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Adam from Lepenski Vir
(D. Srejović and L. Babović. Umetnost Lepenskog Vira. Beograd 1983)

Preface

The prologue to this anthology was the seventh Neolithic Seminar held at the Department of Archaeology, University of Ljubljana in May 2000. The Seminars provided an opportunity for a more balanced exchange of research data of the processes of transition to farming, i.e. neolithisation in Europe and Asia. The participants of the Seminar and the authors of the papers in this volume were selected as individuals who were active in field research dealing with the Mesolithic and the Neolithic in Europe and Asia, and who at the same time being involved in developing the revised perspectives for understanding the processes of transition to farming. As far as content is concerned, we have maintained the link with cultural, periodic and typological paradigms, although the focus has been shifted to questions in regard to the processes of globalisation of the Neolithic palaeoeconomy. Two concerns were emphasised at the first Seminar, how and when agriculture spread to Europe. With the growing body of data from different regions, it has become apparent later that agriculture developed independently in many areas of the world, and that modes of transition to food production from food gathering were specific for each individual geographic entity. It is clear from recent studies that the introduction of farming to Europe was not the monothetic consequence of the "wave of advance". It is broadly accepted that contacts between foragers and farmers, occurring within an agricultural frontier zone must have had a direct effect on the nature an the rate of the transition, and may have acted as a delaying mechanism in the process of the transition on the regional level. However, one of the most important points is that playing an active part as individuals and as communities, hunters and gatherers contributed to the generation of a different kind of Neolithic through their own communities and their influence on the established farming settlement. It has been already pointed out that in many parts of south-eastern Europe, there were clusters of Mesolithic settlements capable and ready to serve as a promotion centres of agro-pastoral farming in the course of which process these communities could be expected to develop or to adopt and to modify agro-pastoral practices and pottery production and integrate them with existing subsistence strategies. However, Feng Zhang has noted in this volume that many Chinese archaeologists agree that transition to farming in Eastern Asia correlates with the transition from the Palaeolithic to the Neolithic and, as Chaohong Zhao and Xiaohong Wu showed, it was pottery that appeared first.

Besides the analyses of the transition to farming in Europe and Asia, special attention was paid to technological analyses of the Neolithic painted pottery in North Greece and Central Iran as well as to pottery sequence of the Neolithic tell site of Vinča.

Radiocarbon dates given in this volume using the convention bp and bc refer to uncalibrated dates. BP and BC are used to indicate calibrated radiocarbon dates unless otherwise noted by the authors.

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Between Foragers and Farmers in the Iron Gates Gorge: Physical Anthropology Perspective

Djerdap Population in Transition from Mesolithic to Neolithic [1]

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ABSTRACT – *The research presented here aims at discerning possible interactions between Mesolithic hunter-gatherers of the Iron Gates Gorge (Serbia-Romania) and the surrounding Neolithic farmers during the 7th and the 6th millenniums BC. In order to examine the interactions of communities with different modes of subsistence (foraging and farming respectively), the nonmetric anatomical variants of the skull and postcranial skeletons were examined on the sites with the largest number of individuals buried. Another set of analyses, aimed at discerning environmental (occupation/nutrition) changes that could have affected the population in transition was performed on metric variables of postcranial skeleton. The combination of these two sets of analyses argues for local continuity within the region, with high degree of initial heterogeneity, and temporal ordering as the most likely explanation for the pattern of change.*

IZVLEČEK – *Naš namen je spoznati močne medsebojne vplive med mezolitskimi lovci-nabiralci v Železnih vratih (Srbija-Romunija) in sosednjimi neolitskimi kmetovalci v 7. in 6. tisočletju BC. Da bi ugotovili medsebojne vplive skupnosti z različnima načinoma preživljanja (lov-nabiralništvo in kmetovanje), smo raziskali nemetrične anatomske različice lobanj in postkranialnih skeletov z najdišč, kjer je največ individualnih pokopov. Opravili smo tudi analizo metričnih različic postkranialnih skeletov. Z njo smo želeli ugotoviti spremembe okolja (naselitev/prehranjevanje), ki bi lahko vplivale na skupnosti v tranziciji. Obe vrsti analiz kažeta na lokalno kontinuiteto z veliko začetno heterogenostjo in na časovno strukturiranost kot najbolj verjetno razlago vzorca spremembe.*

KEY WORDS – *Mesolithic; Neolithic; Iron Gates Gorge; non-metric traits; Lepenski Vir; Starčevo*

Dedication: To peoples and cultures, past and present, sacrificed to others' understanding of progress.

1. INTRODUCTION

The transition from foraging to agriculture can be regarded as one of the most fundamental cultural-ecological transformations that has occurred in the human career, as it enabled large scale sedentism, subsequent population growth, and the appearance of an urban way of life. Recent revival of interest in this phenomenon is witnessed by a number of edited volumes that discuss concepts of domestication and plant cultivation, the origin and spread of agricultural practices in different regions, as well as populational and social implications of the transition (*Cohen and Armelagos 1984; Gregg 1991a; Harris 1996a; Price and Gebauer 1995*). With the growing body of data from different regions, it has become apparent that agriculture developed independently in many areas of the world, and that modes of transition to food production from food gathering were specific for each individual geographic entity.

The study presented here aims to understand the patterning of the change from foraging to farming in the Lower Danube as reflected in the transition from Mesolithic "Lepenski Vir" culture to Neolithic "Starčevo" complex in the Iron Gates Gorge in Serbia

1 This paper is based on the Doctor of Philosophy Thesis defended at Simon Fraser University before the Committee: Dr. Ruth Tringham, Dr. Christopher Meiklejohn, Dr. Jonathan Driver, Dr. Jack Nance, and Dr. A. Catherine D'Andrea.

Fig. 1. Iron Gates Gorge in May 2000. On the left side of the photo the clearing of the submerged Hajdučka Vodenica terace. The other sites are located further upstream.

(Fig. 1). Since a long period of coexistence of the Mesolithic and Neolithic ways of life in this region has been proposed (*Radovanović 1996b*), this research will attempt to reconstruct the extent and mode of interactions between farmers and foragers through the examination of skeletal material from four of the most important sites excavated in the region: Lepenski Vir, Hajdučka Vodenica, Vlasac and Padina.

1.1. Theoretical background

It is generally accepted that methods of food production, together with the cultigens, were introduced to Europe from the Near East *via* Greece and the Balkan Peninsula. The mode of transition was either the transfer of farming techniques to indigenous populations with practically no genetic admixture, the migration of farmers themselves, or both. The archaeological data alone do not permit the distinction between these modes even if they were mutually exclusive. Based on genetics of living European populations, Cavalli-Sforza proposed the model of "demic diffusion", which argued for the spread of agriculture by migration of people from the southeast to the northwest, at an average pace of 1 km a year (*Ammerman and Cavalli-Sforza 1984*). In later publications, this model came to incorporate the transfer of technology as a part of the process (*Cavalli-Sforza 1996*). Assimilation of foragers by farmers, through deforestation and acceptance of agricultural practices (competition and acculturation) and marriages of hunter-gatherer women to farmers (acculturation), would have created the "gradient" observed in the Principal Component Analysis (PCA) of genetic data. The underlying assumption of the model, that the Mesolithic population was sparse throughout Europe, has been questioned by recent paleodemographic studies (*Meiklejohn et al. 1997*).

In the extremes of the European periphery (Scandinavia, Portugal, Spain, Baltic States) this model has been questioned by the survival of Mesolithic cultures in proximity to incoming Neolithic ones (*Price 1996; Thomas 1996; Zvelebil 1996a*). The craniometric analyses of European prehistoric samples failed to provide support for the model of population replacement (*Harding et al. 1989*). Further, coexistence and mutualistic exchange that was proposed recently for Central Europe, as opposed to confrontation and acculturation, provides a more likely and flexible context for understanding the early interactions of farmers and foragers (*Gregg 1988, 1991b*). Given the fact that the first farmers were moving north into essentially unknown habitats, and progressively more marginal climatic conditions for the production of their newly domesticated plants, while the foragers were long time inhabitants with excellent knowledge of seasonal food availability, it is unlikely that the neolithisation of Europe could have been as swift without involvement of local Mesolithic inhabitants (*Prinz 1987*).

1.2. Relevance of this study

Most of the studies that propose models for Europe as a whole, are based on the spread of the "Linear Bandkeramik" culture that is limited to Central Northwest Europe and, in terms of European periodisation, contemporaneous with the Late Neolithic cultures of the Southeast (Vinča, Dimini, *see* Table 1). The first manifestations of the Neolithic in southeastern Europe precede Linear Bandkeramic culture and show significantly different economic and social patterns. Neither the spread of "Cardium-impresso" culture in the circum-Mediterranean region, nor the apparent processes in the Aegean or Balkans conform to the demic diffusion model.

The comparatively understudied Balkans are rarely discussed in theoretical literature except for the absolute dates, which are usually applied without reference to the "cultural" or socio-economic background and are used to argue the direction and the pace of migration. In order to build larger geographic models, it is crucial that areas of Europe that have not been carefully examined become the focus of a critical study. Further, as neolithisation of southeastern Europe precedes the neolithisation of the rest of the continent, understanding the processes and those attributes of Mesolithic in the area that allowed for the rapid neolithisation is of extreme importance. The goal of this research, and of the ongoing work by the team of researchers from the Institute of Archaeology and the Departement of Archaeology in Belgrade, is to make the Iron Gates Gorge material accessible for comparison with that from other regions of Europe and thus provide a basis for building sensible models of neolithisation of the continent.

Archaeological and anthropological study of the material from the Iron Gates Gorge (Figs. 1 and 2) is supported on a number of bases:

- the neolithisation of this area preceded the neolithisation of all other parts of Europe except the Aegean;
- the extent of excavations of a number of sites on both banks of the Danube has been unparalleled in the last three decades as it has exposed substantial living surfaces amenable to detailed archaeological analyses;
- the sites provide insight into both cultural and populational consequences of the transition through abundant architectural features, artefacts, faunal, palynological and osteological remains and;
- since the coexistence of the Mesolithic foragers, belonging to the Lepenski Vir culture, and Neolithic Starčevo farmers has been established (*Boroneanț et al. 1995; Radovanović 1996a; 1996b*), the degree and mode of interaction between them can potentially be traced in both archaeological and osteological remains.

1.3. The Lepenski Vir culture

Material remains of the Mesolithic Lepenski Vir culture have been uncovered on a number of sites in Iron Gates Gorge and dated from 7500 to 5800 BC. The culture is characterised by a sedentary or semi-sedentary foraging economy based on varied and abundant resources provided by the Danube and adjacent mixed growth forests. A long period of cultural stability, complex social organisation and developed religious beliefs can be postulated from remarkable architectural achievements and expressive monumental sculpture. Most of these sites are at least partly contemporaneous with farming communities of the Gura Baciului, Anzabegovo, Starčevo and Karanovo type (*Gimbutas 1976; Jovanović 1984; Radovanović 1992; Srejović and Letica 1978*). However, throughout the period when contact was possible, Lepenski Vir culture did not change significantly, and the pressure from the outside served more to seal the bonds between different Iron Gates Gorge sites, than to undermine their cultural or economic unity (*Srejović 1978; Radovanović 1996c; 1996d*).

Iron Gates Gorge	Karpathian Pannonian Balkans	Macedonia	Bulgaria	Thessaly	Central Europe	Date BC ca.
	Vinča	Vinča	Karanovo IV	Dimini	LinearBand Keramik	5000
Starčevo IIB	Starčevo Körös Cris	Vršnik	Karanovo III	Early Neolithic III (Sesklo)		5500
Lepenski Vir	Starčevo Körös Cris	Vršnik	Karanovo II	Early Neolithic III (Sesklo)		6000
Lepenski Vir	Gura Baciului	Anzabegovo I	Karanovo I	Early Neolithic II (Proto Sesklo)		6500
Lepenski Vir						7500

Tab. 1. Schematic representation of the chronological relationships between geographic regions in Southeast Europe. Dates BC only approximate.

Osteological material that is central to my research comprises 362 or more individuals from four sites of the Lepenski Vir culture: Padina, Hajdučka Vodenica, Vlasac and Lepenski Vir. These four sites, situated on the south bank of the Danube and characterised by sophisticated architectural remains, were chosen for their large number of burials. This is one of the two largest skeletal series that span the Mesolithic to Neolithic transition in Europe. The time period they cover is over 1500 years. The other large series comes from sites in Russia and the Baltic States. In addition, the restricted regional distribution makes this sample more meaningful and amenable to statistical analyses than the Russian and Baltic material. Since basic metric analyses have been done, at least for Lepenski Vir and Vlasac (*Mikić 1981a; 1981b; Nemeskeri and Szathmary 1978a; 1978b; 1978c; 1978d; 1978e*), and odontometrics for Vlasac (*y'Ednak and Fleich 1983*), and in the view of partial inhumations and unequal preservation of individual skeletons, I have decided to concentrate on the distribution of non-metric anatomical variants as the most relevant measure of population distances.

2. THE PROBLEM OF DISTINGUISHING MESOLITHIC FROM NEOLITHIC

Although the Mesolithic is a well-established term in archaeological literature, its exact meaning remains susceptible to differing interpretations. Since the focus of this work is the Mesolithic population of the Iron Gates Gorge and its presumed contact with Neolithic peoples, and since the debate over the meaning of this term has historically played an important role in discussions between principal investigators of the Iron Gates Gorge sites (*Boroneanţ et al. 1995; Jovanović 1972; Srejović 1971; 1979; Srejović and Letica 1978*), it is important to provide clear definitions of both Mesolithic and Neolithic as they are used here.

2.1. Definition of terms

2.1.1. Mesolithic

In 1865, John Lubbock divided Prehistory into the Old Stone Age – "Palaeolithic" characterised by flaked stone, and the New Stone Age – "Neolithic" – characterised by the introduction of polished stone implements. This division was formal and typological. It enabled archaeologists to assign finds into two global categories of prehistoric technology. The first to coin the term "Mesolithic" was Hodder M. Westropp who in 1872 used it to denote everything from "Reindeer period caves" until the introduction of agriculture, therefore both Upper Palaeolithic and Mesolithic as we use it today (*Rowley-Conwy 1996*). At about the same time M. Reboux, independently introduced the term in France to describe an industry intermediate between those that he defined as producing only flakes (such as Levallois and Mousterian in general) and those that produced polished axes, essentially including the same time span and typology as Westropp (*Orliac 1988*). Although his classification was not accepted, the term "Mezolithique" came to live on in the work of Archibald Carlyle who applied it to an industry of "small geometric flints" found in India (*quoted in Orliac 1988*). The temporal notion was introduced in 1893, by an antiquarian Allen Brown, who used the term to describe those cultures of the Holocene that existed

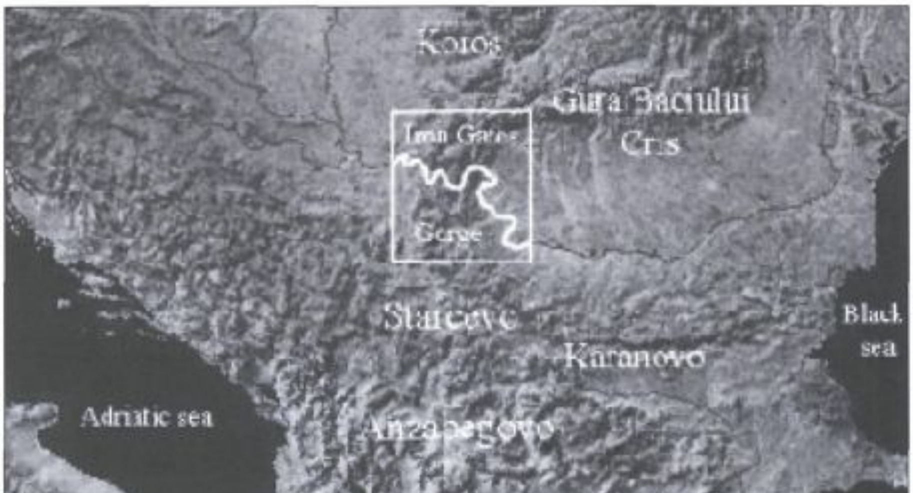


Fig. 2. Satellite map of the Pannonian Plain, Karpathian Basin and the Balkan Mountains. Flowing through the Pannonian Plain, the Danube enters the Karpathian Mountains and forms the Iron Gates Gorge (outlined by the white square). The Early and Middle Neolithic cultures that are partially contemporaneous with Lepenski Vir culture are outlined in the centers of their respective areas. (*Adapted from NCARTA 1998*).

before the introduction of agriculture (*Pedersen pers. comm.*). According to Orliac (*1988.686*), the widely spread definition that viewed as "Mesolithic all the industries between Magdalenien and Neolithic" was introduced by J. de Morgan in 1909.

Current definitions can be classified in two major groups: one typological and the other chronological. For the proponents of the typological definition the characteristics of flint industry (such as the appearance of microliths) have the most decisive value. Orliac proposes that those industries situated between Palaeolithic and Neolithic that possess "characters sufficiently different from those of the industries of the two periods" (*Orliac 1988.686*) should be determined as Mesolithic. Although it may be appropriate for western European archaeology, even though "sufficiently different characters" remain essentially arbitrary and ambiguous, the definition falls short in other areas of the world. For proponents of chronological definition all hunter-gatherers of the Holocene are regarded as Mesolithic, regardless of whether they show differences from the Palaeolithic hunter-gatherers. Since it would include a number of communities in the Holocene that continue with essentially the same mode of food procurement and mobility patterns as their Pleistocene counterparts as well as significantly different groups, the need to introduce 'Mesolithic' as a different term is not as obvious.

Introduction of economic parameters "that the [term] never had historically" (*Orliac 1988.686*) has, in a number of cases, led to economic determinism, which includes an open or subdued notion of evolutionism. Distinction is made between the Epipaleolithic – in which Holocene adaptation does not produce any changes in way of life and lithic technology (*Kozłowski and Kozłowski 1986; Leroi-Gourhan 1965*) and the Mesolithic – with its substantial changes in economy, ecology, and material culture (*Kozłowski and Kozłowski 1986*). The latter would be found only in innovation zones leading to food production (*Leroi-Gourhan 1965*), or enabling change from food collection to food production (*Clark 1980*). This definition supposes a unidirectional evolution towards food production and contradicts the data from large areas of the world where substantial changes in economy, ecology and material culture did not lead to introduction of agriculture (e.g. West Coast of Canada).

In order to overcome chronological and typological ambiguity, as well as economic determinism characterised by an implicit evolutionist basis, Radovanović (*1996a.14*) argues that a qualitatively different phenomenon, capable of distinguishing archaeologically Mesolithic groups from those of the Palaeolithic and Epipaleolithic, can be found in the appearance of formal disposal areas for the burial of the dead. Formal disposal areas need not be a phenomenon separate from the habitation site, as that would exclude all western and central European sites (*Meiklejohn pers. comm.*), with the exception of the newly excavated Mesolithic necropolae in France (*Duday and Courtaud 1998*) and Belgium (*Cauwe 1998*). They are determined as "...areas of continuous, ceremonial, mortuary disposal" (*Radovanović 1996a.14*). Further, they are an archaeologically visible phenomenon that is interpreted as arising from the need to lay claim on the territory by its ideological integration (*Chapman 1981*) [2]. The need to claim territory, in turn, would arise from a combination of linear rather than hexagonal arrangement of units within one hunter-gatherer group or higher than usual population densities (*Gamble 1986.52–53*), and a hunter-gatherer economy based on intensive exploitation of a vital resource, or a greater variety of resources in the vicinity, with semi-sedentism or sedentism. This would result in a structural complexity of the social unit (*Srejović 1979*) usually expressed through developed ancestral and mortuary rituals. While the appearance of formal disposal areas for the dead does not necessarily arise exclusively from the concerns of territoriality, and while they are not associated exclusively with the Mesolithic, their appearance is a clear sign of changing times in prehistory associated with changes in the social arena (*Chapman 1993*). However, although they are an archaeologically visible element, they are not the only one that enables recognition of a site as Mesolithic. Furthermore, as they allow for different interpretation and understanding of what constitutes a formal disposal area, they are not necessarily the best element for classification.

The introduction of economic parameters and, even more importantly, mobility patterns, once evolutio-

2 Although this monocausal explanation that was applied to all the mortuary monuments in Neolithic Europe is overly simplistic, and reveals more about the preoccupations of modern-day western scholars than prehistoric inhabitants of Europe (*cf. Cullen 1995.286*), it remains one of the possible, and even plausible reasons, but can not be perceived as the only cause of the arising importance of mortuary ritual in the period (*Masset 1993*).

nist connotations are removed, has the potential to make this term more meaningful and appropriate for regions where the distinction of Mesolithic from Palaeolithic and Neolithic, based on flint, stone and bone industries, is not as straight-forward as in France (for example, since microliths in Africa appear as early as 70 000 BP), or where ceramics (traditionally associated with the Neolithic) appear earlier than agriculture, as for example in the Jomon (*Imamura 1996*) or in Scandinavia (*Werbart 1998. 37, and quoted literature*).

This innovation and change in adaptation is usually linked with intensification of exploitation of one or more abundant resources (*r*-resource) as opposed to exploitation of a *K*-selected resource (*see Gamble 1986.41*) that characterises mobile hunter gatherers. The availability of an abundant and stable resource that can be exploited in the relative vicinity of the camp has been linked to reduced mobility. This combination seems to be determinative of Mesolithic settlements. For example, the specific climatic conditions of the Iron Gates Gorge, the refugial character of its flora, and the great variability of plants without a dominant species where 44% of the 371 species of plants are useful in human, and 59% of them useful in animal nutrition, has enabled intensification of both settlement and exploitation. However, throughout the period, the terrestrial animal component (*K*-resources) remains dominant (*Radovanović 1996a. 37*) and although fish is deemed an important resource providing the bulk of the protein during the Mesolithic (*Bonsall et al. 1997*), Radovanović argues that its role is more *vital* than dominant, thus providing a buffering mechanism in periods of scarcity, rather than being a year round staple. Either way, its availability becomes the key factor enabling different spatial distribution of settlements and other features of Mesolithic organisation.

Structural complexity, seen as a segmentation or an increase in the parts that make up the whole (*Kent 1989a.10*), could arise from changes in mobility patterns and increased sedentism which results in population increase and the need for an arbiter in settling disputes (*Lee 1972a; 1972b*). However, it can not be taken for granted and must be demonstrated by independent data in many areas of the world where it has been assumed (*Brinch-Petersen and Meiklejohn in press*).

Moving in full circle from cause to the effect, that in its turn becomes a cause, rises a complex picture of interacting forces of environmental productivity, sedentism motivated by linear distribution of resources or their availability, and causing social restructuring. Structural complexity arissing from sedentism, causing further environmental changes. Together with sedentism, the latter influences mortuary ritual, while mortuary ritual in turn influences both sedentism and social structure.

In the context of this study, and for the area in question, the Mesolithic is best defined as primarily based on intensified exploitation of food resources on a limited territory with reduced mobility. Settlement distribution and mobility patterning, interacting with more intensive exploitation of *r*-resources (plant or fish), and aggregation necessary for tasks demanding cooperative effort, can be regarded as both determinative of the Mesolithic and as providing sufficient archaeological visibility. Within the Iron Gates Gorge, regardless of whether fish played a key role as staple or as a vital resource, its availability is the *sine qua non* of reduced mobility (*sensu Kent 1989a*) and the change in its exploitation provides clear evidence of the Mesolithic economy and social organisation.

2.1.2. Neolithic

Proceeding from the typological classification of prehistory, the Neolithic in Europe has been regarded as a period when polished stone was introduced, alongside ceramic production. This typological distinction was questioned with further developments in archaeology, especially the excavations of "pre-pottery Neolithic" in the Levant (*Wright 1992*). An economic definition in which "the shift in mode of subsistence to agro-pastoral farming remains the only process that is relatively clearly defined, geographically widespread and sufficiently archaeologically detectable" to act as a signature of the Neolithic (*Zvelebil 1996b.625*) is widely accepted and both ethnologically and archaeologically traceable. Preceding and subsequent changes in social structure, ideology or any other aspects of life need to be examined on a regional basis. The other two questions, that of how much evidence of plant manipulation and animal husbandry constitutes enough evidence (*sensu Harris 1996a and quoted literature*), and whether a horticultural stage of farming economy - characterised by lack of impact on the environment (*Willis and Bennet 1994*) - can be perceived as agriculture, also need to be regarded on a local scale. In Southeast Europe, the introduction of cultigens and domestic animals from the Near East solves this problem, as these are not found in the wild. Their introduction indicates a shift in subsistence strategy and reliance (at least partial) on imported cultigens.

2.2. The Iron Gates Gorge context

In terms of the Iron Gates Gorge, this semantic discussion is by no means unimportant. Interpretations for Lepenski Vir - Schela Cladovei culture range from Epipaleolithic (*Boroneanţ 1969; Lazarovici 1979; Letica 1971*), Protoneolithic (*Srejović 1968*), Epipaleolithic in its early and Protoneolithic in its late phase (*Srejović 1979*), Mesolithic (*Prinz 1987; Srejović 1989; Voytek and Tringham 1989*), to Mesolithic and Early Neolithic (*Jovanović 1972; 1974*). This variety stems to a great degree from the above mentioned definitions: one chronological, in which Holocene hunter-gatherers are differently viewed as Mesolithic or Epipaleolithic; and the other based on material culture where microliths are taken as a telltale sign of the Mesolithic, while ceramics, polished stone axes and adzes are used as markers of Neolithic (*for discussion and appreciation of the theoretical positions in these different approaches see Radovanović 1996a*). Littoral distribution of the sites in the Iron Gates Gorge that resulted in reduced mobility or possibly even sedentism, increased social complexity evidenced by specialisation of ritual *vs.* domestic activities (*Srejović 1979, but see Chapman 1993*) and increased population aggregation (*Jackes et al. 2000*) are all very prominent features of Mesolithic components on the sites of this culture. Neolithic in the region is characterised by introduction and reliance, at least partial, on the Near Eastern cultigens and livestock. Although hunting, fishing and gathering remain important in the region, the proportion of domesticates *vs.* wild fauna and flora is sufficient to argue for the introduction of Neolithic economy.

Crucial to our understanding of the Iron Gates Gorge Mesolithic/Neolithic transition is the period of the coexistence of these two modes of life in the immediate proximity (Fig. 1). It is evidenced by both ^{14}C dates and Starčevo ceramics and flint blades within Mesolithic strata of the Lepenski Vir culture. This period witnesses the coexistence, communication, trade and interaction between Lepenski Vir hunter-gatherers and Starčevo farmers. It is in this light that the semantic discussion of the two terms becomes increasingly important for understanding archaeological data[3].

Therefore, if intensification of exploitation of food resources, on a limited territory with reduced mobility, characterises the Lepenski Vir Mesolithic, then all strata within these sites that do not have evidence of food production and/or introduced domesticates (*above 5% as suggested by Zvelebil 1996a*) should be regarded as Mesolithic. If we accept that Neolithic in the region is characterised by introduced cultigens and livestock, then evidence for food production and appearance of these cultigens in the strata should be regarded as crucial for identifying them as Neolithic. In this perspective, the sporadic appearance of Starčevo (Neolithic) type ceramics and Starčevo blades in Mesolithic strata, i. e. Mesolithic type house with ceramics *in situ* (*Jovanović 1984*), requires explanation. A porous agricultural frontier with transfer of knowledge, material items, and individuals across the board (*Zvelebil 1996a*) offers a reasonable model, if we accept that this exchange could have involved both different direction and different form over this long period of coexistence.

2.3. Forager - farmer's interactions: possible scenario(s) for Europe

Historically, the role of local forager populations has received little attention. This is due to the perception of human culture as "developing" over certain immutable stages, through which every society would eventually have to pass (*Childe 1936; 1951; Engels 1972 /1884, see also: Earle 1994, for an overview of different classificatory models*), and since the spread of farming into Europe was modelled on the spread of European agriculturists into the New World (*Alley and Findlow 1984*), these populations, more than their Palaeolithic predecessors, cave painters and big game hunters, were perceived as insignificant because of an almost complete lack of art and their microlithic industry (*Clark 1978.2*). A considerable amount of evidence in the last quarter of the century has shown that many prejudices toward hunter-gatherers in general, and Mesolithic peoples in particular, were unjustified[4]. Hunter-ga-

3 It became apparent in my numerous discussions with Dr. Jovanović at the Institute of Archaeology that we were using Mesolithic to denote quite different phenomena. Once we passed this barrier, the largests gaps in our respective interpretation were bridged.

4 Although they are only rarely explicitly present in up-to date archaeological literature, it is not so for other disciplines: see Rodrigue (*1992*) for a critique of current perception of domestication by cultural geographers who regard ritual sacrifice as major impetus for domestication of animals and portray preagricultural populations as: "*roving* and *hungry* hunters and gatherers," while farming is perceived "as creating leisure time" (p. 417 and quoted literature, my italics). It is possible to observe that there is practically no interaction between human geography on one hand, archaeology, and anthropology on the other, or else this statement could hardly be understood given recent insight into different subsistence strategies and their work-loads.

therers around the world "have for many millennia routinely manipulated plant and animal populations in diverse ways to optimise their use of them" (*Harris 1984; Harris and Hillman 1989; and examples quoted in Dennell 1985*). Farming and foraging are considered as "overlapping, interdependent, contemporaneous, coequal and complementary domains in the Amazonia" (*Sponsel 1989.37*).

Hunter-gatherers and agriculturists coexisted in many parts of Europe for several centuries, and in some areas, for millennia. Early farming communities were scattered amongst predominantly forager populations, and, depending on many of the historical contingencies, the spread of agriculture was sometimes rapid, sometimes gradual. It even retreated at times or showed no change over long periods of time (*Dennell 1985.113*). The interactions between these populations were inevitable, and our perception of their frontiers, communications and avoidance strategies has been largely improved from information gathered by cultural anthropology on recent foragers and farmers.

It is very important to stress, when dealing with past human populations, that our perception of possible interactions needs to remain open-ended so that interactions can be perceived as changing and fluctuating. Primarily, this is important since patterns of recent interactions are at least partly determined by the growing marginalisation of both subsistence farmers and foragers in the global industrialised economy. Secondly, the archaeological record preserves only a very limited portion of total interactions, namely, those that concern exchange, and can therefore only rarely provide insight into other aspects of it. Further, archaeology operates within time frames that largely surpass our personal experiences: since interactions between local foragers and farmers in the Iron Gates Gorge, in Portugal, or in Denmark, spread over almost one millennium, it would be unreasonable to think that they remained the same throughout that period and that they were always characterised by either mutualistic exchange or warfare. Also, the perception of cultural unity, as shown by recent research on interactions of foragers with farmers, does not necessarily stem from the same mode of life and "models of interaction which make insufficient allowance for the lack of coincidence between ethnic grouping and mode of production or the influence of different societies on each other may need to be revised" (*Jolly 1996.234*). The archaeological record produced by people belonging to two clearly distinct ethnic groups, one pastoralist, the other hunter-gatherer, can leave very similar material remains, which are determined neither by economy nor ecology, but by intention or anticipated mobility (*Kent and Vierich 1989*).

Perception of subsistence farmers as dominant over hunter-gatherers in recent small-scale societies has been fairly well documented (*Speth 1991 and quoted literature*). This current perception could result from the actual physical and numerical dominance of agriculturists in the modern world and would be irrelevant for the patterns of perception in prehistory. In all instances observed in contemporary populations, cultural traits move from dominant farmers to their neighbouring foragers (*Hodder 1982*), while women from foragers groups move into their neighbouring dominant farmer units (*Speth 1991; Zvelebil 1996a*). Although many mythological and ritual practices have unrestricted and bi-directional flow from one society to the other (*Lewis-Williams 1996 and quoted literature*), hunter-gatherers participate in farmers' initiation rituals and not *vice versa* (*Turnbull 1961; Jolly 1994*).

Current patterns of domination could stem from the fact that modern farmers are less dependent on forest products than foragers are on carbohydrates (*Speth 1991 and quoted literature*). The situation could have been very different at the time of the spread of agriculture into Europe. Therefore, extrapolating current perception as relevant for past human societies unreasonably assumes that agriculture had greater objective value than foraging, and would therefore be necessarily perceived as a better cultural adaptation by both farmers and foragers of the past. In prehistoric Europe it could be expected only within the context of the late Neolithic/Chalcolithic, when farming starts having a serious impact on the environment (*Willis and Bennet 1994*). Only in that context could hypergyny at an agricultural frontier result in the acculturation of foragers (*as suggested by Zvelebil 1996a.338*). Before that, this perception would fluctuate as determined by local and chronological dependence relationships between foragers and farmers. Hypergyny, or the practice of "women of low socio-economic status to move up the status hierarchy, marrying less fortunate men in higher social categories who must marry down to find a mate" (*Speth 1991.20*), commonly observed in these interactions today, would not necessarily mean that hunter-gatherer women would marry into farmers' villages. At least in certain regions where foragers would be numerous, sedentary, and with sophisticated social organisation, as in the Iron Gates

Gorge, they could have been perceived as dominant by small-scale farmers. Hypergyny would, then, take on a different direction.

Optimal forager models for subsistence transitions argue that "sharper growth is not associated with broader diet but with subsequent increases in handling efficiency associated with practices that result in domestication" (*Hawkes and O'Connell 1992 and quoted literature*). Population growth rates would, therefore, decline with expanding diet breadth in the Mesolithic and would increase with improvements in the handling during Neolithic (*Hawkes and O'Connell 1992*). This conclusion, however, disregards the role that sedentism had on population growth, changes in subsistence and social complexity (*Kent 1984; 1989a*). It is becoming increasingly evident that both hunter-gatherers and farmers can and do have different mobility patterns that are both ecologically and socially sensitive (*Kent 1989b*), and that these patterns cannot be classified as a simple dichotomy. This pattern is primarily, though not exclusively, determined by the distribution and seasonality of plant (or anadromous fish) resources, not animals (*Kent 1989a.11*). Intensification and localisation of resource exploitation leads to further sedentism, and importantly, aggregation which results in population increases (*Kent 1989a.10 and quoted literature*). Sedentary aggregations result in the need for an arbiter, as disputes can no longer be settled by mobility, as for example in Hadza (*Woodburn 1968.106*). The immediate consequence of arbiter becomes incipient political differentiation concomitant with changes in social organisation.

Since it is also known that many sedentary horticulturists hunt and manipulate plants for higher yields on a regular basis (*Kensinger 1989; Speth and Scott 1989 and quoted literature*), a clear-cut distinction between hunter-gatherers and small scale farmers can not always be made. This is no less true for modern societies than for the Early Neolithic of Europe. If we accept that agricultural practices are only those that "create(s) agroecosystems, which limit subsistence choice because of environmental transformation or labour demands" (*Harris 1989; 1996b; Spriggs 1996*), they could include the early Neolithic of southeastern Europe as evidence for agriculture, although they had little observable impact on environment.

2.4. Neolithisation of Europe

As already stated, the transition from foraging to agriculture can be regarded as one of the most fundamental cultural-ecological changes not only because it enabled large scale sedentism, subsequent population growth, and the appearance of the urban way of life, but also as it represents a conceptual shift in the perception of the world. Recent revival of interest in this phenomenon has brought about the understanding that agriculture developed independently in several areas of the world, and that modes of transition to food production from food gathering are specific for each individual geographic entity, and dependent on a number of particular conjunctions of circumstances in particular places at particular times (*Harris 1996b.552*). This revival has also stressed the importance of Upper Palaeolithic and Mesolithic adaptations for the development of the incipient agriculture, since small-scale cultivation is practised by many hunter-gatherers (*Harris 1989; 1996b; Spriggs 1996*).

It is generally accepted that methods of food production, together with cultigens, were introduced to Europe from the Near East *via* Greece and the Balkan Peninsula. Einkorn, emmer, naked wheat, six row barley, lentils and peas, all imported corps, show up in Early Neolithic settlements in Macedonia, Serbia and Bulgaria (*Zohary and Hopf 1988.191– 193*), while evidence for the introduction of domestic sheep predates full agropastoral economies in the Western Mediterranean (*Donahue 1992; Geddes 1985*). If the problem of origin of cultigens and knowledge of agriculture is solved, the mode of transition and the respective roles of hunter-gatherers and farmers remain unclear. Two major models are proposed: one involving the spread of farmers themselves, and the other based on appropriation of the new method of food production by indigenous foragers.

Since the beginnings of European archaeology, the transition from foraging to farming has been regarded as a replacement of European Mesolithic cultures and populations by Neolithic ones, that spread through colonisation by Near Eastern farmers (*from Lubbock 1865; to Harris 1996c*). The Epipaleolithic and Mesolithic population was perceived as sparse to the point that until the 1950s it was generally believed that no important developments occurred between the Upper Palaeolithic and Neolithic in Europe (*Clark 1980*).

Childe's (*see for example Childe 1958*) evolutionist understanding of the benefits of agriculture culminated in Ammerman and Cavalli-Sforza's (*1971*) theory which was to become one of the most influential models: wave of advance or "demic diffusion."

This interpretation is based on the comparison of the available ^{14}C dates and the genetics of living European populations (*Ammerman and Cavalli-Sforza 1971*). The authors argue for the spread of agriculture by the more or less continuous migration of people from the southeast to the northwest, at the average pace of 1 km a year (or 25 km per generation) with continuing population growth immediately following the advancing front of agricultural settlement (*Ammerman and Cavalli-Sforza 1984*). In later publications, the model came to incorporate the transfer of technology as a part of the process (*Cavalli-Sforza 1996*). Assimilation of foragers by farmers, through deforestation and acceptance of agricultural practices (competition and acculturation) and marriages of hunter-gatherer women to farmers (acculturation), would have created the "gradient" observed in the Principal Component Analysis (PCA) of genetic data.

Authors such as van Andel and Runnels (*1995*) accepted and attempted to moderate this view. Since early Neolithic settlements in both Anatolia (*Roberts 1991*), and southeastern Europe (*van Andel and Runnels 1995*) were characterised by small scale and locally intensive cultivation (*Sherratt 1980*) and situated in areas, at least in the Balkans, that were not occupied by indigenous Mesolithic populations, they argued that migration occurred in discrete steps, "the interval dictated by geography and by the population growth in each of a slowly rising number of parent areas" (*van Andel and Runnels 1995.497*). Cavalli-Sforza argues for expansion rather than migration, as the former involves both population growth and replacement (*Cavalli-Sforza 1996.56*). He also endorses Renfrew's equation of this population as Indo-European speaking (*Renfrew 1996*)[5].

In a recent critique, Fix (*1996.627–628*) has shown that the parameters that Cavalli-Sforza and colleagues used are far from well defined and fixed. He argues that clinal patterns such as those observed in European populations also can be produced by temporal gradients in natural selection. A similar opinion was forwarded in early 1980s by Meiklejohn (*Meiklejohn 1985*). The selective factor would be increasing disease intensities brought about by the "diffusion of agriculture, and especially, by the association between humans and newly domesticated animals" (*Fix 1996.625*). Although the cause of clinal distribution would be agriculture, the mechanism of its spread need not be movement of population. It could, just as well, result from natural selection acting on a local population that has changed (through transfer of ideas and otherwise) its cultural (subsistence) practices (*Fix 1996.641*). Fix is aware of the problems associated with the proposed model: namely it is very difficult to demonstrate small fitness differences for many loci, and prove the association of the origin of certain diseases with domestication of animals, but his model is important as it proposes another look at the data and argues that it is "mistaken to use loci such as HLA, for which there is strong evidence of selection, as neutral markers of population movement" (*Fix 1996.641*). The two models discussed contrast most sharply in the demographic mechanisms for generating the clines and therefore Fix concludes that "knowledge of the population characteristics of the Mesolithic and Neolithic peoples could decide the issue" (*Fix 1996. 641*). Further, the craniometric analyses of European prehistoric samples failed to provide support for the model of population replacement (*Harding et al. 1989; but see Petersen 1997*).

If, as proposed by Cavalli-Sforza (*1996*), not only farming, but farmers themselves originated in the Near-East and then expanded into Europe, it would require that the Near East was a "demographic cistern" that overflowed its surplus to Europe (*Dennell 1985.119*). Early and Middle Neolithic farming communities are rare and small in size in southeastern Europe, and even in the Near East early farming populations seem to have been very low in numbers. Inclusion of local foragers into the genetic pool through hypergyny and acculturation would only have marginal importance in this initial phase according to the clinal distribution of PCA and the isochronic map that is used to support the "demic diffusion" model.

The Mesolithic population of Europe was interpreted as highly homogenous, showing a high degree of similarity with preceding Upper Palaeolithic people (*Henke 1989.541*) with clinal distribution and a continuous gradual change over time. This was suggestive of intensive gene flow between Late Pleistocene and Early Holocene populations in Europe. In Henke's view, "due to a low population density there were continuously, partly overlapping mating networks without any greater barriers to gene flow" (*Henke 1989.560*). The low population densities would increase only later in the Mesolithic with a tribal level of social organisation that was either of

5 For an exellent critique see Sergent (*1995*).

a short duration, or was not prevalent and therefore did not lead to genetic isolation (*Constandse-Westermann and Newell 1989; Constandse-Westermann et al. 1984*). Bocquet-Appel (*1985*) suggested that small populations could avoid extinction only by means of high migratory flow, involving interpopulation gene flow and exchange over large geographic areas. Because of this model and the supposed scarcity of resident hunter-gatherer populations, their role in the process of introduction of agriculture "has been disregarded or minimised" (*Meiklejohn and Zvelebil 1991.129*). That the Mesolithic population was sparse throughout Europe, has been questioned by recent paleodemographic studies (*Jackes et al. 2000; Meiklejohn et al. 1997; Jackes et al. 1997*). However, a careful reading of the argument by Constandse-Westermann and Newell points to a greater regional sedentism in the Late Mesolithic and may not be in contradiction with current archaeological or demographic evidence, although Danish material seems to cast considerable doubt on this concept (*Meiklejohn pers. comm.*). As with many other lines of inference, recent paleodemographic studies of Portuguese and Danish material have shown that the picture is not only complex but also region-specific (*Meiklejohn et al. 1997; Jackes et al. 1997*).

Given the fact that the first farmers would be moving north into essentially unknown habitats, and progressively more marginal climatic conditions for the production of their newly domesticated plants, while the foragers were long time inhabitants with excellent knowledge of seasonal food availability, it is unlikely that the neolithisation of Europe could have been as swift without involvement of local Mesolithic inhabitants (*Prinz 1987*). Coexistence and mutualistic exchange that was proposed recently for Central Europe, as opposed to confrontation and acculturation, therefore provides a likely and more flexible context for understanding the early interactions of farmers and foragers (*Gregg 1988; 1991b*). As Dennell points out (*1985.118*) lack of evidence for defence structures around early farming villages argues for peaceful interactions rather than raiding and warfare. This is not only in sharp contrast with later societies in temperate Europe but also strongly contradicts the attempt to equate incoming farmers with Indo-Europeans as Renfrew (*1996*) does. However, idealistic peaceful interactions have been contested by L. Keeley (*1997*) who argues that the transition to agriculture in central and northern Europe offers evidence for substantial amount of violent relationships, especially in the western realm of the Linearbandkeramik (LBK) spread.

The diffusionist point of view, so influential in English-speaking archaeological tradition was criticised as early as the 1970s by Garašanin (*1973; 1974b*), and greater emphasis was placed on understanding local Mesolithic populations as active participators in the process of neolithisation (*see also Guilaine 1976*). Price's conclusion (*1983.771*) that "the end of the Mesolithic is not brought about by an advance of invading farmers but rather reflects a period of readaptation and adjustment to changing environments and new subsistence practices, *often within the context of existing societies*," stresses the importance of adaptations of Mesolithic foragers that enabled the transition to agriculture. It precedes the recent shift towards placing greater emphasis on the role of Mesolithic populations in Europe and their incorporation of farming techniques as a mode of transition to agriculture (*Barker 1985; Dennell 1984; 1985; Hodder 1990; Thorpe 1996; Zvelebil 1996a; 1996b*). As Barker (*1997*) noted, what was heresy in the academic core in the early 1980s has become orthodoxy in 1990s and in this new development the role of population movement has been underplayed. In light of this shift in direction, the appreciation of incipient indigenous cultivation and domestication that was proposed for Lepenski Vir by Srejović fails to be as unlikely as it was back in 1972 when it was first published in English (*Srejović 1972*).

It is important to note here that, although the positions discussed above propose models for Europe as a whole, or imply continent wide implications in their titles, most of the studies of the spread of agriculture are based on the evaluation of the spread of the LBK culture limited to Central and West-Central Europe and, in terms of European periodisation (Tab. 1), contemporaneous with the Late Neolithic cultures of the Southeast: Vinča-Tordoš and Dimini (*Demoule 1988; Garašanin 1980a; 1980b; Lichardus and Lichardus-Itten 1985*). The spread of "Cardium-impresso" ceramics in the circum-Mediterranean region, with little evidence of agriculture but with even earlier pre-pottery evidence for domestic *Caprinidae* (*Batović 1966; Benac 1979; Donahue 1992; Lichardus and Lichardus-Itten 1985*), or "La Hoguette" pottery in the South-Western and Western Europe for which an African – more specifically Central and Eastern Saharan – origin was recently proposed (*Winiger 1998*), contradict the above model.

The evidence provided by southeastern Europe, and the Balkans in particular, is rarely discussed in the theoretical literature or syntheses except for absolute dates that are used to argue the direction and pace of migration or spread of cultural influence. The explanation for the neglect of patterns of interaction and change in these "marginal" European regions is mostly due to searching for a "general processual model" so typical of 1960s, 1970s and even 1980s (*as pointed out by Harris 1996c*) to which these regions do not provide a good fit, but also to the fact that the majority of data are published within local research traditions even when they are published in English. "Indigenous archaeology" (*Evans and Rasson 1984*) which has a long tradition in Balkans, is perceived as devoted exclusively to typological studies and as lacking the more sophisticated economic perspective and scientific approach of the "New archaeology". With the demise of the New archaeology in Anglo-American archaeology, that was rejected by Balkan researchers because of its apparent mechanicism (*Garašanin 1996*), "indigenous archaeology" has gained new importance for non-local archaeologists. This is apparent in the work of authors such as G. Barker and J. Chapman who not only use available data from the published reports but also discuss and sometimes incorporate the ideas and interpretations of local researchers.

In conclusion to this section, we can state that replacement is not demonstrated, although it is neither impossible nor improbable, and that the change in subsistence practices was not as uniform as previously believed. As pointed out by Van Gijn and Zvelebil (*1997.3*), "both the Mesolithic and the Neolithic were internally far more heterogeneous than we have recognised." The long coexistence of farming and foraging communities, that has been demonstrated or proposed for different regions in Europe, provides the general framework for this study. However, the cultural and biological identity of farmers needs to be examined on a regional basis. Based on archaeological evidence, we cannot assume that the same population was responsible for the neolithisation of the Balkans as for the neolithisation of the Circum-Mediterranean, Central European, or Baltic regions, nor can we argue that modes of interactions between these populations would have been the same over the entire continent. Therefore, building meaningful continent-wide models has to repose on well documented regional occurrences.

Further, comparisons between regions should be made on the basis of archaeological sequences and data, rather than testing preconceived models on local data, as there is an incipient tendency in the latter to search for adequate data in local manifestations that would fit the (usually) monocausal model (as is the case with Cavalli-Sforza's argument). This however, does not mean that comparisons and general models are not possible or meaningful. On the contrary, they become possible when the same level of insight is obtained for different regions and periods. The process of learning about the past, although embedded in the present, has to overcome this determinism, and rather then being unilinear, rooted in either local data or global theories, must incorporate both in order to transcend the present and reveal more about past than it does about our current agendas, which are implicit in Shanks and Tilley's (*1987*) approach (*see also a critique by Van Gijn and Zvelebil 1997*). In that respect, some basic premises of this work are:

- Understanding the processes of neolithisation for each region must incorporate understanding of the Mesolithic substrate and its response to (among other factors): availability of agricultural knowledge or contact with agricultural settlements.
- Responses of past foragers to contact with farming were determined by both economic and ideological strength of the local Mesolithic culture. In any of the regions they could have taken a number of forms that were not necessarily paralleled in other regions. Further, the mode of contact need not (or was even unlikely to) have remained the same over long periods of time in which these different forms of subsistence were practised by respective populations.
- Introduction of material and symbolic (as much as we can perceive them) elements of one culture into the other, if they did not substantially change the subsistence base, can only be used as evidence for contact and not as evidence for acculturation.
- Regardless of the ultimate origin of agriculture, the farming community with which local Mesolithic inhabitants were coming into contact, could have been at the time: of different geographic origin or of the same geographic origin.
- This population in either of the above cases could have been: morphologically and/or genetically distinguishable or morphologically and/or genetically indistinguishable.

2.5. The choice of study area

The first manifestations of the Neolithic in Southeastern Europe and the Balkans precede the LBK culture and show significantly different economic, social and ideological patterns (*Benac 1979; Garašanin 1979; Srejović 1979*). Three major complexes are distinguished within the Neolithic of Southeastern Europe. Each covers relatively vast geographic areas and includes groups that are more or less related. These are the Balkano-Anatolian complex of the Early Neolithic, the Balkano-Karpathian complex and the Occidental Mediterranean complex (*Garašanin 1980*). The Balkano-Anatolian complex includes (in the European part) Thessaly, South-East and South of the Balkan Peninsula (Thracia south of Stara Planina and Macedonia), as well as an important enclave that spreads north into the Pannonian plain and the Karpathians. It includes groups defined as Protosesklo in Thessaly, Anzabegovo Vršnik I in Macedonia, Karanovo I in Thrace and Gura Baciului in the Karpathian basin (*Garašanin 1980.58*). Although based primarily on the typological and stylistic analysis of ceramic production and habitation, it coincides with economic parameters. The major distinction between the Balkano-Anatolian and Balkano-Karpathian complex is that goat/sheep herding predominates in Thessaly (*Bökönyi 1974; Barker 1985. 63*), while cattle are characteristic of Starčevo-Criş-Körös farmers (*Bökönyi 1974*). Bökönyi argues for local domestication of cattle in Argissa Magula (*Milojčić et al. 1962*) and Nea Nikomedeia (*Higgs 1962*) that was soon replaced by animal husbandry based on caprovines, and that gave rise to the Starčevo-Criş-Körös complex of the Early and Middle Neolithic. Unfortunately no faunal data are published for Gura Baciului, and the fauna of the closest related settlement (that of Lepenski Vir III) is published without regards to LV IIIa being synchronous with Early Neolithic (Gura-Baciului, Thessalian tradition) and LV IIIb with Middle Neolithic, classical Starčevo. In the Lepenski Vir III settlement wild animals predominate (74,5%) while bovines are most common among the domesticates (15,83%) (*Bökönyi 1972*). Goat/sheep remains follow and are also attested at the Mesolithic site of Padina although their exact provenience is not clear (*Clason 1980*). Also, the fact that in the Balkans there is a paradoxical absence of palynological and other evidence for agricultural impact on the landscapes until c. 4000 BC (*Willis and Bennet 1994*), points to a different scale and importance of agriculture in this period than for the Late Neolithic Dimini-Vinča-LBK agriculture.

The fact that new cultigens and (some) domestic animals are introduced to Southeast Europe together with the spread of ceramic and polished stone axes can be conveniently used as a sign of a moving agricultural frontier. The question is how to perceive and study this frontier, and the interactions that "Mesolithic foragers" and "Neolithic farmers" could have had. Dennell states that from 5300 to 4300 BC there was a rapid expansion of agriculture by pottery-using communities living in "large, permanent settlements" across much of Southeast and Central Europe. "Thereafter, agricultural expansion into northern and western Europe was more gradual and seldom associated with large, year-round settlements until much later." (*Dennell 1985.121*).

What he refers to as "large, permanent settlements" are "tells" such as Anzabegovo (*Garašanin 1974a; 1979; Garašanin and Garašanin 1961; Gimbutas 1976*), Karanovo, (*Georgiev and Čičkova 1981*), or Argissa Magula (*Milojčić et al. 1962*) that could have resulted from non-permanent but repeated use (*see also Bailey 1997*). Starčevo I (Early Neolithic) and Starčevo II (Middle Neolithic) settlements that characterise the Central Balkans present a different picture both in terms of architecture and spatial organisation. They do not have the complex vertical stratigraphy of the "magulas" or "tells" and were most probably not re-occupied after being abandoned. Permanent occupation of both types of sites is questionable, since the extensive (shifting) agricultural practices require that new land is found whenever the one currently being used becomes too poor in minerals and necessary elements and therefore requires either enlarging the radius of exploitation (with rising cost of transport and protection of the crops) or moving a settlement. The latter seems to be characteristic of both the Anzabegovo and Starčevo types of settlements. Only with the Vinča intensive agriculture (*Garašanin 1979*) and LBK introduction of crop rotation (*Willerding 1980*) does it become possible to have permanent settlements.

Dennell's (*1985*) appreciation of size and permanence (and associated mobility) of different groups in Balkans prehistory, leads him to assume that hunter-gatherers would perceive the agriculutralists as having "more substantial houses, novel items such as pottery, polished stones and so forth" and would therefore be more inclined to observe them as "better off", which would result in hypergyny and a loss of the Mesolithic population to incoming farming groups. Although this model does not fit all the archaeological data of the region (especially in terms of permanence of the Early Neolithic settlement and perception of farmers by foragers), determining the frontier for the interactions of early farmers and local foragers as porous, allowing transfer of people, resources and techniques across the border, seems appropriate in at least some of the early interactions and has been a crucial breakthrough in our understanding of forager-farmer interactions (*Zvelebil 1996a and quoted literature*). Since hunter-gatherers would have a larger radius of movement, they would more often come in contact with local farmers near the latter's villages, and could thus appropriate their knowledge and techniques, or be appropriated (one way or another) by farmers.

2.6. Why Mesolithic population of the Iron Gates Gorge?

Both the Epipaleolithic and Mesolithic of the Balkans, with the exception of the Iron Gates Gorge and some smaller sites in Montenegro and eastern Serbia, are understudied. However, the Iron Gates Gorge has been excavated extensively and has produced evidence for all of the Mesolithic economy and structure (as discussed above). The sites in the area offer a unique possibility to observe possible (and probable) interactions between foragers and farmers over a substantial time span. These interactions can be further traced in the skeletal record and potentially some of the biological features of them could be delineated. Ideally, we would have as large a collection of Neolithic sample from the region, but it is not the case. We could lump all of the osteological material from early and middle Neolithic of the Balkans together, but this could cause the general trends of the region to obscure the specifics of interaction and therefore, a more regionally restricted approach was deemed better. With the stated problems in mind, the region was chosen for several reasons:

- The neolithisation of this area preceded the neolithisation of all other parts of Europe except the Aegean.
- The extent of excavations on a number of sites on both banks of the Danube has been unparalleled in the last three decades as they have exposed substantial living surfaces amenable to detailed archaeological analyses.
- Through abundant architectural features, artefacts, faunal, plant and osteological remains, the sites provide insight into both cultural and populational consequences of contact.
- Since the archaeological coexistence of the Mesolithic Schela Cladovei-Lepenski Vir culture and Neolithic Starčevo culture has been established (*Bonsall et al. 1997; Boroneanț et al. 1995; Radovanović 1992; 1994; 1996a; 1996b; 1996c*) the degree and mode of interaction between the bearers of these cultures can potentially be traced in human osteological remains.
- Since this is one of the largest Mesolithic skeletal samples in Europe, information provided by skeletal data can be crucial in our understanding of the resulting biological change in the population under transition and potentially elucidate its causes.

2.7. Questions

This research attempts to reconstruct the extent of interactions between farmers and foragers through examining two aspects of skeletal material from four of the most important sites excavated in the region: Lepenski Vir, Hajdučka Vodenica, Vlasac and Padina. Here I propose a list of questions that this work will attempt to answer. The choice of material, theoretical premises and methods, are discussed in subsequent Chapters (3 and 4). The results of the analyses are presented and discussed in Chapter 5 and a discussion and conclusion offered in Chapter 6 and 7 respectively.

1st question: In light of a proposed porous frontier between Mesolithic and Neolithic cultures in the studied region, traceable in the archaeological evidence, can we presume the interactions between bearers of these respective cultures?

2nd question: If there was an interaction between foragers and farmers, are we able to perceive it through the study of anthropological material?

3rd question: If the spread of agriculture was a consequence of cultural transfer alone, is it likely that the biological profile of the population will change significantly? In which direction?

4th question: If the Early Neolithic population of the Balkans is different from the Iron Gates Gorge Mesolithic population, can we trace the effects of contact on the latter?

5th question: If we can argue for a change in the Iron Gates population as a result of contact with Neolithic population WHEN did this change occur? Did it happen at the time of the first contact, which did not bring about the change in subsistence, or later, when the subsistence changes sufficiently to determine Iron Gates sites as Neolithic?

6th question: In either case, what explanation can we propose for the change: genetic admixture, replacement or changing ecology (occupation/nutrition)?

3. THE LEPENSKI VIR CULTURE

This chapter is an attempt to summarise the archaeology of the Mesolithic to Neolithic transition in the Iron Gates Gorge, through some of its major features. In keeping with the goal of examining the possible biological (populational) effects of contact of Mesolithic foragers with Neolithic farmers, the chronology and the evidence of contact in the archaeological record were examined. The four sites from the right bank of the Danube are presented together with details of chronological assessment of each of the skeletons within the sites. Because of the fact that the Mesolithic component is present on all four of the sites, while Neolithic (as defined earlier) could be ascertained only at Lepenski Vir, these interactions are examined from the Mesolithic perspective. Accordingly, considerable space is allocated to the description of the basic features of the Iron Gates Gorge Mesolithic. The Neolithic component at the Lepenski Vir site fits well within the Balkano-Karpathian complex as described by Garašanin (*1979*). Therefore, it will only be discussed briefly in reference to pottery as the most prominent evidence of the contact at the sites. After the examination of the proposed methodology (Ch. 4) and the presentation of the results (Ch. 5), discussion on the morphological and biological affinities of each of the examined populations is proposed in Chapter 6.

3.1. Research, publications and interpretation history

As recently as 1950 the Central Balkan was deemed to be uninhabited during the Mesolithic period (*Srejović 1989*). The surveys and excavations that were undertaken before the building of the dam on the Danube downstream from the Iron Gates Gorge during the 1960s unearthed a number of Holocene sites in the Gorge that were ultimately assigned to the Lepenski Vir-Schela Cladovei cultural group. On the Yugoslav bank of the Danube (Fig. 3), Padina (*Jovanović 1972; 1974*), Stubica, (*Jovanović 1971; 1974*), Lepenski Vir (*Srejović 1968; 1969; 1971; 1979; Srejović and Babović 1983*), Vlasac (*Srejović and Letica 1978*), Hajdučka Vodenica (*Jovanović 1984a*), Velesnica (*Vasić 1986b*), and Kula (*Sladić 1986*) were excavated over a 20 year period. On the Romanian bank of the Danube, Privod, Alibeg, Ilisova, Razvrata, Ostrovul Banului, Schela Cladovei, (*Boroneanţ 1973*) Vodneac, Cuina Turcului (*Boroneanţ n.d.*), Climente I and II, (*Boroneanţ n.d.; Radovanović 1981*), Veterani terrace, Icoana, Ostrovul Corbului (*Mogosanu 1978*), Ostrovul Mare 875, and 873 (*Boroneanţ 1980*) were excavated in successive campaigns from 1964 to 1973.

From the 1970s onwards, a number of important volumes appeared: an English language compilation of the known data by Tringham (*1971*), a monograph on Vlasac by Srejović and Letica (*1978*), the Cuina Turcului final report (*Paunescu 1978*), the papers from the conferences on the problems of neolithization held in Sarajevo in 1977 and Krakow 1979 (*Benac 1978; 1980; Garašanin 1978; Srejović 1978; 1980; Mikić 1980; Kozłowski and Kozłowski 1978*), the conferences on the Mesolithic in Potsdam, Edinburgh (*Boroneanţ 1989; Srejović 1989; Voytek and Tringham 1989; Chapman 1989*), Grenoble 1995 (*Radovanović 1995; Boroneanţ et al. 1995*), and conferences on the Mesolithic and the chipped stone industries of the earliest farmers at Krakow (*Kozłowski 1982; Kozłowski and Kozłowski 1987; Paunescu 1987*). As well, a number of analyses were published on the chipped stone industry: from Padina (*Radovanović 1981*), Vlasac (*Prinz 1987*), and Lepenski Vir (*Kozłowski and Machnik 1980*) as well as on floral and faunal remains (*Clason 1980*). Syntheses also appeared at the time: in *Praistorija Jugoslovenskih Zemalja* [Prehistory of Yugoslavia] by Srejović, Benac and Garašanin (*1979*), then in *Esquisse d'une Préhistoire de la Romanie* (*Mogosanu 1983; Dumitrescu et al. 1983*), followed

Fig. 3. The map of the Iron Gates Gorge. The sites analysed in the present study are outlined in bold. (Adapted from NCARTA 1998).

by a synthesis on Banat in the Neolithic by Lazarovici (*1979*). Lepenski Vir was briefly discussed in *La Protohistoire de L'Europe* (*Lichardus et al. 1985*), as well as in *Domestication of Europe* (*Hodder 1990*), in *Europe in the Neolithic* (*Whittle 1996*), and in a number of articles by Chapman (*Chapman 1989; Chapman and Dolukhanov 1993*).

