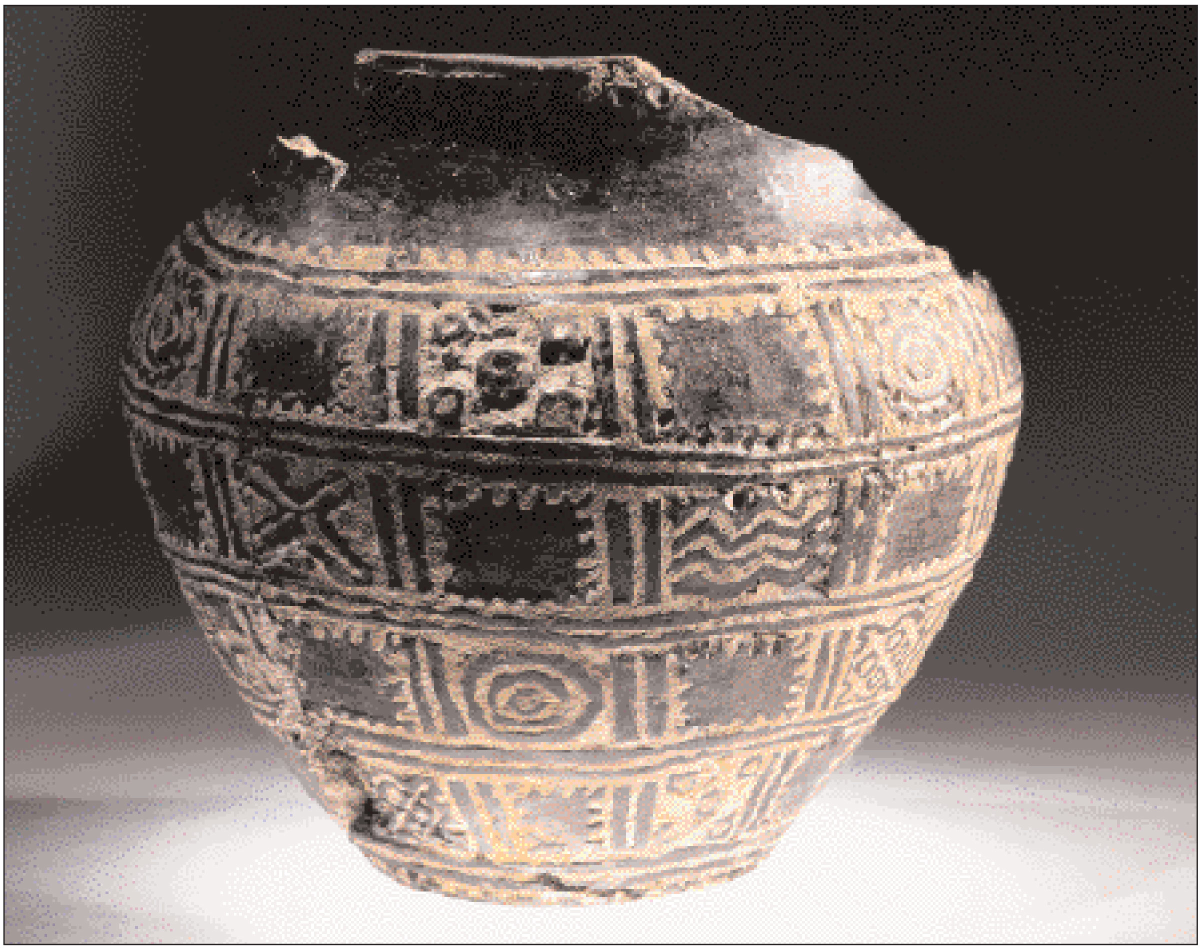


Fig. 18.

area that shows the sky on the terrine vessels, there are 8 perpendicularly divided fields with symbols of Venus, according to analogies on other Vučedol vessels, and three small holes like those in the lower part. There are four symbols of Venus.

The upper section, where the lamp was added above the terrine, contained some kind of attached lid with a wide opening in the centre. This had five marked fields also containing symbols of Venus. Four fields had 3 and one had 2 signs, for a total of 14 Venus symbols.