Radovanović provides an excellent historical and critical overview of the phases of research and publications in the region (*1996a.2–10*). The monograph by Radovanović is the first synthesis based on published works, field documentation and a new approach to a combination of stylistic, chronological, and material analysis for the entire region. While she draws heavily from all local resources available, Radovanović manages to incorporate a new understanding of a variety of issues into her appreciation of the data collected in the field. Benefiting from firm knowledge of the regional archaeology, access to field documentation, as well as a wide array of theoretical perspectives, the volume successfully incorporates different intellectual traditions into a comprehensive study. More importantly, this volume provides a wealth of information on particulars of the regional Mesolithic so often lacking in theoretical discussions by non-local scholars.

A number of analyses that appeared in the 1980's on chipped stone assemblages from Lepenski Vir, Vlasac and Padina established continuity between the Iron Gates Epipaleolithic and Mesolithic. However, different synchronisations among phases of the sites were proposed (*Radovanović 1996a.9 and quoted literature*). Late Palaeolithic finds from Cuina Turcului I were perceived as predecessors of the Lepenski Vir culture by Srejović (*1989.54*) and he offered the following periodisation:

① Late Palaeolithic, (Cuina Turcului I);
② Epipaleolithic (Cuina Turcului II, Ostrovul Banului I–II);
③ Early Mesolithic (Icoana I, Ostrovul Banului IIIa, Schela Cladovei I, Padina A, Vlasac Ia, Proto-Lepenski Vir);
④ Late Mesolithic (Icoana II, Ostrovul Banului IIIb, Schela Cladovei II, Padina B1, Vlasac II–III, Hajdučka Vodenica, Lepenski Vir I–II);
⑤ Mesolithic/Neolithic (Padina B2, Kula, Alibeg, Ostrovul Mare) and
⑥ Early Neolithic – the formation of Proto-Starčevo (Lepenski Vir IIIa, Cuina Turcului III, Padina B3).

Boroneanţ (*1989*) supported the appreciation of continuity from the Late Palaeolithic, through the Epipalaeolithic (Clissourien-Romanellien and Schela Cladovei) and into the Mesolithic Lepenski Vir culture until the Middle Neolithic. The process of neolithisation is regarded as a local development by both of these authors although their interpretations differed in details.

A different opinion is presented by Paunescu (*1978*) who perceives the Neolithic culture of Starčevo-Criş (Middle Neolithic) type as an immigrant population that interrupted the local isolated development of the Schela-Cladovei hunter-gatherer-fisher group. He also maintained that an earlier Neolithic population (Early Neolithic of Proto-Sesklo, Anzabegovo, Donje Branjevine, Gura Baciului type) was contemporaneous and in contact with Schela Cladovei (*Paunescu 1987*). Unfortunately this argument is not discussed in relation to the sites on the right bank of the Danube and only Lepenski Vir III is incorporated and attributed to the classic phase of Starčevo Culture *contra* Srejović who makes a distinction between IIIa and IIIb in which the IIIa would be Early or Proto-Starčevo (*Srejović 1969*).

For Lichardus-Itten (*1985*), the contemporaneity of the Starčevo and Lepenski Vir cultures completely excludes the possibility of local neolithisation. Jovanović (*1987.14–15*) has maintained that all three settlements of Padina B phase belong to the Starčevo-Criş complex based on *in situ* finds of Starčevo ceramics in Lepenski Vir type houses. Voytek and Tringham (*1989.494–495*), who propose extensive social contacts between these two subsistence systems, argued for their coexistence.

While most of the authors agree that the origin of the Schela Cladovei-Lepenski Vir complex should be looked for in the local Late Palaeolithic, their disagreements range both in the timing and mode of transition from the Mesolithic Lepenski Vir to the Neolithic Starčevo culture, as evidenced by the Middle Neolithic Starčevo horizon in Lepenski Vir IIIb. Drawing on analysis of the chipped stone industry and her revaluation of the typological and chronological associations from the sites on the right bank of the Danube, Radovanović (*1996a.313*) accepts that certain elements of the Iron Gates Mesolithic tool kit were related to the preceding Epipaleolithic period. The VIIIth millennium BC witnessed the change in the mobility pattern of local hunter-gatherer groups, which led to more permanent settlements. Three groups (at least) can be distinguished in the local Mesolithic community. The (1) Upper Gorge group, (2) the Ključ area group that split from the first one and (3) the Lower Gorge group(s). All groups are characterised by a hunting-gathering-fishing economy, similar settlement and burial practices, and distinguished by their preferences in hunting, different architectural and burial elements, as well as details of stone industry (*Radovanović 1995; 1996a; 1996c*).

The Mesolithic economy of the Lepenski Vir culture is of long duration, from the second half of the VIIIth to the first half of the VIth millennium or perhaps even until the Vth millennium - already characterised by late Neolithic Early Vinča culture in the region (*Radovanović 1995*). Contacts with the Neolithic population were possible from the mid VIIth millennium (Donje Branjevine, Gura Baciului). However, there is no change in subsistence until the fully Neolithic (Middle Neolithic) Starčevo settlement Lepenski Vir IIIb, and a Starčevo settlement in the vicinity of Padina sector IV (*Jovanović pers. comm.*), where food production and imported domesticates (sheep/goat) are attested. Radovanović places contact with groups using pottery (Starčevo Neolithic groups) in her phase 6 (see later in the discussion of chronology) while pottery sporadically appears from phase 4. The meaning of this intrusion has been discussed in the literature, from taphonomic effects of site formation (*Srejović pers. comm.*) to local architectural development within the Starčevo complex (*Jovanović 1987*).

Ranging from local continuity to brisk interruption by incoming farmers, the Mesolithic/Neolithic transition of the Iron Gates Gorge offers an array of possible interpretations. In the view of likely interactions between two subsistence systems that changed over time, the chronology (Ch. 3.3), and individual sites with details of their archaeological features, as well as detailed chronological determination for each of the individuals (Ch. 3.4) are presented.

3.2. Natural setting and basic archaeological data

Once the Danube leaves the fertile Pannonian plain and cuts its way through the Karpathian massif, the vast mass of water that measures more than 5 km from one bank to the other enters a bottleneck that measures ten times less (Fig. 1). Before the building of the dam for the hydroelectric plant, navigation in the Gorge was very difficult in winter and spring. In geological terms it is dominated by limestone massifs with typical karstic traits, but also siliceous bedrock in the valley-like parts of the Gorge. The presence of limestone bedrock on siliceous bedrock (these are not however, the only formations) influences the great variability in soil types (*Misić 1981, quoted in Radovanović 1996a*). The differences in vegetation types, caused by subsoil and soil types, between the canyon-like and the valley-like parts is great. In the vicinity of Lepenski Vir and Vlasac (Gospodjin Vir) alone, there are 20 types of forest and scrub associations. The climate is different from the surrounding regions with more rainfall, lower summer, and higher winter temperatures. It also differs between regions of the Gorge. It is dryer in the canyon-like parts, with more rainfall in the valleys.

During the Pleistocene, the specific geomorphology of the Gorge played an important role in reducing climatic oscillations, which is evident in an important number of relict Tertiary species found in the Gorge, especially in the lower altitudes. Together with considerable precipitation, this was the major factor in quick forest regeneration in Pleistocne (*Cvijić 1987/1922; Mišić 1981; Radovanović 1996a*). With the Early Holocene (Preboreal and Boreal) the difference between the Iron Gates Gorge and the surrounding areas diminish.

Pollen remains were collected on only two of the four sites: Lepenski Vir (*Gigov 1969*) and Vlasac (*Carciumaru 1978*), and only a portion of them has been analysed. On the Romanian side, palynological data are available for Icoana (*Carciumaru 1973*), and the most comprehensive sequence is provided by the site of Cuina Turcului (*Pop et al. 1970*). Carciumaru argues for the appearance of Cerealia type pollen grains in Vlasac II, and an increase in size and importance of the Cerealia type grains in the Boreal and in the beginning of the Atlantic at Icoana. Their size increases in the upper parts of the section. In comparison their appearance is earlier than at Vlasac.

Animal remains are very diversified at all sites. However, some species predominate. As mentioned earlier, even with the introduction of a Neolithic economy, hunting and fishing remain important on the sites. New studies of the animal bone material are under way for all four sites, as some of the problems (seasonality for example) were not adequately treated in previous research (*Dimitrijević pers. comm.*). A more serious problem is that most of the analyses treat sites as units, regardless of the stratigraphy (*Bökönyi 1969; 1978; Greenfield 1984*) except for Padina (*Clason 1980*) where the stratigraphy was respected. However, it was possible in most of the cases to reconstruct the provenience and arrive at relative representations of species per period for most of the sites (*Radovanović 1996a.52–59*) and reconstruct the importance of different species per period. A long overdue refined analysis, recently undertaken by Dimitrijević (*pers. comm.*), takes into account the context, and promises more comprehensive conclusions. Radovanović proposes the following picture of hunting practices in the Gorge:

> Red deer, ibex, wild pig and aurochs are among the most important wild species in all periods. In the Epipaleolithic, the difference between sites is based on the site-type. In the Mesolithic the situation changes. The dominant hunting species on the right bank of the Danube is red deer, while wild pig seems to be extremely important on the left bank (unfortunately data are known only for Icoana). Hajdučka Vodenica, across from Icoana, also has high proportions of wild pig. It seems that its importance was higher in the Lower Gorge. Although red deer is less frequent among faunal remains in the Neolithic period, it remains the most important hunted animal. It is also worth noting that wild ass is hunted not only at Padina B and Lepenski Vir III but also at a number of Pannonian Körös and Starčevo sites (*Lazić 1988. 24–27; Radovanović 1996a.55*).

Fishing, as already pointed out earlier, played an important role in the Mesolithic Iron Gates subsistence. But, just how important, remains an open question. The main fishing season coincided with migration of the red deer to higher altitudes and could have been instrumental in establishing camps on the river bank in greater numbers than previously. This difference would arise from the Black Sea transgression and the rise in water temperature that caused the growth of shoals of local and anadromous fish (*Radovanović 1996a.55 and quoted literature*). The data collected on a number of sites imply that fishing in the Epipaleolithic was not systematic. Fish of both low and high quality (10 species total) are noted. Throughout the Mesolithic and Neolithic the number of species fell to four, but the quality as well as quantity of any of these four species is much larger, and fish remains comprise as much as 60% of osteological remains for Vlasac and Lepenski Vir I and over 87% of bones at Padina. Hajdučka Vodenica, with its 83.33% of game and only 1.58% of fish poses some problems in interpretation (Tab. 2). Several explanations are plausible:

- The site was a highly specialised ritual site (*Jovanović pers. comm.*) and the bones reflect the prescribed food for the veneration of ancestors (evidenced by a large number of graves in the formal disposal area).
- Fishing was impractical at the site and game was more readily available.
- Along the same lines, this could have been a seasonal hunting station.
- There is an important preservational or excavational bias that acted to reduce fish remains. Although this last explanation is always a possibility, since the same team excavated both Padina and Hajdučka Vodenica and their respective percentages for fish and game are practically inverse, it seems the least likely, however preservation bias can not be ruled out.

The lack of anadromous fish (sturgeon or beluga *Huso huso* and sterlet *Acipenser ruthenus*) at Vlasac and Lepenski Vir is surprising and it points to a change in fishing practices between Epipaleolithic and Mesolithic. Clason notes that sturgeon is not found among fish remains of Starčevo and Körös period either. Its presence in Padina is, most probably, in association with the Epipaleolithic Padina A stratum. Bonsall *et al.* (*1997*) have argued that fish played not only a vital, but also the most important part of the subsistence of both Mesolithic and Neolithic people in the Gorge. The proportion of the game/fish bone coincides with the importance of the fish in the diet, although these proportions should be taken with caution due to the unequal yields as well as preservation and collection bias. However, it does not exclude other sources of protein as suggested by isotope analysis. Since the $\delta^{15}N$ values distribution is not very well understood (*Nelson pers. comm.*) and very few analyses have been done on the local fauna, especially Black sea fish, zooarchaeo-

Site/period	Game	Fish	Dog	Other domestic
Vlasac	33.48%	59.95%	6.57%	–
Lepenski Vir I	37.74%	57.31%	4.95%	–
Lepenski Vir II	62.60%	25.72%	11.60%	–
Padina A	57.13%	39.47%	2.18%	1.19%
Padina B	8.54%	87.34%	3.45%	0.65%
Hajdučka Vodenica	83.33%	1.58%	3.96%	11.11%
Lepenski Vir III	57.49%	16.88%	5.91%	19.69%

Tab. 2. Game, fish, dog and other domestic animals in the Mesolithic and Neolithic of the Iron Gates Gorge. Based on identifiable skeletal elements. (*Adapted from Radovanović 1996a.57 and Bökönyi 1969.224–225*).

logical evidence seems to bear more weight. More research into the isotope values for different foodstuffs and better sampling is needed in order to forward conclusive results, even if we accept that the method is sufficiently developed to distinguish without doubt between riverine and terrestrial resources.

The lack of anadromous fish in both the Mesolithic and Neolithic (Starčevo sites) in the region is much harder to explain and Radovanović proposes the ritual importance of anadromous fish, resulting in food taboos, as a probable explanation. Preservation bias should not be excluded from consideration since these fish are characterised by cartilaginous skeleton. However, dermal plaques preserve well and have been attested in the Epipaleolithic and Early Mesolithic strata at Padina.

The presence of domestic animals creates another issue in the debate. Dog was domesticated in the Iron Gates Gorge without doubt and is found in the Mesolithic, Transitional and Neolithic strata of Lepenski Vir, Vlasac, Padina and Hajdučka Vodenica. At Icoana selective hunting of wild pig (very young and very old animals) and possible domestication of dog point in the same direction (*Bolomey 1973*). The analyses from Padina and Hajdučka Vodenica are not as conclusive as the material, in both cases, was studied without respect to chronological units. Although many features in this table merit explanation the most important feature in this respect is the low percentage of domestic animals (other than dog) at all but Hajdučka Vodenica and Lepenski Vir III. Hajdučka Vodenica has an unlikely lack of fish bones that could account for elevated percentage of domestic animals, but when domestic animals are viewed as a sample, 52.6% of them belong to the domestic pig, 26.3% to the dog and only 7.9% of the 11.1% (less than 1% of the total sample) belong to *Bos taurus*. Since the transitional phase as well as the Mesolithic are present on the site, and while no distinction between strata is made in the faunal report, we cannot argue for the presence of Neolithic economy at the site. Incipient pig domestication plays an important role in the faunal assemblages of the Lower Gorge sites and represents a local development.

All of the other units, except for the Lepenski Vir III (Neolithic) strata present less than 5% of domestic animals which coincides with Zvelebil's (*1996a*) explanation of a porous agricultural frontier, and serves more as evidence of contact (trade or raiding) rather than of a Neolithic economy. A high proportion of wild animals and fish in Lepenski Vir III points to a strong local tradition among the Early and Middle Neolithic settlers of the site, or to the possibility that Lepenski Vir was an atypical Neolithic site, a non sedentary station for hunting and gathering. Either way, the knowledge of the region and the know-how of the Mesolithic hunters were already acquired. Again, it would be of great value to be able to distinguish between Early LV IIIa and Middle LV IIIb Neolithic settlements as the relative importance of *Ovis/Capra* and *Bos taurus* are expected to have changed in the region from one subperiod to the other.

Bonsall *et al.* (*1997.56–57*) argue that preservation bias could have played a role in the lack of domestic animals in Lepenski Vir I and II which both Chapman and Whittle (*1996*) consider to be synchronous with Neolithic Starčevo. Although faunal analyses by Bökönyi, performed within the framework of the 60s and 70s are lacking in detail (*see Lyman 1994, for new approaches to MNI and skeletal elements proportions*), they are consistent throughout the Iron Gates material. Therefore, it would be hard to argue for preservational bias regarding domesticated animals in LV I–II if no such bias is observed in LV III strata. Very restricted numbers of identifiable specimens in LV I–II (less than 500) compared to LV III (over 2000) could account for some bias in species representation, but not for the total lack of selected exploited species. If sieving can account for a greater share of fish bones in recent excavations at Schela Cladovei, there is no reason to suppose that the overall proportions of mammal skeletons would be significantly altered.

Mesolithic settlements are exclusively open-air sites, usually on the small terraces along the Danube, or on islets in the river. They seem to cluster in favourable areas, and although their distribution, as we know it, could have resulted from the surveying constraints, it is more likely that certain regions, marshy and uninhabitable today (like the estuary of the Porečka River), were the same in the Mesolithic. The size of settlements is variable, determined by the available space which also plays one of the crucial roles in the spatial organisation (*Radovanović 1996a.65*). However, the number of houses would be more strongly influenced by the number of inhabitants and the type of their social organisation, than by the available space. Therefore, Radovanović (*1996a*) suggests that the number of houses within each time slice had to be lower than proposed by authors who have investigated the settlements (*Jovanović 1987; Srejović 1972*).

Architectural structures of Lepenski Vir culture are reported only on the right bank of the Danube. The major theme is trapezoidal house floors that resemble in their outline the hill of Treskavica situated across from the site of Lepenski Vir. This dominant rock formation, bereft of vegetation in its upper parts, still looks impressive from the water line and is the reasonable prototype for the house outlines (*Srejović 1969*). They are not the only type of habitation. Radovanović (*1996a*) distinguishes the following:

① dugouts (Vlasac),
② semi-dugouts with oval base and circular hearth (Ostrovul Corbului),
③ semi-dugouts with oval base and rectangular hearths (Proto Lepenski Vir),
④ semi-dugouts with trapeze-like shape and ellipsoidal hearth beside them (Vlasac I),
⑤ semi-dugouts with trapezoid shape and rectangular hearth in the open or within the house (Padina B, Lepenski Vir I, Vlasac Ia–b),
⑥ above ground habitations with trapezoid shape and rectangular hearths (Padina B, Lepenski Vir II, Kula I),
⑦ above ground habitations with circular base and rectangular hearths in the open air (Vlasac II–III, Hajdučka Vodenica I, Kula I), and
⑧ above ground rectangular habitations with rectangular hearths within or in the open (Vlasac III, Hajdučka Vodenica I).

The canonised measurements (*Srejović and Babović 1983.44–45*), sophisticated outline of these dwellings and associated sculptures and ritual objects, have led to different interpretations of their meaning, ranging from houses, ancestral shrines (*Chapman 1993; Whittle 1996*), ancestral and river deity shrines (*Srejović 1969; Srejović and Babović 1983*) and solar shrines (*Babović 1998*).

The most prominent and chronologically sensitive features of the architecture of the Lepenski Vir-Schela Cladovei culture are the hearths. The chronology based on the stylistic analysis of the hearths compared with superimposed (slightly displaced towards the slope) house floors at the site of Lepenski Vir has matched the data for superimposed houses at Padina, and thus provided a basis for the chronological comparisons between sites as well as regional differences between the Upper and Lower Gorge (*Radovanović 1996a*). All domestic and/or ritual activities seem to have been centred around the hearths and their association with graves was important at all sites, nowhere more than at the site of Hajdučka Vodenica (Fig. 13). Synchronisation of the houses for Lepenski Vir I subphases proposed by I. Radovanović (*1996a*) differ considerably from those proposed by Srejović and imply different social organisation, as well as different forces behind these processes. While Srejović argues for ever increasing competition between two "clans" within the Lepenski Vir settlement (*1969.57*), Radovanović proposes that as early as Lepenski Vir I (2), her phase of consolidation and symmetry, the Mesolithic population comes in contact with the Neolithic population. This results in more centralised, more canonised and more cohesive picture of the settlement as a reflection of stronger ideological integration.

The essential raw materials for chipped stone industries during the Epipaleolithic and Mesolithic were of local origin. A small percentage of non-local obsidian (from the Tokay Presov region) in the Epipaleolithic points to spatially large (but small volume) exchange networks in which the Iron Gates population participated. A more significant role of exchange can be confirmed in the post contact period at Lepenski Vir I, Padina B1–B3 at Sector III and the horizon with rectangular hearths in Sector II, and Hajdučka Vodenica, based on the importance of the Pre-Balkan Plateau flint. For the finds of this type of flint at Vlasac III, Kozłowski and Kozłowski (*1987*) propose taphonomic explanations. This flint variety is the most prominent raw material in the Early and Middle Neolithic of Oltenia, Banat and Transylvania, as well as at the majority of the Körös sites in Hungary (*Radovanović 1996a.231–235 and quoted literature*). In terms of chipped stone industry, local tradition seems to be very important throughout the Mesolithic and well into the Neolithic (*Radovanović 1995*). One important difference is the increase in retouched blades and decrease in geometric microliths at Lepenski Vir III a–b, Cuina Turcului III and to a lesser extent at Vlasac III. Radovanović (*1996a. 250, Fig. 5.16*) distinguishes four chrono-typological units based on the relative frequencies of scrapers, retouched flakes and retouched blades. The Epipaleolithic industries (first group) are characterised by a high percentage of endscrapers, increase in retouched flakes and disappearance of retouched blades. The second group (the Lower Gorge) is characterised by a high percentage of retouched flakes and an increase in retouched blades. The third group contains industries with a trend towards a further decrease in the proportions of endscrapers, a decrease in retouched flakes, an increase in retouched blades. The fourth group represents Neolithic industries with a high percent of retouched blades. The data provided by the chipped stone industry argue for a strong local continuity. All of the sites with formal disposal areas fall neatly within the third group: Vlasac I–III, Lepenski Vir I–II, Schela Cladovei I–II, Hajdučka Vodenica I, Kula I–II, while the fourth group is represented by sites with either a Neolithic component or strong Neolithic influence: Padina B, Lepenski Vir IIIa–b, Kula III, Hajdučka Vodenica II, Cuina Turcului III–1/3. It is important to note the significant overlap in absolute chronology between industries of group III (7200–5300 BC) and group IV (6100–5200 BC).

Pottery, long held as a tell-tale sign of the introduction of the Neolithic to Europe, appears in many of the sites within the Iron Gates Gorge and has been a major source of discussions between Srejović, Jovanović, Boroneanţ and many non-local researchers. On the left bank of the Danube, pottery is associated mostly with well defined sites of the developed phase of the Starčevo-Criş (middle Neolithic) complex, except in the case of Schela Cladovei, where a "Proto-Sesklo" hut was dug into the Mesolithic layer (*Boroneanţ 1989.479*).

On the left bank the Neolithic habitations, when superimposed on local Mesolithic settlements with particular habitations, hearths, and chipped stone industry, are all clearly divided stratigraphically. On the right bank the situation is reasonably clear in the Lower Gorge, Ključ and downstream from Ključ (Hajdučka Vodenica, Kula, Velesnica). The most problematic is the situation of Lepenski Vir and Padina, both of which are situated in the Upper Gorge (*Radovanović 1996a.282*). Since both sites have complex vertical and horizontal stratigraphy and evidence of other imported material, but no evidence of change in the economic structure and ideological world of the local inhabitants, the appearance of pottery is recognised as evidence of contact between local foragers and pottery bearing Neolithic farmers. Pottery appears in all horizons of Padina B at all sectors, while there is no evidence of its appearance in Padina A, or A/B. Similarly, Proto-Lepenski Vir and Lepenski Vir Ia–b (Radovanović's phase I–1) did not contain pottery, while it starts appearing in Lepenski Vir Ic–e (*Srejović 1969*), or Radovanović's phase I–2 and I–3. Lepenski Vir II did not contain any pottery, and it appears again with the Neolithic economy of Lepenski Vir IIIa and IIIb. Vlasac I–III, akin to the Lower Gorge settlements, did not contain any pottery until fully Neolithic Vlasac IV stratum. The appearance of pottery coincides with the distribution of the pre-Balkan Plateau flint, and argues for greater importance of trade.

While assuming that pottery is necessarily a Neolithic invention throughout Europe is inherently problematic, there is no reasonable doubt that pottery was brought into the Iron Gates Gorge Mesolithic communities by surrounding Neolithic people since it fits well within the Gura Baciului and Starčevo tradition (*Jovanović 1984a; 1987*). In terms of newly proposed periodisation by Tasić (*1997; 1998*), the ceramics found at the sites of Lepenski Vir and Padina fall well within the Early and Middle Neolithic of Central Balkans with no particular developments that would suggest local invention. Early Padina ceramics correspond to the ENCB phase (*Tasić 1997. 125*), which is consistent with assignment of Lepenski Vir IIIa (Srejović's Proto Starčevo) into the MNCB I and Lepenski Vir IIIb (Classical Starčevo) into the MNCB II phase. However, since the absolute dates from Lepenski Vir are much later than would be expected, and the ceramics have not been published, Tasić refrains from firm assignation noting that the published material would fit in his MNCB II phase.

Sporadic appearance of the ENCB type ceramic in the pre-Neolithic layers at Lepenski Vir and Padina would not necessarily represent imported goods, and could well be local production within the tradition of the Neolithic of the Central Balkans. Therefore, the appearance of pottery on these sites can serve as a marker of the contact between farmers and foragers, independent of absolute chronology and uncertainties of ^{14}C dates and will therefore be discussed further in the chronology section. The rationale behind the use of pottery as an independent marker of contact is found in its non-local origin that supposes either trade, transfer of knowledge, or transfer of people with this particular knowledge into the Iron Gates Gorge communities. All of these imply the availability of contact, even where there is no firm evidence of contact itself.

3.3. Chronology

"The absolute chronology of the Lepenski Vir culture is impossible to establish on the basis of comparative historical methodology, as throughout its long existence it remains entirely isolated, devoid of any contact with the outer world" wrote Srejović (*1969. 41*). The subsequent unearthing of a number of sites on both the left and right banks of Danube in the

Iron Gates Gorge itself and in at least two localities downstream from the region of Ključ (Velesnica, Kula) made it apparent that, although isolated, the Lepenski Vir culture has its predecessors in the Schela Cladovei complex of late Romanellian period (*underlined by recent use of the name Lepenski Vir-Schela Cladovei by Boroneanţ 1989*), and had extensive communication with the later cultures of the Starčevo-Criş-Körös complex in the late phases of its existence. Its territory, understood as restricted to the Iron Gates Gorge by Jovanović (*1969*), Nandris (*1972*) and Tringham (*1971*) was subsequently enlarged to incorporate not only sites below the Gorge in the Ključ Region, (*Boroneanţ 1980; Mogosanu 1978; Sladić 1986; Srejović 1989; Srejović and Babović 1981; Vasić 1986a*), but also seasonal field camps in uplands such as Baile Herculane (*Nicolaescu-Plopsor et al. 1957*).

The most comprehensive work to-date on the Mesolithic of Iron Gates, by Ivana Radovanović (*1992; 1996a*), provides the chronological framework that I have used in my research. Radovanović has established her chronological division of the Lepenski Vir culture on the basis of the stratigraphy of superimposed architectural elements of which the most important data are provided by analogies between types of hearth constructions, but also in comparison with other architectural elements, mortuary practices, the flint knapping industry and bone, antler and tooth artefacts. By far the best element for the reconstruction of the relative chronology and the chronological relationships of different localities is provided by the stratigraphic position and the typology of hearth constructions (*Radovanović 1992; 1996a; 1996b*). Without entering into details and rationale of her classification, the phases she discerned, together with absolute chronology (given in calibrated years BC), and data relevant for the four sites are presented here. A comprehensive list of absolute dates for the series is provided by Radovanović (*1992; 1996a.App. 3*) together with calibrated dates (*Tasić 1989; 1997*). Only those dates that refer directly to the skeletal material will be considered in detail, together with AMS dates provided by Bonsall *et al.* (*1997*) for Lepenski Vir.

Two reasons can be given to justify this approach. Absolute chronology on the sites is only relatively important, since our determination of any of the strata in the four settlements is based on the economic patterns. If burials can be reasonably accurately associated with any of these occupations then absolute dates do not provide useful additional information. Only in cases where the dates contradict the general temporal framework in which Mesolithic before contact ends at c. 6500 BC and both transitional (contact Mesolithic) and Neolithic begin after that date in the region, will the absolute dates be taken as more informative than stratigraphic information. Given the framework of our study, in which Mesolithic economy can be contemporaneous with Neolithic, it does not assume unidirectional evolution of economic pattern. It simply states that regardless of the economic pattern of a particular site, or phase within the site, once the contact with Neolithic peoples in the region becomes possible, it is no longer regarded as purely Mesolithic but falls within the Mesolithic/Neolithic group, signifying the availability of the contact. The economic behaviour at any particular site will further determine whether it is Mesolithic/Neolithic (with little or no change in the economic domain) or Neolithic (implying increased importance of domesticates).

The second reason concerns the methodology of ^{14}C. Since there is no evidence that dates obtained from charcoal are comparable with dates obtained from human bone collagen (*Bonsall et al. 1997 and quoted literature*) - as the "old carbon" can be ingested from, especially aquatic, foodstuff - there could be important discrepancies that do not reflect actual chronology (*Bonsall 1998 pers. comm.*). Until we have more direct dates from human bones, their value remains tentative.

Dates provided here are from Radovanović (*1996a. App. 3*). The calibration was done by Tasić (*1989*) for Serbian sites and unpublished calibration for Romanian sites based on Radiocarbon Calibration Program 1987 rev.2.0 (University of Washington, Quaternary Isotope Lab) and dates are reported $\pm 1\sigma$.

Here we sumarise Radovanović's chronology as follows:

Phase 1 - According to ^{14}C dates, the *terminus ante quem* for the beginning of this phase is around 7049-6672 BC (Vlasac Ia). This is in accordance with the dates from other sites: 7055 BC Icoana I; 7062 Ostrovul Corbului I - horizon II. Dates from Padina A are even older (7248±103 BC, 7381±58 BC). Therefore, this phase is linked to the second half of the VIIIth millennium BC. This phase is characterised by simple oval hearths bordered by small rocks (Alibeg I, Veterani terrace and Icoana Ia-b). Similar hearths with pressed earthen floors are found at Schela Cladovei and Ostrovul Corbului. Accompanying them on the above mentioned sites as well as at Vlasac Ia and Razvrata I are the oval semi-subterranean houses. The stone construction with graves from Sector III at Padina, and a secondary burial of a skull in Icoana I can be linked to this phase.

Phase 2 - ^{14}C dates are in accordance with Radovanović's determination of this phase on each of the sites (Vlasac Ib 7049-6605 BC; the beginning of Ostrovul Banului III is dated at 7046 BC). In this phase, the formation of the standards of the material culture that will remain unchanged until the very end of the Lepenski Vir culture occurs. Simple hearths are replaced first by ellipsoidal and later by orthogonal hearths. In the early phase of Vlasac Ia they do not present any other constructive elements, while in Vlasac Ib, Hajdučka Vodenica Ia (the earliest sub phase) Proto-Lepenski Vir, Padina A/A-B (sectors I and II) and Ostrovul Corbului I (horizons III and IV) hearths have a receptacle bordered with a row of small rocks or stone slabs. Dwellings are still semi subterranean and oval in shape but some already show the change towards the trapezoid form (Vlasac Ib). Elements of previous phases of inhumation on Vlasac and Schela Cladovei (rearangement of the deceased, diversity in orientation and positions, cremations and the use of ochre) persist.

Phase 3 - Radiocarbon dates from Vlasac II (6970-6470 BC) the beginnings of Razvrata II (6690-6386 BC) and Ostrovul Corbului II (middle layer: 6782-6360 BC) put this phase in the first part of the VIIth millennium BC. This phase is characterised by the same standard hearths from the earlier phase but for the first time we witness differences between Upper and Lower Gorge settlements. For example, in Lepenski Vir I a space for the deposition of ash and the construction of a jamb at the front of a hearth, as well as the traces of construction on the upper hearth slabs, appear. At sites in Lower Gorge (Hajdučka Vodenica Ia and Ostrovul Banului III), these hearths-ovens are different, covered by stone slabs. Dwellings are semi-subterranean trapezoids (the end of Vlasac Ib, Lepenski Vir I phase 1) or above ground, with circular stone constructions (Vlasac II, Hajdučka Vodenica I, Kula I). In the Lepenski Vir I phase, aniconic and ornamented sculptures appear for the first time. In terms of burial practices, this is a younger phase (based on the published graves from Vlasac), characterised by the following changes: the deceased are buried in different positions and with different orientation, the burials are restricted to the space between the houses (Vlasac, Lepenski Vir, Padina A-B and Hajdučka Vodenica) with only young children buried underneath the houses (Vlasac, Lepenski Vir).

Phase 4 - Radiocarbon dates from Phase 2 of Lepenski Vir I (6430-5980 BC) Vlasac III (6425-6130 BC) and Ostrovul Banului IIIb (6610-6170) put this phase in the second half of the VIIth millennium BC. This phase is characterised by the emergence of the 'A' supports in phase 2 of the Lepenski Vir I. Dwellings are still semi-subterranean trapezoids (LV 1, phase 2; Padina B, horizon I) or surface dwellings with circular or orthogonal stone constructions (Vlasac III, Hajdučka Vodenica Ia-b) and the same type of aniconical ornamented sculptures and "altars" are present. In terms of burial practices they remain very much like those of the previous phase except that the orientation of the skeletons tends to parallel the course of Danube (Padina B, horizon I; Lepenski Vir I phase 2; Vlasac III, and Hajdučka Vodenica Ia-b).

Phase 5 - ^{14}C dates for Alibeg II: 6230-5790 BC. The 'A' supports spread to the regions of the Lower Gorge and downstream from the Ključ region (Kula I). The receptacles of the hearths are more often built with stone slabs (Lepenski Vir I-3, Padina B, sector III, Kula I-II). Dwellings are still semi-subterranean trapezoids. Aniconical sculptures and "altars" are still present, although ornamented sculptures are scarcer and ornamentation simpler, while representational sculpture begins to appear. The oldest stone ornamental sculpture on the Hajdučka Vodenica site is stylistically different from those of the Upper Gorge. Mortuary rites are characterised by the same type of burials as in phase 3 and 4.

Phase 6 - The radiocarbon dates suggest the beginning of the VIth millennium BC for the beginning of this last phase of the Iron Gates Mesolithic. This phase is characterised by orthogonal hearths with receptacles constructed by stone slabs and massive 'A' supports (Padina B, horizon III; Lepenski Vir II) in the Upper Gorge and the emergence of a side channel constructed of stone slabs in the Lower Gorge (Hajdučka Vodenica Ib). Concurrently, on the left bank of the Danube, hearths with circular paved receptacles appear on a number of sites (Razvrata II; Ostrovul Corbului II horizon VII; and the sites at km 875 and km 873 on Ostrovul Mare) while on the right bank they are found only in the older horizon of Velesnica. Dwellings are either semi-subterranean or surface dwellings with trapezoid outline (Padina B, Lepenski Vir II). The "altars" and very expressive stone figures are associated only with the oldest layers of Lepenski Vir II. In terms of burial practices, crypts with multiple burials oriented parallel to the flow of the Danube are introduced while earlier forms of burials persist (Lepenski Vir II, Hajdučka Vodenica Ib). The stone and bone industries are typical of the previous phases, as well as excessive use of antler tools. The exception is Padina B (sector III) whose bone industry types and modes of production in phases 4, 5, and 6 are typical for the Old and Middle Neolithic of the region (spatulae, hooks, polished borers). In Padina B horizon II both fine monochrome ceramics and coarse ceramics with silt (sand) and ground straw in the texture are present. The following synchronisation for the four sites in question (Tab. 3) summarises the above chronology and outlines the period when the contact with ceramic producing farming communities in the region becomes established. Although the appearance of ceramics and Pre-Balkan plateau flint does not necessarily imply the "invasion" or even "moving in" of farming communities in the region, it is an evidence of availability of contact between Iron Gates foragers and Balkan farmers. With respect to the proposed research goal, examining interactions between foragers of Lepenski Vir type and Starčevo type farmers as reflected in changes (or lack of them) in the biological (osteological) profile of the Mesolithic inhabitants of the Iron Gates Gorge, the following three phases derived from the above chronology are proposed:

- The *Mesolithic* of the Iron Gates Gorge: appearance on the right bank of the Danube of large formal disposal areas, sedentary or semi sedentary population practising hunting of large game (red deer and auroch for the Upper Gorge and red deer and wild pig for the Lower Gorge), gathering of wild plants, and fishing. No contact with farmers is possible as there are no accessible farming communities. This period lasts from the early VIIIth millennium to the end of the first half of the VIIth millennium.
- The *Mesolithic/Neolithic*, (also referred to in the text as *Transitional* or *Contact*) period in the Iron Gates Gorge is characterised by the same Mesolithic economy, same material culture and ideology, and possibility as well the evidence of contacts with farmers. Essentially, this is a population that remained fully Mesolithic while there was an agricultural frontier with incipient possibility of contact, an equivalent to Zvelebil's "availability phase" (*Zvelebil 1996a*). The period begins with the first farming communities in the region (Anzabegovo, Gura Baciului) in the second half of the VIIth and lasts until the end of the first half of the VIth millennium, when the fully Neolithic economy is introduced in the region, or at least on the sites where it is present. Material evidence for the contact consists of Pre-Balkan plateau flint and ceramics of Starčevo type.
- The *Neolithic* period in the region is characterised by the introduction of a farming economy and reliance, not necessarily exclusive, on domesticated animals and plants. In terms of material culture it is also characterised by Starčevo complex elements: pottery of Starčevo-Cris type, polished stone axes, Neolithic blades on imported flint, pit houses and burial practices typical for this period. It is evidenced on the Lepenski Vir site phase IIIb, Vlasac IV, and Ajmana and Velesnica downstream from Ključ. In the region, different sites would have different dates for this phase, depending on the appearance of a fully Neolithic economy in the region, starting theoretically in the second half of the VIIth millennium and ending with the change from Middle Neolithic Starčevo to Late Neolithic Vinča-Dudeşti in the region.

3.4. People

The function of the Iron Gates sites is still a subject of debate. Recently, a solar cult was proposed as an explanation of the structure and position of houses at the site of Lepenski Vir I and II (*Babović 1998*). The function of Vlasac as a habitation or cemetery site was discussed by Chapman (*1993*) in terms of his landscape markers/social landscape argument. Jovanović (*pers. comm.*) perceives Hajdučka Vodenica as a burial-ritual rather than a habitation site. At this stage we can point out that strict distinction between ritual, ancestral, mortuary, economic and

phase- millennium BC		Padina	Lepenski Vir	Vlasac	Hajdučka Vodenica
6	– mid. 6th	B(III)	II/IIIa	–	Ib
5	– 7th/6th	B(II)	I(3)	–	Ia
4	– 7th–2nd half	B(I)	I (2)	III	Ia
3	– 7th–1st half	A–B	I (1)	Ib–II	
2	– 8th/7th	A/A–B	Proto LV	Ia–b	1a
1	– 8th	A	–	Ia	–

Tab. 3. Synchronisation for the sites in question: shaded areas represent appearance of the ceramics in the stratum: light shade - sporadic appearance, darker shade - ceramic is common as well as Pre-Balkan plateau flint, "Montbany type" of chipped stone blades along with the geometric microliths. (*Based on Radovanović 1996a.289; 1996b; 1996c; Radovanović and Voytek 1997*).

habitational, need not have existed at the time of the formation of the sites. The position and meaning of these sites in respect to those on the left bank of the Danube could have been special, although it is hard to see how this special status would contradict the permanence or sedentism as Whittle argued (*Whittle 1996*). While all these claims might be reasonable and not necessarily contradictory to each other and earlier interpretations, any discussion of the function of these sites without revised analyses of all of the elements of habitation - burial - portable artefacts is tenuous at best. Further research and analyses of abundant but yet unpublished documentation is necessary.

Skeletal remains are found on all of the sites on the right bank of Danube save for Stubica. This site was discovered when the water level was already very high and only a small-scale excavations were possible (*Jovanović 1984b*). On the Romanian side, only Schela Cladovei had important numbers of burials unearthed (33 +), other sites have either isolated bone fragments (Cuina Turcului and Icoana) or 1-3 burials (Icoana III, Ostrovul Corbului I, III). The recent excavations at Schela Cladovei (*Boroneanț et al. 1995*) have produced several more unpublished graves.

Revision of the osteological material from all four sites has shown that minimal number of individuals (MNI) reported for any of the sites is incorrect, as it disregards many fragmentary skeletons as well as individuals represented by single bone fragments. The detailed analyses of skeletal parts representation have not yet been published (***Roksandić in prep.***) and theories based on published anthropological reports that deal with these phenomena might need to be revised. A joint project with the Institute of Archaeology (Serbian Academy of Arts and Sciences) and Faculty of Philosophy (Belgrade University), that would deal with the detailed analyses of the function of these sites, is envisaged. Documentation gathered during excavations on all four sites appears to be sufficient to warrant a more thorough and detailed analysis of habitation and burial patterns.

3.5. Sites

The four sites on the right bank of Danube (Fig. 3) that have yielded osteological material are Padina, Lepenski Vir, and Vlasac in Upper Gorge, and Hajdučka Vodenica in the Lower Gorge. Of the sites downstream of the Ključ region Kula has also yielded five Mesolithic burials, while Velesnica has yielded six (*Vasić 1986*) and Ajmana 16 Neolithic skeletons (*Radosavljević-Krunić 1986; Stalio 1986*). Of these, only the six skeletons from Velesnica were available for examination during my research season in Belgrade.

3.5.1. Padina

Salvage excavations of Padina were carried out from 1968 to 1970 (inclusive) by a team from the Archaeological Institute of Belgrade directed by Borislav Jovanović (*Jovanović 1968; 1969; 1970*). A large-scale excavation was divided into four sectors corresponding to three natural escarpments that were themselves divided by very steep blocks (Figs. 4, 5 and 6). The site is located in the Upper Gorge, on a very steep slope (in Serbian *padina* means 'a slope') that greatly influenced the architecture and mode of construction of the trapezoid houses, typical for the Lepenski Vir culture.

Unfortunately, alterations in the course of Danube had destroyed certain portions of the site, filling the gullies and ravines with massive deposits of silt and stone. B. Jovanović believes that a large portion of Mesolithic Padina would have been severely eroded by this natural process.

The following stratigraphic units were discerned by the principal investigator: A - Mesolithic, B - Early Neolithic, C - Aeneolithic, D - Iron Age, E - Roman period and F - Middle Ages (*Jovanović 1987*). Phase B is further divided in 3 subphases that correspond with Starčevo periodisation. Radovanović claims that both Padina A and B are Mesolithic in character as their subsistence is based on sedentary hunting-gathering-fishing economy. She proposed the following reconstruction of the stratigraphy relative to the chronology and synchronisation with other sites, based on field journals and site maps (*Radovanović 1996a*):

Padina A - Early Mesolithic phase I of the Iron Gates chronology - synchronous with Alibeg, Vlasac Ia, Schela Cladovei I. Srejović's interpretation is different in that he synchronised Padina with Proto-Lepenski Vir, Vlasac I, Schela Cladovei I, Ostrovul Banului IIIa, and Icoana I (*Srejović 1989*). Voytek and Tringham (*1989*) propose a Late Mesolithic date synchronous with Vlasac II-III, Lepenski Vir I-II, Ostrovul Corbului III, Schela Cladovei II Ostrovul Banului IIIb and Icoana II.

Padina A-A/B - Mesolithic phase II of the Iron Gates - synchronous with Vlasac Ia-b, Hajdučka Vodenica Ia, Schela Cladovei I and Proto Lepenski Vir.

Padina A/B - Mesolithic phase III of the Iron Gates - synchronous with Lepenski Vir I(1), Vlasac Ib–II, Hajdučka Vodenica Ia, Kula I, Schela Cladovei II.

Padina B(I) - Mesolithic phase IV of the Iron Gates - synchronous with Lepenski Vir I(2) Vlasac III.

Padina B(II) - Mesolithic phase V of the Iron Gates - synchronous with Hajdučka Vodenica Ia, Lepenski Vir I(3), Kula I–II, Icoana II.

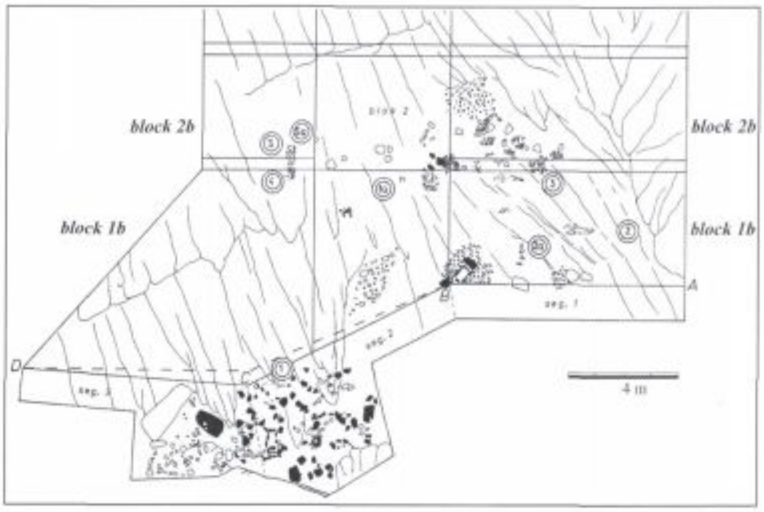


Fig. 4. Padina Sector I. Unpublished site plan. Courtesy of B. Jovanović. Burial numbers are given in circles.

Padina B(III) - Mesolithic phase VI of the Iron Gates - synchronous with Lepenski Vir II, Hajdučka Vodenica Ib. According to Srejović, Padina B1 belongs to the Late Mesolithic - Lepenski Vir I–II, Vlasac II–III, Icoana II, Hajdučka Vodenica, Schela Cladovei II, Ostrovul Banului IIIb; Padina B2: Transition Mesolithic/Neolithic - Kula, Alibeg, Ostrovul Mare; and Padina B3: Early Neolithic - Lepenski Vir IIIa, Cuina Turcului III. Voytek and Tringham consider B1–3 as transitional Mesolithic/Neolithic, Jovanović as classical Starčevo (Starčevo II) and Gimbutas as Starčevo IIa–b, Gura Baciului II.

In Radovanović's system, the appearance of pottery occurs early as phase IV of the Iron Gates Mesolithic. Domesticated sheep/goat and cattle represent a very small percentage of the total faunal material. Although the difference is non-significant, it seems anomalous that they are more abundant in Mesolithic Padina A (1.19%) than in Neolithic Padina B (0.65%). However, since the details of stratigraphy were not available to A. Clason at the time of her analysis, the most plausible explanation is that all of the domesticates belong to the Padina B horizon. Although this would increase the number of domestic animals present at the site in the contact period, their importance would still be economically negligible (less than 5%), but would indicate, together with ceramic and imported Balkan flint, a porous agricultural frontier in the Gorge from the first half of the VIIth millennium BC.

Absolute dates for Padina range from 9331±58 BP (BM-1146) to 6570±80 BP (Grn-8229) (Tab. 4). The "BM" dates are derived from skeletal material while the "Grn" dates are from different charcoal samples and should be compared with care. Calibrated, these dates range from 7381±58 BC to 5568–5411 BC (the latter encompasses 78% confidence interval or 1σ according to Tasić (*1997; 1989*)).

All human skeletal remains belong to phases A and B and are therefore relevant to this study. Human skeletal remains comprise 48 individuals found within grave units and 73 fragmented "scattered human remains" that were found during analyses of the faunal assemblage by A. Clason and V. Dimitrijević (*Jovanović pers.*

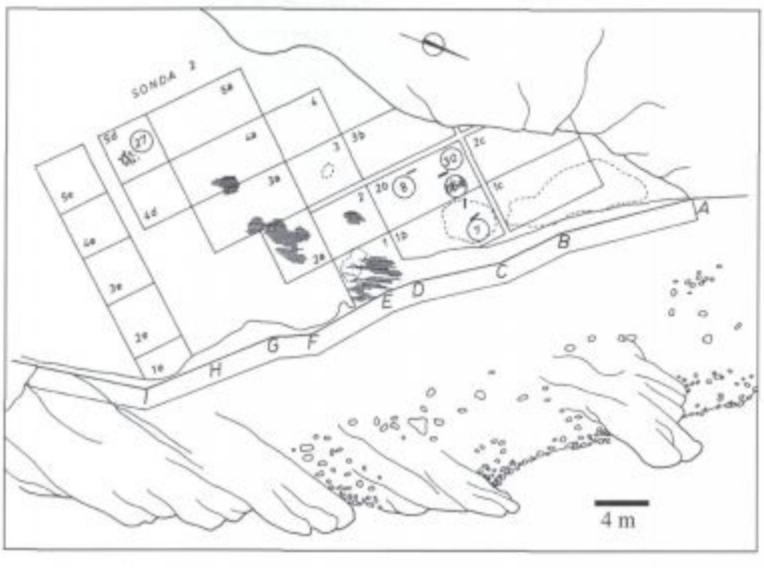


Fig. 5. Padina Sector II. Unpublished site plan. Courtesy of B. Jovanović. Burial numbers are given in circles.

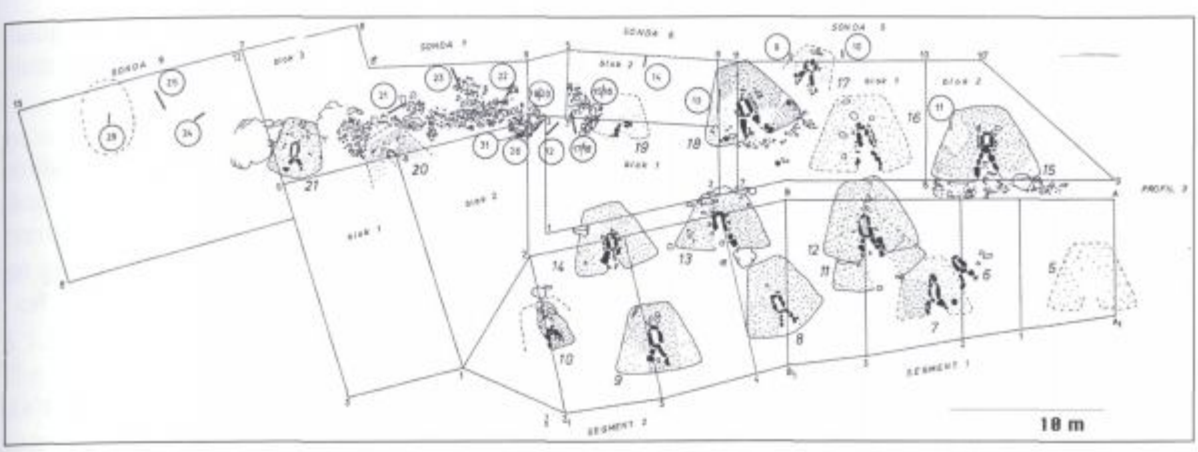


Fig. 6. Padina Sector III. Formal disposal area and habitation structures. Unpublished site plan courtesy of B. Jovanović. Burial numbers are given in circles.

comm.). Three adult individuals from the Sector III and one juvenile from sector II have a sufficient number of matching bones to represent destroyed unidentified graves. It is impossible, with the current state of the analyses of the documentation associated with the scattered human remains, to advance any explanation for their occurrence. We know that they are not uncommon in other sites in the region as well as in the early Neolithic strata of Anzabegovo and Middle Neolithic Starčevo site of Zlatara (*Leković 1985*). Meiklejohn has pointed out that this seems to be a very general problem in European Mesolithic: namely, if the preservation of bones at the site is good, some human remains, not necessarily associated with burials, are likely to be found (*Meiklejohn and Denston 1987*). That they could represent secondary burials of small or few fragments of human remains is shown by the occurrence of very small fragments of "extra" individuals within closed and undisturbed primary burials on all of the Iron Gates Gorge Mesolithic sites. However, the disturbance of earlier burials within a settlement cannot be excluded. It is hard to estimate the MNI for these remains, as taphonomic histories for all of them cannot be discerned with any precision. Although it was possible to plot all of the fragments on the general site plan, according to the unit and layer of excavations, these units were too large to provide relevant information. Detailed pairing (*sensu Duday 1985*) was impractical within the time constraints of the field season. More detailed taphonomic analysis that should take this phenomenon into consideration is planned in future. At this point, since these skeletal elements are too fragmented to provide information on either demographic, metric or non-metric traits of the individuals, they are excluded from further discussion.

Minimal number of individuals (MNI) for the site as a whole amounts to 52 individuals (as, at least theoretically the 73 scattered fragments could have belonged to these 52 individuals). The skeletal representation ranges from small fragments to whole skeletons. Of them, 26 individuals were buried in single, and 14 in double graves, while three grave units had three, four and five individuals each.

Only eleven individuals were assigned sex based on their pelvic morphology, mainly the pubic features, sciatic notch shape and presence and shape of preauricular sulci. Five individuals were determined as male and six as female. Since size and robusticity are one of the parameters often invoked in discussion of differences between Iron Gates population(s) and are part of the analysis in this thesis, sex assignment based on features of the skull and postcranial skeletal robusticity was deemed inappropriate. However, the sex thus assigned was noted and distinguished in tables by a question mark: m? is represented by further 6 individuals and f? by 12 individuals. If robusticity proves to distinguish between sexes rather than populations, this supplementary information can always be incorporated into later analysis. It was not pos-

Period	Grave no.	Lab ID	^{14}C age BP
Mesolithic/Neolithic	Grave 7	BM–1144	8797±83 BP
	Grave 2	BM–1143	7738±51 BP
Mesolithic	Grave 14	BM–1147	9198±103 BP
	Grave 12	BM–1146	9331±58 BP
	Grave 39	BM–?	9292±148 BP

Tab. 4. Absolute dates for Padina (*from Burleigh and Živanović *1980).

sible to assign sex with any accuracy in the case of 13 individuals.

Adults represent the majority of the individuals buried at the site: 44 of the 52 individuals or 85%. In one case it was not possible to determine if the individual was an adult. Among subadults three neonatal skeletons were identified, one child between 2-5 years of age, two between 6-11, and one 12-18 years of age. Among adult individuals ten are less then 40 years old, while nineteen are older than 40 years. For the remaining 15 individuals, it was possible only to state that they are adults. Since demographic data play such an important role in many discussions, the approach was deliberately conservative and sex and age were assigned only in those cases where there was sufficient preservation of relevant features. Ages were assigned in wide categories of young adult, old adult, adult.

I was able to use S. Živanović's anthropological notes as part of the original archaeological documentation kindly provided by Dr. B. Jovanović during the 1996 and 1998 field seasons. The complicated denomination of both burials and individuals is due to the confusion caused by Živanović's insistence that graves should be numbered by a physical anthropologist after the excavation, when he could provide details on numbers of individuals. Since Živanović was not present during the excavations, and in his labelling did not respect the natural associations of the skeletons nor the actual MNI in the burials, it was very difficult to associate (through photos, drawings and provenience points) numbers on skeletons with associated field drawings. When I started working on the osteological material from Padina in the summer of 1996, most of it was not cleaned, although S. Živanović published measurements and other anthropological data. To avoid further confusion, labelling was based on the numbers he had given to the skeletons with reference to the actual number of individuals. For example number 14 was kept for the principal individual, and the fragmented skeleton that was found during the analysis of that grave was labelled as 14(1) and treated as an "extra" individual within the grave. The complex nomenclature of 15-16 is the direct result of this approach. Although Živanović recognised only skeleton 15, 16 and later 16a, we have discerned at least five individuals within the grave. Some of the unrecognised individuals had well-preserved fragments of long bones that are easy to recognise and lateralise, and my impression was that Živanović based his MNI counts on the skull and mandible fragments without any reference to the postcranial skeleton. The same situation was observed in multiple graves at Hajdučka Vodenica.

According to the presented chronology of Padina and the division of the site strata into Mesolithic and Mesolithic/Neolithic contact, skeletal remains were assigned to either of the two periods according to the site documentation, superposition of certain features and Radovanović's analysis of the burials.

The following 18 individuals belong to the Mesolithic period in Padina:

single burials: 1; 18b; 21; 22; 39; *double* burials: 12; 12(1); 14; 14(1); 17; 17(1); 23; 23(1); *multiple* burials: 15(15-16a); 15-16(15-16a); 16 (15-16a); 16a(15-16a); 16(1)(15- 16a).

To the Mesolithic/Neolithic Transition belong the remaining 31 individuals:

single graves: 1a; 3; 6; 7; 8; 9; 10; 11; 13; 18; 19; 24; 26; 26a; 27; 28; 29; 30; *double* graves: 2, 2(1); 6a, 6a(1); 25, 25(1); *multiple* grave: 4/4+5+5a/, 5/4+5+5a/, 5a/4+5+5a/, 5a(1)/4+5+5a/; 20, 20(1), 20(2).

It was not possible to assign four individuals from the disturbed unidentified graves into either of the periods with any accuracy.

Absolute dates derived directly from human bones (*Burleigh and Živanović 1980; Radovanović 1996a. App. 3*) coincide well with the relative chronological attribution of the graves by Radovanović (*1996a*).

The only publications of the osteological material from Padina to date are the preliminary reports by S. Živanović (*1975a; 1975b; 1975c; 1976b; 1976c; 1979b; 1988*) who concentrated mainly on their typological affinities. In 1973 he concluded that humans from Padina represent a homogenous, autochthonous and isolated group of people that lived at the locality for 1500 years or more. According to him, although the population is typical Cromagnoid in character, it has some traits of later Neolithic populations and is therefore obviously in transition. In one of his later articles he determined the Padina population to be "Proto-dinaric" (*Živanović 1975a. 165*) while still later based on two ^{14}C dates obtained from human bones (6487±83 BC and 7248± 103 BC) he claims that the individuals buried at this site are the first representatives of Cro-Magnon population in the region (*Živanović 1976b*). While it was possible to reconstruct serial numbers of the individuals on which he bases his "Proto-dinaric" type (18a, 25 and 26), no data are given for his "Cro-Magnon" specimen. Further on, he claims that the bones of the postcranial skeleton show numerous marks of gracilisation. He also notes an average height of 170 cm. (Reconstructed on the basis of one set of postcranial bones. *Sic!*).

3.5.2. Lepenski Vir

The expressiveness of the Mesolithic sculpture from the site of Lepenski Vir prompted Srejović to propose that: in the harsh and unpredictable environment of the Gorge, where light and dark suppress each other quickly, where no form or distance is constant and where no silence can ever be heard, people could survive only if they sharply and decisively delimited the boundaries of their world. This would both separate them from nature and provide the necessary balance with it (*Srejović 1969.27; later exploited by Hodder 1990*). In the rich environment of the Gorge, the quest for survival would not have been in the economic domain but in the spiritual realm, as more energy was needed to subdue and bring to human measure the chaotic movements and amorphous shapes that are constantly present in the outer world. Srejović's (*1969*) appreciation of the natural phenomena at Lepenski Vir differs remarkably from the present-day situation. Today, the site is located on a relatively high terrace, the Danube river has become easily navigable by large barges and the whole scenery is pervaded with peace. The description of the dramatic changes in the light, shape and distances during the day is no longer there, yet the impressive artistic achievement and sophisticated social and ritual play at the site still demand explanation.

The name Lepenski Vir is derived from the existence of the whirlpool in front of the site that has, apparently, played an important role in fishing (in Serbian *vir* means 'whirlpool'). The site is located in the middle of the Upper Gorge on a semicircular terrace on the right bank of the Danube, bordered by a very steep slope of Korsho hill (Fig. 6). It was first noted as an archaeological site during a survey in 1960 and was believed at the time to be a small village of the Starčevo culture. In 1965, when Srejović begun excavation, a great (central) portion of the Neolithic (Starčevo) village had already been destroyed by the activity of the Danube. However, under the layers of the Starčevo village (observable in the profiles formed by the erosive activity of the Danube), the site of an earlier period emerged. In subsequent years, an area of 2500m^2 was excavated to reveal architecture, monumental sculpture and graves of the Lepenski Vir culture. The archaeological layer was 3.5 m deep on average. Some 1700m^2 of the eastern part of the terrace were destroyed by the activity of the Danube and another 3000m^2 of the site proper remained unexcavated. In 1969, one of the floor plans of the excavated portion of the site was cut into blocks and reconstructed on the terrace some 30 meters above its original setting. Considering the extent and depth of the excavated area and the incredible speed with which it was done (approximately 12 months altogether) the methodological approach of the team of the University of Belgrade, led by Srejović was remarkable, in that much economic and ecology oriented data were gathered and a number of charcoal samples was obtained for ^{14}C dating. The extensive documentation offers the possibility that the site can be reconstructed in more detail. However, apart from Srejović's publications in 1969 in Serbian and 1972 in English, and some articles and catalogues on the monumental art of Lepenski Vir, little has been published in detail, and while sculptures and house floors have figured in at least one monograph (*Srejović and Babović 1983*) graves never received a comprehensive treatment.

Srejović discerned four major horizons separated by more or less substantial changes in soil colour, that define four major stages in the development of the site: Proto-Lepenski Vir, Lepenski Vir I a–e (Fig. 7), and Lepenski Vir II (Fig. 8) belonging to Mesolithic period and a Lepenski Vir III layer that belonged to the Neolithic culture [6]. In his early publications Srejović (*1968; 1969; 1971*) argues for a local development of the Neolithic in the region and divided development phases into Proto-Starčevo and a Starčevo that were both present at the Lepenski Vir site. Although his observations of continuity were appropriate, the argument could not withstand the critique by Jovanović and Garašanin, who argued that Starčevo comes to Lepenski Vir in its fully developed "classical" phase (*Garašanin 1980*). The synchronicity of some of the Lepenski Vir houses at Padina with fully developed Starčevo II ceramic ware was used by Jovanović (*1987*) to argue for a Neolithic date and context for the Lepenski Vir material. Srejović has moderated his view in his later publications (*Srejović 1979; 1989*) and his local continuity came to incorporate contact with surrounding far-

6 Unfortunately, no general plan was available for this period.

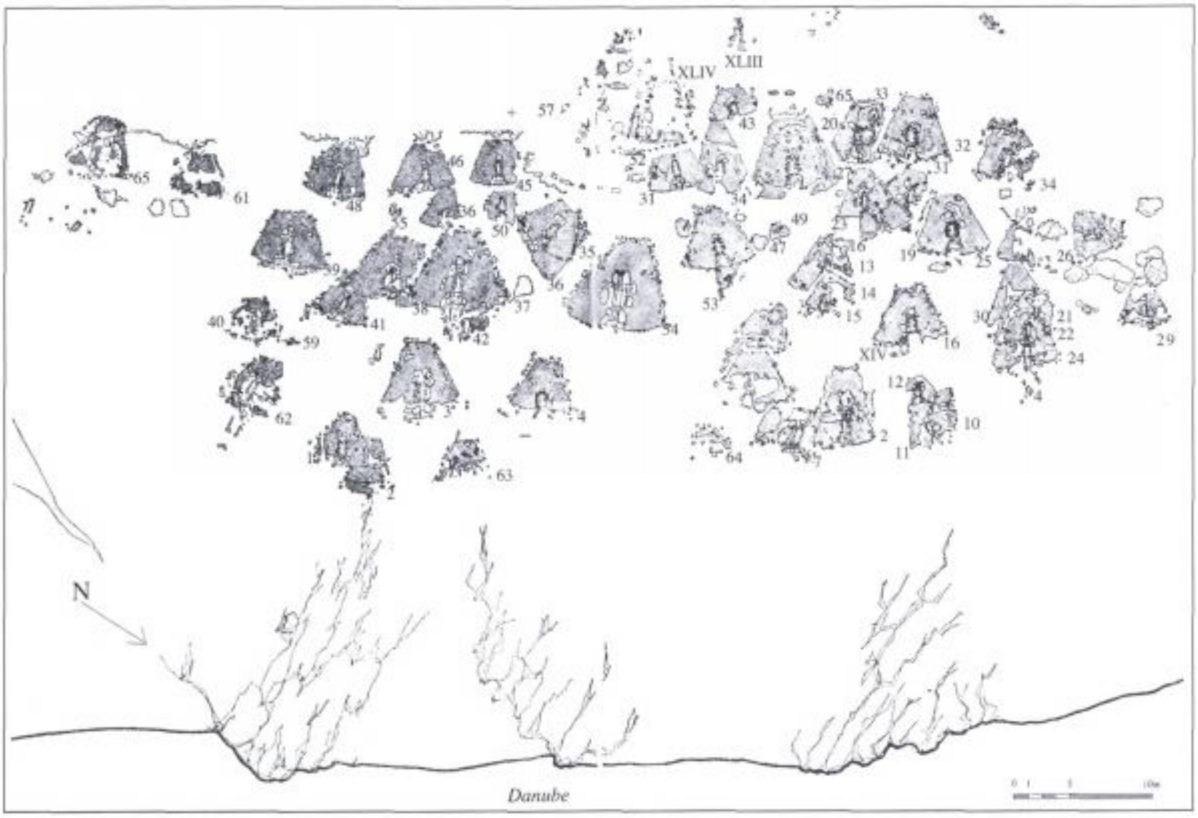


Fig. 7. Composite plan of the Lepenski Vir I (a-e) settlement. **(Adapted from Srejović 1969.52–53, Fig. 7).**

ming communities as part of the explanation for the development of the Lepenski Vir sequence[7].

While Radovanović (*1996a*) keeps the basic distinction between horizons, she has argued for different interpretation of spatial organisation of the site and has concluded that Srejović's five building phases in Lepenski Vir I represent eleven cycles of the re-building of the settlement. Her argument is based on stylistic analysis of hearths within superimposed houses and, since it was tested and confirmed on superimposed houses in Padina, it is more convincing. These 11 re-building incidents are grouped in three chronological units that are important to this study. As her phases do not always incorporate all of the buildings that Srejović assigned to his phases of the horizon LV I it would be hard to present a comparative table. No detailed plans of the site that would include the distribution of the burials are available as yet although Babović is currently working on their reconstruction (*Babović pers. comm.*). Schematic representation of housefloor plans in different phases of settlement can be found in Srejović (*1969; 1979*) and Srejović and Babović (*1983*). More detailed discussion can be found in Radovanović (*1992; 1995; 1996a*).

Proto-Lepenski Vir: small settlement along the bank of the cove that extends over 90 m.

Lepenski Vir I –1: A settlement with two central zones – one for the upstream part of the settlement, and the other for the downstream part.

Lepenski Vir I–2: In this phase there is only one central house (54) around which other dwellings are rebuilt. The extreme upstream and downstream buildings represent another evidence of concern for symmetry. This is the phase of consolidation (*Radovanović 1996a.109*) but also of sporadic appearance of pottery and Pre-Balkan Plateau flint. The settlement is synchronous with the Neolithic of the region and these occurrences provide evidence for an exchange (trade) relationship with farming communities in the vicinity.

Lepenski Vir I–3: During this phase habitations "move" towards the rear of the terrace; there is a lot

7 I met Prof. Srejović for the last time in 1996 in Belgrade, several months before his untimely death from cancer, and we discussed my project. He shared his unchanged fascination with the site and its meaning with me, and it became apparent that he changed his original ideas significantly. However, the idea of ideological continuity in the region was still strongly present.

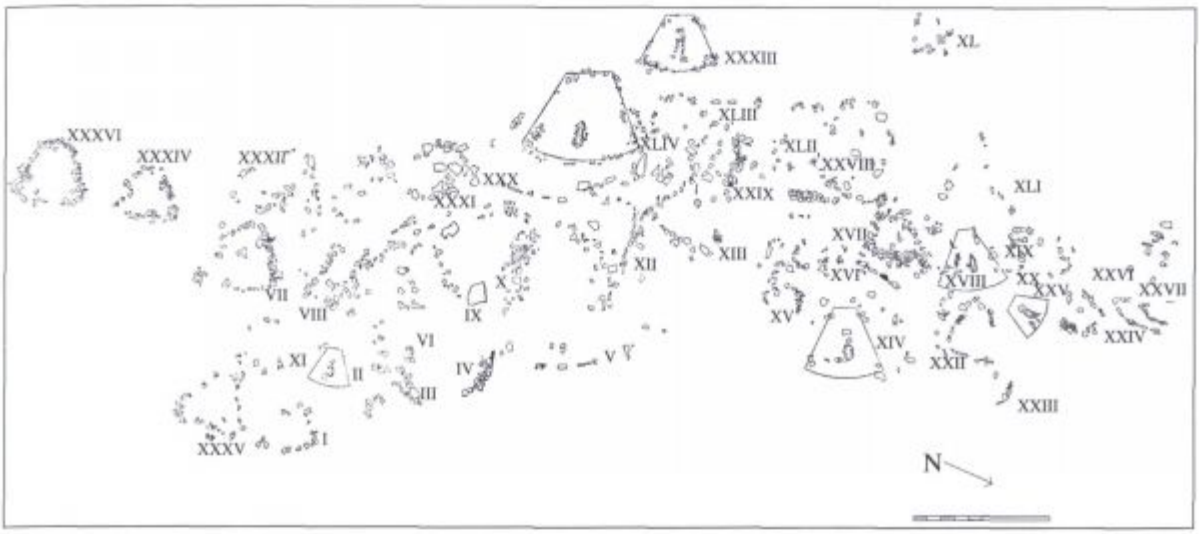


Fig. 8. Composite plan of the Lepenski Vir II settlement. (**Adapted from Srejović 1969.78-79, Fig. 18*****).***

of rebuilding activity, and the house 57 stands out as the largest house in the whole sequence.

Lepenski Vir was abandoned for a period of time (testified by a thin layer of brown loessic sand observed at places between the LV I and LV II settlements (*Srejović 1966.13; Radovanović 1996a.113*). There are significant differences in the organisation of the settlement, with supporting walls and artificial terraces. However, the houses are often at the same spot as the houses of the previous phase (*Srejović 1969.78–81*).

Lepenski Vir III is not considered by Radovanović as she deals only with Mesolithic strata. It is divided into LV IIIa perceived by Srejović as early Neolithic and LV IIIb – Middle Neolithic Starčevo settlement. If the evidence for contacts with Neolithic communities from LV I is taken into account, the designation of the LV IIIa into early Neolithic is somewhat problematic. It is supposedly synchronous with Gura-Baciului and arguably different from the classical Starčevo complex – at least based on its ceramic production. Since the ceramics from Lepenski Vir have not yet been thoroughly examined in the light of new interpretation of Starčevo development (*Tasić 1998*) further discussion is fruitless. However, the high percentage of game and fish, as discussed earlier, argues for substantial influence of local tradition.

Absolute dates for Lepenski Vir were obtained from charcoal samples and have caused considerable discussion, especially on the dates of the Neolithic settlement. Since these are not crucial to our analysis, only the dates reported by Bonsall *et al.* (*1997*), derived from human bone collagen are examined here. Unfortunately, R. Lennon, who collected the bone samples in 1989, made only Lepenski Vir III material available for processing, although many more specimens were collected[8]. The dates (Tab. 5) have quite a wide range (from 6993 to 5593 BC) although they are all derived from the Neolithic phase of the settlement.

These dates do not coincide with Radovanović's and Srejović's archaeological determination of the site sequence and present a considerable problem. However, since they are only few and all of them are from a single phase in the sequence, the phase that seems to have been the most readily discerned by the field crew and since a possibility of them being contaminated with the ^{14}C from the ground water,

Skeleton number	Lab ID	^{14}C age BP	cal BC age 1σ	cal BC age 2σ
31a	OxA–5827	7770±90	6621–6462	6993–6414
44	OxA–5830	7590±90	6463–6267	6552–6189
32	OxA–5828	7270±90	6178–5990	6229–5897
88	OxA–5831	7130±90	6018–5970	6159–5763
35	OxA–5829	6910±90	5840–5667	5954–5593

Tab. 5. Absolute dates. Lepenski Vir III settlement (**from Bonsall et al. 1997.Tab. 6*****).***

8 As evidenced by bones from all three periods that have been severely damaged by collection of unnecessarily large samples, more dates could have been available.

it is hard to incorporate these dates in the present study. Until more dates are available their value remains tentative.

Human remains examined in this study come from all three settlements. They comprise 190 individuals from 134 graves plus 34 adults, five subadult individuals and three newborns from different unidentified contexts. Of note is that many of the "scattered" adult remains bear traces of ochre. However, until a more detailed study of taphonomy is done and full access to field data is available, the explanation for these bones cannot be offered. Some of them are no less well preserved than some of the remains with associated grave numbers. However, since none of them have sufficient features for either demographic, morphometric or non-metric analysis they are excluded from further discussion.

MNI for the site as a whole amounts to 190 individuals (as at least theoretically these 42 "scattered human remains" could have belonged to them). Skeletal representation ranges from small fragments to complete skeletons. Of them 101 individuals were buried in single, 58 in double graves, three graves contained three individuals, while four, five, six and seven individuals were buried in one instance each.

Only 25 individuals were assigned sex based on pelvic morphology (same procedures as described for Padina). Females are represented by 11 positive determinations and males by 14. The site has a particularly high proportion of neonatal skeletons: 51 individuals or 27%. These burials are most often associated with house construction (underneath the floor) but also they are found within adult burials as well, often represented by only one bone fragment. A further 33 skeletons belong to children of different ages: 2–5 years old by seven individuals, 6–11 years old by 13 individuals, 12 –18 years old by eight individuals, while for five subadults it was impossible to determine age. The total for adults is almost identical as for subadults (83 compared to 84) while no age could be assigned to 23 individuals.

As with the collection from other sites, previously non-identified individuals were given the same number as the noted grave with the additional serial number in brackets.

According to the presented chronology of the site and division of the strata into the Mesolithic, Mesolithic/Neolithic contact and Neolithic periods, skeletal remains were assigned to one of the following phases according to site documentation (kindly provided by Prof. Srejović, the principal investigator) for the Neolithic burials or Radovanović's analysis of Mesolithic burials (*1996a.174–189*):

The following 32 skeletons have been assigned to the Mesolithic period:

single burials: 3; 21; 22; 46; 60; 61; 67; 69; 110; 111; 112; 113; 117; 118; 119; 120; 121; 132; 133; *double* burials: 50, 50(1); 64, 64(1); 99, 99(1); 102, 102(1); 109,109a; *multiple* burials: 101, 101(1), 101(2).

It is interesting to note that 17 of these individuals are newborn babies found underneath the house floors (all of the numbers above 100).

To the Mesolithic/Neolithic contact period belong following 68 individuals:

single burials: 11; 12; 15; 16; 17; 23; 26; 28; 46; 68; 70; 90; 91; 92; 94; 95; 96; 97; 100; 103; 104; 105; 115; 116; 122; 126; 127; 128; 129; 130; 131; 134; *double* burials: 7a, 7b; 13, 13(1); 14, 14(1); 45a, 45b; 63, 63(1); 74, 74(1); 93, 93(1); 98, 98a; 99, 99(1); 106, 106(1); 107, 107(1); 108, 108(1); 114, 114(1); 123, 123(1); 124, 124(1); 125, 125(1); *multiple* burials: 54a, 54b, 54c, 54d, 54d(1), 54e.

Newborns represent 29 of these burials, most of them found underneath the house floors once the site was removed onto a higher terrace, as evidenced by their high sequence number (≥100) assigned during excavation.

To the Neolithic period Lepenski Vir IIIa and IIIb belong the following 40 individuals:

single burials: 1; 4; 5; 6; 8; 9; 20; 31a; 33; 35; 37; 38; 39; 42a; 43; 44; 48; 51; 53; 56; 57; 59; 66; 71; 88; *double* burials: 18, 18(1); 19, 19a; 32a, 32c; 52, 52a; 55a, 55b; 73, 73(1); *multiple* burials: 83a, 83a(1), 83b.

Unfortunately, for 48 burials there was not enough information to provide chronological assignment:

single burials: 2; 10; 24; 25; 29; 36; 40; 41; 49; 58; 62; 65; 72; 75; 76; 78; 86; *double* burials: 77, 77(1); 80; 81; 82; 84, 84(1); *multiple* burials: 27a (27a+e), 27(27b), 27 (27C), 27 (27d), 27(1), 27 (27f), 27(2); 34a, 34b, 34c; 79a, 79b, 79c; 85, 85a, 85b/85(1)/, 85b; 87, 87(1), 87(2), 87(3), 87(4); 89a, 89b, 89b(1).

The skeletal material has received little detailed publication. Presented in Srejović's book (*1969.239–257*) by Nemeskeri in a preliminary report it gives little information on the structure of the population. Nemeskeri, in keeping with the traditional approach of Central European anthropology was most interested in demographic profiles and typological determination of sub-populations. He distinguishes 2 major types further divided into 2 subtypes each, and concludes that for the differences between early and late population of Lepenski Vir (from the phase I to that of IIIa) to have evolved *in loco*, it must have taken 125 generations, or 2500 years. He therefore discarded the possibility of local evolution and argues for abrupt population change (*Nemeskeri 1969. 255*). Mikić has dealt with the entire Iron Gates Gorge series in his works on the process of neolithisation in Iron Gates Gorge (*Mikić 1981a; 1989*) and argues for the *in loco* evolution. Zoffmann (*1983*) has made an important contribution to anthropological publication on Lepenski Vir, and although sex and age determinations for individual skeletons were not reported, I was able to use the original documentation (kindly provided by Prof. Srejović in 1996) in which sex and age determinations were given by Zoffmann. However, in the following season, in keeping with revision of sex determination for osteological material from other sites, I have reassessed sex using a more conservative approach based exclusively on pelvic morphology. It was interesting to note that differences in sex assignment were least important between my assessments and hers, while they differed considerably between both my and Nemeskeri's results, and my and Živanović's results. The major reason for this could be that the two later authors based most of their conclusions on cranial remains.

3.5.3. Vlasac

Vlasac was found at the very end of the campaign in the late summer of 1970. In the autumn of 1970, 432m^2 of this site, situated in the Upper Djerdap Gorge downstream from Padina and Lepenski Vir, were excavated. A further 208 m^2 were excavated in 1971, right before the inundation by the accumulation lake of the Djerdap Hydro-plant. In less than four months, the team of archaeologists, geologists, architects, and students unearthed 43 dwelling structures, 87 graves and more than 35 000 mobile objects. The monograph of the site was published in 1978 and is the most comprehensive publication on archaeological, environmental and anthropological data on any individual site of the Lepenski Vir culture (*Bökönyi 1978; Buczko et al. 1978; Carciumaru 1978; Srejović and Letica 1978*). The graves are treated and presented individually with relevant data on position, orientation, age and sex, and accompanied by drawings and pictures (Figs. 9, 10 and 11). The anthropological report is extensive and besides chapters on methodology, demography, pathology, dating, and sex and sexualisation (sexual dimorphism change over time) gives individual data for each of the skeletons (*Nemeskeri 1978; Nemeskeri and Lengyel 1978a; 1978b; Nemeskeri and Szathmary 1978a; 1978b; 1978c; 1978d; 1978e*). It is of extreme importance to any of the metrical analyses, and also has all the relevant information on the dates obtained from human bones, useful in comparisons of stratigraphic assignments by researchers with Radovanović's (*1992; 1996a*) chronology discussed below. However, a revision of the osteological material has shown numerous discrepancies between Nemeskeri's and my assessment of MNI and sex. During the 1996 campaign this difference started to appear, first and foremost in the number of individuals per grave. My first impression was that poor storage conditions had caused some mixing of the material. In 1998 campaign, this conclusion was dropped for a number of reasons: the mixing of the material had to be considerable to allow for such large discrepancies, the "extra" individuals were represented either by fragments of long bones, or very small fragments of skull. At least in one case (grave no. 7) a decorated bone implement (Fig. 12) was found with the postcranial remains.

In at least one case a whole coxal bone could be reconstructed where Nemeskeri assigned sex on the basis of the skull (grave no. 4a). The same coxal bone with embedded fragment of bone projectile was not discussed in his chapter on paleopathology (*Roksandić 2000a*).

These instances have supported the conclusion that different results that Nemeskeri and I found in respect to both MNI and sex assessment stem from different weight accorded to the skulls and the postcranial skeleton in both of the analyses and also points out the benefits of detailed reconstruction of skeletons that was undertaken in the 1998 field season. More relevant information on the burial ritual is expected from the forthcoming analysis of skeletal representation and taphonomy of the material.

According to the building horizons, Srejović and Letica have divided the site into three chronological phases of the Mesolithic settlement (Vlasac I, II, and III) and one of the Neolithic (Vlasac IV). Since no human skeletal remains were associated with the lat-

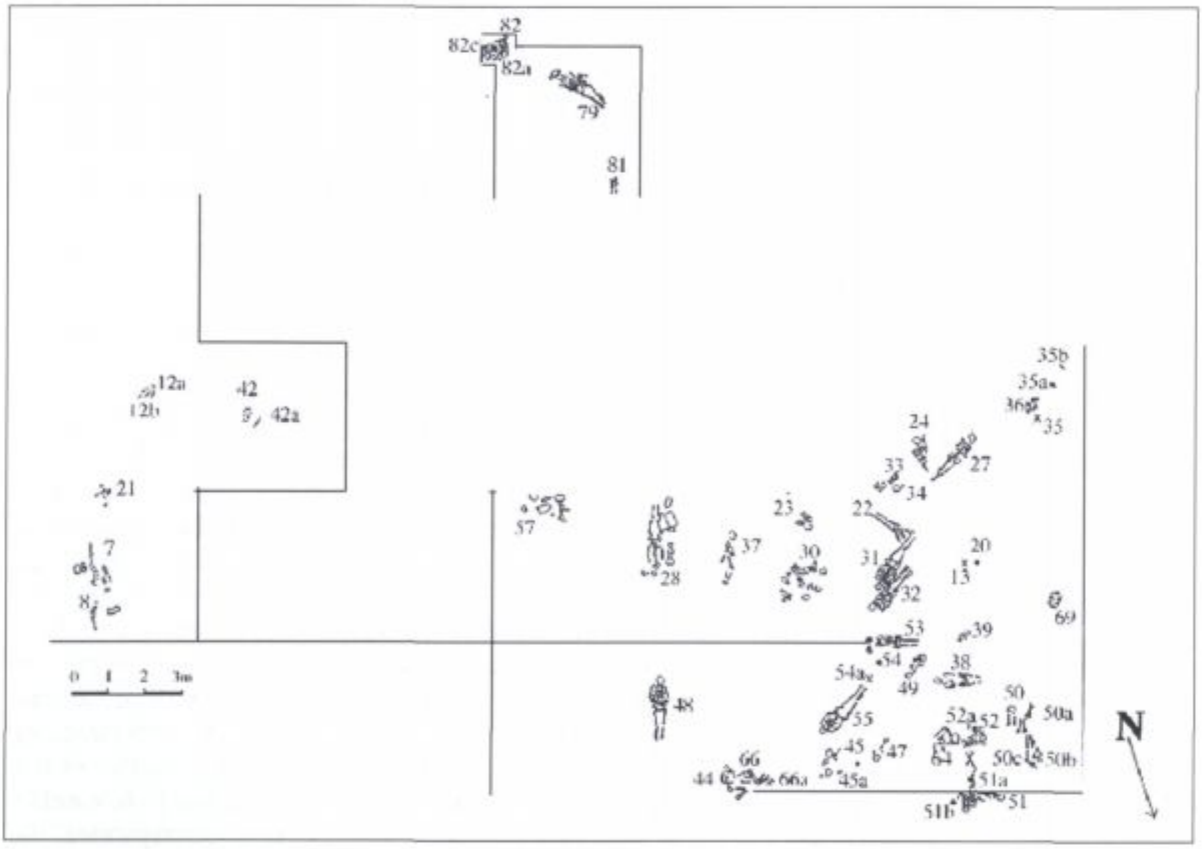


*Fig. 9. Vlasac West. Position of graves (***Adapted from Srejović and Letica 1978.Fig. 57***).*

ter, it will not be discussed in detail. Radovanović has observed significant changes in burial practices over time and has proposed a division of formal disposal areas into two chronological phases. Based on the published material, as well as field documentation (kindly provided by late Prof. Srejović, the principal investigator), she was able to distinguish an important change in burial practices that began to occur at the end of the Vlasac I but certainly were present in the Vlasac II phase (*Radovanović 1996a. 187–218*).

In the early Vlasac I phase she distinguishes a formal disposal area in the upstream Western Sector (Fig. 9) with parts of the Central Sector (Fig. 10) and a habitation area in the Eastern Sector. The situation changes in the Horizon II when habitations are clearly present on the border of the rocky plateau facing the river at both the Eastern (Fig. 11) and Western sector of the settlement. Burials are distributed along the whole settlement area. Some of the burials from Vlasac II are associated with the early and some with the later formal disposal areas.

However, both Vlasac I and II would belong to the Mesolithic pre-contact period and only Vlasac III would chronologically belong to the period when the contact with the Neolithic populations was possible. All of the cases where Radovanović could not certainly distinguish between the Vlasac II and III burials are treated as Mesolithic/Neolithic contact. However, a separate test was run with these individuals included in the Mesolithic group since contacts between Lepenski Vir and surrounding farming population(s) is least attested in Vlasac of all of the sites: no pottery was found in these layers, and all of the Pre-Balkan Plateau flint was explained as intrusive (*Srejović and Letica 1978; Kozłowski and Kozłowski 1982*).

Five ^{14}C dates (Tab. 6) derived from human skeletal remains are given in Bonsall *et al.* (*1997*) and they are well in accordance with Radovanović's (*1992; 1996a*) determination of the burials phases since only Grave 24 is determined as belonging to the Contact period.

Another set of dates was calculated on the basis of nitrogen and fluorine content (*Buczko et al. 1978*). The authors acknowledge that the content of nitrogen and fluoride is also dependent on climatic changes and therefore propose two different values for each of the skeletons. These values all fall within the range of 5250±100 to 5900±200 for the column

A and between 6250±150 and 7400±300 in the column B. They also provide a set of more probable dates based on the relative - archaeological chronology. Since the whole process depends on the archaeological data, these absolute dates are perceived as uninformative and are not discussed further.

All of the human skeletons from the site belong to the Mesolithic settlement. Human skeletal remains comprise 164 individuals from the 84 reported graves. This differs significantly from the 119 individuals reported by Nemeskeri (38% increase). These "extra" individuals are represented by very small cranial or postcranial fragments. No scattered human remains were reported among the faunal remains. The skeletal part representation varies from fragments of bones to whole skeletons. Of these, 45 were buried in single graves, 44 in 22 double graves, 13 graves contained remains of three individuals each (39); five graves had four individuals each (20); two graves contained remains of 5 individuals each (10); and one grave contained six individuals.

Adults represent the majority of the sample: 108 individuals or 66%. Young adults are represented by 21 individuals, and old adults by 40; for 47 of them it was possible only to state that they were adults. Of the 47 subadult individuals 26 are of neonatal (or perinatal) age (16% of the total sample or 56% of the subadult sample), one was a child between 2-5 years, 8 children were between 6-11 and 6 between 12-18 years old. For six of the subadult skeletons the age could not be determined. In nine cases it was not possible to determine if the individual reached adulthood. As with other samples from the series, the approach to age was very conservative and age was assigned in deliberately broad categories.

Positive sex determination was possible in 41 cases of the total adult sample (38%) of which 26 were determined as females and 15 as males. A further 16 were determined as possible females and 31 as possible males on the basis of robusticity. The larger number of determinable females could be due either to more elements (such as preauricular sulci) being significant to the female pelvic morphology or to a cultural agent. It will be discussed later with data on size and robusticity.

In keeping with the marking of the other sites, "extra" individuals within graves were given a grave number from existing documentation and publication and an additional in brackets.

According to the presented chronology the following 125 individuals are determined as Mesolithic precontact burials:

single burials: 7; 8; 10, 11; 13, 20; 25; 28, 30; 31; 32; 33; 34; 37; 38; 39; 40; 41; 44; 59; 61; 63; 68; 72; 79; 81; *double* burials: 9, 9(1); 12a, 12b; 19,

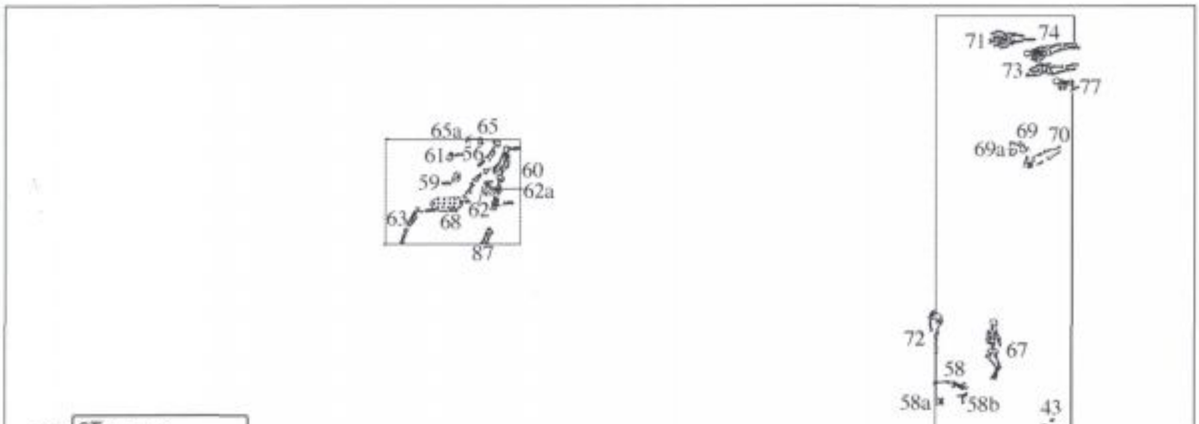


*Fig. 10. Vlasac Central Section. Position of graves (***Adapted from Srejović and Letica 1978.Fig. 58***).*

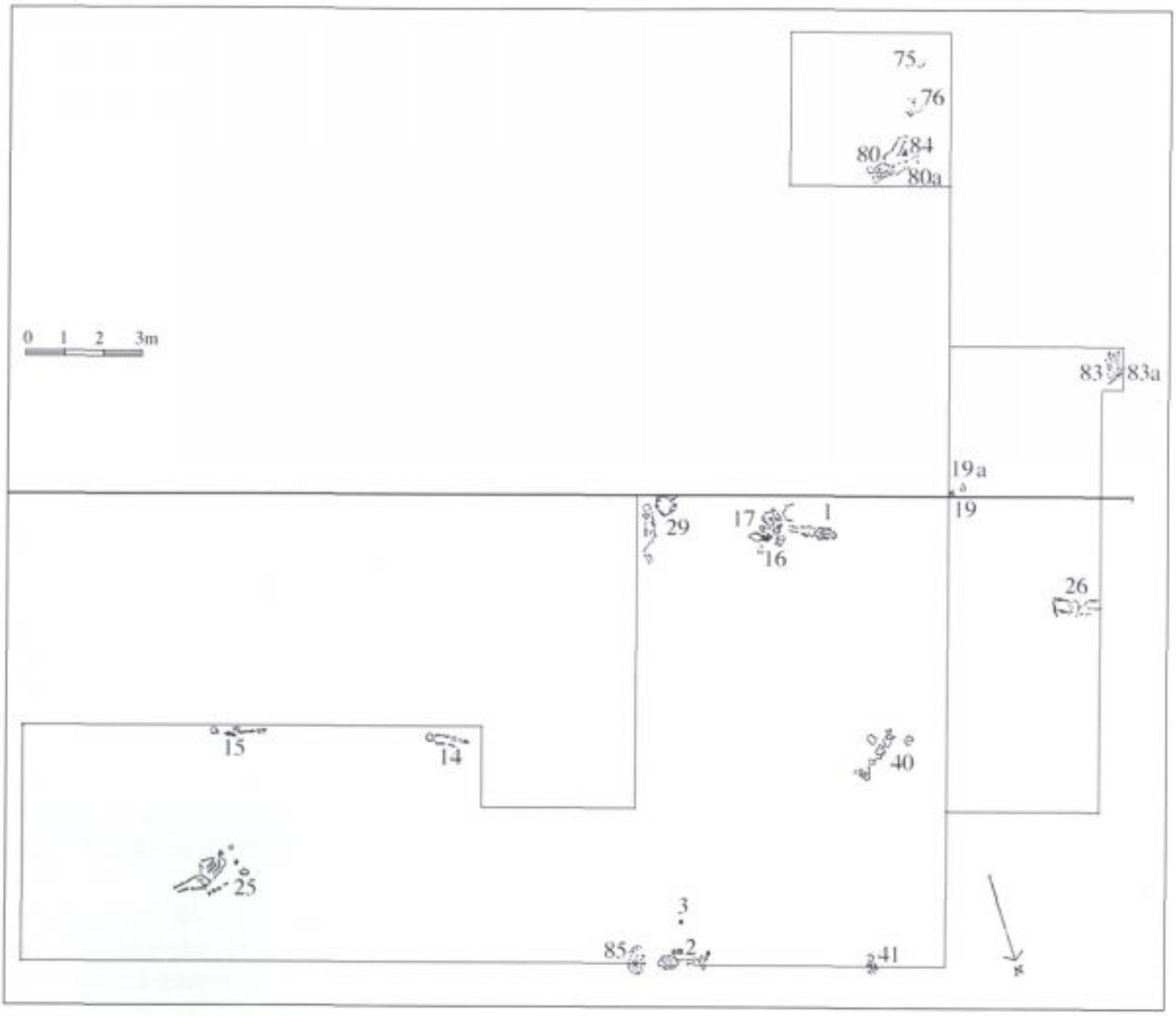


*Fig. 11. Vlasac East. Position of graves (***Adapted from Srejović and Letica 1978.Fig. 59***).*

19a; 35, 35a; 42a, 42b; 47, 47a; 48, 48(1); 53, 53(1); 56, 56(1); 57, 57(1); 60, 60(1); 62, 62(1); 66a, 66a(1); 80, 80a; 84, 84(1); *multiple* burials: 4a, 4b, 4b(1); 5, 5(1), 5(2); 6, 6a+6(1), 6(2); 18a, 18b, 18c; 21, 21(1), 21(2); 36, 36(1), 36(2); 45, 45(1), 45a+45(1); 49, 49(1), 49(2); 50, 50(1)+50a (1), 50a, 50a(2)+ 50b(1), 50a(3), 50b; 51, 51a, 51b, 51+51a+51b(1), 51+51a+51b(2); 52, 52(1), 52(2), 52(3); 54, 54(1), 54(2); 55, 55(1), 55(2), 55(3); 58, 58a, 58b; 64, 64a, 64b; 65, 65(1), 65a; 67, 67(1), 67(2), 67(3); 82, 82 (1)+82b, 82(2)+82c, 82(3), 82 (4)+82a; 83, 83a+83(1), 83(2), 83(3).

The following 35 individuals were assigned to the Mesolithic/Neolithic contact period:

single burials: 2; 14; 16; 17; 22; 23; 24; 43; 46; 75; 76; *double* burials: 15, 15(1); 27, 27(1); 70, 70(1); 71, 71(1); 73, 73(1); 77, 77(1); 78, 78a; *multiple* burials: 29, 29(1), 29a; 69, 69(2), 69a, 69(1)+ 69a(1); 74, 74(1), 74(2).

For the following four individuals it was not possible to determine chronological position:

single burials: 1; 3; *double* burials: 26, 26(1).

Vlasac figures prominently among Iron Gates Gorge osteological material with a thorough publication by

Skeleton number	Lab ID	^{14}C age BP	cal BC age 1σ	cal BC age 2σ
72	OxA-5824	10240±120	10317–9749	10482–9138
51a	OxA-5822	8760±110	7949–7585	8027–7537
83	OxA-5827	8200±90	7411–7039	7476–6824
54	OxA-5823	8170±100	7300–7033	7473–6771
24	OxA-5826	8000±100	7039–6655	7252–6562

*Tab. 6. Absolute dates for Vlasac (***from Bonsall et al. 1997.Tab. 6***).*

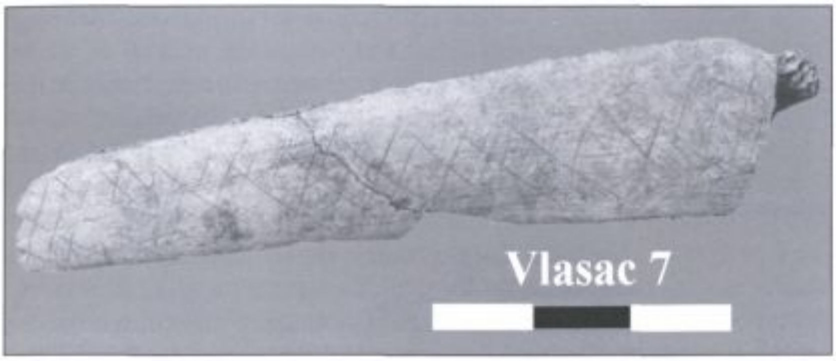


Fig. 12. Ornamented bone artefact found with human remains.

Horizon II (*Jovanović 1968; 1969*). In Horizon I, two superimposed building structures are discerned (Ia and Ib). A chamber tomb, to which most of the burials from the site belong, is assigned to Horizon II in the Central area. In the south-western area, only traces of burning are associated with anthropogenic layer of dark soil with no pottery finds, while horizon II has two levels of stone constructions associated with numerous pottery finds (Fig. 13).

Nemeskeri and his colleagues (*Srejović and Letica 1978.Vol. 2*). Although there are discrepancies between current research and Nemeskeri's in the MNI and sex assessment, the basic cranial metric analysis is thorough and the postcranial metrics are improved only by the addition of reconstructed bones from the site.

3.5.4. Hajdučka Vodenica

This site is the only site on the right bank of Danube situated in the Lower Gorge and some particularities are therefore to be expected. This site is by far the most under-reported of Iron Gates Gorge sites, and apart from several articles published by Jovanović right after the excavation, in which Jovanović misinterprets the site as an Iron-Age locality, there is only one article on human remains from Hajdučka Vodenica. In this article Živanović (*1976a*) follows the archaeological assignment of the skeletons to either the Lepenski Vir culture or the Iron Age and claims that they are substantially different populations. However, neither the archaeological material, nor the human remains warrant such a sharp distinction between the two groups (*see Radovanović 1992; 1996a*). Živanović (*1976a*) has reported 10 skeletons washed away by Danube in the course of excavations, for which he has, from the photos, and drawings, assigned the sex and age in some cases (*Sic*!). Jovanović (*1984a; 1984b*) has dropped the Iron Age argument and Radovanović (*1992*) has shown that all the skeletons should be regarded as belonging to the Lepenski Vir culture alone and could be divided into two phases (*Radovanović 1992*). Jovanović distinguishes between Horizon I (a and b) and

Radovanović's interpretation of the stratigraphic sequence associates the "habitation" in the central area with the burials in the Chamber tomb. The early habitation floor Ia and the later Ib floor within the same location (but shifted slightly towards the back of the site) of the central space are divided by 0.80 m of cultural debris. The earliest level of graves within this debris is noted as Ib1 by Radovanović (signifying its pertaining to the early phase of the Ib horizon. Jovanović's layer Ib (the later habitation floor is noted as Ib2 by Radovanović and found to be synchronous with the chamber tomb that Jovanović denotes as Horizon II. The later level of the graves in the tomb (above the floor) is denoted as Ib3. Following synchronisation (Tab. 7) for the whole of the settlement and formal disposal area was proposed.

Within the proposed framework, all of the burials from Hajdučka Vodenica would fit within the Mesolithic/Neolithic contact period. The meaning of the Chamber tomb and the two levels of the associated habitation are still very hard to discern. More thor-

layer	Central Area	South-western Area
II		two levels of the stone construction containing pottery of the Starčevo type
Ib3	later horizon of the chamber tomb	late level with rectangular hearths and the formal disposal area, pottery finds more frequent (1b1–3)
Ib2–Ib3	chamber tomb dug in – early burials	
Ib2	later habitation floor	
Ib1	early burials	
Ia	early habitation floor	early level of stone construction with sporadic pottery finds

Tab. 7. Synchronisation of Hajdučka Vodenica by areas of excavation. (*Adapted from Radovanović 1996a*).

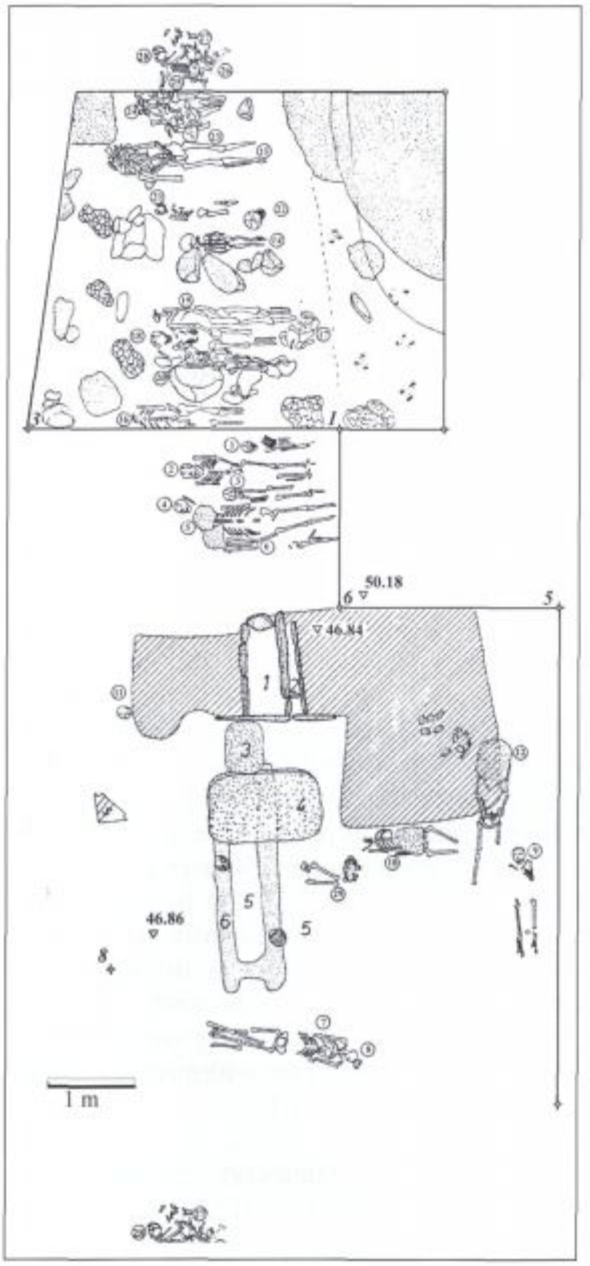


Fig. 13. Hajdučka Vodenica. Southwestern Area featuring two layers of hearth and architectural construction and burials. Note that the burials in the "burial chamber" (background) are in two levels. Unpublished site plan courtesy of B. Jovanović.

ough analysis of the material present within the two is needed. In the light of the importance of game and small amount of fish it becomes even more crucial to offer a detailed study of the spatial distribution of different finds and artefacts within the site. Unlike the other sites, the graves show remarkable uniformity in the burial position and even orientation. This uniformity, as well as the restricted and well respected space for the burials, is well in accordance with the (comparative to other sites) short time span of the necropolis and of the chamber tomb.

The skeletal representation ranges from small fragments of skulls and postcranial remains to whole skeletons. For the 32 graves recorded on the site the MNI was calculated at 46. This MNI includes one individual for all of the 10 missing graves. Since Živanović did not pay attention to small fragments of secondary buried individuals these graves cannot be ascertained as single graves and therefore will be excluded from further discussion. Eight individuals were buried in single burials, six in three double graves, two graves had three individuals each, and three graves had four, five and seven individuals respectively:

missing burials: 1; 2; 3; 4; 5; 6; 7; 9; 10; 12; *single* burials: 8; 11; 16; 21; 22; 30; 31; *double* burials: 14, 14(1); 29, 29(1); 33, 33(1); *multiple* burials: 15 m, 15 s, 15s(1); 17/17-20(3)/; 18/17-20/; 19/17-20(2)/; 20/17-20(4)/; 17-20(1); 20; 20(1); 23+24+25(1), 23+24+25(2), 23+24+25(3), 23+24+25(4), 23+24+25(5); 26+27+28(1), 26+27+28(2), 26+27+28(3), 26+27+28(4); 32, 32(1), 32(2).

Of the 36 skeletons that were examined, 27 were adults (75%): 9 of them old, 2 young and for 16 age could not be determined with precision. Among children, there are no newborns or children below 5 years of age, only two children between 6-11 years and 4 in 12-18 years category. It was not possible in three cases to determine if the individual had reached adulthood at the time of death.

Only in seven cases of the 27 adults, was sex determination possible on the basis of pelvic remains: one individual was female and six were determined as male. A further four individuals were determined as possible females and 8 as possible males. In eleven cases, it was not possible to determine sex on adult remains.

All four sites, as is evident from the above descriptions, present a different set of features, but within the same cultural tradition. Their function, as we have previously noted, is far from clear. New research on the specifics of mortuary ritual, settlement organisation, cognitive and symbolic aspects of the art, is needed in order to understand the interaction of these discernible features with social and ideological aspects of Lepenski Vir-Schela Cladovei complex. This research aims at discerning a possible regional pattern of biological interaction between hunter-gatherers and neighbouring farmers that can provide a starting point for understanding their more complex social interactions.

4. METHODS

Two types of data are considered in this research: cranial and postcranial non-metric traits and postcranial size/robusticity data. They were selected on the basis of the following:

- Craniometric analyses have already been reported for most of the material and different conclusions were offered by Nemeskeri, Mikić, Zsoffmann and others primarily for Lepenski Vir and Vlasac. It was felt that a comparison of the results from the study on non-metric traits with previously published results based on cranial metrics would be beneficial both as an independent test of current understanding of population interaction and evolution in the Iron Gates Gorge Mesolithic and/or in order to provide additional interpretations for the phenomena.
- The material from the four sites comprises individuals with unequal skeletal representation. This has resulted in an important reduction of sample size for metric analysis and also possible selective bias. Namely, skeletal representation in the Iron Gates Gorge is to a great extent due to different mortuary practices that include whole skeletons as well as small fragments of secondarily disposed individuals (*Roksandić in prep.*). The disposal practices are not well explained and body part representation has not been compared to chronological sequences, although an attempt from the published literature is made both by Radovanović (*1992; 1996a*) and Chapman (*1993*). In the light of this phenomenon, the selection of fairly complete skulls for analysis could result in a systematic bias towards a segment of the population. Secondarily disposed skeletons without the skull, or primary burials from which the skull was taken away and re-deposited in a different, thus far unknown location would not figure in the analysis. It is not difficult to envisage, although it need not necessarily be correct, that a supposedly different incoming population could have had different treatment at death, resulting in either over or under representation in the total number of examined individuals. Although non-metric analysis cannot pretend that the population examined is representative of the living population of the site, as every cemetery population is necessarily biased, it is more evenly distributed, and the bias is not unidirectional.
- Since dental traits reflect genetic make-up of an individual (and a population) much more unambiguously than other elements, their examination was one of the logical choices. However, during the 1996 season, it was established that the improper curation of the specimens has resulted in severe damage to the enamel. In order to maximise the number of observations, a thorough conservation was needed for most of the teeth. In the restricted time and finances of the project this was deemed impractical. Provisions to reduce further damage as well as some conservation and reconstruction is underway and should help bring these traits forward in a complementary study.
- Although there is an ongoing discussion amongst anthropologists about the ability of different analyses to establish relationships among skeletal samples, a paired study of analyses of diverse non-metric traits and cranial measurements demonstrates that the former are more powerful in this respect (*Jackes et al. 1997*).
- However, since non-metric variants could prove to be inconclusive, an independent measure of differences between chronological and site units was deemed necessary. Size and robusticity differences between samples - observable throughout the Iron-Gates material - provided a possible other measure, independent of the non-metric traits, for both secular trends, environmental - nutrition based changes and population differences.

A combination of these two methods covers a large area of possible explanation for observed changes and, since there is no indication that they are dependent on each other, they could show different patterning and thus provide firmer grounds for explanation.

4.1. Non-metric traits analysis

4.1.1. Background

In the literature, nonmetric skeletal variants are described as discrete, discreta, discontinuous, anomalies, atavisms, all-or-none attributes, minor variants, nonmetric characters - emphasising discontinuity; or quasi-continuous traits, epigenetic polymorphisms, threshold characters - emphasising underlying continuity (*Saunders 1989.96, Tab. 1*). The term nonmetric minor anatomical variants (further non-metric traits) that distinguishes them from general morphological features, seems to be the most appropriate as it is purely descriptive, implying neither scoring procedure nor their biological background.

There are more than 200 variants observed on the skull alone (*Hauser and De Stefano 1989; Ossenberg 1976*) and almost as many on the postcranial skeleton (*Saunders 1989*). They have been recorded as early as 1670 by Kerckring as skeletal anomalies, and only in the XIX[th] century were they employed in early studies of comparative anatomy and phylogeny (*Antouchine 1878; Bertelli 1892; Schultz 1919*). Although familiar occurrence was reported as early as 1893 by Shepherd (*1893*), it was not until the studies by Gruneberg (*1952*) and Berry and Berry (*1967*) on mice, that these traits were perceived as relevant for studying population affinities (*Hauser and De Stefano 1989*). After an initial phase of confidence in the method (*Berry and Berry 1967*), methodological studies criticising a number of underlying problems with these early studies have brought down the initial enthusiasm and it was suggested that their value is inferior to that of metric analysis in examining population distance (*Corruccini 1974; 1976; van Vark and Schaafsma 1992*). Assumptions that there is no side, sex and age correlation, and interrelation between traits, were soon reviewed and criticised (*Ossenberg 1969; Suchey 1975*) and it was shown that environment plays an important role in trait manifestations.

Gruneberg (*1952*) has shown that single gene mutations in mice could produce a number of these traits, but also those traits could reach high frequencies in normal mice of certain inbred strains. He also observed that there are no strict correlations between parents and offspring, indicating that the traits did not follow simple Mendelian patterns of inheritance. Hauser and De Stefano (*1989.5–10*) accept the model of "threshold character" proposed by Falconer (*1965*) in relation to the pathological conditions as the underlying theoretical basis for all of the characters. The liability (as in the context of disease) to develop a trait is normally distributed, and depending on the position of the individual's inherited tendency to develop the character relative to the threshold, the character may or may not be expressed. The genes involved are multiple genes with small additive frequencies. Threshold models permit a number of other environmental and developmental factors to be included in the determination of the trait's expression and allow for the observed gradients in some of the traits. An individual situated just below the threshold in one environment may be pushed over it in another (*Hauser and De Stefano 1989.7*) which reinforces the population specific character of the frequencies of trait expressions. The proportion of total variance attributed to the additive effects of genes, known as the heritability of the trait, was calculated from the study of the frequency of the condition in a series of related individuals of known sex and age (*Sjøvold 1984*) and was shown to be significant although low. However, any attempt to relate individuals within a series to one another failed to perform, because of this underlying complex genetic basis of the traits (*e.g. Crubezy 1991*).

4.1.2. Choice of characters

The choice of characters for the present study is based on a number of characters for which low environmental influences were suggested by Saunders (*1989*) and Buikstra and Ubelaker (*1994*) as well as some additional characters observed as present during the first field season on the Iron Gates Gorge material itself (*sutura squamo-mastoidea* and *tuberculum marginale*). The original list comprised the following traits for the skull (Tab. 8).

Of the total of 66 variables for the skull, 29 paired (cranial traits that could be recorded bilaterally) and eight axial (that had only sagittal expression) were recorded. Procedures for recording followed *Standards* (*Buikstra and Ubelaker 1994*) where applicable and Hauser and De Stefano (*1989*) in all other cases. Most of the traits were recorded on a scale rather than present or absent in order to allow more flexibility in the final analysis. However, they are treated as discrete in the statistical analysis. Since Buikstra and Ubelaker (*1994*) offer very little in terms of postcranial non-metric traits, a list of postcranial traits adapted from Czarnetski (*1972b*), Czarnetski *et al.* (*1985*) and Saunders (*1978*) was added (Tab. 9). Only one of the characters was not paired (unfused *processus odontoideus*). The remaining 21 could be observed on both left and right side, which totalled 43 variables for the postcranial skeleton.

4.1.3. Reducing the number of variables

A great number of variables is not only cumbersome in terms of statistical analysis but can also act to reduce the observed difference between subsamples. A more restricted number of appropriately chosen variables can distinguish better between populations (*Krenzer 1996*). Although Krenzer's primarily goal was to distinguish between major geo-populations of Eurasia, this statement is also valid for more restricted geographic samples (*Molto 1983*). Given the preservation of the material, many of the traits that were initially recorded failed to allow sufficient numbers of observations. Therefore, reduction of traits was necessary for both theoretical and practical reasons.

1st step – Only adult skeletons from all of sites were taken into consideration since the occurrence of nonmetric traits in subadults can be ambiguous. For

CRANIAL CHARACTERS WITH CODE AND SCORING SCHEME

character	CODE	scoring
metopic suture	met	absent/ partial/ present
supraorbital notch	snl/snr	absent, <1/2, >1/2, multiple notches
supraorbital foramen	sfl/sfr	absent/ present/ multiple
marginal tubercle tuberculum marginale	tzl/tzr	present/ absent
infraorbital suture	isl/isr	absent/ partial/ complete
multiple infraorbital foramina	mifl/mifr	absent/ internal division two foramina/multiple
zygomatico-facial foramina	zffl/zffr	absent/ large/ small/ multiple
parietal foramen	pf	absent/ parietal/ sutural
epipteric bone	ebl/ebr	absent/ present
coronal ossicle	cbl/cbr	absent/ present
bregmatic bone	breg	absent/ present
sagittal ossicle	sag	absent/ present
apical bone	apic	absent/ present
lambdoid ossicle	laml/lamr	absent/ present
asterionic bone	astl/astr	absent/ present
ossicle in occipito-mastoid suture	occml/occmr	absent/ present
parietal notch bone	parnl/parnr	absent/ present
inca bone	inca	absent/ complete single/ bipartite/ tripartite/ partial
condylar canal	concl/concr	non patent/ patent
divided hypoglosal canal	hypl/hypr	absent/ partial internal/ partial within canal/complete internal/ complete within canal
flexure of superior sagittal sulcus	flex	right/ left/ bifurcate
foramen ovale incomplete	foil/foir	absent/ partial/ no foramen
foramen spinosum incomplete	fsil/fsir	absent/ partial/ no foramen
pterygo-spinous bridge	psbl/psbr	absent/ trace/ partial/ complete
pterygo-alar bridge	pabl/pabr	absent/ trace/ partial/ complete
tympanic dehiscence	tdl/tdr	absent/ foramen/ full defect
auditory exostosis	audtl/audtr	absent/<1/3/ 1/3–2/3/>2/3
suprameatal spine and depression	pael/paer	large s no d/ no s and deep d / small s and no d/ small s small d/ large s small d/ large s deep d
mastoid foramen location	mffl/mffr	absent/ temporal/ sutural/ occipital/ sutu. and temp./ occ. and temp.
mastoid foramen number	mfnl/mfnr	absent/ 1/ 2/ >2
sutura squamo mastoidea	ssml/ssmr	present/absent
mental foramen	mefl/mefr	absent/1/ 2/ >2
mandibular torus	matl/matr	absent/ trace/ moderate/ marked
maxillary torus	maxl/maxr	absent/ trace/ moderate/ marked
palatine torus	pal	absent/ trace/ moderate/ marked
mylohyoid bridge location	mhbll/mhblr	absent/ near mandibular foramen/ center of grove/ both with hiatus/ both no hiatus
mylohyoid bridge degree	mhbdl/mhbdr	absent/ partial/ complete

Tab. 8. Cranial traits examined in the study (l = left and r = right for paired bones).

POSTCRANIAL CHARACTERS WITH CODE AND SCORING SCHEME		
character	**CODE**	**scoring**
atlas bridging posititon	abpl/abpr	absent/ lateral/ posterior
atlas bridging degree atlas	abdl/abdr	absent/ partial/ complete
facies articularis condilaris partitum	faal/faar	absent/ partial/ complete
dens axis isolated	denai	fused/ unfused
fovea costo-clavicularis deep	fccl/fccr	absent/ present
		shallow/ semicircular / >2/3
suprascapular foramen or notch	ssfl/ssfr	notch/ foramen
accessory acromial articular facet	aaafl/aaafr	absent/ present
unfused coracoideus	uncol/uncor	fused/ unfused
glenoid fossa extension	gfel/gfer	absent / present
ligament teres in cavitas glenoidalis	ltcgl/ltcgr	absent / present
		absent/ small perforation/
perforatio fossae olecrani	pfol/pfor	multiple sp/ 1-2mm/ 2-5mm/ > 5mm
supratrochlear spur	stsl/stsr	absent/ present
fossa bicipitis radii	fbrl/fbrr	absent/ present
unfused processus olecrani	upol/upor	fused/ unfused
fossa faciei lunatae	ffll/fflr	absent/ present
Allen's fossa	alfl/alfr	absent/ present
third throcanter	ttl/ttr	absent/ present
Poirier's facet of extension	pofl/pofr	absent/ present
Vastus notch	vnl/vnr	absent/ <60°/ 60-90°/>90°
Squatting facets on distal tibia	sfl/sfr	absent/ present
Squatting facets (talus) superior surface, anterior to the articular facet for the tibia	sftl/sftr	absent/ present
Shape of the talar articular surface on calcaneus	ctasl/ctasr	discrete facets/ anterior and middle joined/ all 3 joined

Tab. 9. Postcranial characters examined in the study (l = left and r = right for paired bones).

example, unfused *processus olecranii* can be a non-metric trait in adults, while in subadults it is associated with a certain stage of development of the skeleton. This has reduced the total number of individuals examined from 438 (MNI) from all four sites to 259 (MNI) adult individuals.

2nd step – Since the chance of purely random significant correlation occuring on the tested samples becomes greater with the number of correlation tests performed (*Tallig pers. comm.*), the first step in the procedure was to remove all of the variables that could not be observed (both as absent or present) on at least 10% of the examined adult sample. This resulted in the elimination of the following variables with the number of possible observations in brackets: ISL (20), ISR (23), MIFL (18), MIFR (20), CONCL (25), CONCR (27) FOIL (7) FOIR (12), FSIL (13) FSIR (8), PABL (17), PABR (16), TDL (4) TDR (12) in cranial traits and ABPL (12), ABPR (9), ABDL (12) ABDR (9), FAAR (12), DENAI (24), SSFL (4), SSFR (2), AAAFL (11), AAAFR (11), UNCOL (27), UNCOR (18), GFER (26), FFLL (21), FFLR (16), in postcranial, or a total of 32 variables.

3rd step – In the studied population, a number of traits had very low incidence of positive values across the sample (less than 5). As, depending on the sample size, a small absolute number of occurrences can produce biased results, the following 16 variables were excluded even before their frequencies within subpopulations were examined: MET (2), EBL (0), EBR (1), CORL (2), CORR (2), BREG (1), OCCML (1), OCCMR (3), INCA (4), GFEL (0), STSL (4), STSR (4), FAAL (2), FBRL (2), FBRR (3), FCCL (4), FCCR (2), UPOL (0), UPOR (0).

4th step – Of the remaining 55 variables another group of characters, those with low overall frequencies, were checked against chronological and spatial subpopulations in order to assess their overall variability. If the traits show low variability within the population, they will tend to reduce the interpopulation difference in statistical analysis, as they have a negative, reducing effect on the variance of the MMD (*Sjøvold 1977; Molto 1983.113*). Sjøvold (*1977*) recognises two types of low variability traits: those that have reached fixation in every sample studied, and others that have very low uniform incidence in any set of population samples.

Rather than using the χ^2 or Fisher's exact between samples test to exclude the variables for which the significant difference is not obtained in at least one pairwise comparison (*as suggested by Sjøvold 1977*), the empirical results that Molto (*1983.114*) reported for an Ontario Iroquois sample were applied. In Molto's study (*1983.115*) the largest range of frequencies among the traits that had low variability was 7.1 (for example, 0.0% in one sample to 7.1% in another). Molto has excluded these traits from further consideration and kept those with minimum range in any of the samples equal or greater than 10% (e.g. 21% in one and 31% in another). By using this observation as a rule of thumb in the present study, rather than increasing the possibility of finding statistical significance (where there might be none) through a large number of tests performed, following traits were determined as having low overall variability and excluded: ASTL, (14.29–20), ASTR (17.86–21.74), PARNL (8.5–16.67), PARNR (8.7–14.29), PAEL (0.00–6.25) and PAER (0.00–3.03).

5th step – The following variables were excluded because of the high inter or intra observer error: MFLL/MFLR, MFLN/MFLR, MHBLR/MHBLL, calculated from the observations recorded in 1996 and those recorded in the 1998 field season on a randomly chosen subsample.

6th step – The Fisher exact test of significance was performed in order to check for possible correlation of traits with sex. Only one variable pair was found to be potentially correlated with sex: the mandibular torus (MATL/MATR). In the published literature, there is no definite pattern of preference according to sex, but the general trend of predominance in females is reported (*Hasuer and de Stephano 1989 and quoted literature*). The trait was excluded from further consideration.

7th step – Since the number of variables thus obtained was still sufficiently large and in view of the poor preservation of the sample, it was felt that recording frequencies in individuals rather than sides, as well as pooling sides, would result in reducing bias, especially in the very restricted Neolithic sample. Tests of side correlation were performed on all of the pairwise traits. The ones that showed correlation were excluded. In doing so the risk of increasing the probability of false correlation was ignored, as potential benefits in increasing the number of observations outweighed the concerns.

8. Remaining traits – Of the remaining 26 traits, further comparisons have eliminated coronal ossicle (No. 7 on the list of traits) because of very low variation (0–2.86%) in frequency. Traits that had less than 9 observations on left and right side combined in any of the subsamples (see further discussion on the sides recording of the traits) were also excluded. Only 17 traits that were used in the analysis are described in detail and their recording presented here. These are presented in Table 10. As can be seen only two traits of the postcranial skeleton are included in the final analyses: the septal aper-

trait name – common	Latin	code	trait no.
Marginal tubercle	*tuberculum marginale*	(TZ)	1
Squamomastoid suture	*sutura squamomastoidea*	(SSM)	2
Supraorbital notch	*incisura supraorbitalis*	(SN)	3
Supraorbital foramen	*supraorbital foramen*	(SF)	4
Zygomatico facial foramen	*foramen zygomatico-faciale*	(ZFF)	5
Parietal foramen	*foramen parietale presens*	(PF)	6
Coronal ossicle		(COR)	7
Lambda ossicle		(LAM)	8
Auditory torus	*torus auditivus*	(AUDT)	10
Mental foramen	*foramne mentale*	(MEF)	11
Maxillary torus	*torus maxilaris*	(MAX)	12
Mylohyoid bridge	*ponticulus mylohyoideus*	(MHBD)	13
Septal aperture	*perforatio fossae olecranii*	(PFO)	15
Third trochanter	*trochanter tertius*	(TT)	17
Apical bone		(APIC)	23
Inca bone	*os inca*	(INCA)	24
Palatine torus	*torus palatinus*	(PAL)	26

Tab. 10. Traits used in various combinations in the final analyses. Sides pooled.

ture (No. 15) for the humerus and the third trochanter (No. 17) of the femur. All other traits had to be excluded due to poor preservation of the relevant areas of the bone, especially in the Neolithic period. Therefore, inclusion of postcranial metrics seems even more complementary to the analysis of non-metric traits.

4.1.4. Description of traits and scoring procedures

The following description and discussion of traits relies largely on Hauser and de Stefano (*1989*) and quoted literature.