The relation is interesting between the five fields in the lid of the censer and the eight segments in its lateral section. A ratio of five to eight related to Venus was also noted in the Venusian calendar of the Mayans from the Central American region, known as the Dresden Codex (*Carlson 1984.224*). This explains that five synodical orbits of Venus around the

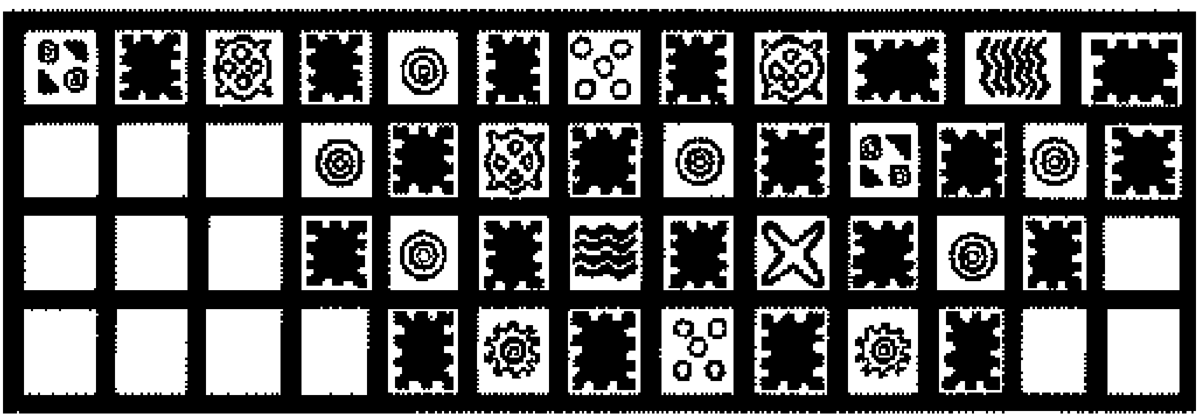


Fig. 19.

Fig. 20.

Sun agree exactly (to the day) to eight revolutions of the Earth around the Sun (5 x 584 = 2920 = 8 x 365). The ratio of the speed of the orbits of Venus and the Earth around the Sun is 5:8, and this corresponds to the relations of the censer segments.

Thus this censer was above all an important instrument in the correction of the annual lagging of the Vučedol calendar, as despite how many days the latter had, there were problematic days in a year that could not be accurately corrected even with the setting of Orion's Belt below the horizon.

Along with Venus, the planetary symbol for Mars can also be recognized, which, as was noted before, can sometimes serve as a replacement for the Pleiades.

Some terrines, but also small amphorae from the final phases of the culture, merely have incised parallel zigzag lines in the position above the horizon, which undoubtedly indicates the major problem of interpreting the astral or heavenly waters and the manner in which they arrive in the upper sphere, i.e. the firmament and bring fertility to earth.

Two vessels, found in a late Vučedol culture grave of a "duke" in Mala Gruda, the Tivat Field (*Parović-Pešikan 1971*), bear ornaments depicting water both, above and bellow the horizon (Fig. 21, 22). These disturbed waters negating the horizon symbolize Death itself.

"I am on my way to kind Earth's bourne to see Okeanos, from whom the gods arose......"

Homer, The Iliad 14, 200–201

"I might easily lull another to sleep-yes, even the ebb and flow of cold Oceanos, the primal source of all that lives."

Homer, The Iliad 14, 245–246

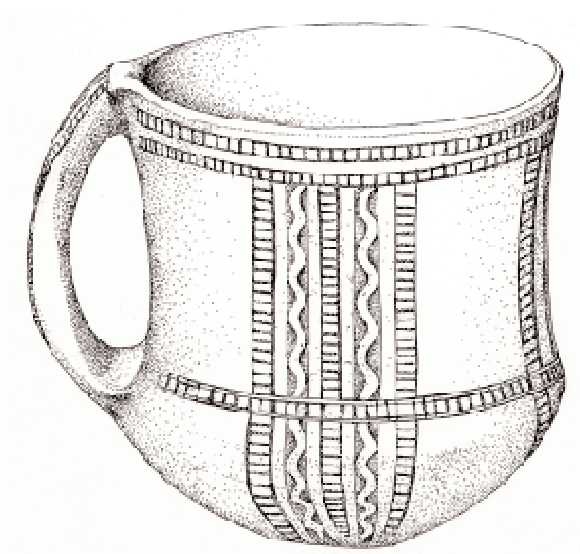


Fig. 21.