Marginal tubercle (No. 1) (Fig. 14): Hauser and de Stefano (*1989.226–230, Pl. XXXII, Fig. 36*) - This feature is differently known as *tuberculum marginale, processus marginalis, apophysis pyramidalis, processus Sömmeringi*. or *tuberculum zygomaticum*. It is a tubercle or a projection on the temporal border of the frontal processus of the zygomatic bone. This feature was observed as early as XIX[th] century and Luschka (*von Luschka 1869 quoted in Hauser and De Stefano 1989*) ascribed its formation to the insertion of the temporal fascia. Although no specific studies on the time of onset of the formation are known, it is observed in newborns. No inheritance studies have been carried out so far. The occurrence of the trait is symmetric. Perizonius (*1979*) has found it to show, on the largest European sample studied this far, a slight preponderance in males (36.7% compared to 30.0% in women). No correlation with sex was observed in the Iron Gates Gorge sample. There are not enough data on frequencies in different populations to allow comparisons. It seems to be a fairly common trait in European populations (*Perizonius 1979*). In order to determine the presence of a marginal tubercle, "a line is drawn from the most temporal point of the frontozygomatic suture, tangential to the deepest point of the curve on the superior temporal edge of the zygomatic bone" (*Hauser and De Stefano 1989.227*). This is done by using a small transparent ruler. If a part of the frontal process projects beyond the margin of the ruler, a marginal tubercle is present. The trait was coded as present or absent without distinguishing finer categories proposed by Hauser and De Stefano (*1989*).

Squamomastoid suture (No. 2) (Fig. 15): (*Hauser and De Stefano 1989.206–207, Fig. 32*). Known also as: *sutura squamomastoidea, sutura (fissura) mastoidea squamosa, sutura petrosquamosa*, mastoid notch. The junction between the anterior part of the mastoid process, characterised by a smooth surface, and the posterior part roughened by muscle insertions, presents a suture in newborn and early childhood. If this suture, or parts of it, persist in the adult, it is recorded as a nonmetric variant. No genetic studies have been reported to date. There is not

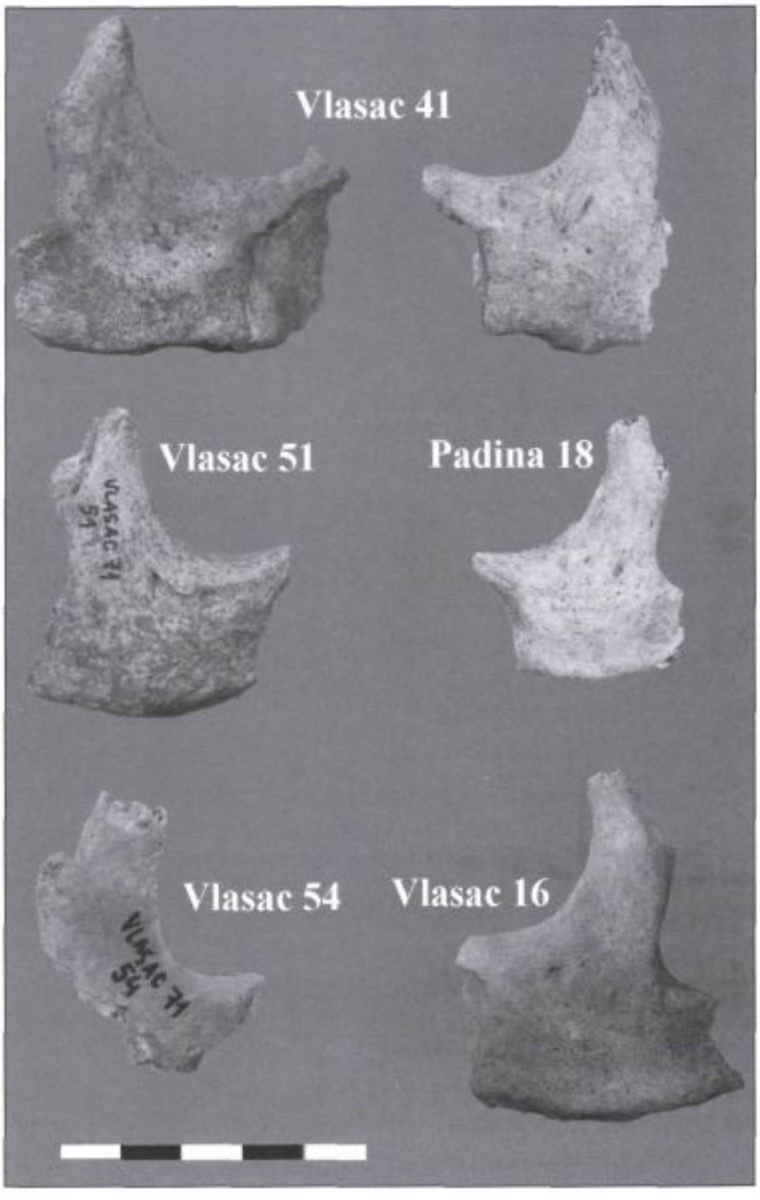


Fig. 14. Different expressions of the marginal tubercle.

Fig. 15. Squamomastoid suture. Lepenski Vir 26.

enough information on population incidence of the trait.

Supraorbital notch (No. 3) and ***Supraorbital foramen*** (No. 4) (Fig. 16): (*Hauser and De Stefano 1989.50–58, Fig. 10 Pl. VIII*). Supraorbital notches are also known as supratrochlear notch, *incisura supratrochlearis*, supraorbital medial notch, *incisura supraorbitalis medialis*, frontal notch, *incisura frontalis*, *sulcus supraorbitalis*, supraorbital foramen incomplete, supraorbital lateral notch, *incisura supraorbitalis lateralis*, *incisura supraorbitalis*. Supraorbital foramen is also known as: *foramen supratrochleare*, trochlear foramen, supratrochlear canal, *foramen supraorbitale mediale*, supraorbital notch closed, medial supraorbital canal, *canalis supraorbitalis*, frontal foramen, *foramen frontale*, *foramen supraorbitale laterale*, accessory foramen, supraorbital lateral canal, *canalis supraorbitalis lateralis*, *canalis supraorbitalis*. The supraorbital margin of the orbit is formed entirely by the frontal bone, which in this region might show either notches or foramina or both in varying positions and numbers, and of varying size. The notches may have blurred or acute margins. The foramina correspond to external orifices of canals perforating (piercing) the margin of the orbital roof. Care should be taken not to confuse these with external orifices or nutrient canals or large porosities. Simply stated they have to pierce through the bone to be recognised as such (*Hauser and De Stefano 1989. 51, Pl. VIII*). In the study of prematurely born infants the notches and foramina were observed as early as the 25th gestation week (*Hauser and Bergman 1984*). There is an observable increase in canals and formation of a second notch later in development. However, age dependency ceases in adulthood and these traits remain constant throughout the adult years (*Berry 1975; Perizonius 1979*). The early manifestation of these traits suggests a strong genetic base. Sjøvold (*1984*) recorded presence and absence of the trait in a number of skeletons of families of known sex, age and origin, and came to the same conclusion. The fact that both the shape and the number of notches and canals vary suggests both different growth patterns and different morphology of nerves and vessels. The number of canals can relate to bifurcation modalities i.e. a nerve can bifurcate before it enters the supraorbital margin or after and will produce a different result. No statistically significant differences were observed between males and females and there is apparently no side preference (*Dodo 1987; Mouri 1976; Hauser and De Stefano 1989*). There seems to be a general increase in frequency between puberty and adulthood (*Berry 1975; Cesnys 1982; Hauser and De Stefano 1989; Perizonius 1979*). There is a number of scoring procedures for these traits. Hauser and De Stephano (*1985; 1989*) distinguish supratrochlear, medial and lateral notch, as well as the supratrochlear foramen as a separate trait, noting the number of occurrences. In the present study no distinction was made between trochlear, medial and lateral supraorbital notch (lateral was not encountered). Supratrochlear and medial supraorbital notches are easily confounded and they differ more in the degree and position than in position alone, and therefore it is likely that a medial supraorbital notch with less than half of the structure occluded by spicules can be confounded with a supratrochlear notch by different observers, as can be seen from both the diagram and the photos of the traits provided by Hauser and De Stefano (*1989.Fig. 10, 54, Pl. VIII c, 52*).

Following Buikstra and Ubelaker (*1994*), the distinction was made between notches and foramina and

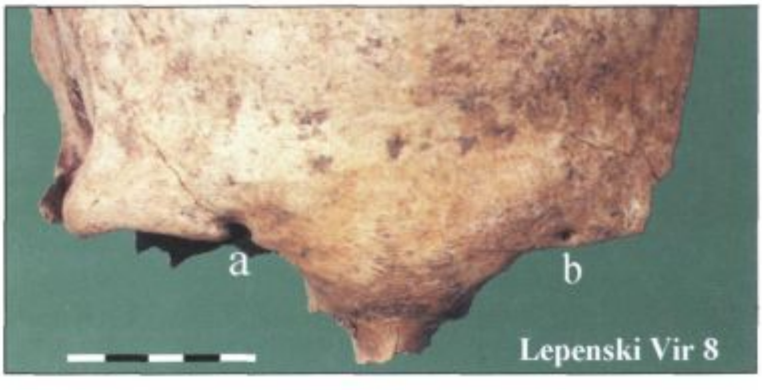


Fig. 16. Supraorbital notch (a) and foramen (b). Lepenski Vir 8.

the coding was done in the following manner: Supraorbital notch: values: *0* - absent; *1* - present < 1/2 occluded by spicules; *2* - present > 1/2 occluded by spicules; *3* - present degree of occlusion unknown; *4* - multiple notches; *9* - unobservable. In the final analysis 0 = absent and 1, 2, 3, 4 = present. Supraorbital foramen: values: *0* - absent; *1* - present; *2* - multiple foramina; *9* - unobservable. In the final analysis 0 = absent and 1, 2 = present.

Zygomatico-facial Foramen (No. 5): (*Hauser and De Stefano 1989.224-6, Fig. 35*). Also known as *foramen zygomatico-faciale*, zygo-facial foramen. On the facial surface of the zygomatic bone one or more foramina are usually present. Rarely, however, this foramen is absent. Generally they appear 5-8 mm below the orbital border, but may vary significantly in position. Also, multiple foramina may occur. These foramina represent the external aperture of a canal whose internal orifice is situated in the orbit. The numbers of the former and the latter need not correspond. Sjøvold (*1984*) reported a low heritability estimate for the absence of the foramina. Significant difference between sexes with higher incidence in females was reported by Cesnys (*1982*), and Corruccini (*1974*), others have noted only tendencies for higher incidence in either males or females. No sex correlation was found in this study. Incidences vary from 8.6% in Modern Japanese (*Mouri 1976*) to 99.1% in medieval Serbian populations (*Živanović 1979a*). Scoring differs among different authors. Berry and Berry (*1967*) note absence only, while Hauser and De Stefano (*1989*) suggest a more detailed scheme including (a) number: absence, one, two, three or more; (b) size of the largest: small = 0.3 mm wire enters, medium = 1 mm wire, large = 1.2 mm wire, excessive = 2 mm wire; (c) position: on the corpus, on the frontal process. Buikstra and Ubelaker (*1994*) suggest the following scheme: *0* = absent, *1* = 1 large, *2* = 1 large plus smaller, *3* = 2 large, *4* = 2 large plus smaller, *5* = 1 small, *6* = multiple small.

In the following study only the number of foramina was recorded in the following manner: value *0* - absent; *1* - one small; *2* - one large; *3* - two; *4* - more than two. In the final analyses 0 = absent 1, 2, 3 and 4 = present.

Parietal foramen (No. 6): (*Hauser and De Stefano 1989.78-82, Pl. XII*). Also known as *foramen parietale, emisarium parietale; foramina parietalia permagna.* One or two, rarely more foramina pierce the parietal near or in the sagittal suture in the obelion area. They vary in position, size and number. In 1/3rd to 1/6th of the population they are absent. Embryologically, the lateral angles of the bilateral clefts of the *fontanella obelia* may be perforated by vessels and so give rise to foramina when the ossification is complete (*Gisel 1964*). Large foramina known as foramina permagna are thought to represent a defective ossification of the parietal bones (*Pamperl 1919 quoted in Hauser and De Stefano 1989.81*) and are subsequently noted as a separate trait. In the present series none of the foramina permagna were recorded. The heritability estimate for absence of foramina parietalia is estimated to be high by Sjøvold (*1984*) in an extensive pedigree study. Berry and Berry (*1967*) scored presence only. Following Hauser and De Stefano (*1989*) and Buikstra and Ubelaker (*1994*), both presence and the position were scored. Since both sides were examined for presence, if the position is sutural, the score 2 was given for both sides to facilitate comparisons. Size has not been recorded. An extensive literature on sex differences (*see Hauser and De Stefano 1989 and quoted literature*) shows that there are no significant differences in the frequencies for males and females. Slight increase is observed up to 3 years. Ossenberg (*1969*) and Cesnys (*1985*) reported some increase from childhood to adolescence, while the trait seems to be stable throughout adulthood. Scoring procedures: values: *0* - absent; *1* - present, on parietal; *2* - present, sutural; *9* - unobservable. In the final analysis 0 = absent, 1 and 2 = present.

Sutural and fontanelle ossicles - Sutural bones: Surnumerary bones are present in a number of sutures of the skull. According to Sjøvold (*1984*) the heritability of these traits is very moderate. None of the surnumerary ossicles have a known or suspected medical relevance. Although a great degree of intercorrelation was reported for these surnumerary bones (*Hertzog 1968*) they are considered as reliable by Buikstra and Ubelaker (*1994*). Lambdoid ossicle and apical bone did not show any intercorrelation in the present study and were accordingly retained in the final analyses.

Lambdoid ossicle (No. 8) (Fig. 17) - One or more surnumerary bones can be situated within the lambdoid suture. Sex differences are not consistent as certain authors have found a significantly higher incidences in males (*Ossenberg 1969; Berry 1975; Perizonius 1979a; Molto 1983*) while Czarnetzki (*1975*) noted a tendency for more frequent occurrence in females (*Hauser and De Stefano 1989.93*). No sex correlation was found within the studied sample.

Fig. 17. Lambdoid ossicles a, band c. Lepenski Vir 48.

Apical bone (No. 23) – Also known as ossicle at lambda this surnumerary bone is located at lambda, within the posterior fontanelle. Hauser and De Stefano (*1989.88, Fig. 15a–d*) propose that not only presence or absence but also size and number be recorded. Also degree of protrusion into either parietal or occipital bone can be noted. In the present study no multiple bones were noted and only presence or absence were recorded. No sex predominance was recorded for this trait as well as no changes with age or artificial deformation of the skulls.

Auditory exostosis (No. 10) (Fig. 18): (*Hauser and De Stefano 1989.186–189, Pl. XXVIIa–c*). Also known as auditory torus, *torus auditivus*, *aural exostosis*, ear exostosis, auditory exostosis, exostosis of the external auditory meatus, *torus accusticus*, and *torus tympanicus* – a bony growth situated within or protruding from the external auditory meatus, essentially evolving from the tympanic part or occasionally also from squamous portion. Two different types of bony hyperostosis can be distinguished: the superficial hyperostosis in the outer type of the meatus, which is strictly speaking a pathological benign tumour with genetic predisposition; and the deep hyperostosis that has no genetic predisposition but is caused by prolonged irritation in cold water (*Kennedy 1986*). However, the distinction between superficial and deep meatal type is very difficult, and the present study follows the recommendation included in Buikstra and Ubelaker (*1994*), that is essentially the same as the three degrees of expression recommended by Hauser and De Stefano (*1989.187*). The reports on both sex and side dependence vary and frequencies vary from 0.0% in prehistoric Siberians (*Konzitsev 1972*), Canadian Inuit (*Dodo and Ishida 1987*), and modern Caucasoid North Americans (*Corruccini 1974a*), to 26.2% in medieval Serbian population (*Živanović 1979a*). An important article on auditory exostosis in the Vlasac material was published by Frayer (*1988*) who ascribes this trait to hand netting as a method of fishing the large cat-fish reported among the faunal material at the site (*Bökönyi 1978*). Although Zoffmann (*1983*) has reported lack of auditory exostoses in Lepenski Vir, 3/28 individuals (10.7%) were recorded on that site. While Frayer reported 13/38 individuals (34.2%), 17/46 (36.9%) were found in the present study. This could be due to the fact that Frayer has been able to examine only whole skulls from the site and not the fragmented material found mixed with the postcrania. But the incidence found in the current study does not differ significantly from his findings. At the site of Padina for which Živanović (*1975*) has stated that the auditory exostoses "are always present and very large" the incidence is even greater where 10/19 individuals had this trait (52.6%), while at Hajdučka Vodenica only 3/13 individuals had the trait (23%). Frayer's conclusion that the auditory exostoses can be related to the evidence for fishing, needs to be examined in more detail, since evidence for large fish in Lepenski Vir I is comparable to that of Vlasac, and no simple equation can be drawn between the two. However, there is a strong possibility that the majority of the occurrences of the tori are related to pathological rather than genetic condition and this concern has to be taken into account in the final analysis. Scoring was done as follows: values: *0* – absent; *1* – < 1/3 canal occluded; *2* – 1/3–2/3 canal occluded; *3* – > 2/3 canal occluded; *9* – unobservable.

Fig. 18. Auditory exostoses. Vlasac 40.

Mental foramen (No. 11) (Fig. 19): *foramen mentale* (*Hauser and De Stefano 1989.230–3, Plate XXXIIIe–h*). A foramen situated on the exomandibular surface on each side of the mandible, generally in the area below the premolars and most often below the apex of the second premolar. The foramen may vary in shape and size, it may be double or multiple with varying distances between the apertures and in rare instances even absent. No genetic studies have been reported to date. Since the formation of the mental foramina happens before birth, there might be a fair amount of genetics involved. In the present study, only the number of foramina was recorded. In case of the inner division of the foramen (doubled foramen) it was recorded as 2 foramina. Reported frequencies of accessory foramina vary from 4.7 in modern Indians (*Gerhenson et al. 1986*) to 38.8 in Modern Blacks from Brazil (*Wijsman and Neves 1986*). There is no consensus on predominance acceding to sex, as it varies from one population to another. It occurs asymmetrically more often but there is no general preference of the side. Scoring procedures: values: *0* - absent; *1* - 1 foramen; *2* - 2 foramina or 1 foramen with complete inner division; *3* - more than 2 foramina; *9* - unobservable.

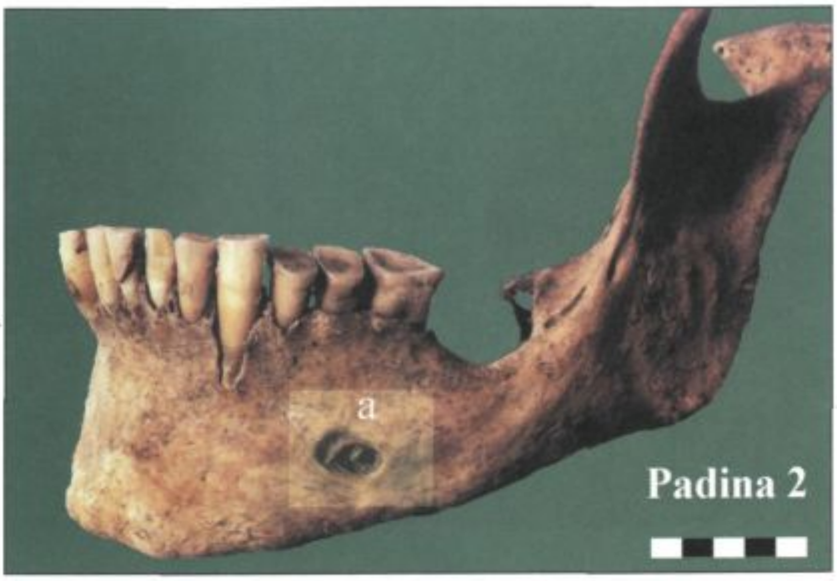


Fig. 19. Mental foramen. Padina 2.

In the final analysis, since there were no instances of absence of foramina, the trait was treated as present only if 2 or more foramina or an inner division were present. If there was only one foramen, the trait was treated as absent.

Maxillary torus (No. 12) (Fig. 20): *torus maxillaris* (*Hauser and De Stefano 1989.180–3, Tab. XXVII d–g*). Also known as maxillary hyperostosis, *torus alveolaris maxillaris.* Both the irregular bony nodules of varying size and a mound like thickening of the lingual margin of the alveolar process in the molar area of the maxilla is referred to as maxillary torus. These protrusions may also involve the buccal side of the molars resulting in hypertrophy of the alveolar margin. In rare cases it can extend to PM4 or even a canine. There is a disagreement about its aetiology, and since it occurs more often in skulls with palatine torus, the same function and interaction between genetics and environmental factors can be proposed. The published results on incidence by sex are inconclusive (*Hauser and de Stefano 1989.183*) and need to be checked against each population. No sex correlation was found in this series. There seems to be no preference for side expression and either no change with age (*De Villiers 1968*) or a slight increase between young

Fig. 20. Maxillary torus. Vlasac 78a.

and old adults (*Van den Broek 1945*). The frequencies reported for different populations vary from 0.0% in recent Dutch (*Perizonius 1979*) and Italians from Sardinia (*Cossedu et al. 1979*) to 52.9% in western Australians (*Milne et al. 1983*). No intercorrelation with the palatine torus was found in the Iron Gates Gorge material. Scoring procedures: values: *0* - absent; *1* - trace (can palpate but not see); *2* - moderate: elevation 2mm - 5 mm; *3* - marked: elevation > 5mm; *9* - unobservable. In the final analysis, 0 = absent, and 1, 2 and 3 = present. Sufficient replicability was obtained both between observers and in intraobserver test to warrant inclusion of trace presence.

Palatine torus (No. 26): *torus palatinus* (*Hauser and De Stefano 1989.174–180, Tab. XXVI*). Also known as torus palatinus sagittalis, exostosis mediopalatina. The trait consists of paramedian, rarely median, bony protuberance of varying size, form and extent situated along the median suture of the hard palate. It may extend from the incisive foramen to the posterior border of the palatine bones. It may be short and restricted to a part of the hard palate. It is mostly situated in the middle, less commonly occupying the posterior, and very rarely in the anterior position. It varies also in the degree of expression and can be found either on both sides or only unilaterally (on either side of the median suture). Only the degree of expression was noted in the present study following Buikstra and Ubelaker (*1994*). Although various authors observed familial occurrence, and high concordance in monozygotic twins, others favoured functional explanation. The latter observation is based on the reduced frequencies in edentulous group and after the third decade observed by some authors. Hauser and De Stefano (*1989*) favour Schreiner's (*1935*) suggestion that a genetically determined strong osseous response to irritation leads to the formation of a palatine torus. The occurrence of palatine torus is already observed by a later foetal stage and in newborns. There is a marked age dependency in late infancy and during the first three decades of life both incidence and size continue to increase. Although Hauser and De Stefano (*1989.178–9*) report higher incidence in females than males in most of the series, there is too much variability to build a straightforward picture. No sex dependence was observed in the present study. Generally, the torus is rarely expressed before five years of age, there is a steady increase with age until the 3rd decade and subsequently a decrease which has been attributed to loss of teeth by Axelsson and Hadegaard (*1985*).

There is a disagreement on the correlation of the palatine, maxillary and mandibular tori, and these features have to be compared within the series itself. As noted for the maxillary torus, no intercorrelation between the two traits was observed. Scoring procedures: values: *0* - absent; *1* - trace (can palpate but not see); *2* - moderate: elevation 2mm - 5 mm; *3* - marked: elevation > 5mm; *4* - excessive covers most of the palate; *9* - unobservable. As in the case of maxillary torus, only 0 was recorded as absent, 1, 2, 3 and 4 were recorded as present.

Mylohyoid bridge (No. 13) (Fig. 21): *ponticulus mylohyoideus* (*Hauser and De Stefano 1989.234–237, Pl. XXXII*). Also known as canalis mylohyoideus, arcus mylohyoideus, mylohyoid bridging. The mylohyoid groove descends downward and anteriorly from the mandibular foramen endomandibularily. This groove can be covered by an osseous roof of varying length, and is thus transformed into a canal. The formation of this canal can begin at the upper or central part of the groove or more rarely both. The two can exist with an intermediate uncovered part. Although there have been no studies on the heritability of the trait, the pattern of regional and group variability suggests strong genetic basis. It is usually scored according to its location and degree. There are no conclusive results on the influence of sex and side symmetry and no correlations with either were found in the present study. According to Ossenberg (*1969*) it rarely achieves expression before adolescence and shows rapid increase into adulthood, but remains relatively stable in adult years.

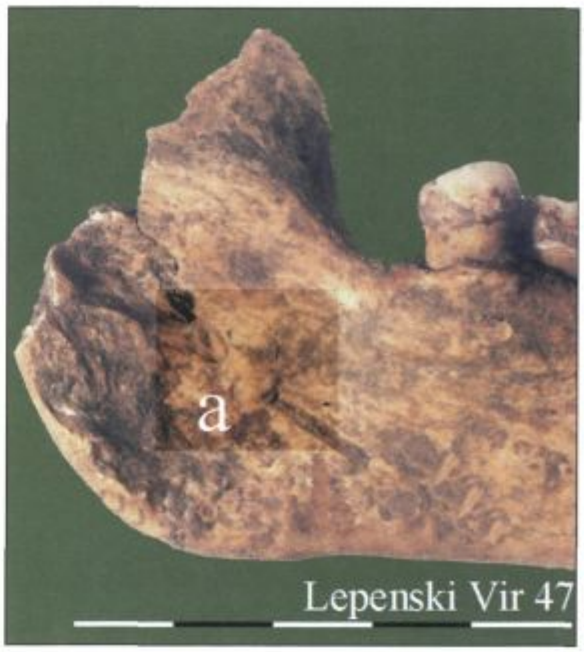


Fig. 21. Mylohyoid bridging. Lepenski Vir 47.

Frequencies between population vary from 5.8% in modern Japanese (*Mouri 1976*) to 33.7% in Aleuts (*Dodo and Ishida 1987*). Scoring procedures: values: *0* - absent; *1* - partial; *2* - complete; *9* - unobservable.

Septal aperture (No. 15) (Fig. 22): *Perforatio fossae ollecranii* (*After Sounders 1978*). The trait consists of any number of smaller or larger perforations between coronoid and olecranon fossae at the distal end of the humerus. Saunders (*1978.105–127*) notes both side and sex correlation for this trait. Both Finnegan (*1973*) and Gaherty (*1970*) have found important correlation with sex. However, no correlation with either side or sex was found in the present study. This is not uncommon, since studies differ in terms of results for correlations as has been shown in cranial traits. Apart from the possibility that correlations would occur randomly in the case of a great number of tests performed, and the possibility that the trait is simply spurious and lacking in biological significance (*Saunders 1978.121*), two other explanations are possible: (a) the trait's correlation with both side and sex differs among populations, and (b) that in order to get reliable results for trait correlation we need a greater sample size than in the current population. Although the results by Saunders are derived from much larger populations, the size of the population examined in this study was not negligible and the trait was subsequently retained. Scoring procedures: values: *0* - present; *1* - 1 small perforation with "thinning"; *2* - multiple small perforations; *3* - small perforation between 1-2 mm; *4* - perforation 2-5 mm; *5* - large perforation > 5 mm. In the final analysis 0 = absent; 1, 2, 3, 4 and 5 = present

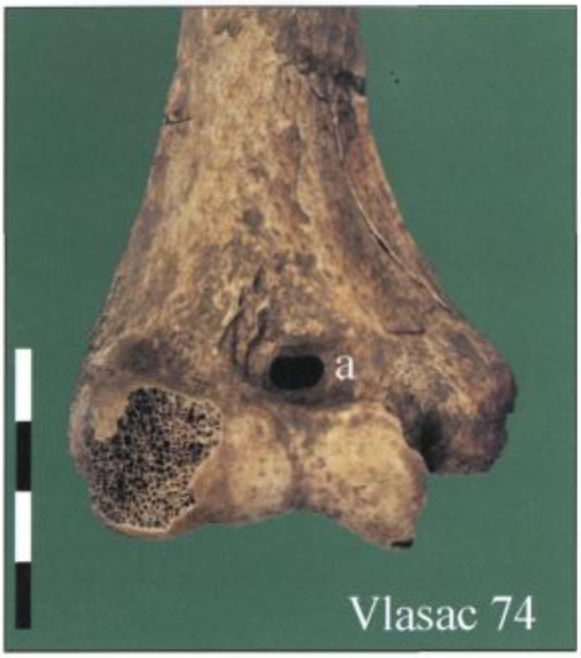


Fig. 22. Septal aperture. Vlasac. Coding value "5".

Third trochanter (No. 17): *trochanter tertius* - A rounded, conical tubercle at the superior end of the gluteal tuberosity of the femur. The third trochanter appears as a separate trochanter-like entity, reasonably easy to distinguish, even from a very large gluteal tuberosity. According to Saunders (*1978.115, Tab. 5*) there is no side preference for this trait, and no correlation with sex in any of the separate samples studied. The trait was scored only as present or absent in the study. There is no inter-correlation for these two postcranial traits, nor are they correlated with any of the cranial traits in the present study.

4.2. Size and robusticity analyses

During a pilot study of the material in 1996, significant difference in size and robusticity between certain individuals became evident (Fig. 23). This observation is not new, as size and robusticity data have been used by Nemeskeri (*1978*), Živanović (*1975*) Mikić (*1981a*), Zoffmann (*1983*), and Schwidetski and Mikić (*1988*) to argue for different processes. Arguments were based on the degree of gracilisation pertaining to the skull. This preference for the skull in previous reports was partly responsible for concentrating on postcranial remains in the present study. Another reason for this choice is that morphometric changes in skull often illustrate changes in skull shape and robusticity at the same time. Postcranial measurements are far simpler and although changes in shape (often expressed as indices) are common due to a number of possible causes, size changes are more readily visible than in the case of the skull.

The list of variables was selected to provide the most information on size and, to a degree, on robusticity (as reflected in different indices). For description of the measurements refer to Buikstra and Ubelaker (*1994*). These variables are:

- *for clavicle* - CML (maximal length); CAD (anterior-posterior diameter at midshaft); and CSD (superior-inferior diameter at midshaft);
- *for humerus* - HML (maximal length); HEB (epicondylar breadth); HVD (vertical diameter of the head); HMXD (maximum diameter at midshaft); HMND (minimum diameter at midshaft);
- *for radius* - RML (maximum length); RAPD (anterior- posterior diameter at midhsaft); RMLD (medial-lateral diameter at midshaft);

Fig. 23. Comparison of these two clavicles shows the striking extent of sexual dimorphism in the Iron Gates Gorge series.

- *for ulna* – UML (maximum length); UMC (minimum circumference);
- *for femur* – FML (maximal length); FBL (bicondylar length); FEB (epiconylar breadth); FMDH (maximum head diameter); FAPSD (anterior-posterior subtrochanteric diameter); FMLSD (medial-lateral subtrochanteric diameter); FAPM (anterior-posterior midshaft diameter); FMLM (medial-lateral midhsaft diameter); FMC (midshaft circumference);
- *for tibia* – TL (length); TPEB (maximum proximal epiphyseal breadth); TMDB (maximum distal epiphyseal breadth); TMDNF (maximum diameter at the nutrient foramen) TTDNF (transverse or medial-lateral diameter at nutrient foramen); TCNF (circumference at the nutrient foramen);
- *for calcaneus* – CCML (maximal length); CCMB (maximal breadth).

While examining the output of descriptive statistics, many of the variables were found to have too few observations. Only variables with more than 60 observations (25% of the adult sample) were retained for the initial metric statistics. These are CAD (61), CSD (60), HEB(62), HMXD (78), HMND (79), RAPD (71), RMLD (71), FMDH (60), FASPD (94), FMLSD (94), FAPM (90), FMLM (89), FMC (84), TMDNF (64), TTDNF (63).

Ideally this analysis aimed at providing a different template on the basis of which to redefine our subgroups. For each of the four sites a subsample of robust and a subsample of gracile individuals would be obtained. Then, frequencies of non-metric traits would be calculated for each of the subsamples, and compared.

If the robust subsamples would cluster together and the gracile together, we would have a strong case for populational differences in robusticity, with the incoming population more gracile. If, on the other hand, they would cluster in a different pattern, the scenario of gracilisation as the result of changed subsistence and lifestyle would be proposed.

However, this requires that a number of well-chosen measurements, providing the best separation either through PCA or discriminant analysis would be present for most of our adult specimens. Unfortunately, this was not the case. While single measurements could never be found in common on more than 90 skeletons, a combination of any two measurements (regardless of the fact that they were or were not correlated) could not be found on more than 71 individuals. When the number of measurements was increased to three, the number of comparable individuals fell to 46. Obviously, although anthropologists never expect an ideal situation, dividing 46 individuals into males and females, and then into 4 distinct sites and further into two robusticity groups, made the goal set out in the beginning impossible. However, size/robusticity analyses were still performed in order to see whether any distinct changes in size could be recognised between chronological periods described earlier.

4.2.1. Sex determination and consideration of sexual dimorphism

It has already been noted that in previous studies of the material, sex determination was based on both pelvic characteristics and some of the skull features associated with greater robusticity in males than females (*Nemeskeri 1978*). This can potentially create a problem, as same or intecorrelated features would be used for both sexual and populational distinction within the series.

To avoid this methodological problem as well as ascertain to what degree we can determine sex based on size and robusticity data, only those individuals with pelvic remains sufficiently preserved to determine sex were assigned sex as males (m) or females (f). For all of the individuals where sex determination was based on any feature expressing secondary sexually characteristics (*Workshop of European Anthropologists 1980*), a question mark was added to the designation creating "m?" for males and "f?" for females. As presented in the above diagrams the two sexes clearly separate on the basis of simple size measurements presented as Probability Plots (Fig. 24 a–f). Probability plots were performed using SYSTAT 7 PPLOT command. They present a powerful visual display of the distribution of data. The values of the variable are plotted against the corresponding percentage points of a theoretical distribution (*Gnanadeskan 1977; Wilkinson 1990.345*). In this case the theoretical distribution is normal, and the data should, if normally distributed, lie on a straight line. The interesting feature of the presented plots is their extreme bimodality corresponding to sexes.

These probability plots show clear separation between males and females, and even more importantly they classify the "?" cases into their respective groups. Accordingly, the cases based on robusticity were considered as accurately determined in terms of sex to warrant their inclusion in the analysis. The "t" tests comparing sexes run on SYSTAT 7, showed significant difference for each variable examined.

Based on the above, the individuals assigned to m? and f? were added to their respective groups in order to get a more representative sample size. Further analyses were then based on thus assigned sexes. They are presented in the chapter 5.4. after the nonmetric analyses.

5. ANALYSIS AND RESULTS

This chapter provides the results of different statistical analyses performed on non-metric and metric data. The first three sections of the chapter (5.1. to 5.3) present discussion on the statistical treat-

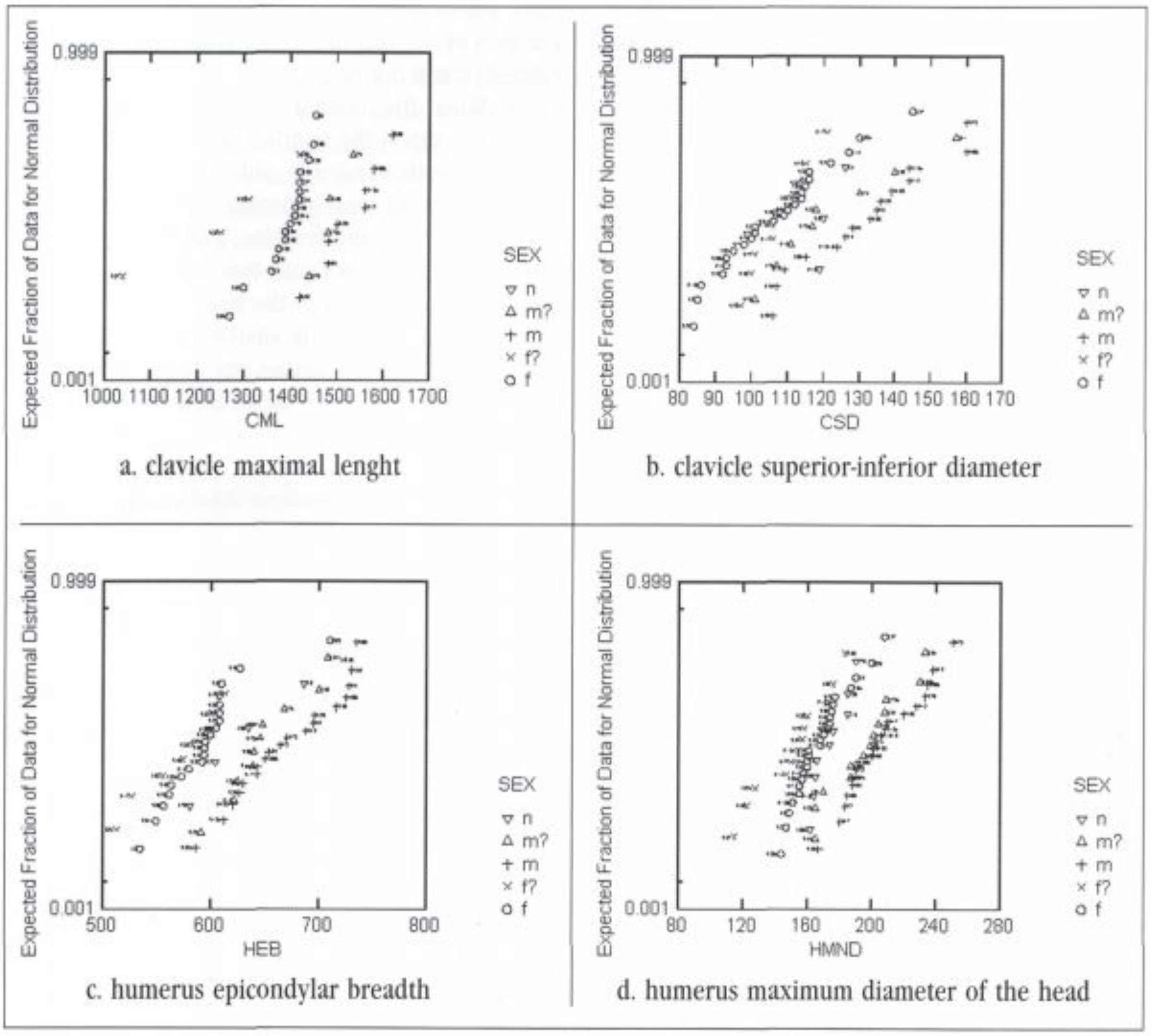
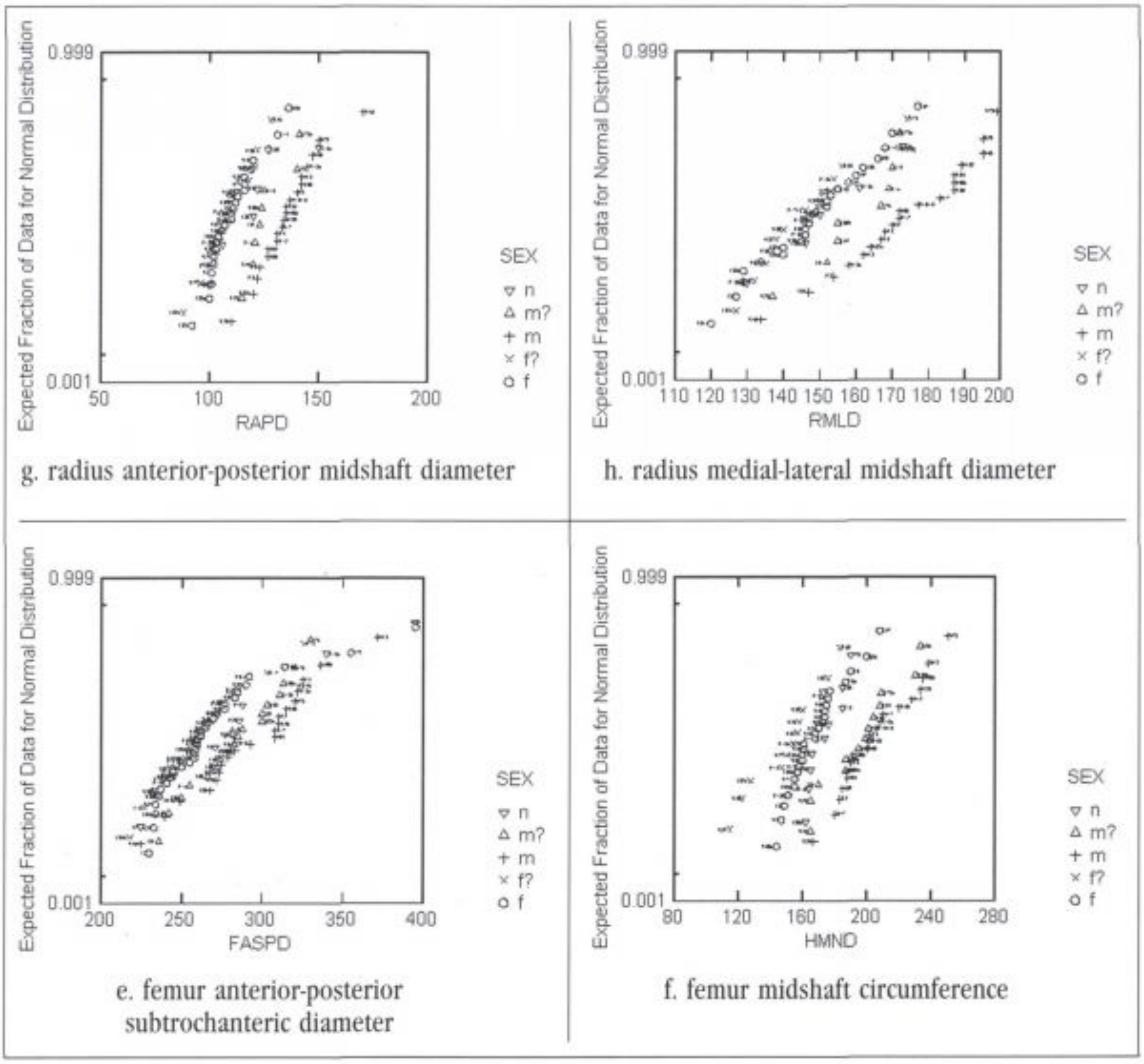


Fig. 24 a–d. Probability plots of different measurements. Overlaid diagrams for sexes. Note the linearity of the plots showing normal distribution, as well as the alignment of "?" individuals with their respective sex. "n" individuals remain unclassified.



g. radius anterior-posterior midshaft diameter

h. radius medial-lateral midshaft diameter

e. femur anterior-posterior subtrochanteric diameter

f. femur midshaft circumference

Fig. 24 e–h. Probability plots of different measurements. Overlaid diagrams for sexes. Note the linearity of the plots showing normal distribution, as well as the alignment of "?" individuals with their respective sex. "n" individuals remain unclassified.

ment of the non-metric data set. In Chapter 5.4. the results of analyses of the size/robusticity data are discussed.

Statistical analyses are crucial in examining large quantities of numeric data. They tend to become more complex in archaeological studies because of the problem of small sample sizes, representativeness and appropriateness of statistical methodology in studying archaeological data. Apart from samples being small and inadequate, they are often skewed with outliers and usually fraught with potential problems of archaeological context (*Key and Jantz 1990*).

Statistical analyses often rely on a number of assumptions that may or may not be valid for the archaeological samples. Two assumptions are made in this thesis:

① *The non-metric* traits have a strong genetic basis.
② *The sample* is representative of the populations we are trying to compare.

Let us consider the first assumption. Although the influence of changing environment (occupation, habitat, nutrition) cannot be excluded for most traits, this assumption is reasonably well founded in the research on the genetics of non-metric traits. We are examining the population structure and not the genetic make-up of the individuals, and therefore even if the influence of environment on the expression of traits (due to their threshold character) can not be disregarded, the validity of the population comparisons is not reduced.

The assumption of the representativeness of the sample that is examined can rarely be proved in the archaeological sample. As already discussed in Chapter 3, burial samples are often (if not always) biased. Even if we disregard the fact that excavations rarely expose the entire burial site, hoping that the excavation design has taken sufficient care to provide us with a representative picture, we have to keep in mind that buried individuals almost never reflect the living population. Since not everyone gets buried in a cemetery, and since the mode of deposition is strongly dependent on the social persona of the individual (*Masset 1993; Roksandić 2000 and quoted literature*), it is unreasonable to assume that the sample studied is unbiased. Furthermore, the direction of bias can be discerned only rarely, after a thorough study of all of the social, biological and taphonomic aspects of the skeleton.

Although we can not assume the representativeness of the sample for the purpose of studying the mortuary ritual and its social implications, there is hope that the populational biology (or the genetic make-up) of a changing population will still be represented adequately to discern it in our sample. Only under the circumstances of a completely different burial ritual for the local and the supposed incoming population, that would obliterate one or the other from our sample, the assumption of the representativeness could not be sustained. Although unlikely, this possibility had to be considered in the present study. Since burial ritual in the Mesolithic varies greately and becomes more or less canonised only in the Lepenski Vir IIIb period which belongs to the Middle Neolithic (*Antunović 1990*), and since inhumation is a demonstrated pattern for both of the periods, there is no reason to suspect total obliteration of any of the hypothetical groups in the current sample.

5.1. Statistical analysis of non-metric traits

Berry and Berry's (*1967*) article was a turning point in non-metric trait analysis for a number of reasons. It asserted the value of non-metric traits in population studies, it provided a lengthy list of cranial traits that were subsequently commonly used by many osteologists and, most importantly, it drew attention to the Smith-Grewal statistic for calculation of average distances between sample populations (*Saunders 1989.98*). Smith's Mean Measure of Divergence (MMD) has further been investigated and developed by Sjøvold (*1977*) and serves, with minor modifications, as the major statistic used for examining the inter-sample distance. Stated simply the Mean Measure of Divergence (MMD) is the summed divergence between two samples, divided by the number of traits included in the analysis.

For this type of analysis, proportions of the sample exhibiting a trait are given as *theta* (θ) values symmetrical around 0, such that the incidence of 50% equals a theta of zero (*Jackes et al. 1997.645*). Sjøvold has determined that the Anscombe formula is the best modification for calculation of θ, most accurately transforming the incidences of traits and stabilising the variance well, except in cases when incidences are extremely high or low (*Sjøvold 1977*). If the sample sizes are small and incidences are accordingly low, the Freeman-Tukey transformation is judged to provide somewhat better variance stabilisation than Anscombe (*Jackes et al. 1997.645*).

The actual formulae used in this study were taken from Jackes *et al.* (*1997*). The programming as well as the running of some of the data sets was done by Professor Mary Jackes on the QuatroPro spreadsheet program at the University of Alberta in Edmonton. Others were run by myself on MicrosoftExcel program provided by Professor Mary Jackes.

5.1.1. Formulae

The following formulae were used:

• Freeman Tukey transformation: appropriate for small sample sizes:

$$\text{theta}(\theta) = (0.5^*\arcsin(1-(2^*k)/(N+1))) + (0.5^*\arcsin((1-(2^*k+1))/N+1))),$$

where **k** is the number of skeletal elements showing the trait and **N** is the number of elements observed (where observations were possible).

• Anscombe transformation:

$$\text{theta}(\theta) = \arcsin[1-(2^*(k+0.375)/(N+0.75))]$$

• Mean measure of divergence: the summed divergence between two samples, divided by number of traits:

$$(\text{MMD}) = 1/r^*\Sigma[(\theta_1-\theta_2)^2 - V],$$

where **r** is the number of traits analyzed and

$$V = (1/N_1+0.5)) + (1/N_2+0.5)),$$

where **N** is the number of observations for each trait;

• the variance of the MMD = $\sigma^2 = 2/r^{2*}\Sigma(V^2)$

• The **Z** statistic (appropriate for any variable with normal distribution, mean of 0 and the variance of 1, which is the case of both theta and MMD) provides the significance for the MMD (*Jackes and Gao in press*):

$$Z = \sqrt{(2^*S)} - \sqrt{((2^*r) - 1)},$$

where

$$S = \Sigma[(\theta_1 - \theta_2)^2/V]$$

• Degree of isolation (DI) is calculated in order to confirm the **Z** value:

$$DI = MMD - (\sigma^*2)$$

An MMD value that is more than twice its standard deviation is significant at .05: thus a positive **DI** value is significant. All of the tables provide the statistics calculated on the basis of these formulae. The **Z** statistic was used further to develop the dendrograms that show the relationships between different sites.

5.2. The organisation of the presentation of the analyses

Since many features in the chapter will be repeated from one analysis to the next, it is appropriate here to propose a number of explanations that will make the reading of different tables and figures easier.

Each analysis is presented through three tables and two figures that respect the same order and that are numbered with the table/figure number and the analysis number in brackets. The first number is a sequential number of the table or figure while the numbers in brackets refer to the analysis number and one of the following: (1) for the data table, (2) for the computer output table, (3) for the Z matrix table.

Table 22 therefore would indicate the Z matrix table of the second analysis. The same labelling is used for figures where numbers indicate: (1) dendrogram from cluster analysis, (2) multidimensional scaling plot.

Data tables – All of the data tables (see for example Table 11) presented in this section of the chapter follow the same outline. The shaded area on the left represents the trait number as given on Table 10 in the previous section. In the upper shaded row, the number refers to the site number, to which the name of the site is given in the following column (*e.g.* 1 for Hajdučka Vodenica, 2 for Lepenski Vir, 3 for Padina, and 4 for Vlasac). These numbers are important in understanding the Z matrix tables. "k" refers to the number of positive observations (trait present) while "N" refers to the total number of cases where the observation was possible (sum of trait absent and trait present).

Output tables (Tabs. 12, 13, 14, 15) – The first 4 columns on the left refer to the subsamples compared in the first two columns (names of sites, chronological units or combinations of the two that will be explained separately for each of the analysis) and numbers given to these subsamples in the next two columns (see for example Table 16). Following statistics are represented on all of the output tables (for formulas refer to section 5.2.1.):

mmdFT – mean measure of divergence;
sdFT – standard deviation;
standFT – standardisation value: mmd/sd. It is used when the sample sizes are different. This value is highly correlated with **Z** statistic. **Z** statistic is preferred by Jackes because it is more correlated with **di**;
total n – an average of the number of observations possible across traits for the units compared;
ZFT – provides the measure of significance for the **mmd**;
di – (**mmd – 2*sd**) is strongly correlated with the **Z** and shows correlations as significant whenever this value is positive;
S – is used to calculate **Z** and is based on θ. The formula for this statistic is given in the section 5.2.1.

formula – **FT** stands for Freeman Tukey and signifies that the output is based on this transformation rather than Anscombe (which was also run).

These columns and values are consistently presented for each analysis. In analysing the distance between the populations, it is possible to use **MMD**, **Z** and **stand**. The choice here is based on the fact that **Z** is a way of standardising the minimal measure of divergence in case of unequal sample sizes and is more explicitly correlated with both MMD and DI, the latter being the measure of significance of the distance (*Jackes and Gao in press*).

'Z' matrix tables (see for example Tab. 12) – These are regular distance matrices. Upper and left shaded rows present the units of analysis either as numeric and textual (upper row) or only numeric (left row). The numbers are derived directly from the output.

Figures – Two figures are provided for each analysis: a Dendrogram derived from cluster analysis, and a Multidimensional Scaling (MDS) plot. Although it can be argued that MDS plots are a more appropriate way of presenting distance relationships (*Nance pers. comm.*), dendrograms are retained as they are commonly provided for these types of analyses in the literature and since some of the relationships are more readily visualised through them. The MDS plots definitely outline the relationships between all components in a more appropriate way so that most of the discussions are based on them. Labelling followed the pattern for tables.

Dendrograms (see for example Fig. 26) - Dissimilarity matrices were used to produce dendrograms on SYSTAT 7.0. The Linkage method is Complete as the most appropriate linkage for dissimilarity and similarity matrices. For comparisons of performance of different linkage methods see Wilmink and Uytterschaut (*1984*). The Complete linkage calculates the distance from every distance in the sample and thus avoids the pooling of the cases towards either the largest or the smallest distance provided. The distance measure used with the method is Euclidean, the SYSTAT default. Dendrograms are labeled as Figures with two serial numbers in brackets. The first number refers to the number of the analysis and the second number is always 1 (for dendrogram).

Multidimensional Scaling (see for example Fig. 27) - Since dendrograms can link the samples only in one direction, a spatial distance between different samples can be better appreciated by the information provided by the multidimensional scaling. To produce MDS plots, the same distance matrices as for dendrograms were used. Scaling is Monotonic, Kruskal Stress (measuring how well the curve fits all the points), and two dimensions because of the small number of points plotted were found the most appropriate. In each of the MDS plot figures, captions include the scores for the two dimensions, the Kruskal stress of final configuration - that should be less than .1 on a "good fit" (*Wilkinson et al. 1996.667*) - and a proportion of variance expressed, is presented.

5.2.1. The discussion of sides

Since no side correlations were found for any of the traits used in the analyses (Tab. 10), several approaches were possible:

Method 1 - to select only one side per individual and use the record for that side only (*favoured by Saunders 1978*)

Method 2a - to pool sides for each individual. The incidence is calculated as the number of individuals with trait present on one or both sides/number of individuals. Proponents of the first approach argue that it is more reasonable to treat individuals rather than sides as members of the breeding unit. Further, because of the age dependency of the proportion of bilateral occurrence, the side method exaggerates the effect of age-regression in variant incidence, the side method artificially inflates sample size and introduces redundant information deriving from strong positive left-right correlation in trait presence (*Molto 1983.133*). The individual approach is favoured by Buikstra (*1972*) and Suchey (*1975*). The rationale behind the 'individual' method is that, since nonmetric traits are threshold characters, any expression of a trait should be treated as 'trait present' and therefore, if a trait is expressed on either of the sides, it is regarded as present. This leaves us with a number of cases in which not both of the sides are sufficiently preserved to warrant determination. These cases could be included only when present, while, when absent, they would be excluded from the analyses since we can not ascertain whether they were expressed on the other side. This would drastically reduce the number of observations (already low at some sites and periods) and would accordingly - because of the small sample sizes, substantially bias the frequencies, which in turn would make comparisons with any other material impossible.

Method 2b - pooling sides by randomly selecting one or the other in case their expressions differ. Because the discussed 'individual' method was not operational as it selects against poorly preserved skeletons with trait absent, an attempt to overcome this problem was made by selecting the sides (in cases where the expression differs) randomly. In this way it was possible to retain 'individuals' as units of observation, while avoiding the problem of increasing incidence in a sample of small size due to unequal representation of sides.

Method 3 - adding sides and treating the material by elements and not by individuals. In this case the incidence is calculated as number of skeletal elements (regardless of the side) with traits present/ total number of elements. This method is preferred by Ossenberg (*1978 quoted in Molto 1983.136-137*) who proposed the theoretical explanation as to why 'side' method should be more successful than 'individual' method. She argues that the observed correlation between the intensity of trait incidence and the proportion of bilateral expression reflects genetic factors since an individual expressing a trait bilaterally has a stronger dose of trait positive alleles than an individual with unilateral expression of the trait. Therefore, computing the frequency of a discrete trait on the basis of pooled sides quantifies the genetic potential in the population better than does the individual count. This way of recording has the benefit of expressing the underlying threshold character of the traits as it takes into account the total genetic potential for the trait expression within population. It also increases the sample sizes in many cases without violating the biological bases of the trait expression. Accordingly, sides were added in the following manner:

$$k/N\ L + k/N\ R = k/N$$

or

$$(2/5 + 3/8 = 5/13)$$

where k is the number of instances in which the trait was recorded as present, while N is the total number of possible observations.

In order to demonstrate how similar these two methods are in their outcome, a series of analyses were performed using 'individual' (with sides pooled by 2b method) and 'side' method where skeletal elements are treated as discrete units. Here only one of the two pairs is presented as illustration. Since they differ very little in the significance of the results and resulting distance measures, side method was used as it allowed for increased sample size.

5.2.2. Analyses based on the individuals (method 2b) for sites (Tab. 11)

In this analysis only 10 traits which had sample sizes of 5 or more were used. Although sample size of five is far from desirable, insisting on more representative sample sizes would have made comparisons with Hajdučka Vodenica impossible for most of the traits.

trait	1	HVod	2	LVir	3	Padina	4	Vlasac
no.	k	N	k	N	k	N	k	N
2	2	5	8	26	8	16	4	37
3	5	9	14	28	13	16	24	49
6	5	6	16	31	12	16	26	42
10	3	13	3	28	10	19	17	46
11	1	15	0	35	2	19	4	47
12	1	6	3	25	1	8	8	31
13	1	9	7	11	2	14	9	17
15	1	5	5	15	3	11	19	47
17	0	8	7	18	3	8	9	26
25	1	5	9	28	2	12	16	45

Tab. 11. "k" and "N" values for sites based on individuals.

5.2.3. Analyses based on the elements (method 3) for sites (Tab. 13)

As can be seen from the above figure, the multidimensional scaling produces the same spatial relationships between the four sites regardless of the method of pooling the side information. The differences in the positioning of Vlasac and Lepenski Vir on the diagram (Fig. 25) result from the difference in the "Z" statistic (Tabs. 12 and 14), that has increased twice because of the greater sample size. The actual relationship between the sites has remained the same. Accordingly, only the analyses performed by element are presented in further discussions.

Z(ft)	1	2	3	4
1	0			
2	1.5643	0		
3	–0.0926	3.2085	0	
4	1.1091	1.5259	2.4937	0

Tab. 12. Z matrix based on individuals.

trait	1	HVod	2	LVir	3	Padina	4	Vlasac
no.	k	N	k	N	k	N	k	N
2	4	9	14	46	13	24	4	62
3	8	14	24	50	22	27	41	82
6	7	10	31	60	23	28	44	77
10	7	22	5	48	17	33	27	76
11	1	21	2	61	3	30	6	82
12	1	9	6	41	1	13	15	59
13	2	14	12	18	4	25	16	32
17	0	10	12	29	4	13	13	35

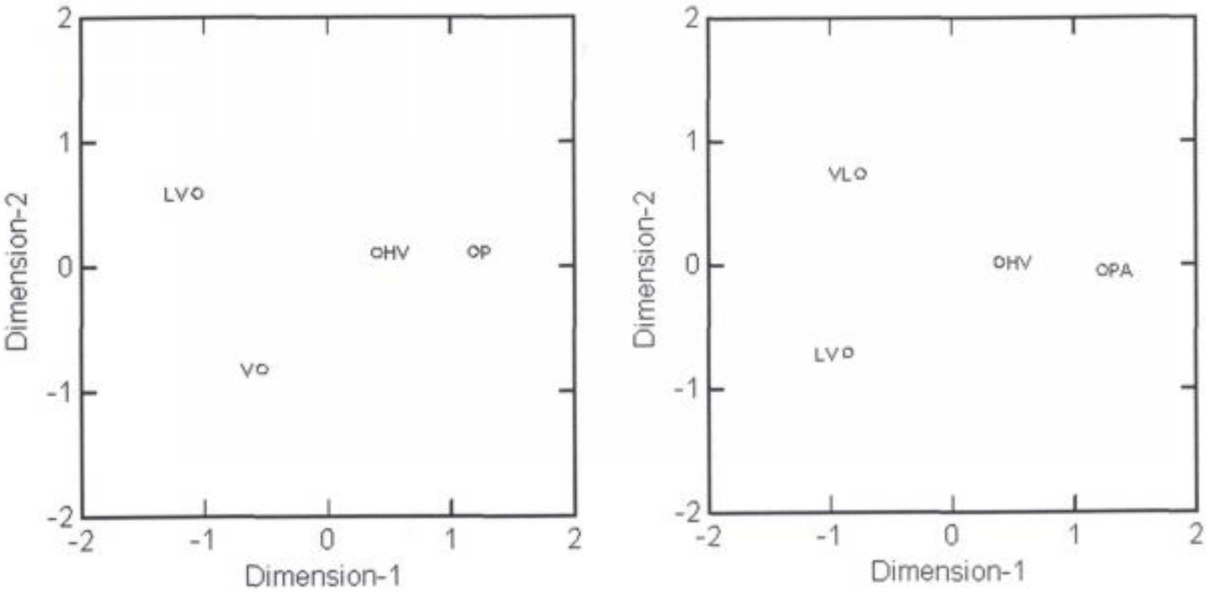
Tab. 13. "k" and "N" values for sites based on elements.

Z(ft)	1	2	3	4
1	0			
2	3.1996	0		
3	0.7411	6.1667	0	
4	2.8046	3.3144	5.9511	0

Tab. 14. Resulting "Z" matrix based on elements.

5.3. Results of the analyses of non-metric traits

In subsequent analyses, the Iron Gates Gorge population was divided into subsamples based on sites, chronology, and combination of sites and chronology. According to the discussion of the meaning of Mesolithic and Neolithic in the context of the region, the chronological division comprises three periods: Mesolithic, Mesolithic/Neolithic, and Neolithic. Mesolithic presumes lack of contact with farming populations, Mesolithic/Neolithic, the period when the contact, even if it did not take place, was possible, and the Neolithic, when the change in the subsistence base is evidenced on one of the sites.



a) based on sides polled by individuals (method 2b)

b) based on added sides (method 3)

Fig. 25. Multidimensional scaling for the two different methods of pooling sides.

In order to assess the degree of difference and meaning of the relationships within the group, an outlier was chosen from the published literature. The chosen outlier is Franzhausen I, a Bronze Age population from Austria (*Wiltschke-Schrotta 1992*), based on a number of variables that were recorded in common, the system of recording that followed the same general procedures (*Czarnetzki 1972a; 1972b; 1972c; Czarnetzki et al. 1985; Buikstra and Ubelaker 1994; Hauser and De Stefano 1989*). Also, the site is sufficiently removed chrono-spatially, but still within the same general geographic area, to be appropriate as an outlier. Importantly, Wiltschke-Schrotta has recorded her sides separately and has presented the side data in a manner that made it possible to add them up without problems and obtain a methodologically comparable sample.

5.3.1. Analysis based on Sites (Tabs. 13, 15 and 16)

The first set of analyses investigate if any particular patterns of difference are observable between geographic units (sites) and assesses whether there was any genetic separation between Lower and Upper Gorge. Traits that had at least 9 observation at any of the sites were used (Tab. 13).

As suggested by the dendrogram (Fig. 26), Hajdučka Vodenica and Padina are virtually identical. The dendrogram also shows that Padina is further removed from both Lepenski Vir and Vlasac. However, it fails to show that Hajdučka Vodenica is not as removed from the two sites as is Padina with which it clusters.

The interpretative potential of the diagram in Figure 27 is very limited. Hajdučka Vodenica (Lower Gorge) and Padina (Upper Gorge) seem to be virtually identical, although they are the most geographically removed. Other differences are significant and most pronounced between Padina and Vlasac and Padina and Lepenski Vir. Since both Hajdučka Vodenica and Padina have a significant Mesolithic/Neolithic component, while Vlasac has important Mesolithic as well

site1	site2			mmdFT	sdFT	standft	total n	ZFT	diFT	SFT	formula
HVod	Lvir	1	2	0.2513	0.0540	4.6572	58	3.1996	0.1434	25.0106	ft
HVod	Padina	1	3	0.0495	0.0647	0.7656	38	0.7411	–.0798	10.6451	ft
HVod	Vlasac	1	4	0.2264	0.0499	4.5344	77	2.8046	0.1266	22.2953	ft
LVir	Padina	2	3	0.3246	0.0374	8.6891	68	6.1667	0.2499	50.3980	ft
LVir	Vlasac	2	4	0.0792	0.0237	3.3428	107	3.3144	0.0318	25.8292	ft
Vlasac	Padina	4	3	0.2800	0.0332	8.4249	87	5.9511	0.2135	48.2567	ft

Tab. 15. The output of the statistical analysis of sites.

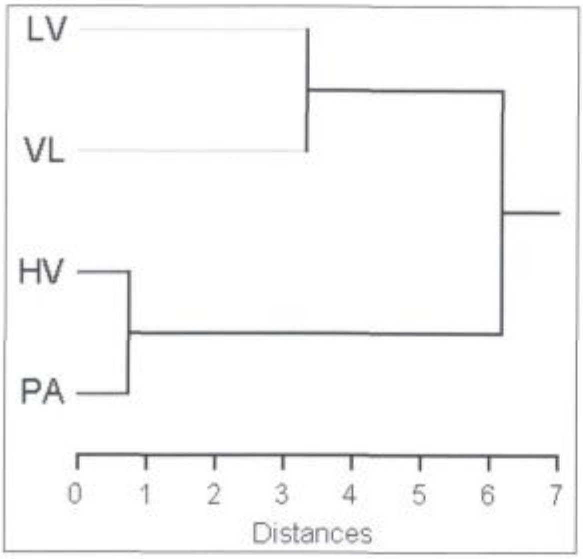


Fig. 26. Dendrogram based on dissimilarity matrix, Euclidean distance and complete linkage showing relationship between different sites examined.

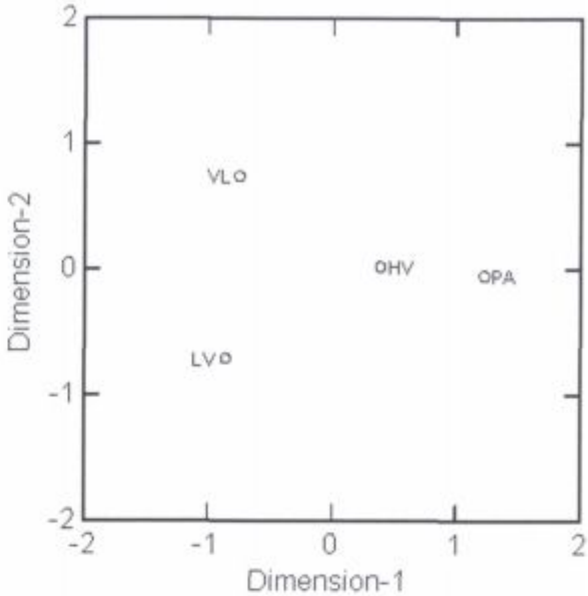


Fig. 27. Diagram showing output of the Multidimensional Scaling for sites, based on dissimilarity matrix. Dimensions (1, 2): HV (.38, .02); LV (-.86, -.71); PA (1.22, -.05); VL (-.75, .74). Kruskal Stress of final configuration: 0. Proportion of variance: 1.00.

Z(FT)	1 Haj. Vodenica	2 Lep. Vir	3 Padina	4 Vlasac
1	0			
2	**3.1996**	0		
3	0.7441	**6.1667**	0	
4	**2.8046**	**3.3144**	**5.9511**	0

Tab. 16. Matrix of Z values for sites. Significant relationships are outlined in bold.

as Mesolithic/Neolithic component and all three periods are represented at Lepenski Vir, it is impossible to argue for isolation based on geography at least in the Mesolithic/Neolithic period.

5.3.1a. Subsamples based on sites with Franzhausen I (Tabs. 17, 18 and 19)

In order to evaluate the distance between different sites, an outlier is introduced into the analysis. This outlier is Franzhausen I site dated to the Bronze Age in Austria. The choice of this outlier was guided by a number of concerns and has already been discussed.

A quick look at Table 20 shows only the difference between Hajdučka Vodenica and Padina to be non-significant. All other distances are significant.

Again, Hajdučka Vodenica and Padina remain virtually identical (Fig. 28), while all other sites seem to be significantly different from each other. Franzhausen, as expected, is the most removed from other sites, while Padina and Lepenski Vir and Padina and Vlasac show next most significant difference. Of all the sites, Hajdučka Vodenica seems to be just slightly closer to Lepenski Vir and Vlasac than to Franzhausen. Padina seems to be almost equidistant from both Lepenski Vir and Vlasac, Lepenski Vir is at the same distance from Vlasac as from Hajdučka Vodenica.

The Multidimensional scaling plot (Fig. 29) shows clear grouping of the Iron Gates Gorge sites against the more removed Franzhausen I site. It also shows that in one dimension Padina and in another Lepenski Vir seem to be the most removed from an imag-

Trait no.	1 k	HV N	2 k	LVir N	3 k	Padina N	4 k	Vlasac N	5 k	FRI N
2	4	9	14	46	13	26	4	62	8	588
6	7	10	31	60	23	28	44	77	211	425
10	7	22	5	48	17	33	27	76	130	638
11	1	21	2	60	3	40	6	82	46	530
12	1	9	6	41	1	10	15	59	8	365
13	2	14	12	18	4	25	16	32	28	446
17	0	10	12	29	4	13	13	35	116	318

Tab. 17. "k" and "N" values used in the analysis of sites with Franzhausen I.

site1	site2	site 1 name	site 2 name	mmd FT	sdFT	stand FT	total n	ZFT	di FT	SFT	formula
1	2	HVmn	LV	0.2954	0.0590	5.0063	57	3.4171	0.1774	24.6591	ft
1	3	HVmn	P	0.0233	0.0724	0.3214	39	0.2896	–0.1216	7.5861	ft
1	4	HVmn	V	0.2678	0.0547	4.8985	74	3.0388	0.1585	22.0737	ft
1	5	HVmn	FRI	0.3548	0.0460	7.7127	486	4.2742	0.2628	31.0451	ft
2	3	LV	P	0.2900	0.0429	6.7659	68	5.3277	0.2043	39.9015	ft
2	4	LV	V	0.0946	0.0263	3.5981	104	3.5686	0.0420	25.7342	ft
2	5	LV	FRI	0.4219	0.0169	24.9836	516	9.5513	0.3881	86.5518	ft
3	4	P	V	0.2290	0.0385	5.9491	85	4.9147	0.1520	36.2973	ft
3	5	P	FRI	0.3769	0.0299	12.5989	498	8.7299	0.3171	76.0812	ft
4	5	V	FRI	0.2554	0.0118	21.6578	533	8.9086	0.2319	78.3023	ft

Tab. 18. The output of the statistical analysis of sites with Franzhauesn I.

ined centre of the four. Noteworthy is that both of them have ceramics *in situ* with Lepenski Vir type house floors. They also have an important Mesolithic component with no evidence of contact. However, the general pattern is that of heterogeneity.

Z(ft) matrix	1 H.Vodenica	2 L.Vir	3 Padina	4 Vlasac	5 FRI
1	0				
2	**3.4171**	0			
3	0.2896	**5.3277**	0		
4	**3.0388**	**3.5686**	**4.9147**	0	
5	**4.2742**	**9.5513**	**8.7299**	**8.9086**	0

Tab. 19. Matrix of Z values for sites with Franzhausen I. Significant relationships are outlined in bold.

5.3.2. Subsamples based on chronology (Tabs. 20, 21 and 22)

Chronological units in these analyses are derived from the data presented in Chapter 3. The baseis for distinguishing the units is provided by the evidence of economic behaviour and evidence of contact with peoples with different economic patterns. Mesolithic refers to the strata within any of the sites where the economy is fully Mesolithic and there is no evidence of contact. The Mesolithic/ Neolithic (Meso/Neo, or M/N in tables and Cont. in diagrams) is the period when contact with

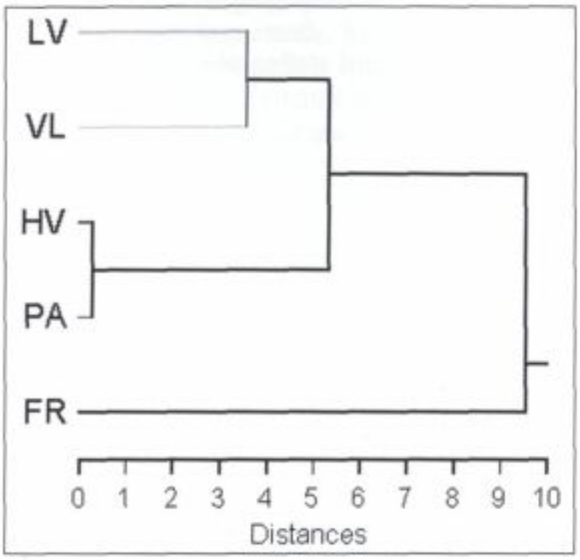


Fig. 28. Dendrogram showing relationship between the Iron Gate's Gorge sites and Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

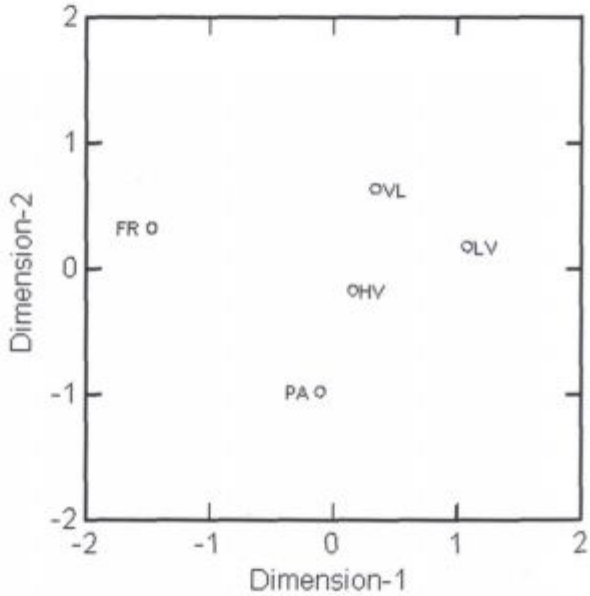


Fig. 29. Multidimensional scaling for the sites with Franzhausen I. Based on dissimilarity matrix. Dimensions (1, 2): HV (.16, –.14); LV (1.00, .39); PA (.12, –1.00); VL (.23, .69); FR (–1.51, .05); Kruskal Stress of final configuration: 0.0270. Proportion of variance: 0.9941.

Trait no.	Mesolithic k	1 N	Meso/Neo k	2 N	Neolithic k	3 N
1	30	33	20	45	1	8
2	10	55	16	66	8	14
3	40	60	43	77	6	14
4	9	66	14	65	2	12
5	23	42	29	43	4	9
6	42	67	48	76	8	18
7	0	62	4	70	0	18
8	16	62	23	73	5	16
10	30	50	26	85	0	15
11	6	81	4	82	1	18
12	12	46	7	51	2	13
23	8	33	3	32	0	10

Tab. 20. "k" and "N" values for traits used in the analysis of chronological units.

farming communities in the region becomes possible. This is similar to the porous frontier of Dennell (*1985*) or availability phase of Zvelebil (*1996a*). Neolithic is, primarily, characterised by greater importance of domesticates in the economic base (>5%). Evidence of adoption of cultural elements of the surrounding farmers of the Balkano-Anatolian and Balkano-Karpathian basin (*ENCB and MNCB of Tasić 1998*) although considered, was not taken as sufficient for determining the find as Neolithic.

A significant feature of the dendrogram (Fig. 30) is clustering of Mesolithic/Neolithic (Contact) period with Neolithic period, which is in contradiction with the wave of advance model for the neolithisation of this region.

site 1	site 2	Site 1 name	Site 2 name	mmd FT	sd FT	stand FT	total n	Z FT	di FT	S FT	formula
1	2	Meso	MN	0.1298	0.0155	8.3884	119	4.8968	0.0988	46.9740	ft
1	3	Meso	LVn	0.4667	0.0398	11.7260	69	6.4826	0.3871	63.6011	ft
2	3	MN	LVn	0.1017	0.0388	2.6230	78	2.4289	0.0242	26.0986	ft

Tab. 21. The output of the analysis of chronological units.

Z (ft)	1 Mesolithic	2 Meso/Neo	3 Neolithic
1	0		
2	**4.8968**	0	
3	**6.4826**	**2.4289**	0

Tab. 22. Matrix of Z values for chronological units. Significant relationships are outlined in bold.

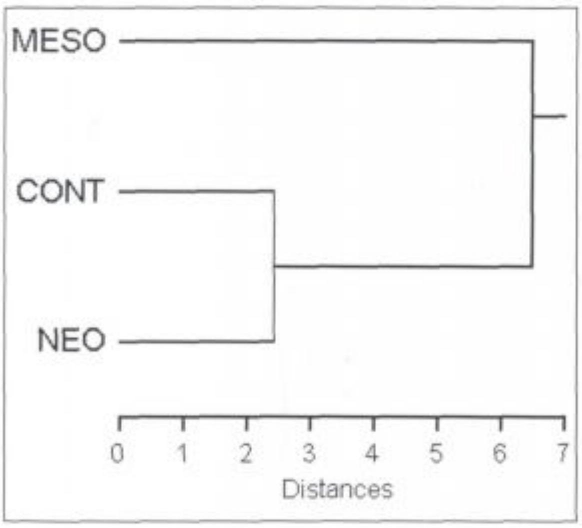


Fig. 30. Dendrogram showing internal relationship of chronological units. Derived from dissimilarity matrix, Euclidean distance, Complete linkage.

In order to demonstrate the spread of Neolithic farmers themselves, and not only their domesticates and/or knowledge, the result should show a slight to non-existent change in the Contact period (as some exchange of genes could be expected) and an abrupt change with the advent of Neolithic. This pattern would argue for an insurgence of people with different genetic make-up who brought about the change in economic base (*as proposed by Cavalli Sforza 1996*). It would also imply that the farmers are genetically different from the foragers in the region.

The outcome presented in the dendrogram (Fig. 30) shows that more change (regardless of its cause) happens between the Mesolithic and Contact period than Contact and Neolithic which cluster together. If indeed the new population moves in at the time of Mesolithic/Neolithic, it does not bring about an immediate change in the economic base and can not be understood in accordance with the "wave of advance" model.

All of the relationships are significant according to the "di" value (Tab. 21). It is noteworthy that the distance between Mesolithic and Contact is more than twice the distance between Contact and Neolithic. This is even more suggestively shown by the Multidimensional scaling plot (Fig. 31).

If there is, indeed, an exchange of genes as well as goods at the time of the first contact, it does not destabilise the Mesolithic society and ideology, as can be seen from the continuation of architectural elements, mobiliary art and general organisation of the sites. Even more importantly, as the basis of subsistence remains hunting, gathering and fishing, this supposed exchange of genes does not bring about a fully developed farming economy.

It is important to note that a certain amount of change in the genetic make-up, as evidenced in the non-metric traits, would be expected due to secular trends. However, for secular trends to be the only source of change, the distances between different periods would need to be approximately the same. The diagram in Figure 31 strongly suggests a change in the population structure at the time of Mesolithic/Neolithic period. There is an indication that, apart from the obvious secular trend reflected in the alignment of the units, a greater amount of change happens between Mesolithic and Contact periods. The introduction of an outlier in the next analysis is aimed to clarify how important this difference was in the amount of genetic change.

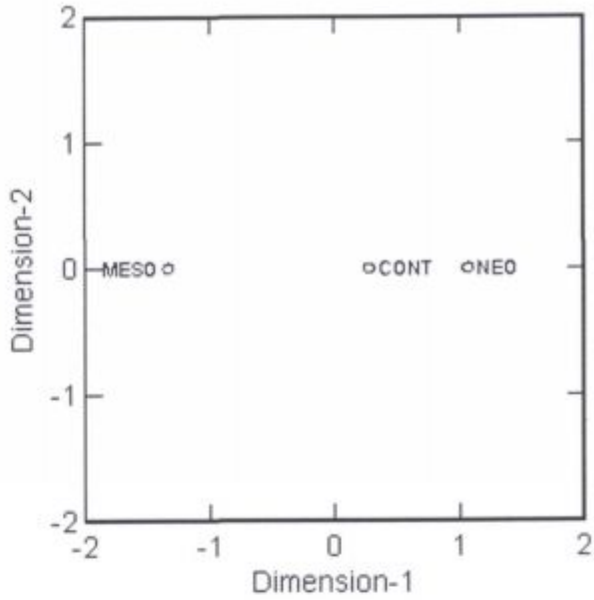


Fig. 31. Multidimensional scaling plot of chronological units based on dissimilarity matrix. Dimensions: (1, 2): Meso (-1.34, .00); Cont. (.27, .00); Neo. (1.07, .00); Kruskal Stress of final configuration: 0.00. Proportion of variance: 1.00.

5.3.2a. Subsamples based on chronology with Franzhausen I (Tabs. 23, 24 and 25)

With the introduction of Franzhausen, further removed in time and space from the subsamples in the studied region, a better appreciation of distance is possible.

As is evident from the Table 24, the difference between Contact and Neolithic periods ceases to be significant when an outlier is introduced (as shown by a negative 'di' value). Furthermore, distances between Mesolithic and Contact, and Contact and Neolithic, according to the Z statistic, become almost equal.

The ensuing dendrogram shows strong clustering of Mesolithic and Contact regardless of the fact that the "di" value determines this relationship as significantly different. Part of the responsibility might lay in the larger "sd" and smaller sample size. There is very little actual difference between Mesolithic, Contact and Neolithic an indication of continuity, with accumulated changes through time resulting in significant difference between Mesolithic and Neolithic.

The introduction of Franzhausen shows that the distances on the local scale become less obvious and that in general they follow the secular trend. However, the unidimensionality of dendrogram (Fig. 32) obscures some of the very important information, and a look at the Figure 33 explains the incompatibility of the clustering information to that provided by the "di" statistic.

While Contact period is almost equidistant from the Mesolithic and Neolithic periods, the two are diffe-

Trait no.	Meso k	1 N	M/N k	2 N	Neo k	3 N	Franz I k	4 N
2	10	55	16	66	8	14	8	588
5	23	42	29	43	4	9	90	451
6	42	67	48	76	8	18	211	425
8	16	62	23	73	5	16	27	190
10	30	50	26	85	0	15	130	638
11	6	81	4	82	1	18	46	530
12	12	46	7	51	2	13	8	365
13	16	39	15	42	1	5	28	446
23	8	33	3	32	0	10	16	194

Tab. 23. "k" and "N" values for traits used in the analysis of chronological units with Franzhausen I.

site 1	site 2			mmdFT	sd FT	stand FT	total n	Z FT	di FT	S FT	formula
1	2	Meso	MN	0.0411	0.0187	2.1905	114	2.0405	0.0036	18.9949	ft
1	3	Meso	N	0.3244	0.0530	6.1157	66	5.1131	0.2183	42.6539	ft
1	4	Meso	Frl	0.3561	0.0111	31.9687	478	12.7567	0.3339	142.4636	ft
2	3	MN	N	0.1024	0.0522	1.9597	74	2.4522	-0.0021	21.6171	ft
2	4	MN	Frl	0.2874	0.0103	27.8134	486	12.0167	0.2668	130.2460	ft
4	3	Frl	N	0.3327	0.0448	7.4201	438	5.8392	0.2430	49.6241	ft

Tab. 24. The output of the analysis of chronological units with Franzhausen I.

rently positioned in respect to Franzhausen (Bronze Age). Namely, the Contact, Neolithic and Franzhausen are to be found on the same axis, while the Mesolithic period forms a different pattern and is situated on a different axis with Contact period.

Z matrix	1 Mesolithic	2 Meso/Neo	3 Neolithic	4 Franz I
1	0.0000			
2	**2.0405**	0.0000		
3	**5.1131**	2.4522	0.0000	
4	**12.7567**	**12.0167**	**5.8392**	0.0000

Tab. 25. Matrix of Z values for chronological units with Franzhausen I. Significant relationships are outlined in bold.

While secular trend is a definite factor in the change from the Mesolithic to the Neolithic and Bronze Age, a significant change, that cannot be explained solely by temporal trend, occurs at the time when the contact with Neolithic populations becomes possible in the Iron Gates Gorge.

5.3.3. Subsamples based on combined chronology and sites (Tabs. 26, 27 and 28)

Subsamples that respected both sites and chronological determination were analysed in order to provide a more fine-grained understanding of the relationship among them. The Padina sample, when divided into Mesolithic and Mesolithic/Neolithic, made comparisons almost impossible because of the small numbers of observations in almost all variables. Since Padina clusters consistently with Hajdučka Vodenica, and since most of the individuals from Padina belonged to the same chronological unit (Mesolithic/Neolithic) those were assigned to Hajdučka Vodenica subsample and thus form the HVPmn (Hajdučka Vodenica-Padina Mesolithic Neolithic). The remaining

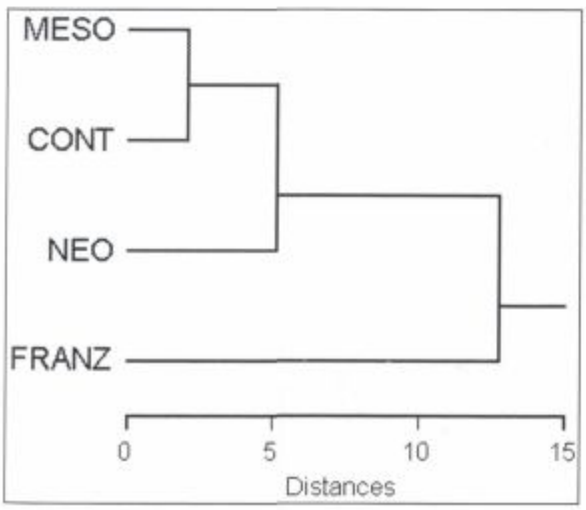


Fig. 32. Dendrogram showing the changing relationship with the introduction of Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

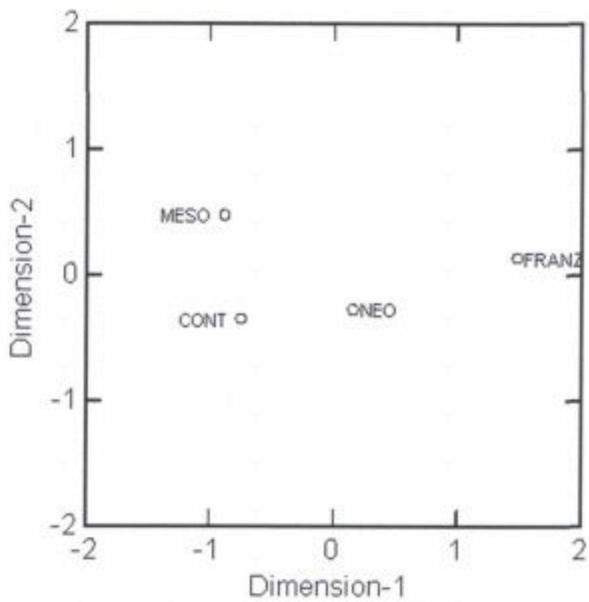


Fig. 33. Multidimensional scaling plots for Chronological units with Franzhausen I. Based on dissimilarity matrix. Dimensions (1, 2): Meso (–.88, .48); Cont. (–.75, –.35); Neo. (.15, –.27); Franz I (1.48, .14). Kruskal Stress of final configureation: 0.00. Proportion of variance: 1.00.

individuals from Padina that belong to the Mesolithic were assigned to Lepenski Vir Mesolithic subsample (forming LVPm – Lepenski Vir Padina Mesolithic). This was done in order to strengthen the Mesolithic sample of Lepenski Vir after a careful examination of frequencies. Although the frequencies do not show substantial differences, this should be kept in mind in the analyses and interpretation.

According to the distance matrix (Tab. 28) produced here, the most similar are Hajdučka Vodenica/Padina Contact group with Lepenski Vir Neolithic. This points to a strong continuity between the two periods. Along these lines is the similarity between Lepenski Vir Contact with the Lepenski Vir Neolithic. But Hajdučka Vodenica/Padina group also shows little difference from the Lepenski Vir Mesolithic subsample. At Lepenski Vir itself, the change is pronounced at the time of Mesolithic/Neolithic transition and very restricted between the Contact and the Neolithic.

It is interesting to note that Lepenski Vir Mesolithic is most different from Vlasac Mesolithic and Lepenski Vir Mesolithic/Neolithic and less, but still significantly different from Lepenski Vir Neolithic. Lepenski Vir Neolithic shows little difference from Vlasac Mesolithic and somewhat more from Vlasac Mesolithic/Neolithic.

The dendrogram in Figure 34 shows that Mesolithic components at Vlasac and Lepenski Vir/Padina are almost the most removed from each other, which is confirmed by the MDS plot in Figure 35. Vlasac Mesolithic and Mesolithic/Neolithic appear to be virtually identical along the second dimension and different along the first dimension where they are pooled by similarity to Lepenski Vir Neolithic. The general outline argues for temporal trend and continuity within the sample with greater variability in the Mesolithic/Neolithic pe-

Trait	HVP	1	LVP	2	LV	3	LV	4	V	5	V	6
no.	mn		m		mn		n		m		mn	
	k	N	k	N	k	N	k	N	k	N	k	N
1	6	11	12	15	2	11	1	8	18	28	12	23
2	11	24	7	19	4	15	8	14	3	36	1	26
3	16	26	20	22	8	19	6	14	20	48	19	32
4	4	19	2	20	5	18	2	12	7	46	5	28
5	7	12	10	12	5	9	4	9	13	30	17	22
6	17	24	19	22	12	22	8	18	23	45	19	30
7	0	17	0	20	2	18	0	18	0	42	2	25
8	4	17	2	18	4	18	5	16	14	44	15	28
11	4	34	0	27	0	20	1	18	6	54	0	28
13	5	24	4	19	6	6	1	5	12	20	4	26
23	1	9	2	9	0	9	0	10	6	24	2	14
24	1	11	1	10	2	11	0	9	0	28	0	15

Tab. 26. "k" and "N" values for traits used in the analysis of subsamples based on site/chronology combination.

site	site			mmd	sd	stand	total	Z	di	S	formula
1	2			FT	FT	FT	n	FT	FT	FT	
1	2	HVPmn	LVPm	0.0205	0.0520	0.3935	37	1.0880	-0.0836	17.3097	ft
1	3	HVPmn	LVmn	0.2698	0.0584	4.6233	34	3.0129	0.1531	30.4878	ft
1	4	HVPmn	LVn	-0.0104	0.0630	-0.1647	32	-0.1692	-0.1364	10.7029	ft
1	5	HVPmn	Vm	0.0959	0.0381	2.5196	56	2.6350	0.0198	27.6085	ft
1	6	HVPmn	Vmn	0.0875	0.0437	2.0041	44	2.5068	0.0002	26.6643	ft
2	3	LVPm	LVmn	0.5018	0.0586	8.5607	32	5.3937	0.3846	51.9135	ft
4	2	LVn	LVPm	0.3109	0.0632	4.9183	30	4.0290	0.1845	38.9387	ft
2	5	LVPm	Vm	0.2715	0.0382	7.1145	55	5.6937	0.1952	55.0150	ft
2	6	LVPm	Vmn	0.1599	0.0438	3.6504	43	3.5494	0.0723	34.8213	ft
3	4	LVmn	LVn	0.1905	0.0718	2.6525	27	1.2510	0.0469	18.2819	ft
3	5	LVmn	Vm	0.2242	0.0459	4.8892	52	3.3118	0.1325	32.8670	ft
3	6	LVmn	Vmn	0.3885	0.0505	7.6860	39	4.1027	0.2874	39.5918	ft
4	5	LVn	Vm	0.1661	0.0507	3.2744	50	2.4544	0.0647	26.2831	ft
4	6	LVn	Vmn	0.1712	0.0553	3.0968	37	3.0302	0.0606	30.6230	ft
6	5	Vmn	Vm	0.1217	0.0300	4.0608	62	3.2961	0.0617	32.7397	ft

Tab. 27. The output of the analysis for site/chronology combination.

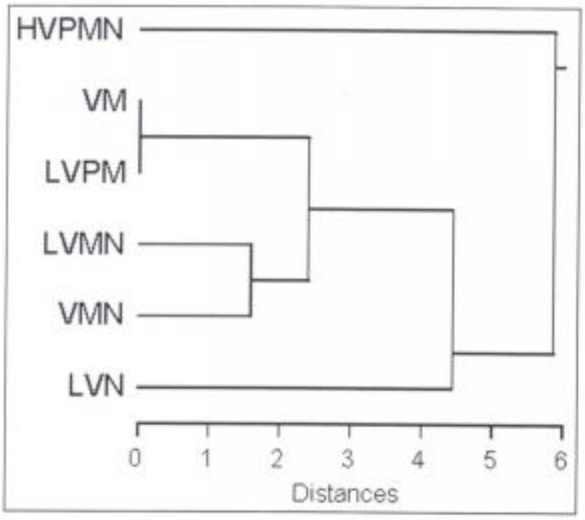


Fig. 34. Dendrogram showing internal relationships of the site/chronology units within the Iron Gates Gorge. Based on dissimilarity matrix, Euclidean distance and complete linkage.

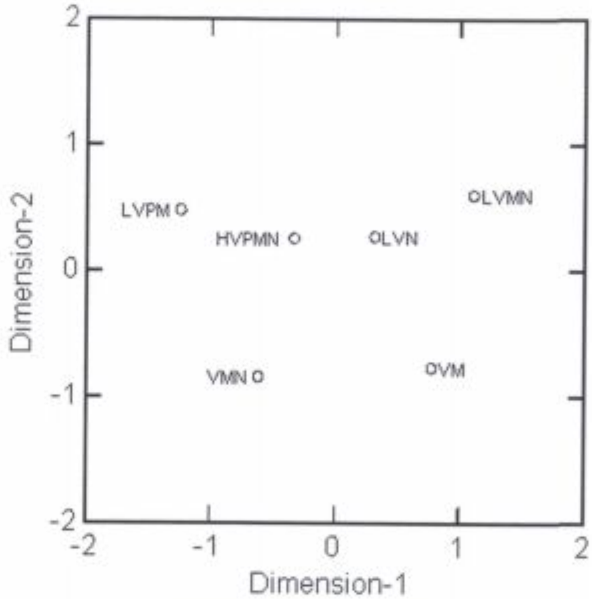


Fig. 35. Multidimensional scaling plot showing internal relationship between the site/chronology units in the Iron Gates Gorge. Based on dissimilarity matrix. Dimensions (1, 2): HVPMN (-.39, .20); LVPM (-1.33, .24); LVMN (.97, .79); LVN (.27, .34); VM (.89, -.63); VMN (-.41, -.95). Kruskal Stress of finalconfiguration: 0.027. Proportion of variance: .993.

riod. While not a definite evidence of insurgence of some new genes in the time of Contact, this pattern presents a strong argument for it.

5.3.3a. Subsamples based on Chronology and Sites with Franzhausen I (Tabs. 29, 30 and 31)

Analysing the site/chronology combination with Franzhausen aimed to clarify the extent of the importance of differences between these different subsamples, and more specifically, the way in which these different groupings are related to each other once an outlier is introduced.

According to the "di" values in Table 30, several distances are non-significant: Lepenski Vir Mesolithic/Neolithic shows little distance from the Neolithic period at the same site. This is, in itself, a strong argument for local continuity at the site in the period of shift in the economic base.

Another feature of interest is the association (continuity) between the two periods at Vlasac. Such a strong association raised doubt that the chronological determination provided by Radovanović (*1996a*), based on stratigraphy and stylistic analysis, could be incorrect. In order to check if this grouping is indeed evidence of continuity, and not the consequence of unreliable separation into different chronological groups, a different designation of chronological units of the sample, based on Srejović's (*Srejović and Letica 1978*) determinations was run through the same procedures.

In order to avoid unnecessary repetition, only the "Z" matrix is presented in the Table 32 as an illustration of the obtained results. Other statistics were scrutinised as well and very little difference was observed.

As shown by comparing the two "Z" matrices on Table 31 for Radovanović's determination and Table 32 for Srejović's, some of the relationships are slightly different in terms of absolute numbers. However, none of the significant relationships change and, more importantly, Vlasac retains practically the same non-difference for its two chronological subsamples. Lepenski Vir Neolithic is equidistant from Vlasac Mesolithic and Vlasac Mesolithic Neolithic. The chronological

Z (ft)	1HVP m/n	2 LVP m	3 LV mn	4 LVn	5 Vm	6 Vmn
1	0					
2	1.0880	0				
3	**3.0129**	**5.3937**	0			
4	-0.1692	**4.0290**	1.2510	0		
5	**2.6350**	**5.6937**	**3.3118**	**2.4544**	0	
6	**2.5068**	**3.5494**	**4.1027**	**3.0302**	**3.2961**	0

Tab. 28. Matrix of Z values for site/chronology combination Significant relationships are outlined in bold.

determination by Radovanović was, therefore, retained, although more direct dates for all of the sites are needed.

As can be seen from the Table 30 and Figure 36, the relationships between different site/chronology units become more complex. Lepenski Vir and Padina in the Mesolithic resemble the Contact period at Hajdučka Vodenica and Padina. This could be due to the fact that Padina is present in both components. However, while the Padina Contact sample is almost the same size as Hajdučka Vodenica in the same period, Padina Mesolithic sample is very small and comparable in frequencies to Lepenski Vir Mesolithic. Therefore it is unlikely that it could pool these two sites together were they different. A strong case of continuity is present between Vlasac Mesolithic and Vlasac Contact. As well continuity can be argued for Lepenski Vir Contact and Neolithic groups. Some shifting and moving of population within the region could explain similarities between the Mesolithic/Neolithic subsamples at Lepenski Vir, Vlasac, Hajdučka Vodenica and Padina. This would coincide with Radovanović's phase of greater territorial integrity and more ideological integration in the region (*Radovanović 1995; 1996a; 1996b*). She argued that this

Trait	HVPmn	1	LVPm	2	LVmn	3	LVn	4	Vm	5	Vmn	6	Frl	7
no.	k	N	k	N	k	N	k	N	k	N	k	N	k	N
2	11	24	7	19	4	15	8	14	3	36	1	26	8	588
5	7	12	10	12	5	9	4	9	13	30	17	22	90	451
6	17	24	19	22	12	22	8	18	23	45	19	30	211	425
8	4	17	2	18	4	18	5	16	14	44	15	28	27	190
10	16	38	12	23	1	18	0	15	18	47	9	29	130	638
11	4	34	0	27	0	20	1	18	6	54	0	28	46	530
12	1	16	3	13	0	9	2	13	9	33	6	26	8	365
23	1	9	2	9	0	9	0	10	6	24	2	14	16	194

Tab. 29. "k" and "N" values for traits used in the analysis of subsamples based on site/chronology combination with Franzhausen I.

site	site			mmd	sd	stand	total	Z	di	S	formula
1	2			FT	FT	FT	n	FT	FT	FT	
1	2	HVPmn	LVPm	0.0236	0.0625	0.3779	40	0.8608	-0.1014	11.2045	ft
1	3	HVPmn	LVmn	0.0638	0.0683	0.9335	37	1.8817	-0.0729	16.5584	ft
1	4	HVPmn	LVn	0.1346	0.0668	2.0161	36	2.5822	0.0011	20.8349	ft
1	5	HVPmn	Vm	0.0891	0.0439	2.0302	61	2.1528	0.0013	18.1553	ft
1	6	HVPmn	Vmn	0.1679	0.0510	3.2912	47	3.3415	0.0659	26.0245	ft
1	7	HVPmn	FRI	0.2940	0.0317	9.2615	444	7.1037	0.2305	60.2433	ft
2	3	LVPm	LVmn	0.2480	0.0708	3.5028	33	3.1803	0.1064	24.8741	ft
2	4	LVPm	LVn	0.4032	0.0692	5.8225	32	4.5975	0.2647	35.8746	ft
2	5	LVPm	Vm	0.1918	0.0462	4.1505	57	3.7504	0.0994	29.0578	ft
2	6	LVPm	Vmn	0.1510	0.0534	2.8303	43	2.9377	0.0443	23.1927	ft
2	7	LVPm	FRI	0.5434	0.0339	16.0297	441	8.7306	0.4756	79.4253	ft
3	4	LVmn	LVn	-0.0231	0.0754	-0.3070	29	-0.1041	-0.1740	7.1021	ft
3	5	LVmn	Vm	0.1954	0.0523	3.7372	54	2.9894	0.0908	23.5464	ft
3	6	LVmn	Vmn	0.1621	0.0593	2.7350	40	2.4154	0.0436	19.7722	ft
3	7	LVmn	FRI	0.1425	0.0400	3.5631	438	3.0453	0.0625	23.9311	ft
4	5	LVn	Vm	0.2797	0.0509	5.4949	53	4.0364	0.1779	31.2792	ft
4	6	LVn	Vmn	0.3378	0.0580	5.8255	40	4.2705	0.2218	33.1581	ft
4	7	LVn	FRI	0.3628	0.0385	9.4119	437	5.9376	0.2857	48.1238	ft
5	6	Vm	Vmn	0.0671	0.0349	1.9210	65	1.8855	–0.0028	16.5800	ft
5	7	Vm	FRI	0.1764	0.0153	11.5023	462	6.3152	0.1457	51.8994	ft
6	7	Vmn	FRI	0.3445	0.0226	15.2427	448	8.1575	0.2993	72.3665	ft

Tab. 30. The output of the analysis for site/chronology combination with Franzhausen I.

integration was brought about by the existence of a different subsistence pattern and different ideology in the region. Availability of contact with Neolithic farmers in the region could have acted to stress the ideological and conceptual unity of the foragers.

Z (ft)	1 HVP m/n	2 LVP m	3 LV mn	4 LV n	5 V m	6 V mn	7 FR
1	0						
2	0.8608	0					
3	1.8817	**3.1803**	0				
4	**2.5822**	**4.5975**	–0.1041	0			
5	**2.1528**	**3.7504**	**2.9894**	**4.0364**	0		
6	**3.3415**	**2.9377**	**2.4154**	**4.2705**	1.8855	0	
7	**7.1037**	**8.7306**	**3.0453**	**5.9376**	**6.3152**	**8.1575**	0

Tab. 31. Matrix based of Z values for site/chronology combination with Franzhausen I. Significant relationships are outlined in bold.

Z (ft)	1 HVPmn	2 LVPm	3 Lvmn	4 LVn	5 Vm	6 Vmn	7 Fr
1	0						
2	0.8608	0					
3	1.8817	**3.1803**	0				
4	**2.5822**	**4.5975**	-0.1041	0			
5	**3.1789**	**3.7119**	**5.3224**	**6.3183**	0		
6	**3.5692**	**3.8970**	**2.6226**	**4.2415**	**2.1087**	0	
7	**7.1037**	**8.7306**	**3.0453**	**5.9376**	**10.8492**	**5.804**	0

Tab. 32. Matrix of Z values based for site/chronology with Franzhausen I. Based on Srejović's chronological assessment.

Figure 37 reveals an even more interesting pattern. Franzhausen, as expected, is far removed from the rest of the sample. The sites examined form a pattern similar to "horseshoe" shape typical of chronological series. However, several features contradict an interpretation of the pattern as reflecting only the change over time. First, Franzhausen is in an unexpected position for chronological change. While it is the furthest removed from the rest of the sites on dimension one, in dimension two it shows less distance and thus does not contribute to the time sequencing. Also, according to the temporal change explanation, the Mesolithic sites should be on one end, Mesolithic/Neolithic in the bottom and Neolithic on the other end of the "horseshoe" diagram. Although the pattern observed reflects this situation to a degree, (observe the Lepenski Vir Mesolithic, Vlasac Mesolithic/Neolithic, Lepenski Vir Mesolithic/Neolithic and Lepenski Vir Neolithic positions), Hajdučka Vodenica and Padina Mesolithic/Neolithic and Vlasac Mesolithic follow a different distribution.

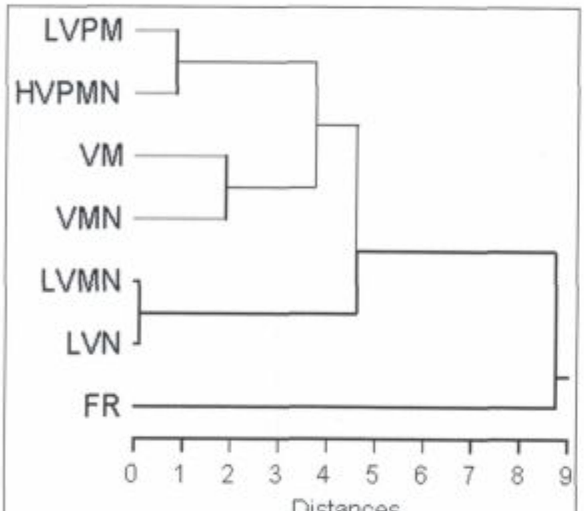


Fig. 36. Dendrogram showing the relationships between site/chronology units and Franzhausen I. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

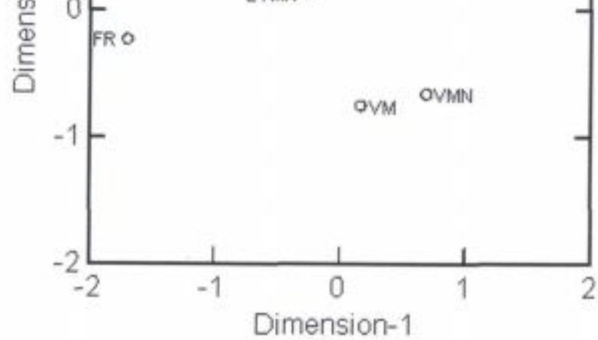


Fig. 37. Multidimensional Scaling showing internal relationships between site/chronology units with the introduction of Franzhausen. Based on dissimilarity matrix. Dimensions (1, 2): HVPM (.46, .42); LVPM (1.10, .31); LVMN. (–.25, .14); LVN (–.42, .77); VM (.15, –.77); VMN (.67, –.69); Franz I (–1.70, –.19). Kruskal Stress of final configuration: 0.064. Proportion of variance: 0.973.

5.3.4. Contribution of traits

Theta values obtained in the Site/Chronology analysis (Ch. 5.3.3.) were submitted to the Principal Component Analysis (Tab. 33, Fig. 38). This, somewhat unorthodox approach was suggested by M. Jackes (*pers. comm.*) based on a published analysis by Christensen (*1997*). Simply stated, 'θ' values are treated as ordinal values and submitted to the PCA in order to ascertain which of the traits contributed the most to the observed pattern. The site chronology analysis being the one on which the interpretation is mostly based, it was deemed unnecessary to subject results of other analyses to the same procedures.

Figure 38 shows the plot of Factor 1 and Factor 2 for the PCA of the 'θ' values obtained for the analysis 5.3.3. The output in Table 33 show that the trait 1 (marginal tubercle 0.90), trait 3 (supraorbital notch 0.92), trait 6 (parietal foramen 0.89) and trait 23 (apical bone 0.80), contribute the most to the first dimension. In real ordinal data this dimension represents the size, here it determines the traits as those with high frequencies. Trait 4 exhibits a strong negative association with the dimension one (supraorbital foramen -0.89), while trait no. 13 (mylohyoid bridge -0.59) shows negative association of a lesser extent. On the second dimension, trait 24 (Inca bone 0.89) has a strong positive association, while trait no. 11 (double mental foramen -0.69) has a strong but negative association. The two components explain 66.6 of the total variation within the sample.

In Varimax rotation (Tab. 34), applied to reduce the number of variables on the "size" axis, Variables 1 and 23 show even stronger positive association (0.97 and 0.98 respectively) while variable 4 shows strong negative association. On the second component, variable 11 shows even stronger negative association, while variable 5 show the strongest positive association with this component. These two components explain 55.7% of the variation in the sample.

Another interesting feature of the PCA analysis is the scatterplot of factor scores 1 and factor scores 2 for the Site/Chronology combination (Fig. 39). More than any other diagram this scatterplot of factor scores shows a "horseshoe" pattern which is characteristic of temporal ordering. Starting with Vlasac Mesolithic in the upper left corner, through Lepenski Vir Mesolithic in Lower left corner, Vlasac Mesolithic/Neolithic in the lower centre, Lepenski Vir Mesolithic/Neolithic in lower right corner and Lepenski Vir Neolithic in Upper right corner. Except for Hajdučka Vodenica and Padina Mesolithic/Neolithic that is positioned centrally, all other units follow the temporal pattern. This indeed can be regarded as strong indication of continuity.

In conclusion to the chapter and as a summary of the analyses, the following interpretation is offered. In general terms, both dendrograms and multidimensional scaling with or without Franzhausen show a strong temporal trend in the data. This is clearly visible in Figure 33 that shows the relationship of the three chronological units with the Bronze Age site of Franzhausen I, and in Figure 39. A significant amount of change within the examined population may be due to non-directional microevolution that is expected for a series covering a time-span of 1500 years. However, as shown by diagrams in Figures 31, 35 and 37, and the position of Hajdučka Vodenica and Padina in Figure 39, the position of different sites/chronology units can not be interpreted as demonstrating a straightforward temporal change. Figure 31 shows significantly more change occuring between Mesolithic and Contact period (due to avai-

Latent Roots (Eigenvalues)

1	2	3	4	5	6
5.0401	2.9539	2.3817	1.1441	0.4803	0.0000
7	8	9			
0.0000	0.0000	0.0000			

Component loadings

	1	2	3	4
V1	0.9061	–0.1902	0.0914	0.3483
V2	–0.0838	0.2467	–0.8662	–0.4264
V3	0.9282	0.3265	–0.0888	–0.1543
V4	–0.8026	0.4243	0.0552	0.0716
V5	0.7571	0.4489	0.4066	–0.2393
V6	0.8946	0.3982	–0.0725	0.0127
V7	–0.4109	0.6277	0.6539	–0.0315
V8	–0.3348	–0.4634	0.7356	–0.3070
V11	–0.2278	–0.6903	–0.5614	0.1728
V13	–0.5891	0.4175	0.0267	0.6585
V23	0.8072	–0.3803	0.1785	0.4010
V24	0.0366	0.8978	–0.3536	0.1874

Tab. 33. PCA output for Theta values of traits analyzed in Chapter 5.3.3.

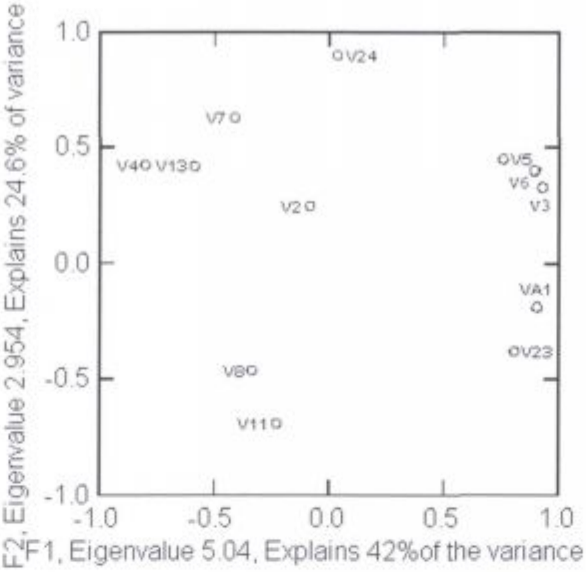


Fig. 38. PCA Factor Scores for Theta values obtained in analysis (Ch. 5.3.3). Variance explained by components: 1 – 5.0401, 2 – 2.9539, 3 – 2.3817, 4 – 1.1441. Percent of total variance explained: 1 – 42.001, 2 – 24.616, 3 – 19.847, 4 – 9.534.

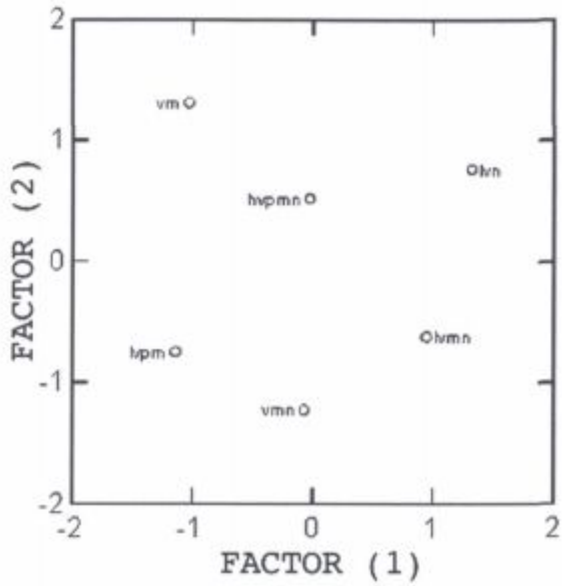


Fig. 39. Scatterplot of PCA factor 1 and factor 2 scores with site/chronology units as labelling variables. vm – Vlasac Mesolithic; vmn – Vlasac Mesolithic/Neolithic; lvpm – Lepenski Vir Padina Mesolithic; lvmn – Lepenski Vir; Mesolithic/Neolithic; lvn – Lepenski Vir Neolithic; hvpmn – Hajdučka Vodenica, Padina Mesolithic/Neolithic.

lability of contact with a different population?) than between Contact and Neolithic. While there is a strong possibility that this results from the situation on one site alone, it can be interpreted as showing a great degree of population heterogeneity during the Mesolithic and/or availability of contact with some influx (but not on a large scale) of new genes from (a) different population(s). The degree of difference of these populations with the indigenous foragers remains, of course, impossible to assess with the current study.

Rotated Loading Matrix (VARIMAX, Gamma = 1.0000)

	1	2	3	4
V1	0.9748	0.1010	0.0652	0.1492
V2	–0.4468	–0.2620	0.7440	0.4220
V3	0.5848	0.4893	0.4623	0.4524
V4	–0.7235	0.0737	0.0293	–0.5501
V5	0.4276	0.8425	0.1079	0.3048
V6	0.6245	0.4965	0.5019	0.2757
V7	–0.4395	0.7166	–0.2264	–0.4832
	–0.2219	0.0959	–0.9464	0.0893
V11	0.0161	–0.9302	–0.0160	0.0872
V13	–0.2559	–0.0350	0.1576	–0.9295
V23	0.9802	–0.0225	–0.1318	0.1019
V24	–0.1509	0.3787	0.8303	–0.3345

"Variance" Explained by Rotated Components

1	2	3	4
3.8798	2.8133	2.7148	2.1118

Percent of Total Variance Explained

1	2	3	4
32.3321	23.4440	22.6232	17.5984

Tab. 34. PCA output for Theta values of traits used in Chapter 5.3.3. Varimax rotation.

After a brief examination of data obtained from metric analyses, these problems and conclusions will be elaborated and presented in the light of research in both anthropology of other series and archaeology of the region.

5.4. Statistical analyses of metric variables

As stated in Chapter 4.2, metric variables reflecting size were subjected to different analyses. Following recommended procedures in Buikstra and Ubelaker (*1994*) left side was used. When not available, the measurement was substituted with that of the right bone. In both ANOVA and PCA tests, individuals originally determined as f and f? were assigned female sex and those determined as m and m? were included as males.

5.4.1. ANOVA tests

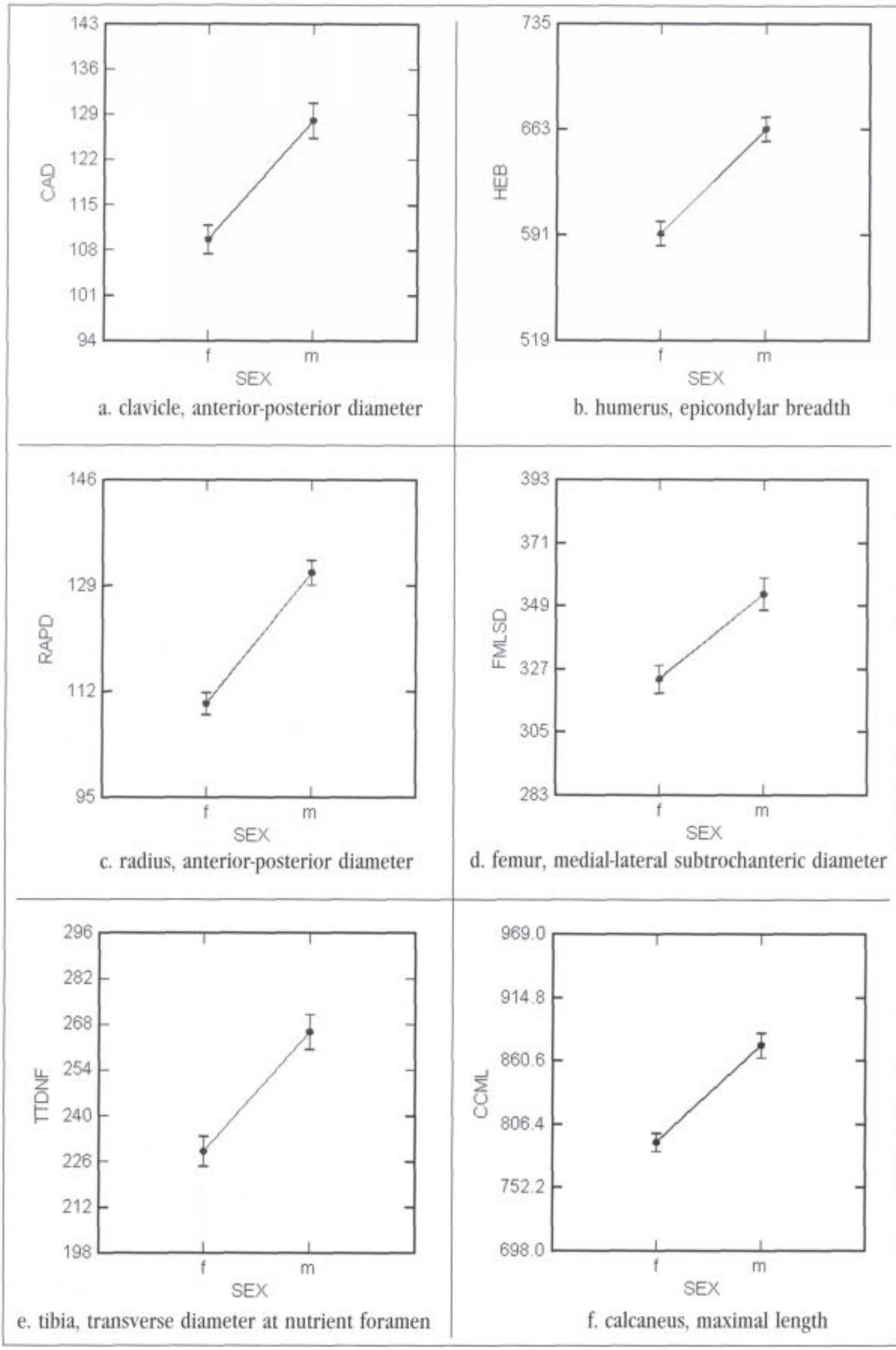
Several cautionary remarks are necessary before inference is drawn from ANOVA tests. First and foremost, searching for significance by submitting large numbers of variables to either 't-tests' or ANOVAs is bound to produce significance.

A Bonferroni procedure to establish a protected criterion for 'p' value (*Wilkinson et al. 1996.454*) can be used to guard against the Type I error (detecting significance where none exists). This procedure divides the commonly considered 'p' of 0.05 with the number of traits examined. If, as in the case of sex separation, our results are consistently significant, even when the level is reduced to $p = 0.05/30 = 0.0017$, there is little doubt that any single variable is significant due to chance alone. Bonferroni procedure can induce the Type II error (failing to find significance where a large number of variables is examined). Therefore, in the first analysis (Tab. 35), finding almost all of the variables significantly different between sexes, even with the reduced 'p' value, does in effect mean that the two sexes are significantly different from each other in the given population. The degree of sexual dimorphism illustrated by Figure 23, and p-plots (Fig. 24), and exemplified here through a number of ANOVA graphs (Fig. 40) is remarkable, and while there is some overlap in actual scatters, the two sexes separate almost perfectly on the basis of even one single variable.

Once the significance of difference between males and females was established, ANOVA tests were performed for chronological units, keeping the sexes se-

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CML	34	0.4214	SEX	1	31	22.5807	0.0000	101
CAD	61	0.3609	SEX	2	58	16.3794	0.0000	152
CSD	60	0.3236	SEX	2	57	13.6353	0.0000	
HEB	62	0.3888	SEX	2	59	18.7661	0.0000	115
HVDH	29	0.6490	SEX	2	26	24.0400	0.0000	89
HMXD	79	0.3943	SEX	2	76	24.7406	0.0000	
HMND	79	0.4724	SEX	2	76	34.0289	0.0000	
RML	32	0.6782	SEX	2	29	30.5604	0.0000	
RAPD	71	0.4503	SEX	2	68	27.8544	0.0000	
RMLD	71	0.3128	SEX	2	68	15.4773	0.0000	
UML	28	0.6099	SEX	2	25	19.5404	0.0000	
UMC	54	0.2556	SEX	2	51	8.7557	0.0005	79
FML	40	0.4488	SEX	2	37	15.0615	0.0000	
FBL	37	0.4092	SEX	2	34	11.7759	0.0001	
FEB	38	0.2203	SEX	2	35	4.9433	0.0129	
FMDH	60	0.3846	SEX	2	57	17.8094	0.0000	
FASPD	94	0.1043	SEX	2	91	5.2964	0.0067	50
FMLSD	94	0.1404	SEX	2	91	7.4298	0.0010	
FAPM	90	0.3140	SEX	2	87	19.9084	0.0000	
FMLM	89	0.3320	SEX	2	86	21.3675	0.0000	16
FMC	84	0.3837	SEX	2	81	25.2151	0.0000	
TL	27	0.5613	SEX	2	24	15.3515	0.0001	
TPEB	28	0.4833	SEX	2	25	11.6915	0.0003	
TDEB	42	0.1909	SEX	2	39	4.6004	0.0161	
TMDNF	64	0.3085	SEX	2	61	13.6044	0.0000	
TTDNF	63	0.2685	SEX	2	60	11.0136	0.0001	52,81
TCNF	55	0.4340	SEX	2	52	19.9380	0.0000	81
CCML	41	0.5550	SEX	2	38	23.6966	0.0000	
CCMB	43	0.2664	SEX	2	40	7.2619	0.0020	

Tab. 35. ANOVA output for variables with N>25, showing differences between males and females in particular measurements (for codes refer to Chapter 4.2 – Size and robusticity analyses). Categorical values encountered during processing for variable 'SEX' are: (3 levels) f, m, n.



a. clavicle, anterior-posterior diameter

b. humerus, epicondylar breadth

c. radius, anterior-posterior diameter

d. femur, medial-lateral subtrochanteric diameter

e. tibia, transverse diameter at nutrient foramen

f. calcaneus, maximal length

Fig. 40. Sex differences expressed through a series of ANOVA graphs based on the analyses in Table 35.

parate. The first set of analysis was performed on male sample (Tab. 36). Since there were no males with measurable postcranial remains in the Neolithic, the test included only two chronological units: Mesolithic and the Contact (Mesolithic/Neolithic).