Much else can be told by the broken fragments of vessels with solar motifs on them, as the Vučedol inhabitants separated them from the superfluous remaining empty sections of the vessel by careful breaking. This newly created object was then perforated with two holes and worn as some kind of amulet.

All data was tested using computer simulation, as the firmament was shifted because of what is known as "precession", and the North Star from 3000–2500 BC was the star Thuban (the brightest in the constellation of the Dragon).

In this manner it is possible to reconstruct the creation of something distinctive in the world, what could be called a completely astral calendar. The beginnings of this earliest European, but also Indo-European, calendar can be tied directly to the period after 3000 BC. The calendar-pot and censer are typologically earlier than the beginning of the late phase of the Vučedol Culture (the context in which they were found), and according to the ^{14}C dates received from analysis at the "Ruđer Bošković" Institute in Zagreb, this stratum was dated earlier than 2500 BC.

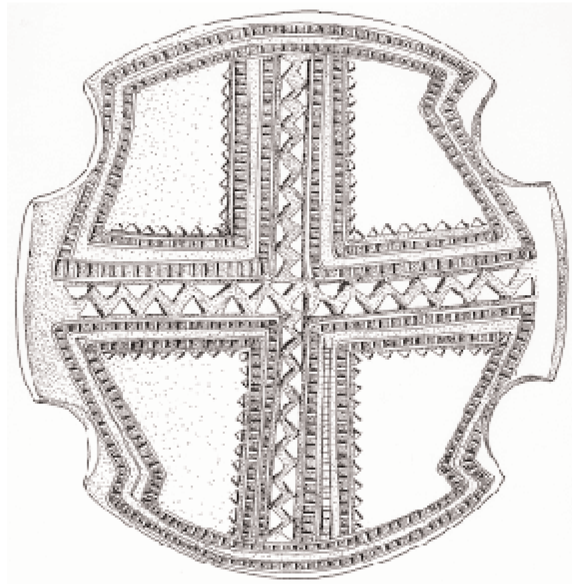


Fig. 21.

The ancients believed that time were the heavenly mills, grinding us all to dust. If this grindstone could not be controlled, various cultures at least attempted to foresee it through measurement. The fixed signs on this mill were constellations (later the signs of the Zodiac), and the fateful, relentless, inexorable grinding was proven by the Sun, the Moon, and the planets (Mercury, Venus, Mars, Jupiter, and Saturn), which, carried by the currents of the heavenly waters, incessantly change their position.

∴

REFERENCES

ALLEN R. H. 1969. *Star names, their Lore and Meaning*. Dover Publication Inc., New York.

BLACK J. and GREEN A. 1992. *Gods, Demons and Symbols of Ancient Mesopotamia*. British Museum Press, London.

THE HOLY BIBLE 1953. Thomas Nelson and Sons, New York.

CARLSON B. J. 1984. The Nature of Mesoamerican Astronomy: A Look at the Native Texts. In E. C. Krupp (ed.), *Archeoastronomy and the Roots of Science: 211–252*.

DURMAN A., OBELIĆ B. 1989. Radiocarbon Dating of the Vučedol Culture Complex. *Radiocarbon, Vol. 31, No. 3: 1003–09*.

GOSSMANN P. F. 1950. *Planetarium Babylonicum*.

HESIOD 1989. *Works and Days*. Translation by M. L. West. Oxford University Press, Oxford.

HOMER 1985. *The Iliad*. Everyman's Library, Random House, UK, Translated by R. Fitzgerald.

1955. *The Odissey*. The World's Classics, Translated T. E. Shaw, Oxford University Press.

KRUPP E. C. 1984. Egiptian Astronomy: A Tale of Temples, Tradition, and Tombs. In E. C. Krupp (ed.), *Archeoastronomy and the Roots of Science: 289–320*.

PAROVIĆ-PEŠIKAN M., TRBUHOVIĆ V. 1971. Fouilles des tumulus de l' âge du bronze ancien dans la plaine de Tivat. *Starinar 22: 129–144*.

SANTILLANA G., DECHEND M. 1969. *Hamlet's Mill*. Gambit Inc., Boston.

TILAK B. G. 1903. *The Arktic Home in the Vedas*. Kesari, Poona City.