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CAD	22	0.0049	CHRO	1	20	0.0986	0.7567	59
CSD	22	0.0100	CHRO	1	20	0.2027	0.6574	
HEB	28	0.0172	CHRO	1	26	0.4560	0.5055	
HMXD	33	0.0228	CHRO	1	31	0.7225	0.4018	
HMND	33	0.0012	CHRO	1	31	0.0376	0.8476	
RAPD	27	0.0099	CHRO	1	25	0.2495	0.6218	
RMLD	27	0.0426	CHRO	1	25	1.1125	0.3016	
UMC	21	0.0049	CHRO	1	19	0.0936	0.7630	28
FMDH	23	0.0658	CHRO	1	21	1.4795	0.2373	
FASPD	34	0.0032	CHRO	1	32	0.1022	0.7512	
FMLSD	33	0.0128	CHRO	1	31	0.4027	0.5303	
FAPM	36	0.0904	CHRO	1	34	3.3786	0.0748	
FMLM	36	0.0318	CHRO	1	34	1.1166	0.2981	7
FMC	33	0.0008	CHRO	1	31	0.0243	0.8771	
TMDNF	22	0.0820	CHRO	1	20	1.7869	0.1963	34
TTDNF	23	0.1543	CHRO	1	21	3.8309	0.0637	20

Tab. 36. ANOVA output for chronological units. Categorical values encountered during processing are CHRO: (2 levels): M, M/N. Males only.

It is obvious that none of the changes from Mesolithic to Contact period is significant even without reducing the 'p' by Bonferroni procedure. The only two variables that show a slightly more important change from Mesolithic to Contact period are TTDNF (0.0637) and FAPM (0.0748), but neither the transverse diameter at nutrient foramen for tibia nor the anterior-posterior midshaft diameter for femur show a statistically significant change between the two periods.

Females were subjected to the same test (Tab. 37). In the first run of the analysis all three chronological periods were kept and the tests were run with 2 degrees of freedom. The aim of the test was to show whether there was any significant change in size variables among females over 1500 year timespan. Since there were three periods in question a post-hoc Tukey test (*Wilkinson et al. 1996*) was run together with the ANOVA in order to ascertain, for those variables that showed significant differences, between which periods the difference appears.

Dep Var	N	Sq multR	sourc	df	df	F-ratio	P	outliers
CML	20	0.0330	CHRO	1	18	0.6143	0.4434	35
CAD	34	0.0921	CHRO	2	31	1.5729	0.2236	66
CSD	33	0.0278	CHRO	2	30	0.4296	0.6547	
HEB	28	0.0939	CHRO	2	25	1.2952	0.2916	20, 43
HMXD	36	0.0938	CHRO	2	33	1.7085	0.1968	20
HMND	36	0.0866	CHRO	2	33	1.5635	0.2245	
RAPD	37	0.2288	CHRO	2	34	5.0441	0.0121	
RMLD	37	0.1174	CHRO	2	34	2.2612	0.1197	
FMDH	27	0.1165	CHRO	2	24	1.5824	0.2263	20
FASPD	44	0.0559	CHRO	2	41	1.2135	0.3076	20
FMLSD	45	0.1679	CHRO	2	42	4.2374	0.0211	49
FAPM	40	0.1466	CHRO	2	37	3.1777	0.0533	
FMLM	39	0.1268	CHRO	2	36	2.6142	0.0871	
FMC	37	0.0616	CHRO	2	34	1.1163	0.3392	63
TMDNF	33	0.0319	CHRO	2	30	0.4947	0.6146	35
TTDNF	31	0.0623	CHRO	2	28	0.9308	0.4061	
TCNF	28	0.0680	CHRO	2	25	0.9123	0.4146	
CCML	24	0.0865	CHRO	2	21	0.9947	0.3866	
CCMB	27	0.2680	CHRO	2	24	4.3929	0.0237	

Tab. 37. ANOVA output for chronological units. Categorical values encountered during processing for variable 'CHRO' are: (3 levels): M, M/N, N. Females only.

Several variables had p values at a level of significance without the Bonferroni procedure. In the case of examining chronological units, 19 variables with more than 20 measurable individuals were subjected to the test. When the reduced value of 'p' was applied (0.05/19 = 0.0026) none of them were significant. They were however examined in order to avoid the Type II error. These are RAPD (Tab. 38) (0.0121), FMLSD (Tab. 39) (0.0211), FAPM (Tab. 40) (0.0533), and CCMB (Tab. 41) (0.0237). For codes refer to the listing of variable labels in Chapter 4.2. While searching for significance is not necessarily an invalid method, the inference based on obtained significance is not as straightforward as it would be with hypothesis testing that involves only a limited number of variables (*Moore 1991.420*).

Upon examining the graphs produced with these variables in Figure 41 it becomes obvious that Neolithic females exert strong influence on the results. This finding in itself would be extremely significant for the present study, but for the fact that the number of Neolithic females with measurable postcranial bones is at most 4. This restricted number cautions against potential bias, and more analyses were deemed necessary. The results of the Tukey "post-hoc" tests on ANOVA show the same. It is also important to note that two of the four significant variables (Tabs. 39, 40, Figs. 41 b, c) show differences only between periods that are the most removed temporally, Mesolithic and Neolithic.

Only two of these measurements show significant differences between Contact and Neolithic period: RAPD, and CCMB. Given that the number of females who belong to Neolithic with these variables measurable is three and two respectively, we can not argue that the results are meaningful. Even if these variables were different between periods without any reasonable doubt, explaining these differences in any of the proposed terms is scientifically dubious.

While the pattern for the four variables shows a significant decrease in size from Mesolithic pre-contact to Neolithic population, they should be considered with great care due to the very restricted number of Neolithic individuals. These trends are observable

Post Hoc test of RAPD. Using model MSE of 91.224 with 34 df. Matrix of pairwise mean differences: 1 M, 2 M/N, 3 N

	1	2	3
1	0.0		
2	0.9848	0.0	
3	−17.8485	−18.8333	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.9556	1.0000	
3	0.0124	0.0118	1.0000

Tab. 38. Post Hoc test of radius anterior-posterior diameter. Females only.

Post Hoc test of FMLSD. Using model MSE of 929.631 with 42 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	−18.8375	0.0	
3	−47.1884	−28.3509	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.1265	1.0000	
3	0.0405	0.3028	1.0000

Tab. 39. Post Hoc test of femur medial-lateral diameter. Females only.

Post Hoc test of FAPM. Using model MSE of 1122.611 with 73 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	−9.9414	0.0	
3	−51.8333	−41.8919	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.4180	1.0000	
3	0.0320	0.1005	1.0000

Tab. 40. Post Hoc test of femur anterior-posterior diameter. Females only. Females only.

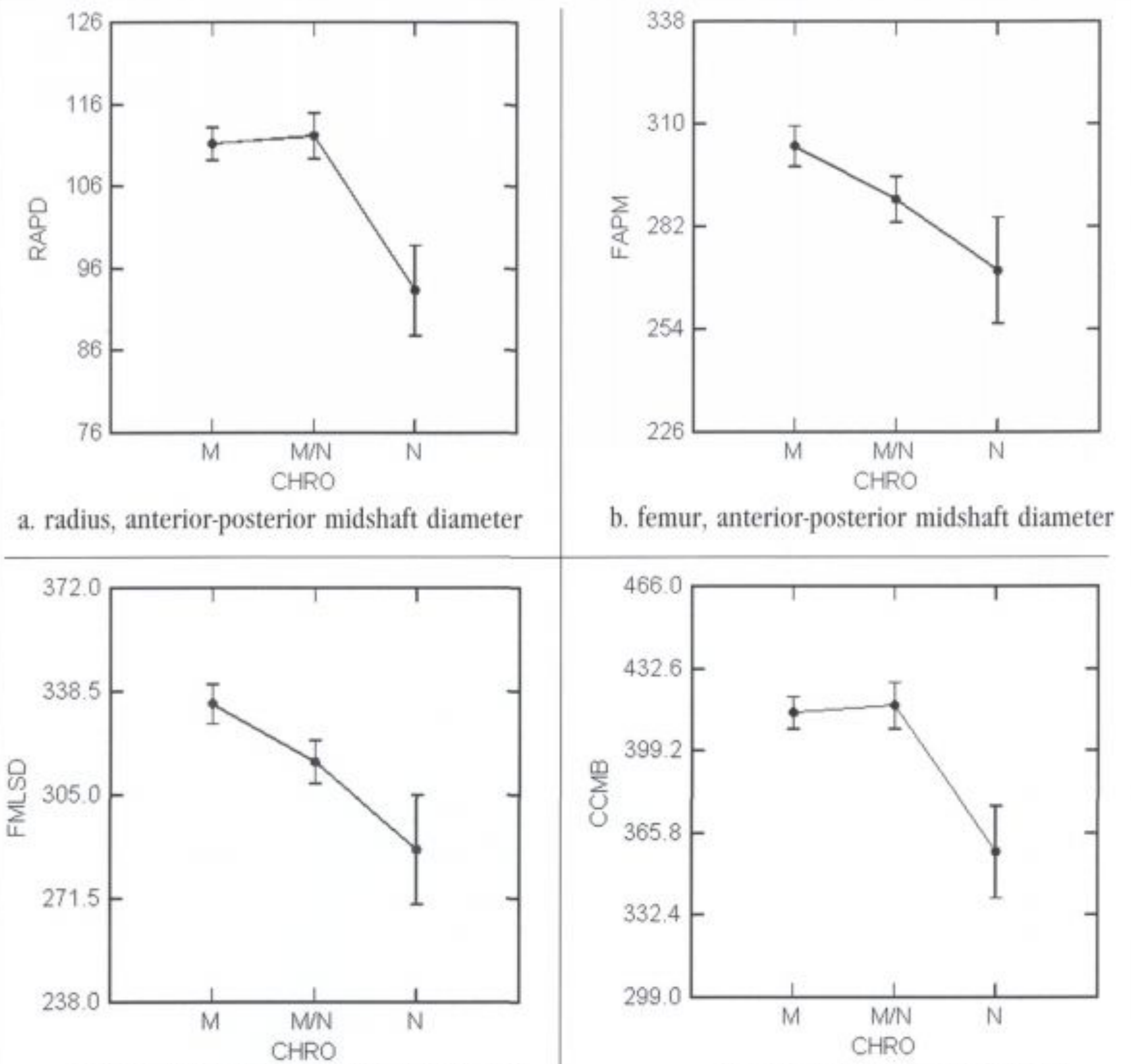
Post Hoc test of CCMB. Using model MSE of 705.559 with 24 df. Matrix of pairwise mean differences:

	1	2	3
1	0.0		
2	2.9191	0.0	
3	−56.7059	−59.6250	0.0

Tukey HSD Multiple Comparisons. Matrix of pairwise comparison probabilities:

	1	2	3
1	1.0000		
2	0.9645	1.0000	
3	0.0229	0.0237	1.0000

Tab. 41. Post Hoc test of calcaneus maximal breadth. Females only. Females only.



a. radius, anterior-posterior midshaft diameter

b. femur, anterior-posterior midshaft diameter

c. femur, medial-lateral midshaft diameter

d. calcaneus, maximum breadth

Fig. 41. ANOVA graphs of chronological differences. Variables showing statistical levels of significance. Females only.

in females and need not follow the same pattern in males.

In conclusion, a certain amount of size reduction in several variables shows a secular trend from Mesolithic to Neolithic. These changes could be due to small sample sizes and un-representativeness of the population, or they can be indicative of some degree of size reduction over time.

5.4.2. Principal Component Analyses for metric data

ANOVA tests performed in search of significant differences in variables are an effective tool for appreciating the amount of difference between certain subgroups in the population. They are more appropriate and informative when testing a tight hypothesis, and where the results are more or less consistently significant (as in the case of sex differences in the first test). They should not be used to search for a pattern of grouping or change (*Moore 1991*).

For exploration of the pattern of grouping within the population, a more appropriate method is Principal Component Analysis (*Baxter 1993; Shennan 1988*). PCA is commonly used by archaeologists and anthropologists for morphological (or typological) analysis. The most obvious advantage of the PCA and other multivariate techniques is the ability to provide us with information based on the analysis of more than one variable at the time. PCA also reduces the number of dimensions in which a series of vectors (derived from correlations of variables) can be represented and thus makes observations of patterning of distances between individuals amenable to graphic representation in two or three-dimensional plots.

The conceptual problem that has to be kept in mind in interpreting data derived from these analyses is that, since it is obtained by a series of mathematical operations, that can always be carried out, it need not represent any true patterning (*Baxter 1993:49*). Care should be taken, as with many statistical procedures, not to over-interpret the resulting diagrams. Lack of explicit patterning, especially if the grouping variable is an archaeological observation, could be considered as a strong indication of continuity across chronological periods or homogeneity between cultural groups examined. A brief explanation of the selection of variables, number of factors and resulting scatterplots is offered. Since the number of skeletons that have all of the variables measured is very low, several analyses were run in order to maximise the number of individuals contributing to the factor scores as well is represented on the scatterplots. The first plot (based on Table 42, Figure 42) recapitulates the already obvious distinction between males and females and is offered here only as an example of a plot with an obvious pattern of grouping.

The first set of analysis was run with variable "sex" as grouping variable on the available upper limb bone measurements. Here, of the total computer output, only eigenvalues and variable scores are presented, together with the amount and percent of variance explained by the 2 factors.

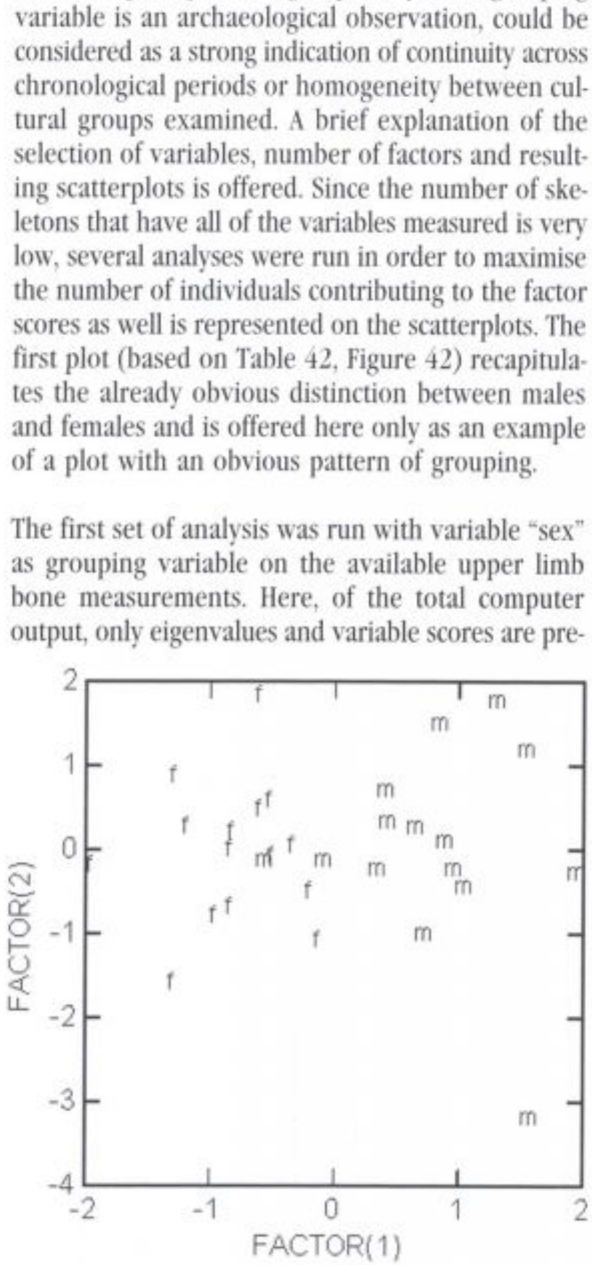


Fig. 42. Scatterplot of factor scores for upper limb bones. Grouping variable sex: "f" for females and "m" for males.

Latent Roots (Eigenvalues)				
1	2	3	4	5
4.6516	0.7521	0.5287	0.4605	0.2675
6	7			
0.2162	0.1234			
Component loadings				
	1	2		
CAD	0.7783	0.2270		
CSD	0.7150	−0.5177		
HEB	0.8656	0.1492		
HMXD	0.7186	0.5663		
HMND	0.9076	−0.2511		
RAPD	0.8931	0.0176		
RMLD	0.8047	−0.1620		
Variance Explained by Components				
1	2			
4.6516	0.7521			
Percent of Total Variance Explained				
1	2			
66.4521	10.7443			

Tab. 42. PCA output for upper limb bone measurements. Grouping variable "sex".

An important feature of the scatterplot in the Figure 42 is almost perfect separation of males and females on the factor (1), and practically no separation on the factor (2) except for the male individual in the lower right corner, Vlasac 26. It is evident that the size (factor 1), plays a major role in the separation of sexes. Following this analysis, the individuals were labelled according to the chronological unit – M (Mesolithic), C (Contact) and N (Neolithic). Three sets of data were examined: a combination of variables of upper limb bones, lower limb bones and a selection of variables that had shown significant difference between Mesolithic and Neolithic in a separate ANOVA test.

As opposed to the previous scatterplot (Fig. 42), the one in Figure 43 (based on analyses in Table 43) does not show any clear separation of individuals by period. The overlap is strong and argues for continuity in respect to upper limb bone size.

Table 44 presents the results for femur and tibia measurements.

As visible from the Figure 44, the measurements of the lower limb show even less patterning.

Latent Roots (Eigenvalues)				
1	2	3	4	5
4.6516	0.7521	0.5287	0.4605	0.2675
6	7			
0.2162	0.1234			
Component loadings				
	1	2		
CAD	0.7783	0.2270		
CSD	0.7150	–0.5177		
HEB	0.8656	0.1492		
HMXD	0.7186	0.5663		
HMND	0.9076	–0.2511		
RAPD	0.8931	0.0176		
RMLD	0.8047	–0.1620		
Variance Explained by Components				
1	2			
4.6516	0.7521			
Percent of Total Variance Explained				
1	2			
66.4521	10.7443			

Tab. 43. PCA output for upper limb bone measurements. Grouped by "chronology."

PCA analysis with variables selected on the basis of significant results in ANOVA tests (Tabs. 36 and 37) on Mesolithic and Neolithic, result - unexpectedly - in a picture of patterning (Tab. 45 and Fig. 45a).

In order to ascertain whether there is indeed a pattern of distribution that argues for a change between Mesolithic and Contact, the scatterplot based on these variables labelled by chronology units is presented together with the one of the same variables labelled by sex in Figure 45a and b.

The superposition of these two scatterplots clearly shows that the pattern of separation along both axes results from small sample size and unequal representation of males and females that have the selected variables measured in the two chronological units.

The only apparent patterning occurs among males, who seem to scatter far more than females. Although the total number of individuals presented by any of these graphs does not warrant overly sophisticated conclusions, this pattern cannot be neglected. The two outliers present among males in Figure 45 - Vlasac 26 and Vlasac 78 - require explanation. They were scrutinised for reconstructed or substituted measurements, since only one (preferably left) side of the individual was recorded. It was substituted with the right bone measurement only in instances where the left bone was missing. This is especially important in the upper limb where lateralisation can induce significant differences between paired bones (*Buikstra and Ubelaker 1994*). During the initial statistical screening I have checked for comparability of left and right bones and since no significant differences were observed in any of the tests, decided that the substitution of left with right bone measurements was acceptable. Both individuals that are definite outliers in the graph have significant number of measurements substituted. Other individuals on the graph, that form a much more homogenous picture, also have substituted measurements, but they differ in respect to the type of the bone. Among outliers, Vlasac 78 has radius and femur substituted, while in Vlasac 26 all three bones that are analysed are substituted. Among those that scatter more consistently Vlasac 50a and Vlasac 17 have all femoral measurement substituted while others have all left bones present. The two outliers were, consequently, removed from further consideration. However, the males still showed less homogeneity than females. Unfortunately, this argument cannot be furthered and explored in more detail, as the number of individuals amenable to this analysis is too restricted.

The results of both ANOVA and PCA analysis suggest heterogeneity of the population in both Mesolithic

Latent Roots (Eigenvalues)					
1	2	3	4	5	6
6.5071	0.5354	0.3590	0.1980	0.1429	0.1138
7	8				
0.1127	0.0311				
Component loadings					
	1	2			
FMDH	0.8433	0.4106			
FASPD	0.8697	–0.2063			
FMLSD	0.8703	–0.3814			
FAPM	0.9733	0.0919			
FMLM	0.9273	–0.1372			
FMC	0.9373	–0.1645			
TMDNF	0.9222	0.0619			
TTDNF	0.8636	0.3473			
Variance Explained by Components					
1	2				
6.5071	0.5354				
Percent of Total Variance Explained					
1	2				
81.3382	6.6924				

Tab. 44. PCA output for lower limb bone measurements. Grouped by "chronology."

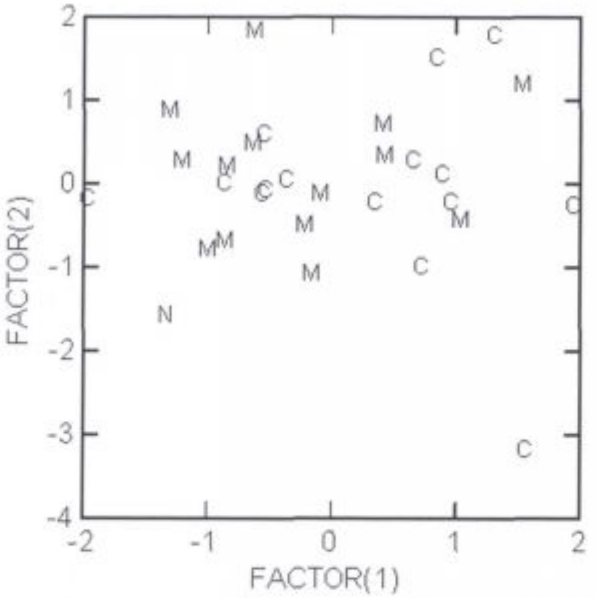


Fig. 43. Scatterplot of factor scores for upper limb bones. Grouping variable chronology: "M" for Mesolithic, "C" for Mesolithic/Neolithic contact period and "N" for Neolithic period.

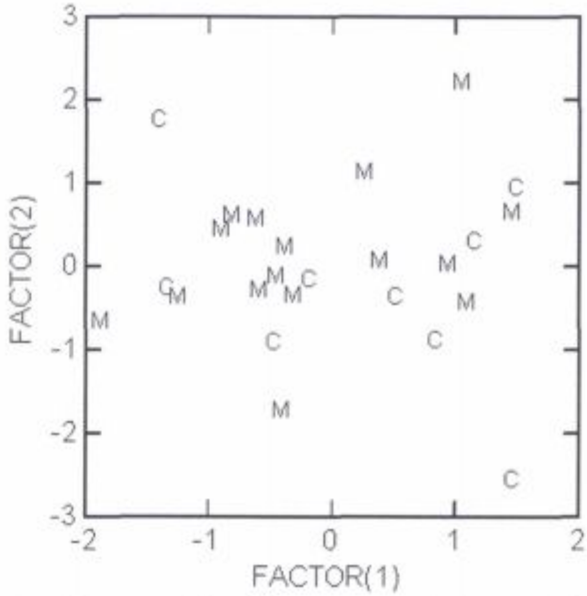


Fig. 44. Scatterplot of factor scores for lower limb bone measurements. Grouping variable chronology: "M" for Mesolithic and "C" for Mesolithic/Neolithic contact period.

and Mesolithic/Neolithic Contact period. It is difficult to draw any conclusions about the Neolithic population considering that only females could be examined, however, on the basis of the analyses presented, there is no reason to suppose a different pattern for the Neolithic. Further, no clear distinction between the three periods can be made on the basis of either single measurements or a combination of measurements. Although examining different sets of variables and rotating the PCA could produce an explicable pattern eventually, as even random numbers will take on some form of patterning in repeated trials, the presented evidence does not warrant such an exercise since the picture presented across different methods is consistent.

Latent Roots (Eigenvalues)					
	1	2	3	4	5
	5.5315	0.6272	0.3505	0.2028	0.1394
	6	7			
	0.0937	0.0548			
Component loadings					
	1	2			
HMXD	0.8351	0.3499			
RAPD	0.9252	–0.0891			
RMLD	0.7289	–0.6480			
FMDH	0.9283	–0.1310			
FASPD	0.8948	0.0969			
FMLSD	0.9415	0.1766			
FMLM	0.9476	0.1385			
Variance Explained by Components					
	1	2			
	5.5315	0.6272			
Percent of Total Variance Explained					
	1	2			
	79.0214	8.9606			

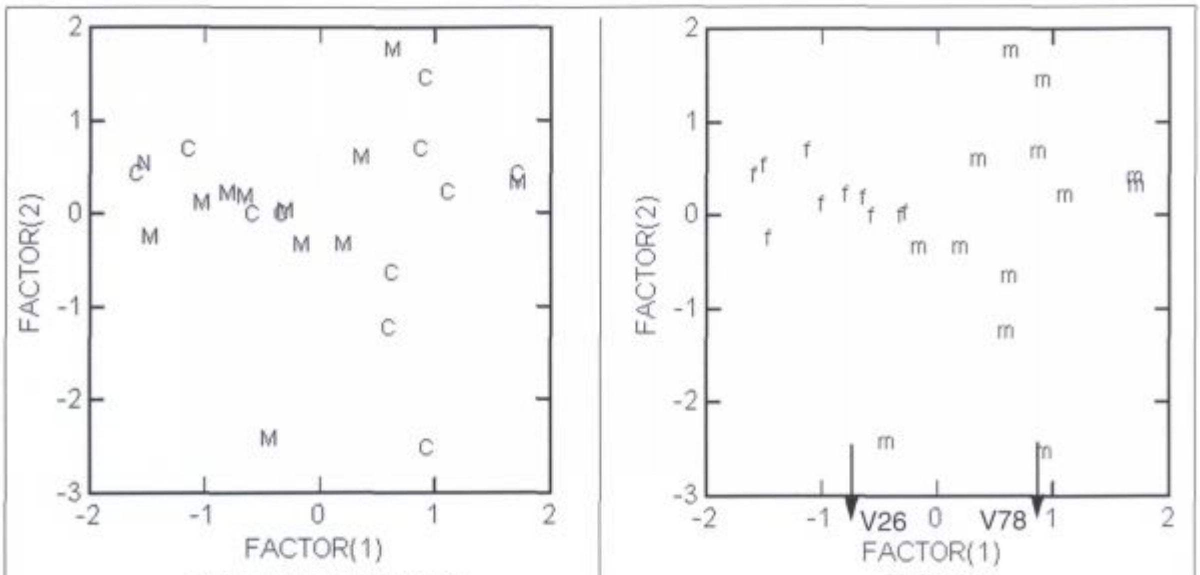
Tab. 45. PCA output for a combination of significant measurements. Grouping variable "chronology." Both males and females.

6. DISCUSSION

In the following sections comparisons will be made between the results presented here and previous research on morphometric analysis (Ch. 6.1). The influence of archaeological interpretations on conclusions reached by anthropologists is discussed in Chapter 6.2. and 6.3. reviews observations of biological phenomena that were derived independently of archaeological interpretation. Interpretation based on several lines of inference is offered in the Chapter 7.1 and a review of planned future research is made in Chapter 7.2.

6.1. Insights from previous anthropological research

As already mentioned, most of the previous anthropological research in the Iron Gates Gorge was based on comparisons of metric data for the two sites that had yielded larger numbers of measurable cranial



a) by chronological unit

b) by sex

Fig. 45. Scatterplots of factor scores for a combination of variables with grouping variables a) chronology and b) sex.

remains, namely Vlasac and Lepenski Vir. One of the first syntheses came from Nemeskeri and his colleagues (*Nemeskeri 1969; 1978; Nemeskeri and Lengyel 1978b; Nemeskeri and Szathmary 1978a; 1978b; 1978d; 1978e*). Nemeskeri's research was very influential and remains one of the most comprehensive studies of the Vlasac material. Here, the conclusions of his research are presented in light of the questions investigated in the present study.

In a comprehensive study of Vlasac osteological material, Nemeskeri and Szathmary (*1978a.178*) conclude that, in view of the time-interval covered by the series, the variations of quantitative and qualitative traits do not indicate any significant heterogeneity. They, however, observe certain differences between chronological sub populations in which heterogeneity is more pronounced within the male and far less pronounced in the female group. In this work, the same results are indicated by the PCA scores scatterplot for a selected number of measurements in Figures 42 and 45b. These figures show greater spread of males along both axes while females tend to cluster more tightly. The measurements and indices of the facial skeleton in females show homogeneity while in males they do not. An inverse pattern, with females more variable than males, is observed only in the case of the neurocranium.

Although the authors rightly caution against too strong a reliance on the analysis based on such a restricted number of individuals (1.5 to 2.7 individuals per generation, not all of which were sufficiently preserved to allow all observations and measurements), they proceed with distinguishing two major taxonomic units with further subdivisions.

These taxonomic units, described as "A" and "B," follow the general chronological outline proposed by Srejović and Letica (*1978*). While the first sub group was represented by an Upper Palaeolithic local population similar to Brünn-Predmosti type (A-1) with two distinct local variants, Cro-Magnon characteristics were present in sub group A-2. The B type is characterised by two phenomena, (1) mixed occurrence of type A-1 and A-2 characters; and (2) a significant and gradually growing tendency for gracilisation. Further subdivision of type B gives the B-1 form, parallel to the A-2 more archaic form, and B-2 form, later in the sequence, that "further developed the peculiarities of the local form A-2 but in a gracile manifestations" (*Nemeskeri and Szathmary 1978b.180*). In Nemeskeri's comparisons with Lepenski Vir, which was viewed by Srejović (*1972*) as presenting phase displacement compared to Vlasac, the local A-1 group would not be present, the A-2 group is of more definite (unmixed) Cro-Magnon type, and the gracilisation is more evident. Furthermore, according to the blood type analysis, females from Vlasac would be more closely related to both males and females from Lepenski Vir than to males from Vlasac (*Nemeskeri and Lengyel 1978a.276*)

In conclusion, Nemeskeri and Szathmary state that the archaic A-1 type might have been the "initial ethnic stratum at Vlasac" followed by a migration of another local type. The formation of the A-2 subtype (characterised as Cro-Magnon "race") in the Iron Gates population preconditions the intensification of the ethnic contact. From it a mixed type B arises, and in later phases becomes more gracile. At Lepenski Vir, which starts slightly later in the Vlasac sequence, the first local Brünn-Predmosti type would be missing and the population would be characterised by the "Cro-Magnon race and its subtypes" (*Nemeskeri and Szathmary 1978b.182*).

Given recent understanding of problems associated with "racial taxonomy" (*Jacobs et al. 1996*), these conclusions could be either rejected or incorporated into a different understanding of population genetics and micro evolutionary changes. Given the great experience and wealth of knowledge (albeit within a different paradigmatic approach) of Nemeskeri, it would be presumptuous to disregard his findings. If his findings are red without the taxonomic labels that he has put on them, a clearer picture can be gained from his conclusions. Several characteristics of the population can be identified:

- Great heterogeneity within the local Mesolithic population. This coincides with the conclusions of independent examination of sites/chronology units in 5.3.3a and is well demonstrated in Figure 37.
- Greater heterogeneity within the male group and greater homogeneity within the female group. Similar conclusions can be derived from the metric analysis of the postcranial skeleton in Figures 42 and 45b.
- Temporal trend of gracilisation. Although it could be indicated by some of the results in the ANOVA tests (Tab. 37 and Fig. 41), the findings of this research do not support the conclusion. Further, the small sample size in Neolithic does not permit any firm conclusion.
- Trend toward homogenisation of the population in later phases that Nemeskeri attributes to greater inter-group gene flow. This could be supported by stronger clustering of Mesolithic/Neolithic components from different sites in Figure 34.

In this generalised form, Nemeskeri's findings correspond, to a great extent, to the results of the current research. However, the fine-grained distinctions, that the authors made in the discussion on the basis of such restricted material evidence - even within the framework of the "anthropotypology" - are not as convincing.

Nemeskeri and Szathmary's conclusions were based on analysis of Vlasac, regarded as a sub population within the Iron Gates population. Concerning the Lepenski Vir material, in a preliminary report Nemeskeri (*1969*) concludes that the Mesolithic strata contain the finds of Cro-Magnon type, while the Neolithic strata show most probably three distinct types belonging to the Mediterranean taxon.

The first synthesis on the Iron Gates material comes from Mikić (*1980; 1981a; 1981b; 1988; 1992*). Following general divisions into A and B types outlined by Nemeskeri and Szathmary, Mikić developed an explanatory scheme that accounts for possible processes that could have induced the change within the series (*Mikić 1981a.104, Fig. 1*). In his first synthesis of the material, strongly influenced by Srejović's appreciation of indigenous Lepenski Vir cultivation and domestication, Mikić proposes that micro evolutionary trends at Lepenski Vir could account for gracilisation as a consequence of neolithisation. He has introduced another set of "types," all based on generalised "Mediterranean" morphology: 'Long-headed Mediterranean', 'Lepenska variety of Mediterranean', and 'Robust Narrow-headed Mediterranean.' All of these were derived through micro evolutionary processes from the "Cro-Magnon" type. This micro evolution occurs within the layer II of Lepenski Vir, and subsequent changes in both shape and size of the skeletons occur without interruption into the Neolithic, eventually producing 'Gracile Mediterranean' and 'Generalised Mediterranean' types. The introduction of the 'Mediterranean' label, however, does not imply the movement of Mediterraneans into the region, and he argues for local evolution from one "type" to another. Abandoning the typological classification in his later works (*Mikić 1988; 1992*), the author argues for local continuity and isolation stressing the morphological similarities between the Palaeolithic Climente specimen and Late Mesolithic and even Neolithic individuals from Lepenski Vir (*Mikić 1992.40*).

Padina and Hajdučka Vodenica were very summarily treated by Živanović and most of the conclusions were based on archaeological interpretation of the sites. Thus, on the basis of morphological examination, he singles out seven skeletons belonging to the Lepenski Vir culture on the site of Hajdučka Vodenica, attributing all others to the Iron Age stratum (*Živanović 1976c*). Considering that in this research Mesolithic/Neolithic finds from Padina and Hajdučka Vodenica cluster together in all of the analyses performed, and that Hajdučka Vodenica does not show any deviation from other sites in the region when the material is treated as a whole, there are no grounds for this morphological separation. Although Živanović claimed that he has recognised a number of more robust skeletons belonging to the "Padina racial sub-group" and substantially more gracile ones belonging to a much later population (*Živanović 1976c.124*), I was unable to make any such distinction once the skeletons were sexed. This 'Padina sub racial group' is viewed as autochthonous, different from all other known groups and best described as "Obercassel type of the Dinaric race" (*Živanović 1975a; 1975b*). Živanović ascribes to Nemeskeri the conclusion that Lepenski Vir belonged to the same "Proto-Dinaric" population, however, Nemeskeri disclaimed this quote (*Nemeskeri and Szathmary 1978b.180*). In summary, both Hajdučka Vodenica robust individuals and Padina in general are very similar. This finding is confirmed by all of the analyses performed in this research. As opposed to Živanović's interpretation, apart from pronounced sexual dimorphism, no evidence of an extremely gracile group was found at Hajdučka Vodenica.

While Živanović does not discuss the series as a whole, the other authors, working within the paradigm of racial typology, agreed on one important aspect of the material, essential continuity within the region. All of the changes were attributed to microevolution towards more gracile forms with intensification of contacts and admixture at the time of Vlasac II/Lepenski Vir I phases. None of the authors perceives any abrupt change in the Neolithic populations of the region. Schwidetzky and Mikić (*1988*) argue that gracilisation cannot be assumed to coincide with Neolithic adaptation. They reach the conclusion that the high rates of change support the microevolutionary processes in the Iron Gates rather than abrupt change in population (*Schwidetzky and Mikić 1988.117*). It is hard to see how the observed greater degree of gracilisation in Neolithic Lepenski Vir as compared to some other anthropological series, in itself demonstrates continuity. Even more problematic is the grouping of Lepenski Vir II and III into a single unit (comprising 13 measurable skeletons) and a small number of measurable individuals attributed to Lepenski Vir I as only four measurements could be taken on all four individuals attributed to the period. For the other 18 measurements the representation is even worse: 13/28 could not be taken on any individual and 5/18 varied between 1–3 individuals.

Quite a different conclusion was reached by Menk (*Menk and Nemeskeri 1989*). While he also claimed a sharp decrease in robusticity between the Terminal Mesolithic and Early Neolithic of the series, as well as considerable change in shape, the author concluded that the change cannot be explained by local evolution, but rather by a progressive replacement of the population. Menk has applied PCA to cranial and postcranial measurements provided by Nemeskeri (presented here in Figure 46). Missing values were reconstructed by estimation from iterative regression. This approach is problematic as it reconstructs, on the basis of regression, those elements that it sets to distinguish as potentially different. Although it gives more specimens for which the observations can be made, it can either accentuate or distort the observed difference. After computation of the 'z' scores for individuals, the sexes were pooled. The Lepenski Vir material is divided into Mesolithic and Neolithic samples while Vlasac was divided into five samples: 'Vlasac 1', 'Vlasac 1?', 'Vlasac 2/3' and two 'undetermined' samples. As Menk notes, the Lepenski Vir Neolithic sample "fractions into three parts with a remarkable gap in the central part of its area" (*Menk and Nemeskeri 1989. 534*).

In itself, coupled with a small sample size and a problematic pooling of the sexes, this finding can invalidate the analysis since the central value of the Neolithic Lepenski Vir population is derived from the strong dissimilarity of the individuals of which it is made. Similarly, this phenomenon is shown even by those ANOVA plots that do show significant differences among the three periods examined in this work in Figure 41, if we observe the variance around the least square means for the Neolithic sample. In two of the four examples presented (anterior-posterior midshaft diameter and medial-lateral midshaft diameter of the femur) the spread of the values around the means overlaps with the spread of the previous period. The other two measurements (anterior-posterior midshaft diameter of radius and maximal breadth of calcaneus) show a slight increase in size in the Contact period and accentuate the problem of small sample size.

A look at the PCA graphic output for components 1, 2 and 3 that Menk and Nemeskeri offer (Fig. 46), shows strong differentiation along axis 1 (corresponding to size) for Lepenski Vir Mesolithic and Lepenski Vir Neolithic. But, the same is true for the distance between 'Vlasac 1' and '1?' and 'Lepenski Vir Mesolithic'. However, the distance between the two on the 2, 3 axis (measuring some form of shape differentiation) is small. It is, in effect, much smaller than between 'Vlasac 1' and 'Vlasac 1?'. Furthermore, the

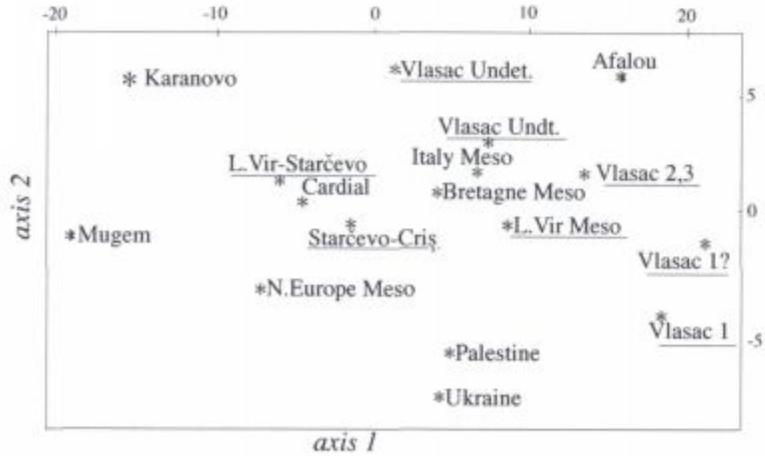


Fig. 46. Menk's scatterplot of PCA scores for different Mesolithic and Neolithic sites. (*Adapted from Menk and Nemeskeri 1989.Fig. 1*).

Starčevo-Cris Neolithic sample seems to be less, removed on the size axis from Mesolithic Lepenski Vir and practically identical with it on the shape axis (axis 2, 3). The only actual difference between different subsamples on the "shape" axis is between Vlasac 1 and Vlasac 2, 3 that show as much difference on the size axis as Lepenski Vir Mesolithic and Neolithic samples. Unfortunately, while the composition of Vlasac and Lepenski Vir can be reconstructed from Nemeskeri's earlier publications discussed above, no indication is given as to what constitutes the Starčevo-Criş sample, or which measurements were considered in the analysis. The conclusion, although not necessarily wrong, cannot be demonstrated on the basis of the published results, and the explanation given in the abstract seems to be contradictory to the conclusion of the paper. The unfortunate fact that the article was finished by the editors rather than Professor Menk, who died before the paper was submitted, could explain some of these inconsistencies. However, the article offers an interesting view on Mesolithic heterogeneity that is in accordance with all other published results. It is also important that, whenever it was possible to reconstruct from published results, the amount of change seems to be most pronounced in the period that is here understood as Contact.

6.2. Insights from archaeological interpretations of the sites

As we have seen from the previous section, archaeological interpretation has exerted a strong influence on the interpretation of (mostly craniometric) data, not only in the initial divisions of the population according to the chronological data derived from archaeology, but also in respect to understanding general processes in the region. To some extent, the findings of both Nemeskeri and Mikić were strongly influenced by Srejović's (*1969*) initial claim that the neolithisation of the region was a process resulting from the indigenous intensification of plant use and domestication in the region. While this domestication remained within the ritual context for a long time, its ripening into an economic category was eventually accomplished in the Lepenski Vir IIIa phase (*Srejović and Babović 1983*). Accordingly, the Lepenski Vir culture would combine the characteristics of both Mesolithic and Neolithic economy and would eventually become fully Neolithic in its Starčevo (IIIb) phase. In this context, Srejović (*1972*) regarded Lepenski Vir IIIa as an early Proto-Starčevo period derived from the Iron Gates knowledge of agriculture, no longer kept secret from general population by a ruling clan or elders. The food production, until then known only within the ritual context and presumably used as a buffering mechanism, became common knowledge. This brought about the ruin of the social order and changed the mode of life. These provide an explanation for the abrupt change in the elements of architecture and material culture, even though both the major part of subsistence and the population remained the same. In this context, Mikić has explained the gracilisation, evidenced starting from the Lepenski Vir II, as resulting from a larger share of domesticates and plant foods in the diet, boiled now that pottery was available (*Mikić 1988; 1992; Srejović 1969*). Similarly, Srejović's interpretation of the chronological relationship between Vlasac and Lepenski Vir and his ideas concerning the movement of the population within the region is strongly reflected in the typological analysis by Nemeskeri and Szathmary (*1978a; 1978b*) and their claim that Lepenski Vir, not having the first initial Vlasac phase in the sequence also does not have any of the individuals belonging to the most archaic group A-1.

While it is obvious that the archaeological framework strongly influences the anthropological results, and while anthropological patterning cannot be understood without the context of archaeological explanation, the work of Živanović on Hajdučka Vodenica is very illustrative of the inherent problems in preconceived archaeological ideas influencing anthropological finds. As mentioned earlier, Živanović has maintained that he can distinguish between the Mesolithic and the Iron Age components at Hajdučka Vodenica on the basis of morphological and epigenetic traits. This distinction (not confirmed by any of the analyses in the present study) can be understood only in the context of the initial dating of Hajdučka Vodenica into the Iron Age, which was later recognised as wrong by the principal investigator (*compare Jovanović 1966 and 1984a*). A coincidence or a bias? Based on a current analysis of carefully reconstructed individuals and bones, there is no evidence for two different populations. On the contrary, Hajdučka Vodenica seems to be the most homogenous of all the sites, with a possible explanation of this homogeneity in the shorter time-span to which the burials belong.

Regarding Menk and Nemeskeri (*1989*), a different paradigmatic approach can be perceived, that of viewing the Neolithic in Europe (in general), and Balkans in particular, through the wave of advance theory (*Ammerman and Cavalli-Sforza 1971*).

Obviously, archaeological understanding of the processes responsible for observed changes not only have an important influence on understanding the anthropological data, they provide anthropologists with a necessary framework for data interpretation. It would be futile to attempt reconstruction of any past population on the basis of anthropological findings alone, as archaeology provides the necessary 'when', 'where' and possibly 'how' of the interpretation.

In that respect the review of archaeological understanding of the data offered in the Chapters 2 and 3 provides the necessary basis for understanding the observed phenomena. New research in the archaeology of the Neolithic transition, that regards the transition from both Neolithic as well as Mesolithic perspective (*Fischer 1995; Rowley-Conwy et al. 1987; Zvelebil et al. 1998*), new insights into the importance of the economic base for self identification in pre-industrial societies (see discussion in Chapter 2.3), and a shift from a dogmatic view of the transition to agriculture as diffusion of Neolithic invaders (*see Barker 1985 for a critique, also Chapter 2.2.*) needs to be considered and incorporated into a possible explanation of the observed pattern of anthropological data. Most importantly, great variability of population responses to the availability of agriculture (regardless of where the knowledge and the farmers come from), and the changing pattern of relationship over time need to be incorporated into any interpretation.

Confronted with the problem of expectations derived from archaeology which lead to conclusions not always firmly based in anthropology, I have deliberately not put forward any model that should be tested by the current analysis of the data. Of course, some expectations were based on the knowledge of published literature, but these have not necessarily been confirmed. An illustration of this is provided by the problem of gracilisation in the sample. I firmly expected to be able to demonstrate that a group of substantially more gracile individuals can be distinguished in the sample. This observation led to the inclusion of size indicators in the analysis and proved my initial expectations wrong. Size of the postcranial skeleton had no explicit connection with any of the periods, and rather, was a function of sex.

In order to avoid inherent bias in setting up the ideas to test, archaeological inference was consulted only in constructing chronological units. These are based on archaeological understanding of both stratigraphy and stylistic analysis of the burials (*Radovanović 1992; 1996a*). The division of chronological units into three periods based on changes in subsistence pattern was independent of any form of chronological sequencing and different archaeological interpretations. Even absolute dates were avoided in the design of the units. The designation of units is purely economic in the case of the Mesolithic and Neolithic, while Contact or Mesolithic/Neolithic period is determined on the basis of the *possibility* of contact between different subsistence groups often confirmed by presence of a small percentage (<5% suggested by *Zvelebil 1996a*) of domestic animals, introduction of ceramics, and Pre-Balkan plateau flint. Anthropological analysis was performed on independent data that should reflect the biological structure of the population. Statements based on anthropological data that can be regarded as independent from archaeological interpretation are reviewed in the following section.

6.3. Review of independently observed biological phenomena

The archaeological literature strongly suggests that the practice of agriculture is a non-indigenous adaptation in the Balkans. The exact mode of spread of agricultural practices in the region is much harder to ascertain. Although there is evidence of incipient domestication of pig and even suggested possible cultivation of cereals in the Iron Gates Gorge at the time of the Mesolithic Lepenski Vir culture (*Srejović 1972; Srejović and Letica 1978; Carciumaru 1978*), the full integration of the region into the Neolithic complex, recognised by the importance of domesticates – as opposed to wild species (both animals and plants) – happens very late in comparison to the rest of the Balkan Peninsula (Chs. 2 and 3).

The coexistence of Mesolithic and Neolithic modes of subsistence is demonstrated for over 1000 years in the region (*Radovanović 1996a and quoted literature*). In view of a proposed porous frontier between Mesolithic and Neolithic cultures in the studied region (*sensu Dennell 1985 and Zvelebil 1996a*), and traceable in the archaeological evidence, can we recognise the interactions between bearers of these respective cultures in the osteological material?

Skeletal material from all four sites containing human remains from the Contact period indicate that a greater admixture with a non-local population could have occurred at the time of the contact with the Neolithic people. From anthropological data, it is not possible to identify if this admixture occurs between local foragers and contemporary farmers, since a non-local population of foragers could have played an important role in bringing about the change in the genetics of the population.

Since there are not enough data on population biology of the Early and Middle Neolithic in the area, it is impossible to ascertain whether there were any mating networks established between foragers and farmers. Osteological material does not show any significant difference between Lepenski Vir Mesolithic and Starčevo Neolithic population at the one site in the Iron Gates Gorge where both are present. Furthermore, the data presented here argue strongly against the wave of advance model that proposes substitution of local foragers by incoming non-local farmers, even if the substitution is understood as partial and continuous. Therefore, spread of agriculture – in this restricted regional context – should be regarded as the adoption of economic practices by a local population. Furthermore, although cultural traits of Middle Neolithic are recognisable at Lepenski Vir IIIa and IIIb settlement, the adoption of agriculture is only partial, and hunting, fishing, and gathering remain economically important. Lack of abrupt change in activity/ occupation/ nutrition is further evidenced by a very slow change in postcranial metrics of the local population.

Several independent observations can be made:

- A strong case for regional continuity can be argued on the basis of both non-metric and postcranial size data. This is reflected in the pattern of sequence of Mesolithic, Contact and Neolithic against the outlier in non-metric analyses, as well as according to the almost total lack of significant difference among the three groups in metric variables. See specifically the results of analysis 5.3.1a and 5.3.2a in nonmetrics and Tables 36 and 37 in metrics.
- Although a case for a demonstrable degree of size reduction in certain variables can be argued, but only between the earliest and the latest periods, the restricted number of Neolithic skeletons and the fact that only females are represented cautions against over-eager adoption of the gracilisation phenomenon in interpretation. In this respect, the lack of significant difference between all but 4 variables for the whole series is especially instructive. This is even more significant in light of the common assumption that the Neolithic population would have deteriorating health/nutrition status and would be expected to show decrease in size (*Cohen 1977; Cohen and Armelagos 1984*). The expected size reduction was not observed in postcranial measurements in the series to a degree that could argue for a directional microevolution. A slight trend towards decrease in size of most variables is perceived in the Neolithic. This could be due to the restricted number of individuals and not any evident biological phenomenon.
- Non-metric traits show a more pronounced degree of difference between Mesolithic and Contact than Contact and Neolithic periods. In terms of metric data, on the other hand, Mesolithic and Contact are virtually identical, and Contact and Neolithic are more different for all of the significant results in metric analysis (again we need to remember the small sample size and that females only are represented). If indeed this represents a true situation and not a bias caused by a small number of individuals in the Neolithic, this discrepancy could be indicative of different levels of genetic *versus* occupational/nutrition changes. In that case, more genetic change could be proposed at the Contact period and more occupational change for Neolithic proper. Lack of evidence of caries and other oral pathologies in the population (*Frayer 1989*) argues against deteriorating nutritional conditions in the period. A secular trend towards reduction in both midshaft diameters of the femur (Fig. 41) is the only observation indicating size reduction in females over time. A more abrupt decrease in the Neolithic of anterior-posterior midshaft diameter in radius and maximum breadth in calcaneus (again, in females only) is more difficult to demonstrate.

Explaining these observations would involve over-interpreting scanty evidence.

- Based on both the patterning of distance in non-metric traits as well as craniometric analysis performed by other researchers (*Nemeskeri and Szathmary 1978a; 1978b; Mikić 1981a*) an underlying heterogeneity of the pre-contact Mesolithic population is observable. The underlying heterogeneity of the Mesolithic population provides adequate explanation for the observed heterogeneity in the later periods.
- There is a strong degree of sexual dimorphism in the population. This pattern is more evident and differently expressed in the postcranial skeleton than in the cranium. The extent of sexual dimorphism could argue for gender based division of labour associated with greater sedentism and incipient cultivation, as discussed in the Chapter 2.3.
- In terms of metric traits, males seem to be far more variable than females who show greater homogeneity (Figs. 42 and 45b.). This observation is confirmed by Nemeskeri and Szathmary (*1978a*) for Vlasac and Mikić (*1981a*) for Lepenski Vir, based on the cranial metrics. Furthermore, local group exogamy was forwarded as a possible explanation for differences in collagen signals between males and females in both Vlasac and Lepenski Vir (*Bonsall et al. 1997.83*). The blood typing also points to a possible non-local origin of Vlasac males (*Lengyel 1978.275; Nemeskeri and Szatmary 1978a*). Although no method by itself can prove this statement (as all of them have significant limitations); a number of independent observations leading in the same direction provides a good argument in favour of local exogamy and matrilocality. Although greater heterogeneity in male metrics can argue for differentiation in task roles, all other evidence supports the explanation of greater homogeneity of females as resulting from female-based lineage and matrilocality.

The above analysis (Tabs. 46, 47 and 48) was aimed at distinguishing the pattern of difference between males and females in Mesolithic and Contact periods. Neolithic group, being too small when split into male and female samples, was excluded.

Variable no.	MesoF	1	MesoM	2	MeNeF	3	MeNeM	4
1	10	20	20	24	11	19	5	20
2	6	29	5	29	9	33	6	29
3	19	34	21	36	19	36	15	28
4	7	33	2	33	6	32	5	21
5	12	17	12	26	9	17	16	21
6	23	34	19	34	27	40	20	33
7	5	17	6	30	16	37	7	28
8	13	34	14	35	11	37	10	38
11	16	36	3	43	1	37	2	34
13	3	41	5	25	0	23	7	23
23	8	23	9	17	9	16	6	18
15	12	30	6	27	10	24	5	19
17	5	15	11	21	3	20	1	12

Tab. 46. "k" and "N" values for traits. Combination of sex and chronology.

It is interesting to note that three differences are non-significant: between Mesolithic females and Contact males (demonstrated by a negative diFT - Table 47), between Mesolithic males and Contact females and between the two sexes in the Contact period. The most important is the difference between Mesolithic females and Mesolithic males. Somewhat less pronounced, but equidistant are Contact females from Mesolithic females and Mesolithic males.

The dendrogram in Figure 47 shows a pattern of "cross-clustering" that seems hard to explain:

s1	s2	name1	name2	mmdFT	sdFT	Stand FT	Total n	ZFT	diFT	SFT	f
1	2	MesoF	MesoM	0.1123	0.0299	3.7564	59	3.4185	0.0525	33.7378	FT
1	3	MesoF	MeNeF	0.0649	0.0289	2.2480	54	2.4915	0.0072	28.0609	FT
1	4	MesoF	MeNeM	0.0565	0.0296	1.9110	51	2.1880	–0.0026	25.8337	FT
2	3	MesoM	MeNeF	0.0580	0.0281	2.0669	55	1.6662	0.0019	22.2189	FT
2	4	MesoM	MeNeM	0.1125	0.0288	3.9103	52	2.4225	0.0549	27.5466	FT
3	4	MeNeF	MeNeM	0.0913	0.0300	3.0401	51	1.9211	0.0312	23.9509	FT

Tab. 47. The output of the statistical analysis for a combination of sex and chronology.

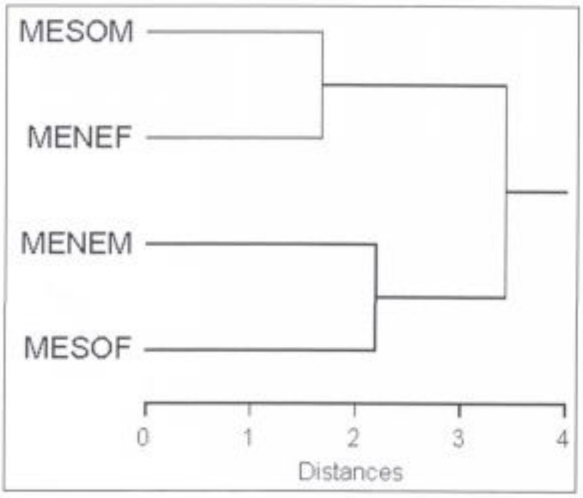


Fig. 47. Dendrogram showing the relationships between units based on a combination of sex and chronology. Based on dissimilarity matrix, Euclidean distance and Complete linkage.

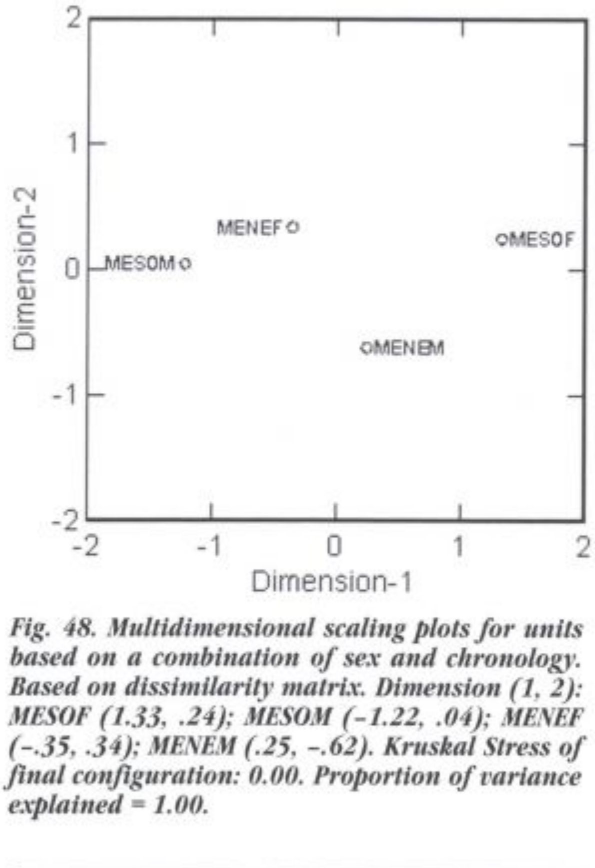


Fig. 48. Multidimensional scaling plots for units based on a combination of sex and chronology. Based on dissimilarity matrix. Dimension (1, 2): MESOF (1.33, .24); MESOM (–1.22, .04); MENEF (–.35, .34); MENEM (.25, –.62). Kruskal Stress of final configuration: 0.00. Proportion of variance explained = 1.00.

	MesoF1	MesoM2	MeNeF3	MeNeM4
MesoF1	0			
MesoM2	**3.4185**	0		
MeNeF3	**2.4915**	1.6662	0	
MeNeM4	2.1880	**2.4225**	1.9211	0

Tab. 48. Matrix of Z values for units based on a combination of sex and chronology. Significant relationships are outlined in bold.

males from Mesolithic cluster with females from Contact and males from Contact cluster with females from Mesolithic. Mesolithic females show as slightly more different from Contact males, than Mesolithic males are from Contact females.

Figure 48 shows much more clearly the greater homogeneity of females who, although they are as much removed on the dimension 1 as the male sample, appear practically indistinguishable in dimension 2. Males, on the other hand, are much more distant on the second dimension. This points towards a more homogenous picture for females in the two periods and could argue for matrilocality.

The fact that Mesolithic males and females are the most removed on the first dimension, and only slightly removed on the second as well as very similar to Contact females, while Contact male sample seems to be the most removed from all of them could suggest that:

- some males from a more distinct male group moving in at the time of contact and
- greater homogenisation at the time of contact.

7. CONCLUSION

7.1. Combining the Lines of Interpretation

In view of the proposed porous frontier between Mesolithic and Neolithic cultures in the studied region, can we presume interactions between bearers of these respective cultures? What forms did these interactions take? Was neolithisation their ultimate consequence?

Interactions, understood at large, involving any amount of change within a population and resulting from the availability of contact or presence of another population, can be assumed even without any specific explanatory mechanism. It is improbable that two populations existing in a relatively restricted geographic area would never interfere or interact with one another (*see Gregg 1991a for an overview of scope of proposed interactions*). Beyond assumptions, the contact between groups with distinct material culture, which in the case of Balkan archaeology correspond well to subsistence groups, is evidenced on many of the sites in the region through the exchange of trade items. The question is therefore centred more on the nature and consequences of this contact than on its existence.

First it is important to stress that this contact need not be uniform and could have been site specific. For example, while there is no evidence for ceramics at the Contact period in Vlasac, Hajdučka Vodenica is rich in potsherds, and ceramics were found *in situ* in Padina houses. Is the close clustering of two periods at Vlasac indicative of greater isolation of Vlasac as a specific locality? Or, is it a consequence of poor chronological separation of a number of skeletons? On the basis of repeated analyses performed on different chronological assignment for the studied individuals, which gave the same results, the latter suggestion seems unlikely, however, it still remains a possibility and argues for more direct AMS dates for the whole series.

In terms of anthropological change within the period, some regrouping of the population is evident. Vlasac seems to be very closed and little population admixture occurs at the time of availability of contact. Similarities between Padina and Hajdučka Vodenica and Lepenski Vir seem to point towards greater mobility within the group as a result of possible pressure from the outside. In Radovanović's terms (*Radovanović 1996b; 1996c; 1996d; Radovanović and Voytek 1997),* this period is a phase of consolidation of the Lepenski Vir culture, of greater ideological integration and most probably associated social differentiation. This ideological consolidation and realisation of some form of unity among the previously dispersed and distinct sites is evidenced by greater insistence on art and ritual. Accordingly, all of the sites on the right bank examined in this study prosper during this period, and the increase in number of graves seems to reflect this greater care for rituals and ancestors.

Can the observed difference between Mesolithic and Mesolithic/Neolithic populations be attributed to admixture between the existing local sub populations of the Mesolithic Iron Gates Gorge, or does it provide evidence for the influx of other, more remote, genes?

The observed differences between the chronological units examined seem to be largely due to a secular trend. At the time of the first contact with Neolithic population a more important change in the genetic profile of the population occurs. This indicates higher levels of admixture with a non-local population. It could have been brought about by an influx of non-local foragers, by an influx of surrounding farmers, or both. In order to answer this question with certainty, a better understanding of local Neolithic populations as well as a wider base of the Mesolithic Iron Gates populations (both from the Romanian side of the Danube as well as from the sites situated more inland) would be needed. Neither was available for this study.

The Neolithic site of Velesnica contained only three female skeletons, while Ajmana (with 17 individuals) was not available for study at the time of this research. The published report by Radosavljević-Krunić (*1986*) does not give enough information for the inclusion in any of the performed statistical analyses. On the Romanian side, only Schela Cladovei has yielded a significant number of individuals (62) that are still under study (*Sweeney at al. 2000*), while a survey beyond the banks of the Danube on both Romanian and Serbian sides is yet to be undertaken.

Based on the data presented here, the distances between Mesolithic components of Vlasac and Lepenski Vir and Padina seem to be important. The great heterogeneity of the population observed by other researchers also support this finding. However, a simple trend towards homogenisation in the Contact period, would have resulted in pooling of the Mesolithic/Neolithic component in these sites somewhere towards the equidistance from the earlier components. This is not the case. As stated earlier, Vlasac seems to remain the most isolated while an important degree of similarity is observed between Lepenski Vir Mesolithic and Hajdučka Vodenica and Padina Contact periods. Some, although minor, introduction of new genes is possible. Ascertaining either that they come from the surrounding Neolithic people or other people moving as a consequence of neolithisation of the surrounding region would be overinterpreting the scant evidence.

It is notable that demographic analysis (*Jackes et al. 2000*) strongly suggest migration at the time of Contact where a slight over-representation of adults among the dead can be observed. The Mesolithic/Neolithic sample could indicate a fall in fertility consequent upon a period of instability associated with cultural change and an influx of adults from outside. This would lead to an apparent over-representation of adults. Such an influx could result in a drop in fertility: the drop could be actual, as a result of the changing and unstable conditions, or it could be perceived, resulting from an unbalanced sex ratio among the migrants (an excess of males). Furthermore, although demographic analysis show increase in fertility in Neolithic sample, when combined with Contact period this sample argues for a stable population with total fertility approaching the foragers and not the farmers pattern.

The migrants, according to morphometric and non-metric data mostly males, did not bring about the change in the economy. If hyperginy is regarded as necessarily favouring the farmers, percieved in contemporary societies as dominant (but see discussion in Ch. 2.3), these migrant males could not have been members of agricultural societies. Furthermore, if we do accept that Neolithic brings about the change in the quality of nutrition and consequently, size reduction (*Cohen and Amerlagos 1984; although see Jackes et al. 1997*), the lack of significant reduction in size of the bones between the two periods, would argue against the Neolithic population moving in. Even if we accept that they would have been different in size, their small number and specific mortuary patterns could account for underrepresentation of these supposed "Neolithic" individuals: the original individuals moving into the community would not necessarily be accorded the same ritual status, and the nutritional and occupational habits would account for the lack of distinction in the subsequent generations. Their genetic input would, however, be reflected in the increase of change between the two periods examined.

Although both of the lines of reasoning point towards migrants as most probably the more remote Mesolithic groups moving into the ideological centre or under the pressure from the farming communities, neither direction of hyperginy, nor the size change caused by neolithisation can be regarded as unequivocal evidence. The identity of the migrants will have to be resolved by comparisons to other populations in the region.

If some influx of new genes is probable in the Contact period, the Neolithic in the region, in terms of population biology, represents the continuation of the local Mesolithic. This is evident in both the non-metric traits - where Neolithic helps make the "horseshoe-shaped" curve typical of temporal ordering (*Greenacre 1984*), and in metrics where there is practically no significant difference between the Contact and the Neolithic. Again, a small number of measurable individuals (all of them females) in the metric analysis, and the fact that this period is present only at the Lepenski Vir site, cautions against too strict adherence to this interpretation. It is, however, the most plausible explanation based on the above data.

In conclusion, large-scale population admixture can not be demonstrated from the above data. Some "seeping in" of the population suggested by Menk (*Menk and Nemeskeri 1989.531*), but without the successive replacement that he argued for, can be proposed on the bases of current research. This "seeping in" happens more perceivably at the beginning of the contact, rather than at the time of change in subsistence. Once this change in subsistence does occur, it is not complete. Fishing and hunting still account for the major portion of the animal assemblage in both Neolithic sub phases at Lepenski Vir. Although the reasons for the change in subsistence are beyond the scope of this research, it can be stated on the basis of the anthropological information that it is not brought about by an incoming population. It must be regarded as a consequence of cultural and social factors operating within the Mesolithic of Lepenski Vir itself, which brought about its disintegration.

Mesolithic Lepenski Vir culture is based on the rich riverine environment that tends to support the richer societies and these are not "among the first to make the transition to food production. Rather they appear to be late lasting in historic terms" (*Brinch Petersen and Meiklejohn in press*). The Lepenski Vir Mesolithic successfully paralleled local Neolithic developments over a long period of time. The contacts with the Neolithic population in the region seem to have helped to form an ideological unity of sites and thus bring into full expression the artistic achievements of an already affluent society. Ideological integration evidenced at the time of possible Contact could have resulted from the growing wealth of the sites based on trade in salt preserved foodstuffs (fish from Iron Gates Gorge and wild game from Gura Baciului) as proposed by Tasić (*1998*). Internal conflicts, overexploitation of the environment and innumerable other factors may have played a role in the disintegration of the Lepenski Vir tradition. The biological descendants of Lepenski Vir culture remained at the locality, in smaller groups, and adopted a different material culture and architecture, but retained the same burial practices, and to a great extent the hunting and fishing economic base. The greater percentage of domestic animals and definite use of domesticated varieties of cereals classifies them as a Neolithic group, but in many respects this population remained unchanged. Only within the fully developed Starčevo phase (Lepenski Vir IIIb) and with the change in burial ritual towards more canonised forms (*Antunović 1990*) did this population finally integrate itself into a larger Neolithic community.

7.2. Future research

Many questions remain unanswered in the Iron Gates Gorge. The ritual praxis associated with burials awaits an analysis based on thorough examination of taphonomic and stratigraphic factors and their integration into understandings of Cognitive archaeology. More AMS dates, as well as an attempt to directly study genetic relationships through DNA analysis, is planned for near future, as well as the re- examination of paleodemography and paleopathology. Re-evaluation of the zooarchaeological evidence, with questions of seasonality of the sites as well as nutritional habits, is currently under way. A thorough examination of the ceramics within their site context is planned and we are hoping that more research can be done on plant remains. A survey of the foothills on both banks of Danube is a necessary step toward a more balanced picture of the subsistence, demography and meaning of these very specific sites.

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Documenta Praehistorica XXVII

The Lepenski Vir Fauna: Bones in Houses and Between Houses

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ABSTRACT – *Besides its monumental stone sculpture and peculiar architecture, and its dubious position between the Mesolithic and Neolithic, Lepenski Vir culture is claimed as one of the first in Europe in which dog domestication occurred. There are notes of other domestic species' bones found in a context originally interpreted as belonging to a fisher-hunter-gatherer society. It is presumable that a subsistence strategy itself, related primarily to animal exploitation, be it of tame or wild, mammalian or non-mammalian species, inspired the foundation of settlements on the Danube's banks in the Iron Gates. In this regard, the first results of previously un-analysed osteological material from the locality are presented. The material originates from the Lepenski Vir excavation campaigns of 1968–1970, from the floors of houses, beneath them, and from the spaces extending between houses.*

IZVLEČEK – *Kultura Lepenskega Vira je znana po svojih monumentalnih kamnitih plastikah, nenavadni arhitekturi in nejasni umeščenosti med mezolitik in neolitik. Razen tega naj bi bila ta kultura ena od prvih v Evropi, kjer so udomačili psa. Obstajajo tudi zapisi o kosteh drugih udomačenih vrst, ki so jih prvotno interpretirali kot da pripadajo ribiško-lovsko-nabiralni skupnosti. Domnevamo, da je prav način preživljanja, povezan pretežno z izkoriščanjem živali – bodisi divjih ali udomačenih, sesalcev ali drugih vrst, vplival na ustanovitev naselbin na bregovih Donave v Železnih vratih. V tem članku predstavljamo prve rezultate dosedaj še neanaliziranega osteološkega materiala z najdišča Lepenski Vir, izkopanega med leti 1968 in 1970. Material izvira s hišnih tal, plasti pod njimi in iz prostora med hišami.*

KEY WORDS – *Lepenski Vir; faunal remains; Mesolithic; Neolithic; Neolithisation*

INTRODUCTION

The faunal remains to be described in this paper originate from material collected in the course of the 1968–1970 excavation campaigns at Lepenski Vir. Excavations at the site of Lepenski Vir were rescue excavations, as part of an intensive archaeological research into the Iron Gates region that was initiated by the construction of the dam near Kladovo. They began in 1965, as small-scale excavation, and with rather modest expectations (*Srejović 1966*), but soon revealed a settlement with a new kind of architecture, and monumental stone sculptures, providing the foundations for the establishment of a new archaeological culture (*Srejović 1966a*). The excavation area was enlarged to incorporate the whole area of the settlement, and work continued until 1970, when the houses of Lepenski Vir were relocated to a site above the rising water level (*Čanak-Medić 1970*). Constant pressure imposed by a time limit, due to the construction of the dam, determined the excavation strategy, and the collecting of animal remains certainly could not have been the priority. Consequently, a rather small sample of animal bones was collected. Animal remains from the earlier excavation campaigns have been analysed and published in the form of a preliminary report (*Bökönyi 1969*). The sample consisted of 2999 identified specimens, of which only 630 were from Lepenski Vir I and II, with the balance deriving from Lepenski Vir III phases. A selection of this sample, as well as animal remains collected in succeeding campaigns, are stored in the National Museum in Belgrade. It was through the kindness of Ljubinka Babović, a curator at the National Museum, that I learned of this material, and she entrusted me with analysing it, for which I am sincerely grateful.

Animal bones stored in the National Museum in Belgrade are packed in bags, with labels designating their origin. The better part of the material originates from the spaces related to the houses, and usually only the number of the house is marked, or whether bones come from beneath the house floor. For the material occurring outside the architectural features, a digging layer is specified, and a square. Since the squares are 4x4 m, and digging layers are not easy to correlate with the building horizons, the position of bones occurring outside the houses is not very precise.

The state of preservation of the bones is very good. There are fragile skeleton parts, bones in articulation, and bones from neonate animals, all indicating that physico-chemical agencies and soil quality did not alter the quantity of bones to a great extent, if at all. We can conclude that the fragmentation of bones is due to predepositional factors, while the amount of bones collected is determined by the excavators' decisions. These were strongly selective, therefore creating a biased sample. Hand collecting resulted in the under-representation of small animals and a small parts of large animal skeletons; furthermore, the vertical and horizontal distribution of faunal components cannot be reconstructed, and the collecting of bones belonging to particular units does not mean that all the bones related to particular features or indicated spaces were actually collected. In this respect, I have decided to present particular units that offer most promise of enlightening particular spots in the settlement area at Lepenski Vir, and enable the reconstruction of particular patterns of man/animal relations. Among the units presented, two are related to houses: house 40, at the eastern end of the settlement, and house 28, at the western end, while the two units derive from the area below the floors of houses 47' and 31, and were in fact, related to the spaces stretching between the houses (Fig. 1). The remains of the following species have been analysed: wild swine, (*Sus scrofa* Linnaeus) from the floor of house 40; red deer (*Cervus elaphus* Linnaeus) from the floor of house 28, and from the area below the floors of

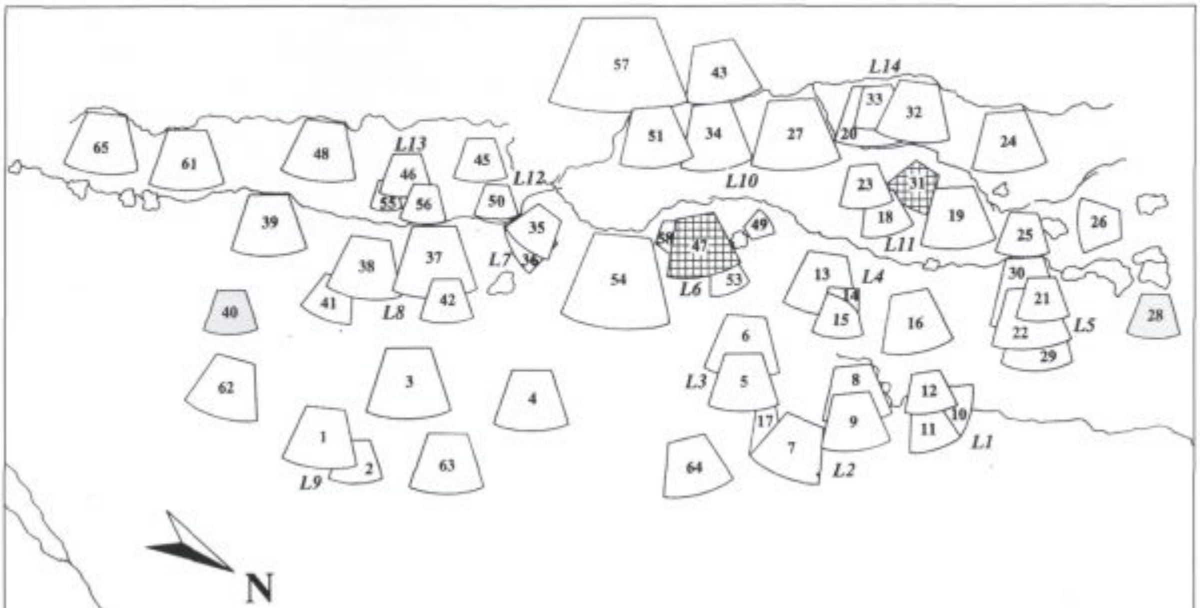

*Fig. 1. Lepenski Vir I plan of settlement (*after Radovanović 1996*). The position of houses 40 and 28, where the bones described in this paper are found on the house floors is marked by shading, and position of houses 47 and 31 where the bones are found below the house floors is covered by mosaic pattern.*

houses 47' and 31; brown bear, (*Ursus arctos* Linnaeus) below the floors of houses 47' and 31; beaver, (*Castor fiber* Linnaeus), roe deer, (*Capreolus capreolus* Linnaeus), and a large species of deer, *Cervidae indet*, from the area below the floor of house 47'.

The wild boar carcass in house 40

House 40 (Fig. 2) is a non-superimposed house found at the downstream end of the settlement. It is interpreted as belonging to Lepenski Vir I, Phase Ic (*Srejović 1969.71, Fig. 15*), i.e. Lepenski Vir I, phase 1 (*Radovanović 1996.176*). A sculpture was found on the floor in the rear part of this house, and a grave (grave 61) beneath the floor, with its head just below the sculpture. There was an altar above the fireplace, and behind it, an adult female mandible ("grave 21") with a stone plaque within it. Another grave was interred behind the left frontal corner of the house (grave 60). None of the graves was noted to contain grave goods (*Radovanović 1996.176*).

Animal bones were found on the house floor, along its longer right wall (B–C (*after Srejović 1969*), as it was labelled during the excavation), mostly of wild boar. As indicated in the subtitle, these are not just fragments showing the presence of the species, but complete or better parts of bones, indicating the deposition of a large section of carcass within the house at the time when its use was suspended (Figs. 3, 4). This could have been either suddenly and unwillingly, or as a prepared departure, with the intention of permanent or temporary abandonment. The following questions could bring us closer to understanding the house abandonment event: whether the bones were stripped of meat in the process of food preparation, and in such a way left behind in the house, or carcass parts were left, either as fresh meat, or dried; whether these remains belonged to a single animal or several different animals; what body parts were present, i.e. exactly what amount of carcass.

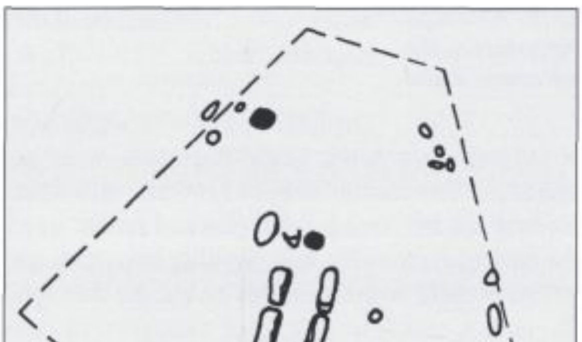

*Fig. 2. House 40, Lepenski Vir I (***after Srejović and Babović 1983***).*

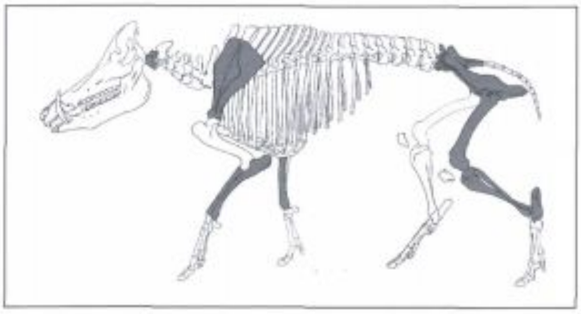

Fig. 3. Wild boar skeleton with bones found in house 40 shaded.

The insight into the skeleton parts' distribution shows that those parts that have most meat are present: the sacral part of the backbone and the final lumbar vertebra, a fragment of atlas, parts of shoulder and pelvic girdles, and mostly the upper parts of fore and hind legs (Fig. 4). Since none of the skeleton elements were found represented by more then a single specimen, the assumption is appearing that we are dealing with the remains of a single animal. To confirm this, we should find all the skeletal elements showing the same age, and fitting by their size.

Regarding the first question, we can notice that the epiphyseal lines are fused in all the bones except one, the thigh bone, in which the epiphyseal line of distal articulation is clearly observable along its whole length (Figs. 4.2a,b). Although thighbone distal articulation fuses late in ontogenetic development, this is also true for the articulations of proximal and distal ulna and distal radius (*Habermehl 1975; Bull and Payne 1982*). These are completely fused in the ulna and radius from house 40 (Figs. 4.4, 4.5), thus indicating older individual age. It is possible, and even probable, that the thighbone did not belong to the same animal as the other bones. Another consideration in establishing whether all the bones belonged to a single animal is their size (Tab. 1).

Measurements after Driesch, 1976, except depths of radius proximal and distal end, and tibia distal end, which are perpendicular to their breadths; the

Fig. 4. Sus srofa scrofa, house 40: 1. sacrum, last lumbar vertebra and fragments of right and left pelvis; 2. femur sin. dist., a. cranial, b. medial view; 3. scapula sin.; 4. radius prox. dext.; 5. ulna and radius sin.; 6. left astragalus, calcaneus and distal fibula in articulation, a. dorsal, b. plantar view; 7. a. same bones, the arrow points to the breakage of fibula, b. fibula diaphysis, c. left distal tibia, the arrow points to the rough surface articulating with fibula; 8. cut marks at calcaneus distal end; 9. cut marks at astragalus medial side.

measurements are greater than or close to the maximal values for wild boar at Vlasac (*Bökönyi 1978*) and Padina (*Clason 1980*), and clearly correspond to the male group, if compared with the Neolithic wild boar remains from Opovo (*Russell 1993*). In any case, remains of probably two wild boars were found in house 40, possibly more then two, which may indicate that in the distribution of the kill, this house for some reason received a good part.

The tarsal bones, talus and calcaneus, together with the distal calf bone, remained in articulation (Figs. 4.6a,b; 7a,b,c). There are no traces of synarthrosis, which would indicate pathological fusing, so it is certain that they were buried in situ as articulated, and not removed from the site afterwards, when the organic tissue had decomposed. The quality of the deposit in which they were embedded, probably enriched by carbonates, made their connection firm even after excavation. In addition, a distal shinbone (Fig. 4.7c) and calf bone shaft (Fig. 4.7b) were found, fitting perfectly the talus and calf bone fragment, indicating that those bones were a continuation of the joint described.

breadth of the distal fibula, which is the greatest breadth of the distal end, and the calcaneus' greatest breadth, which is measured in the antero-posterior direction.

To reach a conclusion as to whether all the bones, or all the bones except the thighbone, are from the same individual, we need a comparison with measurements taken on a large sample of skeletons to find out the individual and sexual variation in the proportion of skeletal elements. Presently, I am not aware that these kinds of data exist. However, it is possible to conclude that all the bones from house 40 originate from a rather large male individual. Particular

The final lumbar vertebra, as well as left and right pelvic girdle fragments, were attached to the sacrum (Fig. 4.1), while two long bones of the left front leg, the ulna and radius, were also in articulation (Fig. 4.5). Another important observation could be made on this part of the skeleton. The ulna is complete, except for damage to its central portion, while the upper part of the radius is broken. The breakage of both bones was caused by a strong blow, and happened while the tendons, and probably also muscular tissue, were still holding the bones together. The single fragment of long bones in the right front leg, the proximal radius, points to a similar breakage (Fig. 4.4), a consequence of the patterned manipulation of the carcass parts.

We should stress here that we are by no means certain that all the bones found at the site were collected. On the contrary, the excavation technique at Lepenski Vir mainly entailed the taking of only a selection of bones, and this selection was made by an excavator unfamiliar with osteological material. So it is quite possible that we are missing some parts of the carcass originally placed in house 40. In fact, they were primarily collected due to a certain notion in relation to the graves of this house, since the original label bore the legend "animal and human bones". Finally, we should consider whether the bones of wild boar found in house 40 were left in the house as a complete carcass, as meat carcass parts, or just as bones stripped of meat, and if we are dealing with meat carcass parts, whether they were raw, dried or otherwise prepared for consuming. First, it could be safely concluded that there was no complete carcass, since there are proofs of butchering. These are clearly observable on the tarsal bones, in the form of several deep transversal grooves on the calcaneus (Fig. 4.8), and few short grooves on the talus (Fig. 4.9), made in the same direction, and in same action indicating disarticulation of the lower hind leg. There are no cut marks on other bones, but there are indications that other butchering techniques besides cutting might have been applied, such as a blow to the middle of the radius and ulna shafts. The left and right pelvic girdle fragments attached to the sacrum were probably broken in the course of the disarticulation of the left and right flanks.

As we have already concluded that primary butchering was performed, we could further ask whether the butchering process was continued to the point of completely stripping the meat from the bones. In this respect it is important to note that there are no traces of filleting, which would be very difficult if not impossible to perform and avoid the contact of sharp artefacts with the bone necessary for this operation. This is especially true of the shoulder blade, on which filleting leaves a characteristic long longitudinal groove (*Binford 1981.Fig. 4.06*). This leads to the assumption that there were several meat parts present, before the house was abandoned, either as raw meat, or dried, or prepared for drying. A part of the left pelvis fragment was burnt, which could indicate contact with fire or hot smoke while the meat was dried, but we have no other signs which would certify this method of food preparation.

		Lepenski Vir house 40	Vlasac Bökönyi 1978	Padina Clason 1980
sacrum	cranial articular breadth	47.00		
scapula	glenoid process length	51.45	29.0–49.0	
	glenoid cavity length	38.70		
	glenoid cavity breadth	33.55	29.0–34.5	
	scapula neck length	34.05	32.0–33.0	
ulna	length	279.45		
	olecranon length	84.20		
	processus anconaeus depth	55.55		
	olecranon depth	44.70		
	coronoid process breadth	33.85		26.0
left radius	distal end breadth	49.45	41.0–47.0	35.0
	distal end depth	39.40	32.5–36.0	
right radius	proximal end breadth	40.55	39.5–41.0	36.5
	proximal end depth	28.85	26.0–30.0	
femur	distal end breadth	61.00		
tibia	distal end breadth	40.55	32.5–44.0	37.0–40.0
	distal end depth	34.80	29.0–38.0	
fibula	distal end breadth	21.45		
astragalus	lateral half length	50.00	47.0–55.0	50.0–53.0
	distal breadth	31.85	29.0–35.0	29.0–31.0
calcaneus	length	102.90	90.0–107.5	71.5–108.0
	greatest breadth	41.60	37.0–40.5	38.5–44.0

Tab. 1. Sus scrofa, house 40, measurements (mm).

Why was the meat placed within the house?

I consider it is less probable that it was left because of the sudden abandonment of the house. There is evidence that animal parts, specifically red deer antlers, were left in many houses, which certainly was not unplanned and unintentional. An example of antlers in house 28 will be described later in the text. It is more likely that the placement of the wild boar carcass parts in house 40 reflects a common tradition performed in connection with an abandonment event in house 40 or the settlement itself. The meaning of this custom could have been to make offerings to the house spirits, because of the quitting of the house for a certain period, or because the use of the house was suspended, while life continued in other houses. Otherwise, it may be a case of food storage for the settlement's inhabitants, or even a sympathetic offering to a chance passenger.

Bone raw material collection under the floor of house 47'

House 47' (Fig. 5) is at the edge of the lower terrace and is covered by another house of similar outline, labelled as house 47 (*Srejović and Babović 1983. 138*). House 47' is built above two smaller houses: the rear part of house 53 and the base of house 58. Both houses 58 and 53, and house 47' belong to Lepenski Vir I (*Srejović 1969.Fig. 8, 14, 16; Radovanović 1996*). A large, non-superimposed house, 54, on the left side of this group of houses, and a very small house, 49, to their right, are interpreted as belonging to phase c of Lepenski Vir I (*Srejović 1969. Fig. 15*). The animal bones collected are from below the floor of house 47'. A more precise position is not noted, but they were deposited most probably in the space between houses 58 and 53 (along the west side of house 58, or in front of its left corner, or behind house 53).

The bone assemblage is diverse, both in the species and the skeletal elements present (Tab. 2) (Figs. 6–9). There are the remains of at least 7 animals, belonging to 5 different species (beaver, bear, and three species of deer) so fur and meat animals, large, medium and small are present. There are broken and complete mandibles of several species, two shoulder blades and many fragmented metapodials. Among the unidentified fragments, long bones and

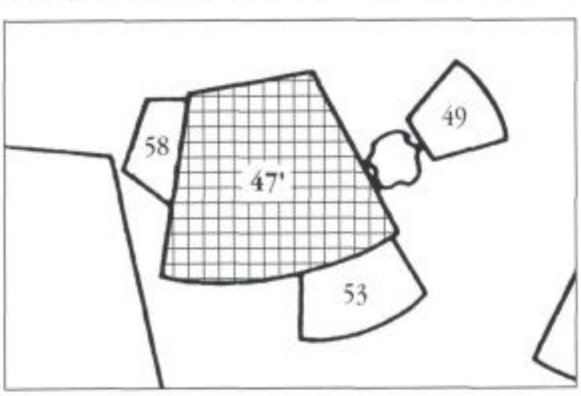

Fig. 5. House 47 (overlaying house 47') and adjacent houses (*after Radovanović 1996*).

metapodial splinters dominate. The composition of the assemblage itself indicates that the reason for its being collected at the site was not the use of the animals' soft parts (meat, skin), but the bones themselves. In fact, there is quite convincing evidence that they were collected as raw material.

Fragmented metapodials are the most representative skeletal part in this respect. The metapodial bones of ruminants, especially of cervids, because of their shape and structure, were the most desirable skeletal part for artefact production throughout the prehistoric periods. A distal metatarsal of roe deer, and 11 fragments of red deer metapodials were found in this assemblage. The red deer metapodials belonged to at least 3 individuals, since among 7 fragments of metatarsals (Fig. 6.3) it was possible to identify two right proximal metatarsal fragments bearing the same elongated facete for articulation with the centrotarsal bone (Figs. 6.3a,c). These fragments would have originated from two individuals. Two remaining proximal fragments are from the left metatarsal, and probably from a single bone (Figs. 6.3b,d). We cannot determine from the proximal parts whether they belonged to fully grown animals, since the proximal epiphysis fuses earlier, but from the two fragments of distal metacarpals, left and right, with fused epiphysis (Figs. 6.1a,b), there is evidence for the existence of at least one fully grown animal. On the other hand, it is not possible to differentiate distal unfused epiphyses and to identify whether they belong to metacarpals, or metatarsals, but since they are of different sizes (Figs. 6.2a,b), and the surface for fusing in the larger specimen is much more compact, revealing a better degree of ossification, it is possible to conclude that they belonged to juvenile individuals of different ages, or in any event, to two different animals. Consequently, the red deer metapodials in the assemblage are from at least three animals, one adult, and two juveniles. All the fragments show certain degree of weathering, having been exposed to atmospheric influence for some time. Their fragmentation started with lengthwise splitting, but continued in various ways. Two fragments belonging to the same left metatarsal (Figs. 6.3b,d) show that the bone was first split lengthwise, which resulted in the separation of these two fragments, but thereafter the larger fragment was broken transversally. The left distal part of the metacarpus (Fig. 6.1a) was modified by flaking its rim. On the diaphysis fragments there are small depressions made by multiplied pressure on the bone, probably in the course of artefact production.

The reason that carpal and tarsal bones of reed deer (Figs. 6.4, 6.5) were found within this assemblage is probably not related to the intention of their further modification, but is the consequence of their being articulated with those bones that were of interest – metapodials. Perhaps someone who had the skill of making artefacts took a part of a skeleton that he knew to be useful for his purpose from a site where primary butchering was taking place, took it to a work area, and disarticulated it as the first step of the work. There are three carpal bones, two of them, the left intermedium and left radiale, probably belonged to the same animal, since their articulations fit perfectly (Figs. 6.4a,b). Another one, the left intermedium, belonged to another animal, probably a young one, as the structure of the bone shows less ossification (Fig. 6.4c). A single phalanx also belonged to a young animal, with unfused proximal epiphysis, and peculiar traces on its diaphysis caused by rodent teeth (Fig. 6.6). It is highly probable that the toolmaker was not always on its working place, so during his absence, a small rodent was sharpening its incisors on this bone while it was exposed on the surface.

Species	Skeletal part	NIS	MNI
Castor fiber (beaver)	mandible	2	1
Ursus arctos (brown bear)	mandible	2	1
Cervus elaphus (red deer)	antler	1	3
	mandible	4	
	upper molar	1	
	scapula	1	
	distal humerus	3	
	distal femur	1	
	distal metacarpal	2	
	proximal metatarsal	3	
	metatarsal diaphysis	4	
	distal metapodial unfused epiphyses	2	
	carpals	3	
	tarsals	1	
	second phalanx	1	
Capreolus capreolus (roe deer)	distal metatarsal	1	1
Cervidae indet. (a species of large deer)	scapula	1	1

NIS – number of identified specimens;
MNI – minimal number of individuals.

Tab. 2. Species and skeletal parts distribution from the area under the floor of house 47'.

The roe deer distal metatarsal (Fig. 7) is also a remnant of lengthways splitting. Its proximal part might have been used for making bone artefacts as well, but this fragment itself shows traces of modification and use. The obliquely broken diaphysis is polished, while its dorsal side has many scratches which are use traces. Its pointed end was broken, perhaps in the course of a working process at the site itself. The other possibility is that the artefact was brought into the workshop to be repaired.

Two shoulder blades found in the assemblage, one from a large species of deer, and another from a red deer, bear clear evidence of filleting in the form of sharp longitudinal furrows (Figs. 8.1c,2b). There are, also, further modifications on the blades, and it is possible to assume that they belonged to carcasses butchered elsewhere and brought to the site as a raw material. These further modifications are best observed on the surface of the large deer shoulder blade (Fig. 8.1c), in the form of multiplied pit-like bone damage, made probably not by direct, but indirect blows or pressure by some implement pressing on the blade, and showing successive movements of that implement, in the course of manufacturing. Two of those groups of pit-like damage lie over the filleting marks, thus demonstrating the sequence of work performed on the bone. Somewhat lower, in the area of the shoulder blade neck, there are two irregular, semi-circular cuts, while the whole surface of the bone is covered with tiny scratches.

The question of identification of the large deer shoulder blade is intriguing. Cervid species of a stature larger than red deer are not recorded in the Postglacial of the region up to date. However, a giant deer, *Megaloceros sp*, and elk, *Alces alces* (Linnaeus), inhabited the central Balkans in the course of the Pleistocene epoch (*Dimitrijević 1983; 1997*), and survived in the Carpathian basin even in the Postglacial period (*Bartosiewicz 1999*). Identification is made more difficult by the fragmented state of the distal articulation, although its circular form and the position of the coracoid process clearly indicate a deer (Fig. 8.1a), and exclude cattle species. The only measurement obtainable, the diameter of the neck of the scapulae (46.1 mm), is greater than the variation range of red deer (33.0-44.0 mm at Vlasac (*Bökönyi 1978*); 27.0-40.0 mm at Padina (*Clason 1980*)). It is possible that the blade belonged to a young animal. Although the co-

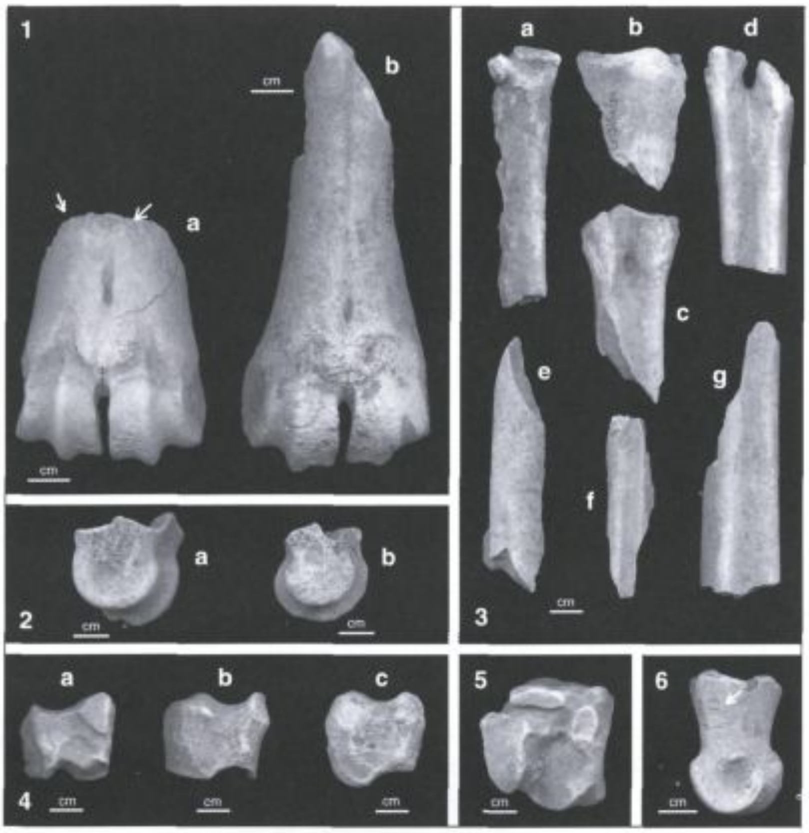

Fig. 6. Cervus elaphus, lower extremital bones: 1. metacarpus dist., dorsal view, a. sinistralis, arrows point to the flaked rim of the fragment; b. dextralis; 2. distal unfused epiphyses, lateral view, a. larger specimen, probably from a slightly older animal, b. smaller specimen, probably from a younger animal; 3. metatarsal fragments, a, c proximal dextralis; b, d proximal sinistralis; e, f, g diaphyses; 4. carpals, a. radiale sin., b. intermedium sin., c. intermedium sin.; 5. centrotarsale, plantar view; 6. phalanx II, lateral view, arrow indicates rodent teeth marks.

racoid process is fused, the structure of the bone inside the glenoid cavity is not very compact, but porous, which is characteristic of young animals.

For the remaining items in the assemblage, represented by skeletal parts not so commonly used in the process of tool making, and not bearing exact modification traces, the intention of including them in this collection of raw material is not so clear. The collection of lower jaws of different species, a deer, a beaver and a bear, is interesting. There are 4 fragments of a red deer's lower jaw, probably belonging to a single branch (Figs. 9.4a–d), thus indicating an in situ breakage. The fragments are heavily weathered and the largest bears cuts and multiple, grouped scratches on the surface. On the other hand, the beaver left and right jaws have almost complete horizontal ramie, and the bear's left mandible even has the incisor part complete, which is the easiest to break down. The beaver left and right mandible branches (Figs. 9.3a,b) belonged to a single lower jaw. There is a conspicuous glow in the simphyseal region, both in the front part, below the incisors, and on the inner sides, on the simphyseal joint itself, which is a possible consequence of its use as a grinder. The presence of beaver mandibles in this context is important, since at the other sites in the Upper Gorge of the Danube, mandibles are overwhelmingly represented among beaver remains (36 mandible fragments against only 5 postcranial bones at Padina [*Dimitrijević and Borić, in preparation*]; 15 mandible fragments among 71 beaver remains at Vlasac, after *Bökönyi 1978*), and there remains the question of the pattern of use of this animal in the Gorges. The incisors are still in place, while they are mostly lacking in the mandible fragments at Padina.

The bear mandible belonged to a young adult animal (Fig. 9.1). There are several short, deep, and sub-parallel cuts in the middle of its basal margin, grouped in two places (Fig. 9.1a). These cuts indicate primary butchering, after which the assumption is that the bone was brought to this site. Besides this left mandible, there is a fragment of a right bear mandible (Fig. 9.2), in the form of a single small basal fragment of a horizontal branch, with old breaks. This could only originate from a heavily fragmented mandible. So, there are two bear lower jaws at the site, one very well preserved, if we exclude excavation breaks, and the other, for some reason, greatly fragmented. The flat mandible surfaces might have had a role in tool manufacturing, but might also have been of interest because of the teeth it contained, among which incisors and canines would have been especially popular for amulet production.

Young deer and brown bear below the floor of the house 31

House 31 is found in the group of houses of Lepenski Vir I positioned in the Middle Terrace (Fig. 10). It is older than houses 18 and 23, since its left front wing is cut by house 18, while the rear of house 18 is covered by house 23, but probably later than house 19 (*Radovanović 1996*). The bone assemblage to be described was collected from below the floor of house 31, so it was accumulated at an open area of an early settlement phase. The bone assemblage contained large mammal bones, fish teeth and bones, a long diaphysis bird bone, and several human bones, probably in relation to grave 97. The complex stratigraphic situation evokes suspicion concerning the assemblage's unity. However, the remains of two skeletons, one of a young deer (Fig. 12), and another of an adult brown bear (Figs. 11, 13, 14), confirm the unity of the assemblage. Both animals were presumably butchered on the spot, showing in that specified process differences, in respect to their age and size, which influenced the butchering method itself. The following skeleton parts of the young deer were found (Figs. 12.1-13): the lower right mandible, atlas, front legs bones (proximal humerus, radius distal epiphysis, a carpal bone, proximal metacarpals), a pelvic fragment, hind leg bones (distal femur diaphysis and a related, unfused distal epiphysis, proximal parts of the left and right tibia diaphyses, and related right unfused epiphysis, the distal part of the right tibia diaphysis, astragalus, and calcaneus with unfused tuber calcanei), as well as a single third phalanx characterised by porous bone structure indicating incomplete ossification.

All the skeleton parts indicate a young, growing animal. The lower jaw bears milk dentition, the long bones have both proximal and distal epiphyses unfused, and short bones have a porous structure. It is possible to conclude convincingly that these are the remains of a single animal, since all the skeleton parts indicate a similar age.

The most precise age is given by the mandible (Fig. 12.1). It is a right mandibular branch, broken orally at the diastema, while the aboral processi of the vertical ramus are also broken. The first and second decidious molars are in alveoli, while the third milk molar was lost post mortem, but its alveoli are fully preserved. The first milk molar has no traces of crown wear, but on the second, some slight wear is observable on the tips of the crown. There are no traces of the formation of permanent premolar crypts. Behind the third milk molar alveoli, the first permanent molar is erupting, and behind it, the crypt is opened where the germ of the second molar was developing. The mineralisation of the first permanent molar crown is complete, and the infundibulum is well formed. The mandible is broken through the first molar alveoli, and the tooth itself damaged in its lower portion, so it is not possible to observe whether root formation had started, but, since the eruption began, it is to be expected that root formation had also started. This stage of development is corresponding to the age of 4 months (*Brown and Chapman 1991*). This also gives us the season of this animal's death, as well as the season of this particular hunting and butchering episode at Lepenski Vir. Since deer give birth in May/June (*Bützler 1986*), this means that the animal was hunted in the early autumn, most probably in late September or early October.

The epiphyseal fusion is not so accurate for ageing, and it is not studied in detail like tooth eruption, but finds like these remains of a young deer below house 31 could be very important if such a study is going to be made in the future, since they give us a set of data direct from prehistory.

It is important to note that elements of both the left and right front legs were found (fragments of the left and right metacarpals) (Fig. 12.6), as well as those of the left and right hind legs (left and right proximal tibia) (Fig. 12.9), in considering what part of the body was actually present at the site. Though we cannot quite exclude attritional processes, the bones are well preserved, in spite of their porous structure, and the presence of both diaphyses and

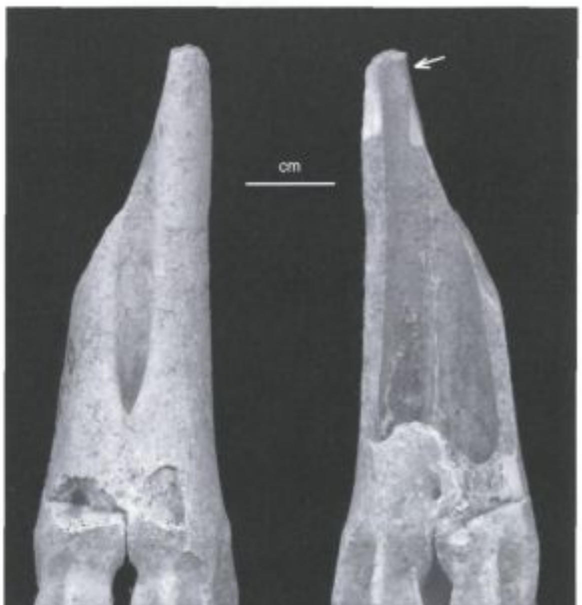

Fig. 7. Capreolus capreolus, distal metatarsal, a. dorsal, b. plantar view, arrow indicates broken polished end.

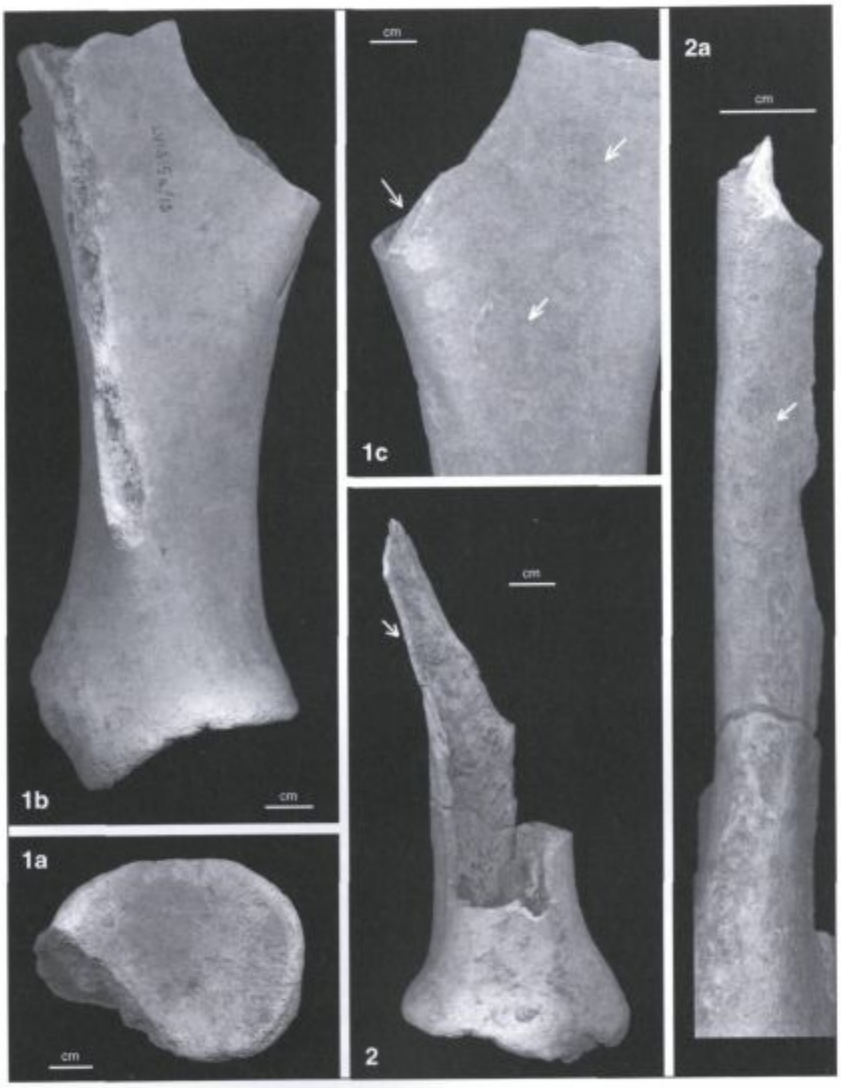

Fig. 8. Scapulae with filleting marks: 1. Cervidae indet., scapula sin., 1a. distal view, 1b. lateral view, 1 c. medial view, detail, upper two arrows point to pitlike depressions, arrow in the middle to longitudinal filleting mark and pitlike depression below crossing over it, and the one at the bottom points to halfcircular incisions; 2. Cervus elaphus, scapula dext., lateral view, 2a. caudal view, detail, arrow points to filleting mark.

epiphyses of unfused long bones (distal femur, proximal and distal tibia) (Figs. 12.8,9,10) and calcaneus (unfused tuber calcanei) (Figs. 12, 13a,b), show that they were not spread out further. It is more probable that not all the bones were collected by the excavators, and it is reasonable to suppose that the whole body, except the head of the animal was at the site.

There are no traces of butchering, but we have to bear in mind that for the butchering of a young animal much less effort is needed, and much fewer interventions made by artefacts. Moreover, cuts made by artefacts on young bones remain mainly in the layer of cartilage, because of which they are not detectable in fossil material, or on porous bone surfaces, where they are not so clearly observable as on compact, mature bones. In addition, since this young deer skeleton was found with the remains of another butchered animal, a brown bear, we should not search for any other reason for its deposition. The brown bear butchered at the site was an adult animal, of a size comparable to representatives of the same species in the region (Tab. 3). According to the skeleton parts' distribution (mandible, vertebral column and rib cage elements represented, both the front and hind legs, as well as both the left and right side of the body) (Figs. 11, 13, 14), the whole carcass was probably butchered on site, excluding possibly only the skull. Unlike the juvenile deer from the same place, traces of primary butchering, as well as traces of further processing of the disarticulated skeleton parts are easily detectable, and they are found on expected places on the bones, and rather easy to interpret.

The articular end of the mandible bears distinct traces of cutting (Figs. 13.1a,b), most probably the consequence of the disarticulation of the mandible from the skull after the masticatory muscle had been already removed. From the vertebral column, two vertebrae are preserved which are mutually articulated, since one is the last thoracic (Fig. 13.2), wearing the anterior demifassete for rib articulation,

humerus	ML distalis	87,9
femur	ML proximalis	86,1
	ML distalis	73,8
radius	ML proximalis	37,6
metatarsus II	length	69,6
metatarsus V	length	82,9
ML – medio-lateral breadth		

Tab. 3. Ursus arctos, extremital bones (mm).

and the second has the anterior processi (*praezigapophysys*) well fitting with the posterior processi of the thoracal vertebrae, so this is probably the first lumbar vertebrae (Fig. 13.3). The cut-marks (several short and shallow parallel cuts) are found at the base of the lumbar dorsal spine and derived from the removal of tenderloin (comparable to *Binford 1981.Fig. 4.21*).

Remarkable cut marks are found on the hip-girdle and long bones, originating both from disarticulation of the long bones from the girdle, and from the further processing of meat parts. At the left hip-girdle (Fig. 13.5), cuts are positioned at the ileum and ischium portions. There are two short parallel cuts at the ileum (Fig. 13.5b), at its narrowest part, while many artefact traces cover the ischium. They were made, if not by different artefacts, then in the course of "operations" of varying intensity: there are short and shallow parallel cuts extending transversally, afterwards a very deep and long single furrow, crossed by a short, deep cut (Fig. 13.5a), while the third group of traces are represented by pit-like notches made by multiple chiselling. At the right hip-girdle fragment the tuberosity at the acetabulum rim is knocked off (Fig. 13.6), which might indicate butchering by blows. There are two more fragments of hip-girdle, impossible to reconstruct with larger fragments, since parts of the broken bone are missing. One reveals longitudinal shallow furrows, most probably filleting marks, and the other is covered by oblique cuts.

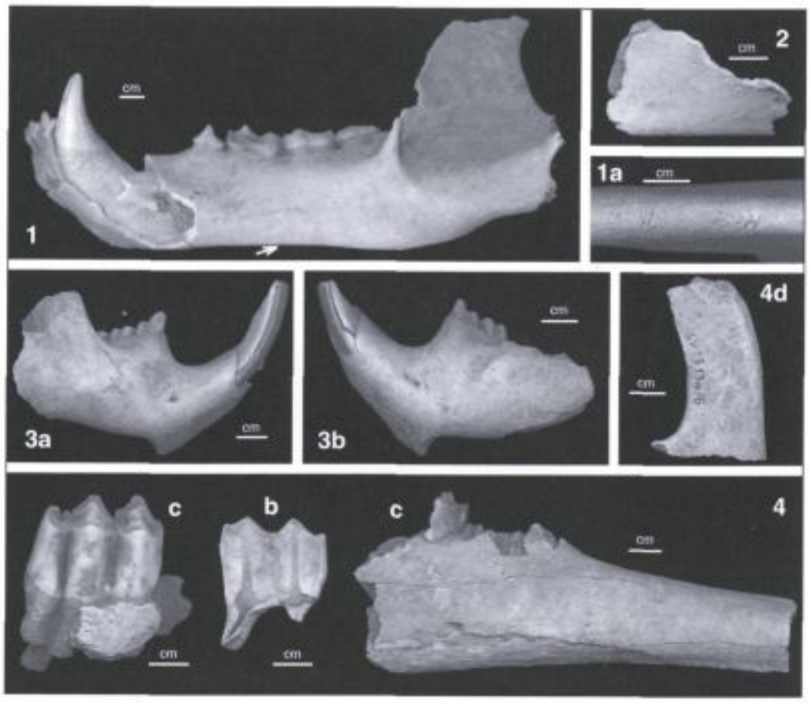

Fig. 9. Mandibles: 1. Ursus arctos, mandible sin., outer view, arrow points to the position of cut marks, 1a. cut marks at basal part of horizontal branch; 2. Ursus arctos, mandible dext., fragment of basal part of horizontal branch; 3. Castor fiber, a. mandible dext., b. mandible sin.; 4. Cervus elaphus, mandible dext., a. fragment of horizontal branch with diastema and fragmented P3 and P4 in alveoli, b. fragment of M2, c. mandible fragment with M3, 4d. coronoid process.

From the front leg long bones, a distal humerus and three fragments of a radius were found. The cuts on the humerus are numerous. There are many oblique, sub-parallel cuts, seemingly made with a single artefact and during a single operation of butchering. They are positioned at the medial epicondyle, starting from its base and spreading to the diaphysis uplift (Fig. 13.8a). At the lateral epicondyle crest there are again oblique sub-parallel cuts, but they are

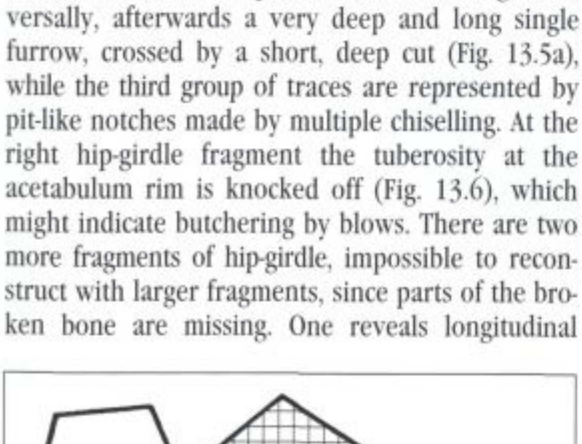

Fig. 10. House 31 and adjacent houses (*after Radovanović 1996*).

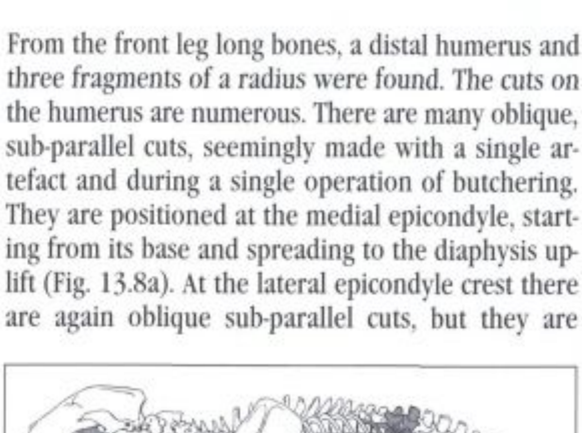

Fig. 11. Bear skeleton with bones found in house 31 shaded.

Fig. 12. Cervus elaphus, infantile: 1. right mandible with milk molars (D2 and D3), and M1 erupting, inner view; 2. atlas, dorsal view; 3. humerus dext. prox., lateral view; 4. radius sin., distal epiphysis; 5. fragment of capitato-trapezoid sin., fragmented, palmar view, articulation fitting to proximal left metacarpal shown in 6b; 6. metacarpus, a. dext. prox., b. sin. prox., c. same bone from the inner aspect showing longitudinal spliting; 7. pelvis dext., fragment acetabulum with fragment of ischium; 8. femur sin., medial view, a. distal end of diaphysis and b. unfused distal epiphysis; 9. tibia dextralis, a. unfused proximal epiphysis, cranial view, b. proximal end of diaphysis, cranial view, c. unfused proximal epiphysis, proximal view, d. tibia sinistralis, proximal end of diaphysis, crista tibiae damaged, cranial view; 10. tibia dext., distal enfused diaphysis; 11. Ph III; 12. astragalus dext., dorsal view, articulation fitting to calcaneus; 13. calcaneus dext., a. unfused tuber calcanei, b. corpus calcanei, medial view.

deeper (Fig. 13.8b) and seemingly made with much more effort, which could derive from cutting the tendon binding the humerus/ulnar articulation in the freshly killed animal (*comparable to Binford 1981. Fig. 4.30.b, Fig. 4.31*). At the trochlea itself, there are no cut-marks, which means that further disarticulation was easy after the tendons binding the humerus and ulna were severed. For the same reason, there are no cut-marks at the radius. Besides the proximal end of the radius (Fig. 13.9), two more radius fragments were found, all with old breaks, showing that further processing was performed on site after primary butchering. Small cuts, found on the diaphysis in two of these three fragments, were probably made when the radius was already separated from the ulna.

From the hind leg long bones, a proximal right (Fig. 13.7) and a distal left part of the femur (Fig. 13.10) were found. At the proximal right femur, damage caused during the dismemberment from the hip-girdle is observable: two cuts on the caput femori, and cuts below the caput on the femur neck (Fig. 13.7a). The interesting feature are several cases of dimple damage below the trochanter minor, which all bear scratches on their bottoms, originating from a multipointed artefact. The remaining part of the diaphysis bears other longitudinal and oblique scratches and cuts, and the end of the fragment was transversely cut after the bone was split longitudinally. On the other hand, the distal end of the left femur bears filleting marks in the form of longitudinal shallow cuts on its diaphyseal part (Fig. 13.10a). There was

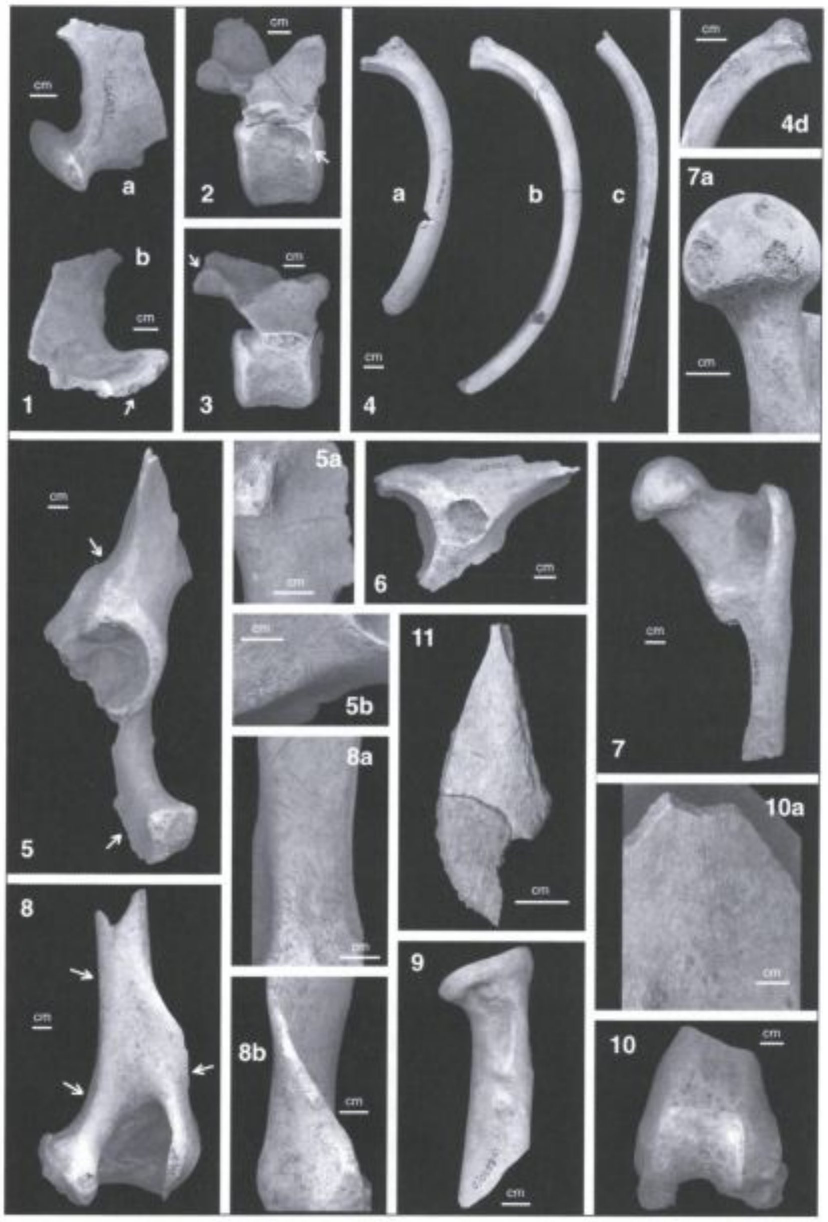

Fig. 13. Ursus arctos, below the floor of the house 31: 1. mandible sin., articular process, a. inner view, b. outer view, arrow points to cut marks made below the articular condyle; 2. last thoracal vertebra, lateral view, cranial side turned to right, arrow points to demifacet for rib articulation; 3. first lumbar vertebra, lateral view, cranial side turned to right, arrow indicates the position of cut marks; 4. a., b., c. three fragmented costae, 4d. cut marks at proximal part of costa shown at 4b, inner side; 5. pelvis sin., arrows point to position of cut marks, 5a. at distal part of ischium, 5b. at narrowest part of ilium; 6. pelvis dext. with damaged tuberosity at the acetabulum rim; 7. femur dext. proximalis, caudal view, 7a. cut marks at caput femoris and neck; 8. humerus dext. dist., caudal view, arrows point to positions of cut marks, 8a. cut marks at medial side, 8b. cut marks at lateral side; 9. radius dext. prox., caudal view; 10. femur sin. dist., cranial view, 10a. same bone, caudal view, detail of the surface covered by filleting marks; 11. fragment of femur diaphysis covered by filleting marks, probably in the continuation of distal femur shown at this figure, 10a.

another fragment of diaphysis belonging to the same distal femur, and showing the same longitudinal grooves, which were obviously a continuation of the grooves found on the larger fragment (Fig. 13.11). Since the breaks are old, it is apparent that after filleting, further breakage of the bone happened on site.

For the assumption that the whole animal was butchered on site, it is important to note the presence of short paw bones from the left anterior leg, and left hind leg. There are 4 carpal bones (Figs. 14.2a–d), well-preserved and not fragmented, belonging to the left front leg, and the second and fourth metatarsal belonging to the hind limb (Figs. 14.1a,b). Two first, three second, and four third phalanges (Figs. 13.3a–h) were found, also well preserved and not fragmented, except a single broken third phalanx. It is not possible to say whether they belong to the front or hind leg. In addition, three sesamoid bones were found (Fig. 14.2e). These bones are small (with a maximum length of 12 mm in this case), bean-like structures, not jointed with other bones, except for muscular tissue and tendons, showing again that the bones of the skeleton did not accumulate independently, but as parts of the skeleton, which primary disarticulation, forced by men, as well as final natural disarticulation, happened at the place.

The deer skull with antlers in house 28

House 28 (Fig. 15) is a non-superimposed house found at the upstream end of the settlement. Its peripheral position and size are similar to house 40, as

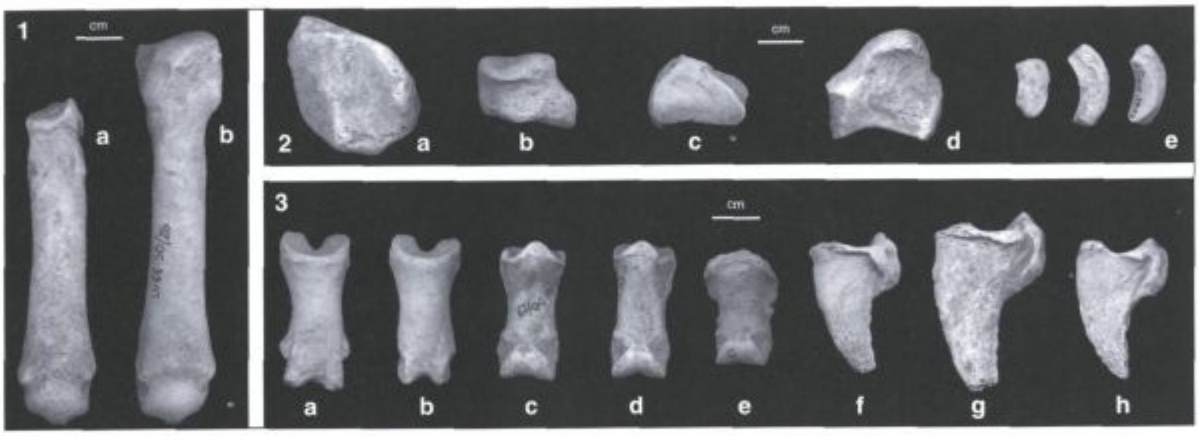

Fig. 14. Ursus arctos, below the floor of the house 31, metapodial and short bones: 1. metatarsalia sinistralis, dorsal view, a. metatarsus II, b. metatarsus IV; 2. a–d. carpalia sinistralis, a. ulnare, b. carpale 1, c. carpale 2, d. carpale 3, e. three sesamoid bones; 3. phalanxes, a–b. first phalanxes, c–e. second phalanxes, f–h. third phalanxes.

well as the arrangement of stone art objects (*Radovanović 1996*). Two sculptures were found, on the right and left sides of a large stone slab in the rear of the house, and because of the large rocks behind it, the house was named "the sanctuary below the rocks" (*Srejović and Babović 1983*).

A red deer skull with antlers was found on the floor. The antlers, both left and right, were preserved at a length of over 50 cm (Fig. 16), and attached to the skull, must have been a voluminous item, whose find itself shows the tradition of the placement of particular skeletal parts of animals in the course of house abandonment. The skull was damaged when lifted from the position where it lay to such an extent that it is not possible to reconstruct it. A delicate structure of bones, rather thin and unfused

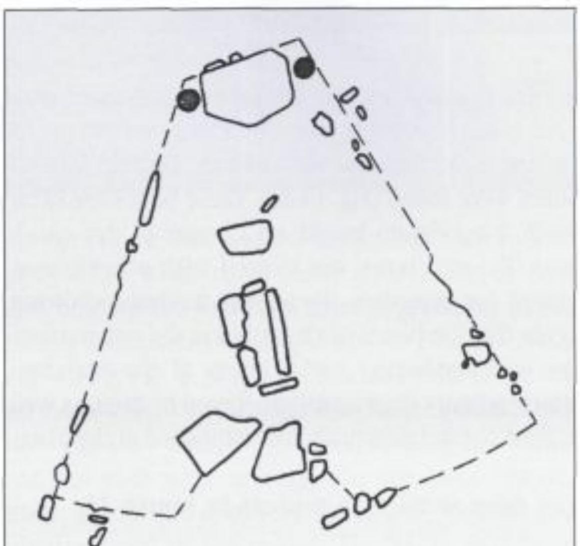

Fig. 15. House 28, Lepenski Vir I (*after Srejović and Babović 1983*).

skull roof bones, and fragile processes contributed to this. However, it is possible to observe that the frontal, temporal and occipital parts of the skull were present, together with the left and right upper jaws. The bones of the face, the nasals and praemaxillars, were not identified.

The animal's age is clearly indicated by its upper teeth, which are in the last stage of milk/permanent dentition replacement and with the last permanent teeth erupting (Fig. 17). Both third milk molars are still holding above the crowns of permanent fourth premolars, although half of the crown of the one on the right side of the jaw is worn out (Fig. 17b); it would have been a matter of days before they fell out. The second and third premolars are erupting, as well as the third molar, preserved only in the left jaw. This stage of dental development in the upper jaw should be analogous to that in the lower jaw, and related to an age of 27 months (*Brown and Chapman 1991*). Since deer give birth in May/June (*Bützler 1986*), this means that the animal was hunted in the early autumn, most possibly in the late September or early October.

The antlers are asymmetrical: the right one consists of a single branch, with just a slight protuberance at the site of the brow tine, while the left antler has a brow tine and simple crown with two tines. Due to their age they are extremely thin (right burr circumference 126 mm, left burr circumference 123 mm, right column circumference, 10 cm from the burr, 80 mm; the same measurement in the left column 76 mm). Although variability in red deer antlers is well known (*Dragičić 1957*), antlers from house 28 should be characterised as unusual in their length and asymmetry.

CONCLUSION – THE ARCHAEO-ZOOLOGY OF TROPHIES

The osteological material described here is not what we are generally accustomed to as animal remains on archaeological sites – a tiresome piles of bone fragments, the remnants of meals and activities difficult to reconstruct, when the main discussion after a thorough analysis is related to measurements and statistics of those many fragments arranged by species and skeletal parts. It is rather what one might describe as a collection of trophies. It seems justifiable to use this expression, since the hunted animals presented, and their particular importance for the society dwelling at Lepenski Vir, and because the units described here related to houses and defined areas between houses, are so precious from the archaeo-zoological point of view, as trophies are for hunters, and finally, because the placement of animal remains in houses in particular instances, especially of red deer antlers, had meaning beyond their economic value.

Red deer skulls with antlers have been found in at least 13 houses at Lepenski Vir (*Bökönyi 1969*). As has been stressed by the inspired doyen of Lepenski Vir culture research, Srejović (*1969.137*), red deer antlers symbolise connections of death and renewed birth, in relation to their unique feature of growing and rejecting yearly cycle, and their amazing ability to grow bigger, stronger and more beautiful every year.

The voluminous antlers on deer skulls positioned on the house floor point further to an item very important for understanding the "life cycle" of the houses themselves, if not the entire settlement. Their deposition marks a time when the house fell into disuse, the house abandoned, and shows that this event was, besides its practical connotations, also of symbolic importance. It also suggests it was prepared. A question remains as to whether house abandonment was a patterned ritual unique to every house, or whether it changed diachronically through the succeeding phases of Lepenski Vir settlement.

Although all the antlers and skulls found in these contexts were not collected during the excavation, because of their volume and apparent meaning, they could not have remained unobserved; they were noted and described. This was not necessarily the case with other osteological finds deposited in the houses, especially if they were smaller skeleton elements, or remains of smaller animals. In this respect, the assemblage from house 40 is important. This assemblage, originating from a part of a wild boar carcass, left in the house either as fresh or dried meat, indicates also a situation at the time of the house being abandoned. There is a possibility that the departure in this case was sudden and unwilling. However, a thoughtful and prepared departure might be a more plausible scenario, especially considering the symmetrical position, similar size and arrangement of stone art objects in relation to house 28, with deer skull and antlers. Whether there is a temporal connection between these two house abandonment events, or at least whether houses 28 and 40 belonged to the same building horizon might be enlightened only by absolute dating.

Fig. 16. Cervus elaphus, house 28, left and right antler, frontal view.

The other two units described in this paper also depict particular events: episodes in the communal life of the settlement. The assemblage found in the area later covered by house 31 contains the bones two animals. They were brought into the settlement after hunting, and butchered on the spot, possibly, but not necessarily at the same time. The remains of one of them, a young deer, point to the same hunting season, early autumn, as well as the deer skull from house 28. The identification of when a particular animal died leads us to the expectation that through the analysis of animal remains, such as large mammals, but also fish, and even birds, might connect exploitation of certain animal species with a specific time of the year. This would undoubtedly help in understanding the "life cycle" of houses and the settlement itself.

Another assemblage, found at an area later covered by house 47', indicates an activity that is to be expected in a settlement of the period: work on bone as a raw material. The bones found in the assemblage are not the final products of a bone workshop, which we are used to seeing reflected in an inventory of bone artefacts from an archaeological site, but mainly products of the initial phases of working on bone material. There are parts of skeletons of various species that were brought to the spot and disarticulated as the first step in the working process, while particular bones were further split, flaked or modified in another way.

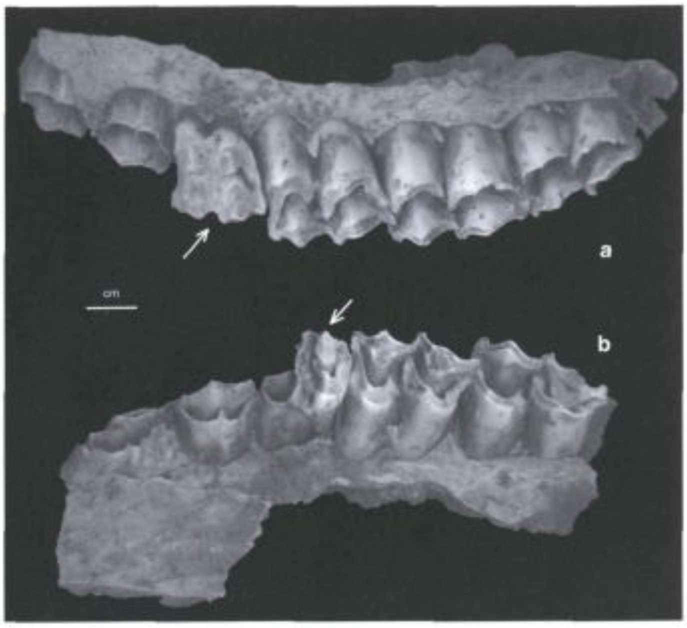

Fig. 17. Cervus elaphus, house 28, upper jaw, arrows point to third decidious premolars hanging above forth permanent premolars: a. P2–M3 dext., b. P2–M2 sin.

Enlightening utilitarian activities in the open areas within the settlement, presented in the osteological material found below the floors of houses 31 and 47', remind us of the general importance of animals in the subsistence strategy, but also to the probability that the foundation of settlements on the Danube's banks in the Iron Gates was primarily initiated by animal exploitation. The importance of animal resources for subsistence continued throughout the development of the Lepenski Vir culture, and is reflected in shared activities exemplified in the archaeological record. But the animals also played a role in the sphere beyond economic importance, and their remains are found in symbolic relation to important events, like the abandonment of a house.

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Documenta Praehistorica XXVII

Stable Isotopes, Radiocarbon and the Mesolithic–Neolithic Transition in the Iron Gates

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ABSTRACT – *The results of stable carbon and nitrogen-isotope analyses of human bone collagen from the Iron Gates sites of Lepenski Vir, Vlasac and Schela Cladovei are reconsidered in the light of recent developments in stable isotope palaeodietary research and new information on chronology. The revised data have implications for the interpretation of Lepenski Vir and Vlasac, and the timing of the Mesolithic–Neolithic transition in the Iron Gates.*

IZVLEČEK – *V članku smo preučili rezultate analiz stabilnih izotopov ogljika in dušika iz kolagena človeških kosti, ki izvirajo iz najdišč Železnih vrat: Lepenski Vir, Vlasac in Schela Cladovei. Pri tem smo upoštevali najnovejše izsledke raziskovanja paleoprehrane s stabilnimi izotopi in nove kronološke podatke. Nanovo pregledani podatki vplivajo na interpretacijo Lepenskega Vira in Vlasca ter na časovno umestitev mezolitsko-neolitskega prehoda v Železnih vratih.*

KEY WORDS – *Iron Gates; stable isotopes; radiocarbon; palaeodiet; Mesolithic; Neolithic; Lepenski Vir; Schela Cladovei; Vlasac*

INTRODUCTION

The Iron Gates has an abundant and continuous record of human occupation in open-air settlements from the Late Mesolithic into the Early Neolithic, *c.* 8500–6500 BP (7500–5450 cal BC). While early farming settlements are well represented in other parts of the Balkan peninsula, Mesolithic sites are uncommon and there are few if any sites that were inhabited continuously from one period to the next. Therefore, the Iron Gates is arguably the only area of southeast Europe where the transition from Mesolithic to Neolithic can be studied in detail.

The evidence for changes in subsistence practices across the Mesolithic-Neolithic transition in the Iron Gates was reviewed by Bonsall *et al.* (*1997*). Their assessment was based largely on the results of stable carbon and nitrogen isotope analyses of human bone from Lepenski Vir, Vlasac and Schela Cladovei.

The purpose of the present paper is to re-examine the Iron Gates stable isotope data and their significance, in the light of better information on food sources and chronology.

DIETARY RECONSTRUCTION FROM STABLE ISOTOPES: SOME BASIC CONSIDERATIONS

Stable isotope analysis of carbon and nitrogen in bone collagen has become a standard technique for palaeodietary studies. The underlying principles may be summarized briefly as follows:

- stable isotope ratios in bone collagen reflect those in diet
- ratios of stable isotopes vary naturally between major food sources
- therefore the importance of different foods in human diets can be estimated from the isotopic composition of collagen.

Table 1 lists "typical" $\delta^{13}C$ and $\delta^{15}N$ values of bone collagen for various major food sources. With each step along the food chain, there is fractionation of one isotope relative to another, resulting in a change in ratio. Most workers assume a slight enrichment in $\delta^{13}C$ (up to 1‰) and an enrichment in $\delta^{15}N$ of 3–4‰ between the bone collagen of the food source and that of the consumer. Because aquatic food webs are more complex than terrestrial food webs, this results in much higher $\delta^{15}N$ values at the top of the aquatic food chain. These factors lead to the "expected" values in bone collagen of humans shown in Table 2.

Food source	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
C_3 terrestrial herbivores	−21.0	+5.0
freshwater fish	−20.0	+11.0
marine fish	−13.0	+13.0

Tab. 1. "Typical" $\delta^{13}C$ and $\delta^{15}N$ values in bone collagen of three major animal food sources available to humans.

The figures for stable isotope ratios in food sources and estimates of trophic level effects cited above should be regarded as "global" averages. There can be significant variation between ecosystems. Therefore, precise dietary reconstruction requires detailed knowledge of the isotopic compositions of local food resources.

Humans feeding on:	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)
C_3 terrestrial herbivores	−20.0	+8.0
freshwater fish	−19.0	+14.0
marine fish	−12.0	+16.0

Tab. 2. "Expected" $\delta^{13}C$ and $\delta^{15}N$ values in bone collagen of humans feeding exclusively on each of the food sources listed in Table 1.

Other factors need to be taken into account when interpreting stable isotope data. Bone collagen in adult humans is estimated to have a turnover (replacement) rate in a range of 10–30 years (*Mays 1998*). Therefore, stable isotope ratios are a reflection of average diet over decadal timescales. However, in children the turnover rate is probably more rapid (*Kleppinger 1984*). Furthermore, the nitrogen isotopic composition of bone collagen is thought to reflect mainly the protein component of the diet as virtually all nitrogen in food comes from protein. Carbon in collagen can be derived from protein, fats or carbohydrates. In high protein diets, the carbon in collagen is thought to come mainly from protein, but in low protein diets a significant proportion of the carbon is probably derived from carbohydrates (*Ambrose 1993*).

REVIEWING THE IRON GATES DATA

Since the original study of the Iron Gates stable isotope data (*Bonsall et al. 1997*), new information has become available that makes it possible to refine some aspects of the interpretation. This includes information on the isotopic composition of the major food sources, and more accurate age estimates for the human bone samples from Lepenski Vir, Vlasac and Schela Cladovei. There is also a larger data set for Lepenski Vir and Vlasac that can be considered.

Food sources

In the original study, because of a lack of detailed information on the isotopic composition of local food sources, the human bone stable isotope results from Lepenski Vir, Vlasac and Schela Cladovei were plotted against data for North American food sources published by Schwarcz (*1991*), with allowance for fractionation effects (Fig. 1). From this it was concluded that the diets of Mesolithic and Early Neolithic populations were a mixture of foods drawn from two major sources, freshwater fish and terrestrial herbivores/C_3 plants.

It is true that, when compared against the North American data, average $\delta^{15}N$ values for Mesolithic skeletons from the Iron Gates appear unusually high for a population that subsisted mainly on freshwater fish (cf. Fig. 1). This has led some other researchers (*Hedges et al. 1998; Schulting 1999*) to infer that the Iron Gates Mesolithic diet must have included a high proportion of Danube-caught anadromous fish from a marine environment, i.e. the Black Sea.

The possibility that anadromous fish were the source of the high $\delta^{15}N$ values was also considered by Bonsall *et al.* (*1997*) but was rejected because there was no corresponding enrichment in the $\delta^{13}C$ values, and because average $\delta^{15}N$ and $\delta^{13}C$ values for Mesolithic adults at Schela Cladovei (where there is abundant evidence for Mesolithic exploitation of

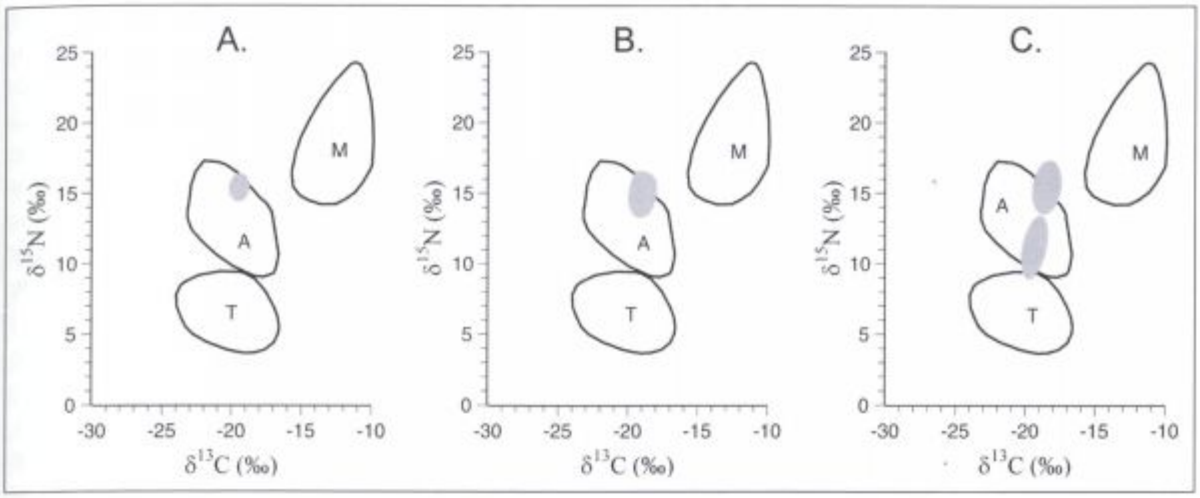

Fig. 1. $\delta^{13}C$ and $\delta^{15}N$ profiles of human populations from Schela Cladovei (A), Vlasac (B) and Lepenski Vir (C) plotted against the ranges of North American aquatic (A), marine (M) and terrestrial (T) food sources, derived from Schwarcz (1991). Redrawn from Bonsall et al. (1997).

sturgeon) appeared very similar to those of their counterparts at Lepenski Vir and Vlasac, where no sturgeon remains were identified by Bökönyi (*1969; 1970; 1977*). Although he did not claim to have been a fish expert, masses of large sturgeon remains would not have escaped his attention. Moreover, he did identify Neolithic sturgeon at the site of Mihajlovac-Knjepište (*Bökönyi 1992*), downstream of Schela Cladovei and the gorge.

In this context it is worth noting that research by Ryan *et al.* (*1997*) strongly implies that the Black Sea was a freshwater lake until 6700 BP, when there was a rapid influx of salt water as the Mediterranean broke through the Bosporus "dam". If their hypothesis is correct, then all Danube fish exploited during the Mesolithic were freshwater fish, and Neolithic people could not have had access to marine fish until after 6700 BP. This in turn implies that freshwater fish are the source of the very high $\delta^{15}N$ values recorded in Mesolithic skeletons from the Iron Gates.

Existing stable isotope data for aquatic food sources from the Iron Gates are limited to analyses of collagen from three fish bones and an otter bone from Lepenski Vir. These show no consistent pattern, with $\delta^{13}C$ values varying between −26.3 and −15.7‰ and $\delta^{15}N$ values varying between +8.2 and +12.9‰ (*Bonsall et al. 1997*). With hindsight, these results may not be unusual. Recent research suggests that $\delta^{15}N$ and $\delta^{13}C$ values of freshwater fish can be highly variable (Fig. 2). Moreover, the values can vary quite considerably for different species from the same freshwater system, and for the same species from different freshwater systems. For example, Dufour *et al.* (*1999*) report inter-species differences from Lake Constance of ~7‰ for $\delta^{13}C$ and ~8‰ for $\delta^{15}N$. In the case of the $\delta^{13}C$ values for the Iron Gates, the spread is almost 11‰. While this spread appears very large, it could be due to a number of factors:

① The number of species in the River Danube could be greater. From the work of Dufour *et al.* (*1999*) it can be observed that for each lake under study, the inter-species differences were much greater than the intra-species differences.

② The age range of the fish from the study of Dufour *et al.* (*1999*) was limited (3–5 years) while those from the Iron Gates could be much greater, as is shown by the evidence of bones from large sturgeon as well as mature carp of extremely large sizes.

③ The study by Dufour *et al.* (*1999*) was effectively a snap-shot in time, while the samples analyzed from the Iron Gates sites could conceivably span several thousand years and there could have been changes in the freshwater ecosystem within this time-span.

④ Most importantly, there could have been a shift to anadromous fish when the Bosporus was breached and the Black Sea became a marine system. The fish specimen with a $\delta^{13}C$ value of −15.7‰ and a $\delta^{15}N$ value of +12.9‰ is certainly not inconsistent with this hypothesis.

If a +3.4‰ trophic level shift is employed between freshwater fish and human bone collagen (*Minagawa and Wada 1984*), then it would require average $\delta^{15}N$ values for Danube fish of approximately +10.5‰, or greater, to produce human bone collagen values of >+14‰, which are characteristic of Mesolithic people from the Iron Gates. While this type of data for fish from the Iron Gates is limited, such values are not uncommon. Iacumin *et al.* (*1998*) and Pate (*1998*) report $\delta^{15}N$ values of about +12‰ for Lake Nasser and South Australia fish, respectively. Dufour *et al.* (*1999*) report $\delta^{15}N$ values >+13‰ for fish from Lake Geneva and Lake Constance, while Hobson and Welch (*1995*) report $\delta^{15}N$ values for large char collected from a high Arctic lake in Canada of >+14‰.

The enrichment of any species will of course depend on the complexity of the food web and its trophic level within the web. Moreover, there is evidence for certain freshwater species that the $\delta^{15}N$ value increases with the age/size of the fish. This is related to the fact that as a fish grows, it tends to feed at higher trophic levels - in effect, it becomes increasingly carnivorous - and beyond a certain growth stage may start to feed on smaller members of the same species. This phenomenon has been reported for arctic char from Canada (*Hobson and Welch 1995*). It may also be characteristic of species such as carp, catfish and sturgeon, which dominate fish bone assemblages from the Iron Gates. Many Mesolithic specimens of these species from the Iron Gates sites were very large and, in comparison to their numbers, such fish may have made a disproportionately large contribution to the food supply.

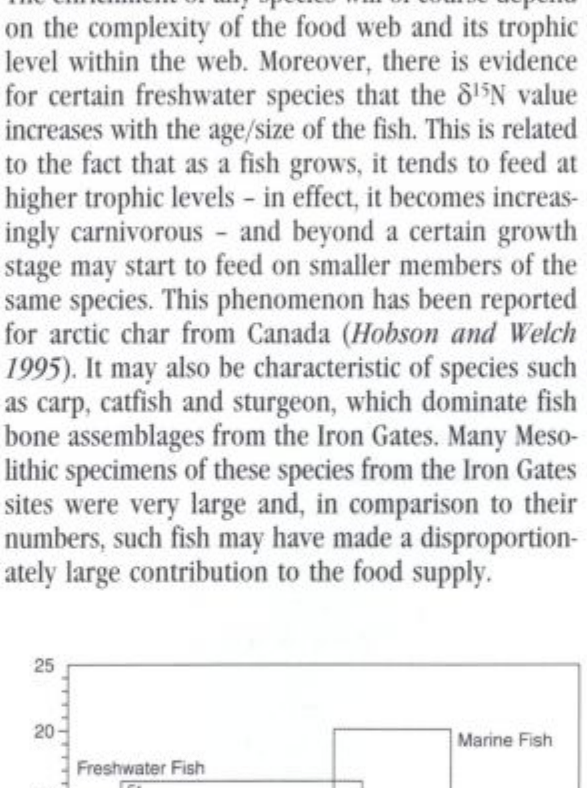

Fig. 2. ***$\delta^{13}C$ and $\delta^{15}N$ natural variations in freshwater fish (F1), terrestrial herbivores (T1) and marine fish from Eurasia (*after Dufour et al. 1999*) compared against North American freshwater fish (F2) and terrestrial herbivores (T2) (*after Schwarcz 1991*) and terrestrial herbivores (T3), river fish (•) and an otter (■) from the Iron Gates (*after Bonsall et al. 1997*).***

It will be evident from the foregoing discussion and Figure 2 that the North American data on freshwater fish published by Schwarcz (*1991*) are not necessarily an appropriate model for the Danube, and that locally derived data are to be preferred. While the locally derived data are limited to three fish bone collagen analyses, the isotopic signature for the otter ($\delta^{13}C$, -19.8‰; $\delta^{15}N$, +10.7‰) effectively provides an average signature for small fish from the Iron Gates, since these will be its primary food source, and arguably, this provides the most reliable model for the Mesolithic human population of the Iron Gates (Fig. 2). An otter's diet comprises primarily small fish, but includes other aquatic animals and small land mammals. Compared to an otter, the bone collagen of a human feeding mainly on much larger fish (and occasionally otters) from the same freshwater ecosystem could be expected to show a slight enrichment in $\delta^{13}C$ and an enrichment of 3-4‰ in $\delta^{15}N$. The data for Mesolithic people from Lepenski Vir, Vlasac and Schela Cladovei are perfectly consistent with this model.

While further research is needed into the isotopic composition of aquatic food resources available to Mesolithic and Neolithic peoples in the Iron Gates, new information *is* available for terrestrial food sources. Collagen values for ungulate bone samples from Mesolithic and Neolithic contexts at Lepenski Vir and Schela Cladovei can be substituted for the North American herbivore data used in the original study (*Bonsall et al. 1997*). Figure 2 compares the two data sets (T2, T3). Although not all the Iron Gates ungulate samples could be identified to species, probably they derive mainly from deer and cattle. The spread of values on the $\delta^{13}C$ axis is significantly less for the Iron Gates data set and, while the spread on the $\delta^{15}N$ axis is similar to the North American sample, the median value (+5.3‰) is significantly higher.

Taking into account the various lines of information on the isotopic composition of aquatic and terrestrial food sources, it seems reasonable to continue to use the $\delta^{15}N$ value as a measure of freshwater *versus* terrestrial food intake in Iron Gates stone age populations (*cf. Cook et al., in press*). An end point of +17‰ for a 100% aquatic diet is assumed, which is the highest $\delta^{15}N$ value measured in an adult from the Iron Gates region (*Bonsall et al. 1997*). For a 100% terrestrial diet a value of +8‰ is assumed. This is based on studies by Ogrinc (*1999*) and Mays (*1998*) supported by local data for herbivores, as discussed above.

Chronology

In their original study, Bonsall *et al.* (*1997*) published new AMS ^{14}C age measurements on human bones from Lepenski Vir, Vlasac and Schela Cladovei. For all three sites, the human bone ages were older than expected on the basis of existing dates on charcoal – for detailed discussion, see Cook *et al.* (*in press, and forthcoming*).

From this, it was suggested that the bone collagen of humans who had ingested large quantities of freshwater fish may be depleted in ^{14}C as a consequence of the consumption of material from a reservoir that differed in ^{14}C specific activity from the contemporary atmosphere, thus resulting in ^{14}C ages that are "too old".

It was further suggested that this possibility could most easily be tested by comparing radiocarbon age measurements on human bones with those on artefacts of terrestrial animal bone found in the same graves. Schela Cladovei provided material ideal for investigating this problem in the form of bone projectile points, made from long bone splinters of artiodactyls, found in direct association with skeletons. These were either embedded in human bone or found immediately adjacent to bones of articulated skeletons (which may originally have been embedded in the soft tissue surrounding the bones). In all cases, the bone points may have been the actual cause of death.

Cook *et al.* (*in press*) obtained AMS ^{14}C dates on paired human and ungulate bone (projectile point) samples. Systematic differences were found between the two sets of ages, demonstrating the existence of a freshwater reservoir effect, and its magnitude was calculated as 540±70 radiocarbon years. From this, and using the $\delta^{15}N$ value as a measure of the proportion of the diet derived from aquatic foods, it is possible to apply a correction to the human bone ages from all the sites (*Cook et al. in press, and forthcoming*).

The corrected ages are given in Table 3. The effect of the correction is to make the human bone ages significantly younger by approximately 200–500 years depending on the $\delta^{15}N$ value. However, the reservoir-corrected ages are less precise, i.e. have larger error terms.

The expanded data set

Bonsall *et al.* (*1997*) reported $\delta^{13}C$ and $\delta^{15}N$ measurements on 70 individual skeletons – 33 from Lepenski Vir, 29 from Vlasac, and 8 from Schela Cladovei. All the skeletons were those of adults of (supposedly) known chronological context. The Schela Cladovei skeletons were a burial group from below and adjacent to a Mesolithic "house", and seven of them were directly dated by AMS to the Late Mesolithic (Tab. 3). The skeletons from the other two sites had all been recorded as belonging to specific phases of Mesolithic or Early Neolithic occupation – Vlasac I-III ("Mesolithic"), Lepenski Vir I-II ("Mesolithic") and Lepenski Vir III ("Neolithic").

To the original data set can now be added the results from a further 46 skeletons, all from Lepenski and Vlasac. They comprise both adults (25 from Lepen-

Site	Laboratory ID	Burial	^{14}C Age BP	Corrected ^{14}C age BP	Calibrated Age Range (2σ) BC
Schela	OxA–4384	M52	8570±105	–	–
	OxA–4379	M43	8550±105	8070±122	7450–6645
	OxA–4385	M55	8510±105	8090±118	7465–6653
	OxA–4382	M49	8490±110	8046±124	7448–6615
	OxA–4380	M46	8460±110	8046±123	7448–6640
	OxA–4378	M42	8415±100	7971±116	7295–6512
	OxA–4381	M48	8400±115	7932±130	7289–6466
	OxA–4383	M50	8290±105	7834±120	7061–6439
Vlasac	OxA–5824	72	10240±120	9850±130	9949–8843
	OxA–5822	51a	8760±110	8380±120	7600–7080
	OxA–5827	83	8200±90	7810±105	7049–6441
	OxA–5823	54	8170±100	7750±115	7032–6401
	OxA–5826	24	8000±100	7600±115	6647–6625
Lepenski Vir	OxA–5827	31a	7770±90	7310±108	6404–5926
	OxA–5830	44	7590±90	7150±106	6225–5797
	OxA–5828	32	7270±90	7040±95	6156–5721
	OxA–5831	88	7130±90	6960±93	6011–5644
	OxA–5829	35	6910±90	6720±93	5772–5479

Tab. 3. Human bone radiocarbon ages from Lepenski Vir, Vlasac and Schela Cladovei, corrected for the freshwater reservoir effect using method 1 of Cook et al. (*forthcoming*). All ^{14}C ages are expressed in conventional radiocarbon years BP (before 1950 AD). The errors are expressed at the one-sigma level of confidence. Calibrated age ranges were determined using CALIB 4.2 (*Stuiver and Reimer 1993; Stuiver et al. 1998*).

ski Vir, and 2 from Vlasac) and children (12 from Lepenski Vir, and 7 from Vlasac). The adults are individuals whose chronological context is either unknown or not recorded, or which (in the case of five samples from Lepenski Vir) were assigned to post-Neolithic occupations. These new data are only presented here in graphic form (Figs. 4–7). Full details will be presented in a later publication.

All analyses were carried out by the sealed tube combustion method described in Bonsall *et al.* (*1997*). Briefly, this comprises the combustion of small collagen samples in evacuated quartz tubes containing copper oxide as the source of oxygen and a small quantity of silver wire to remove halide contaminants. The CO_2 and N_2 are then cryogenically separated and analyzed by stable isotope mass spectrometry. The authors consider this to be the most precise and accurate method to determine stable isotope ratios in human bone collagen, and would advise that these and continuous flow measurements should not be combined.

In the original study, identification of groups was done primarily by visual inspection of bivariate scatterplots. In this paper, a variety of exploratory and formal statistical methods, including exploratory cluster analysis, linear discrimination techniques and hypothesis tests have been used to explore groupings and to assess evidence for pre-defined archaeological groups. Statistical analysis was carried out in MINITAB v. 13.

DISCUSSION

Adults

Lepenski Vir

The original data set from Lepenski Vir comprised measurements on 33 adults from the various Stone Age occupation phases that were recognized by Srejović (*1969; 1972; Zoffmann 1983*) – Proto-Lepenski Vir, Lepenski Vir I, II and III. A bivariate scatterplot of the data (*Bonsall et al. 1997; cf. Fig. 1c*) suggested that there were two groups. One group exhibited $\delta^{13}C$ and $\delta^{15}N$ values that were similar to Mesolithic individuals from Schela Cladovei and Vlasac (cf. Figs. 1a and 1b), indicative of diets with a high input of protein from aquatic sources, and the other showed much lower $\delta^{15}N$ values suggesting diets with increased levels of protein from terrestrial food sources. Cluster analysis of the original data set (Fig. 3) broadly supports these two groupings.

The enlarged data set of 58 adults comprises the 33 individuals that had been attributed to Mesolithic and Neolithic contexts, plus 5 individuals "dated" to the Chalcolithic and Medieval periods, and 20 individuals that were not assigned to any occupation "phase". Dietary end points of +8‰ and +17.0‰ were adopted as representing 100% terrestrial and 100% aquatic diets respectively (*Cook et al. in press*). Cluster analysis of this revised data set suggests that there are at least three groups, distinguished primarily on the basis of the $\delta^{15}N$ value (Fig. 4A). The individuals in group 1 have $\delta^{15}N$ values ranging between +14.4 and +17.0‰, which implies that this group had diets in which 71–100% of the protein was derived from aquatic sources. Group 3 individuals have $\delta^{15}N$ values between +9.3 and +11.2‰, which implies that the bulk (64–86%) of the protein came from terrestrial sources. Group 2 skeletons have $\delta^{15}N$ values ranging from +11.8 to +14.0‰, intermediate between groups 1 and 3, indicating diets in which protein was derived from aquatic and terrestrial sources in similar proportions (42– 67%).

The provisionally identified groups (clusters) do not correspond to archaeological (Srejović) phases and groups contain individuals of diverse age at death and both sexes. However, there appears to be a link between groups and radiocarbon age. Of the five radiocarbon ages currently available (Tab. 3), two lie in group 1 (7310±108 BP, 7150±106 BP), one falls in group 2 (7040±95 BP), and two lie in group 3 (6960±93 BP, 6720±93 BP). The reservoir-corrected ages form a more or less continuous series, and suggest that the three groups relate to different phases in the use of the site.

The dendrogram (Fig. 4A) and scatterplot (Fig. 4B) show that sub-groups may exist within the main groups 1 and 3, but their identification is based on only small numbers of individuals and so remains unconfirmed.

For example, in group 1 there are seven individuals with very low $\delta^{13}C$ values relative to $\delta^{15}N$, and with virtually identical $\delta^{15}N$ values (Fig. 4B, "sub-group 1b"). Of these, five are male/probably male, one is probably female, and one is of indeterminate sex (*Roksandić 1999*). The female is an elderly individual (>40). Given the age/sex composition of this "sub-group" and the fact that there is at least one child with a similar $\delta^{13}C$ isotopic signature (see below), it would be difficult to see these as "outsiders" who had married into the Lepenski Vir community (*cf. Bonsall et al. 1997*). A more likely expla-

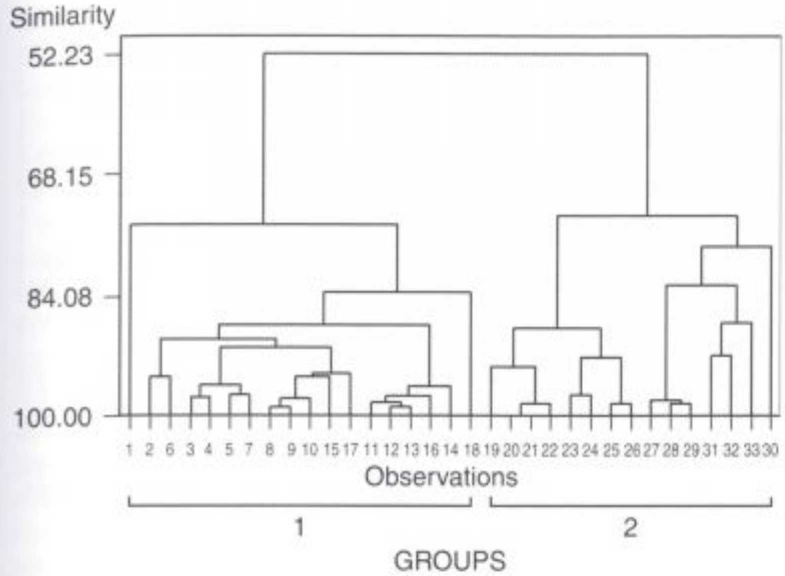

Fig. 3. Dendrogram grouping 33 skeletons from Lepenski Vir (*cf. **Bonsall et al. 1997*) according to $\delta^{13}C$ and $\delta^{15}N$ values.

nation is that they represent a specific phase in the occupation of the site when people had access to aquatic food sources that were relatively depleted in ^{13}C (compared to other group 1 individuals). Variations in the isotopic composition of Danube fish may have occurred through time as a result of natural changes in the freshwater ecosystem.

A similar explanation may be proposed for four individuals in group 3 who have unusually enriched $\delta^{13}C$ relative to $\delta^{15}N$ values (Fig. 4B, "sub-group 3b"). They evidently consumed larger amounts of $\delta^{13}C$-enriched terrestrial (and possibly aquatic) foods compared to other group 3 individuals, which may indicate that they belong to a different phase in the occupation of the site. Theoretically, changes in the natural environment and/or economic practices could have raised average $\delta^{13}C$ levels of some important food sources. Such changes include (i) an increase in grazing herbivores (including domesticated cattle) at the expense of browsers (deer), as agriculture expanded and woodland cover was reduced; (ii) the introduction of C_4 millet (*Panicum miliaceum*) into the food chain during the Neolithic (or a subsequent increase in its use) either directly as human food or indirectly as grown forage for livestock, and (iii) the appearance of true marine fish (anadromous) in the Danube after 6700 BP when the Black Lake was converted into the Black Sea.

The suggestion that within their respective groups, "sub-groups" 1B and 3B are chronologically distinct is a working hypothesis that requires confirmation from radiocarbon dating.

Vlasac

Cluster analysis of the enlarged data set of 35 individuals from Vlasac suggests a division into four groups (Fig. 5A). Groups 1 and 4 are separated on the basis of $\delta^{15}N$. Groups 2 and 3 are distinguished on the basis of both $\delta^{13}C$ and $\delta^{15}N$ (Fig. 5B).

Again, the provisional groups (clusters) do not correspond to archaeological phase (*cf. Srejović and Letica 1978*) and groups contain individuals of diverse age at death and both sexes. Of the five radiocarbon ages currently available, four lie in group 1 (9800±108 - 7768±113 BP) and one lies in group 2 (7598±113 BP). The single group 2 age measurement is in trend the youngest and raises the possibility that the two clusters represent different periods in the use of the site. However, to confirm any time relationship between the two groups would require further ^{14}C measurements with improved precision.

No ^{14}C age measurements are currently available for groups 3 or 4. Groups 1-3 at Vlasac have $\delta^{13}C$ and $\delta^{15}N$ values similar to group 1 at Lepenski Vir, while Vlasac group 4 has $\delta^{15}N$ values in the range of Lepenski Vir group 2. Vlasac and Lepenski Vir occupy almost identical riverside locations just a few kilometres apart that, presumably, gave access to essentially the same food resources. Therefore, it may be suggested that Vlasac group 4 belongs to the same time-range as Lepenski Vir group 2, and is later than Vlasac groups 1-3 and Lepenski Vir group 1.

Children

Isotopic analyses are available for 10 children (under 15 years old) from Lepenski Vir. These are compared against the adult ranges in Figure 6. The overall distribution is similar to that of the adults. Six children have $\delta^{15}N$ values in the range of the group 1 adults, including one with a $\delta^{13}C$ relative to $\delta^{15}N$ value reminiscent of the adult "1b sub-group". One child has a $\delta^{15}N$ value in the range of the group 2 adults, and there are three children whose $\delta^{15}N$ values are similar to group 3 adults.

It is interesting that the first group of children have $\delta^{15}N$ values that are, on average, 1.1‰ higher than the corresponding group of adults (+16.5‰ *versus*

+15.4‰). A tendency toward more positive δ¹⁵N values in children compared to adults has been observed in some previous studies (e.g. *Pate 1997; Ogrinc 1999*). This is usually attributed to the fact that, during infancy, children ingest their mothers' milk and thus, in effect, feed at a higher trophic level. After weaning, it is supposed that bone collagen turnover would result in the progressive loss of this "nursing signal" (*cf. Pate 1997*).

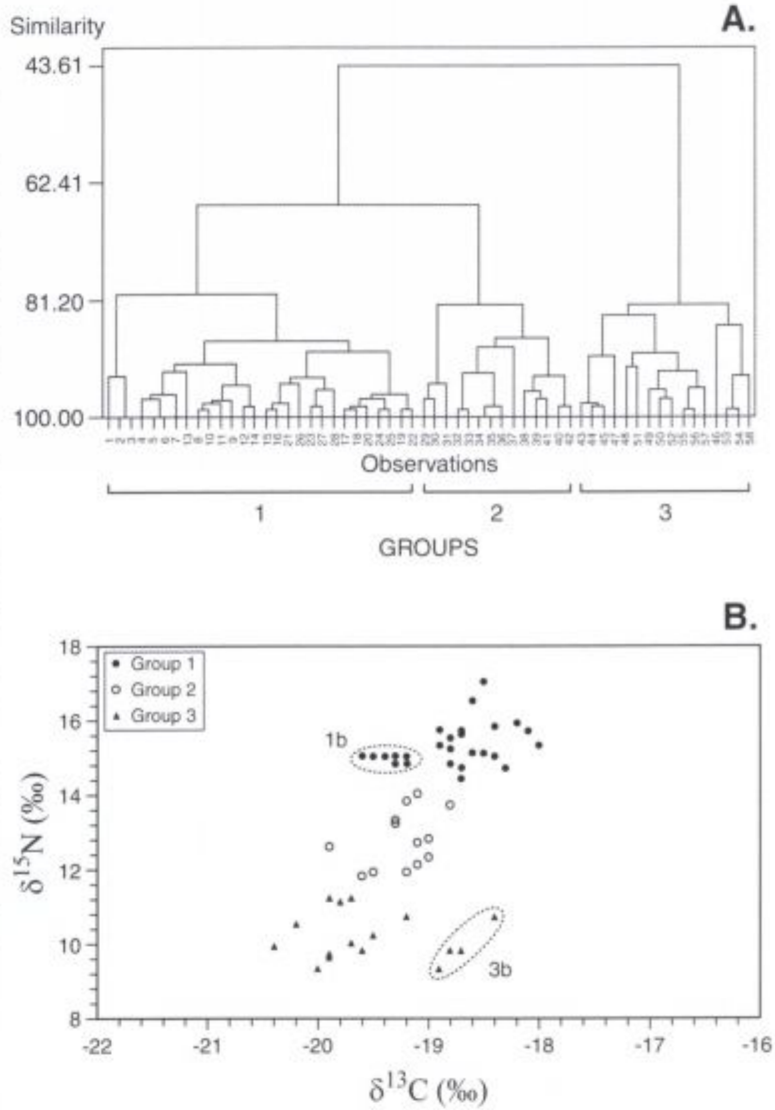

Fig. 4. A. Dendrogram grouping 58 skeletons from Lepenski Vir according to $\delta^{13}C$ and $\delta^{15}N$ values. B. Scatterplot of $\delta^{13}C$ versus $\delta^{15}N$ for 58 adults from Lepenski Vir, and groupings suggested by cluster analysis. Note the exaggerated scale on the $\delta^{13}C$ axis.

A "nursing effect" is not apparent for the other Lepenski Vir children, perhaps because of the very small number of individuals involved. Nor is it evident among the children from Vlasac (Fig. 7), although the possibility cannot be excluded. Of the seven Vlasac children analysed, five have $\delta^{13}C$ and $\delta^{15}N$ values similar to group 1 adults, while another has a $\delta^{15}N$ value that falls at the bottom of the range for group 2 adults. Assuming a 1.1‰ difference between the average $\delta^{15}N$ values of adults and children, it is possible that some of the Vlasac children are the offspring of group 4 females, and others are the offspring of group 1 and 2 females.

The remaining child from Vlasac has $\delta^{15}N$ and $\delta^{13}C$ values of +12.7‰ and −19.8‰, respectively. These are the lowest values recorded for any individual (child or adult) from Vlasac, and fall within the range of the group 2 individuals from Lepenski Vir. This evidence appears to confirm the presence at Vlasac of individuals with "intermediate" diets, and it is not inconceivable that this child was that of a female who had a predominantly terrestrial diet (cf. Lepenski Vir group 3).

Because of the possibility of systematic differences between the isotopic signatures of adults and children, it was decided that separate statistical analyses be carried out.

Dietary change and the timing of the Mesolithic-Neolithic transition in the Iron Gates

The direct AMS ^{14}C age measurements on human bones from Lepenski Vir and Vlasac (Tab. 3) are evidence of human occupation of that part of the Iron Gates gorge from *c.* 9800–6700 BP. Bone collagen stable isotope analyses indicate fundamental changes in diet during that time range.

Humans dated before 7150±106 to 7040±95 BP on the reservoir-corrected time-scale have $\delta^{15}N$ values of ≥+14.4‰, indicating diets in which the bulk (>67%) of the protein was derived from Danube fish. This phase is represented by the group 1 individuals at Lepenski Vir and by Vlasac groups 1, 2 and 3. Since there is no evidence for the keeping of domesticated animals (other than dog) prior to that time, it seems reasonable, using this criterion, to describe the pre-7150–7040 BP inhabitants of Lepenski Vir and Vlasac as "Mesolithic".

If so, when did the people of the Lepenski Vir–Vlasac section of the Iron Gates become "Neolithic" farmers?

A change in diet is evident at Lepenski Vir between 7150–7040 BP. The group 2 individuals from Lepenski Vir show a significant reduction in average $\delta^{15}N$ values, consistent with an increase in the amount of protein derived from terrestrial food sources and a corresponding decrease in protein from aquatic sources. The same change may be represented at Vlasac by the group 4 adults. At Lepenski Vir this can be seen as the beginning of a trend that culminated in the adoption of a predominantly terrestrial diet by *c.* 6960 BP, represented by the group 3 individuals. The timing of this dietary change corresponds quite closely with the appearance of Neolithic farmers in the regions surrounding the Iron Gates, represented by the earliest Starčevo-Criş-Körös settlements, and it is reasonable to infer that the two events are connected.

There are two hypotheses that can plausibly account for the changes observed at Lepenski Vir (and possibly Vlasac) after 7150±106 BP. The first is that Mesolithic people of the Lepenski Vir–Vlasac area adopted farming more or less as soon as it became available to them, and gradually increased the amount of agricultural products in their diets at the expense of traditional aquatic resources. The second is that the local population did not become farmers immediately, but traded with neighbouring farmers for agricultural products for a period of decades to centuries before eventually taking up livestock raising and cultivation.

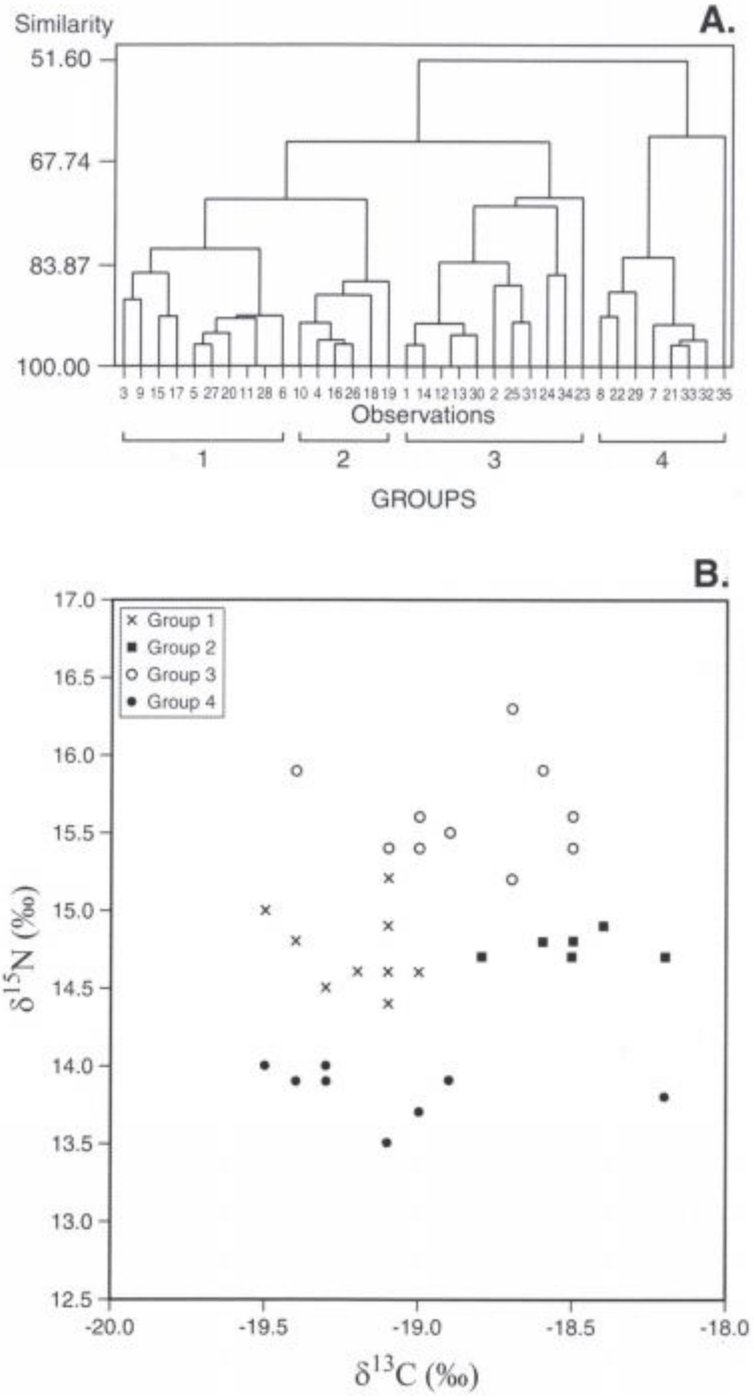

Fig. 5. A. Dendrogram grouping 35 skeletons from Vlasac according to $\delta^{13}C$ and $\delta^{15}N$ values. B. Scatterplot of $\delta^{13}C$ versus $\delta^{15}N$ for 35 adults from Vlasac, and groupings suggested by cluster analysis.

This latter possibility has been suggested by several authors, most notably Voytek and Tringham (*1989*). On the existing radiocarbon evidence, an "availability phase" (*cf. Zvelebil and Rowley-Conwy 1984; 1986*) during which Mesolithic people in the Iron Gates increased their intake of terrestrial protein through trade or exchange with farmers, could have lasted between a few decades and approximately 600 years. The same radiocarbon evidence suggests that it would have ended by *c.* 6800 BP at the latest. Two individuals from Lepenski Vir group 3 with reservoir-corrected radiocarbon ages of 6960±93 BP and 6720±93 BP have $\delta^{15}N$ values of +10.9‰ and +11.2‰, respectively, indicating predominantly (64–68%) terrestrial diets. In the context of the Iron Gates, it is difficult to see how such high levels of terrestrial protein intake could have been sustained without a direct investment in agriculture.

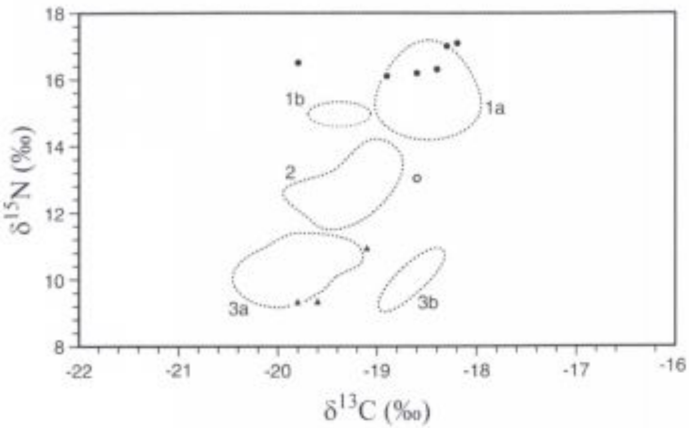

Fig. 6. δ¹³C versus δ¹⁵N for 10 children from Lepenski Vir, plotted against ranges of adult groupings suggested by cluster analysis.

Other explanations could be proposed for the *initial* reduction in average $\delta^{15}N$ values at 7150–7040 BP (cf. Lepenski Vir group 2, Vlasac group 4). They include a long-term increase in the consumption of wild animal and/or plant resources, a reduction in the average size of freshwater fish caught, or even a change in the type of fish caught. However, there is no convincing supporting evidence from either Lepenski Vir or Vlasac. Even if there were, such changes are most unlikely to account for the strongly "terrestrial" isotopic profile of the group 3 individuals from Lepenski Vir.

Stable isotopes and the dating of houses at Lepenski Vir

Since the publication of the account of the Lepenski Vir excavations (*Srejović 1969; 1972*) there has been considerable controversy over the age and cultural context of the trapezoidal-plan houses of Lepenski Vir I and II. While most authors now accept the radiocarbon ages on charcoal from the houses as valid, there is still disagreement on whether the houses should be interpreted as Mesolithic (*cf. Radovanović 1996*) or Neolithic (*cf. Ehrich 1974; Milisauskas 1978*). The radiocarbon and stable isotope measurements on human bones from Lepenski Vir, discussed in this paper, have a critical bearing on the issue.

Charcoal samples from the LV I–II houses produced ^{14}C ages between 6560 and 7430 BP (*Quitta 1972; Borić 1999*). These are similar to the reservoir-corrected ^{14}C ages on human bone (Tab. 3). If the ^{14}C ages of the charcoal and human bone samples are accepted as being correct, then the houses and the human bones can be considered as belonging to approximately the same time-range. Since the human bones appear to span the transition from a Mesolithic to a Neolithic economy, it would be reasonable to conclude that the same applies to the houses. However, as Cook *et al.* (*in press and forthcoming*) have pointed out, the charcoal samples were from long-lived tree species (oak and elm). Such samples can yield ^{14}C ages that are several hundred years older than the archaeological events they purport to date – often referred to as the "old wood" problem. Therefore, it is conceivable that the houses are significantly younger than the radiocarbon ages of the charcoal samples, and all the houses post-date the change in diet between 7150 and 7040 BP, i.e. they belong to the time-range of the group 2 and 3 humans. This would be consistent with the presence of Starčevo pottery in several of the houses that were dated (*Budja 1999.Fig. 7*). These are house 54 (7161±56 BP – weighted mean of five ^{14}C measurements), house 1 (6860±100 BP) and house 16 (6820±100 BP).

Given the uncertainties over the interpretation of the charcoal-based radiocarbon ages, the question may be asked: can it be shown that *any* of the houses at Lepenski Vir belongs to the period of the group 1 ("Mesolithic") humans?

It was suggested above that the division of the human remains from Lepenski Vir into three groups, according to the $\delta^{13}C$ and $\delta^{15}N$ values, represents a time-series. For convenience, this may be characterised as: Period 1 ("Mesolithic") dating before 7040±95 BP and comprising individuals with $\delta^{15}N$ values of ≥+14.4‰. Period 2 ("transitional Mesolithic–Neolithic") dating *c.* 7040±95 BP and represented by individuals with $\delta^{15}N$ values ranging between +11.8 to +14.0‰. Period 3 ("Neolithic") dating after 7040±95 BP and comprising individuals with $\delta^{15}N$ values of ≤+11.2‰.

If the "phasing" of the human remains based on $\delta^{15}N$ is reliable, where there is a clear stratigraphic relationship between a human skeleton and a house, it follows that the bone collagen $\delta^{15}N$ value can be used to infer the age of the house. However, this would only apply in the case of articulated skeletons. Many of the "skeletons" uncovered in the Lepenski Vir excavations appear to be groups of disarticulated bones. These could represent delayed or secondary burials of individuals who had died some time previously, and hence there could be a significant "age offset" between the time of death of the individual and the time of final burial.

Few details of the stratigraphic relationships of burials and houses are provided in published accounts of the Lepenski Vir, but there is a limited amount of photographic evidence that can be considered.

Published photographs of house 21 (*Srejović 1969. Pl. 69; Radovanović 1996.Fig. 4.3*) show the articulated skeleton of an adult female lying below the floor of the house. It is clear from other photographs published by Radovanović (*1996.Figs 3.14, 3.31, 3.32*) that the burial was inserted through the plaster floor. This relationship indicates that the burial must have been emplaced after the plaster floor was laid, and therefore (presumably) post-dates construction of the house. The skeleton (7b or 7/I) has a $\delta^{15}N$ value of +15.8‰, placing it firmly within Period 1 ("Mesolithic"). Unless this is a case of delayed burial following excarnation, which seems highly improbable, the evidence implies that house 21 is also Mesolithic.

According to Srejović (*1969; 1972; Srejović and Babović 1983*) and Radovanović (*1996*) house 21 is superimposed upon houses 22, 29 and 30 (Fig. 8), which therefore places them also in period 1. Thus, there are at least four houses at Lepenski Vir that, on the combined evidence of stratigraphy and bone collagen isotopic data, can be argued to pre-date the change in diet between 7150 and 7040 BP.

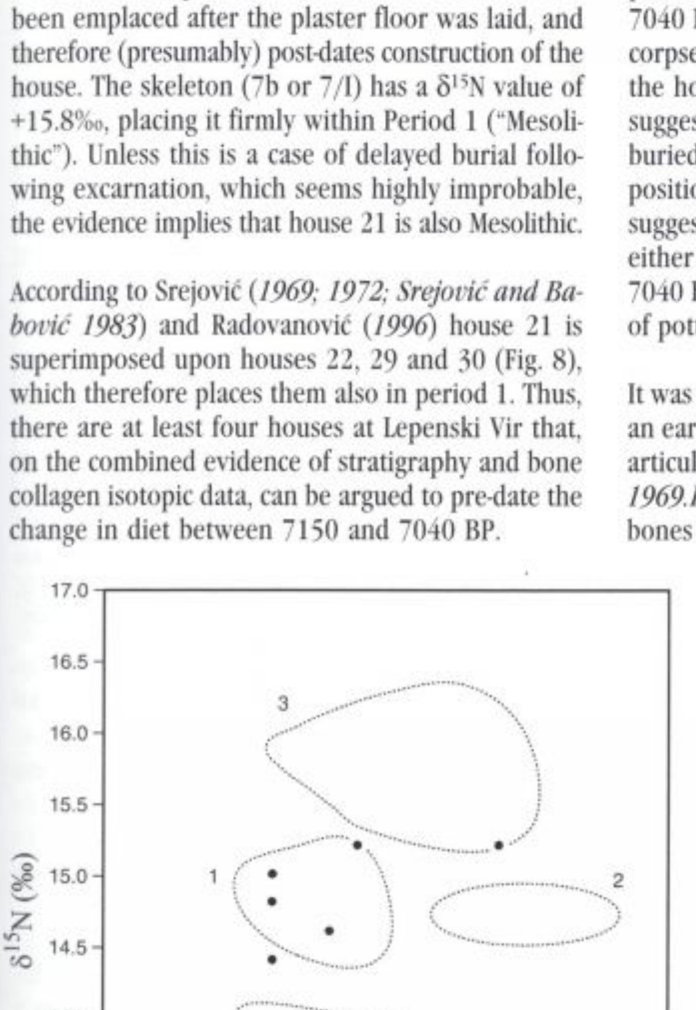

Fig. 7. $\delta^{13}C$ versus $\delta^{15}N$ for 7 children from Vlasac, plotted against ranges of adult groupings suggested by cluster analysis.

It is significant that none of the four probable period 1 houses discussed appears to have been associated with Starčevo pottery (*cf. Budja 1999.Fig. 7*). This would be consistent with a Mesolithic context and an age prior to 7040 BP.

The photograph in Srejović (*1969.Pl. 67; Srejović 1972.Pl. 58*) shows the articulated skeleton of an adult female (54e) lying directly above stone slabs apparently set into the floor of house 65 (Fig. 8). This skeleton has a $\delta^{15}N$ value of +13.2‰ and belongs to period 2, post-dating the dietary change at 7150–7040 BP. Leaving aside the question of whether the corpse was deliberately left exposed on the floor of the house, or placed beneath a cairn (a possibility suggested by other photographic evidence), or buried in a grave pit dug from a higher level, the position of the skeleton with respect to the floor suggests that the house is older and could belong to either period 1 or period 2. A period 2 (post-7150–7040 BP) age would be consistent with the presence of pottery inside the house (*cf. Budja 1999.Fig. 7*).

It was suggested by Srejović that house 65 contained an earlier burial (54d), which is represented by disarticulated bones around skeleton 54e (*Srejović 1969.Pl. 67; Srejović 1972.Pl. 58*). One of these bones gave a $\delta^{15}N$ value of +15.3‰ suggesting an age prior to 7150–7040 BP. It was claimed that the bones of 54d had been disturbed by burial 54e. However, given the disarticulated nature of 54d and the fact that the bones may be from more than one individual, they are more plausibly interpreted as a secondary burial and cannot therefore be used to "date" house 65.

The stable isotope data also have implications for Radovanović's architectural phasing of the Lepenski Vir houses (*Radovanović 1996*). As noted above, there is good evidence that houses 21, 22, 29 and 30 are Mesolithic and predate 7150–7040 BP. In Radovanović's scheme, houses 21 and 22 are assigned to phase I.2, and houses 29 and 30 to phase I.1 (Fig. 8). If her phasing of the houses were correct, one would have to conclude that the shift away from a traditional Mesolithic diet began either during or after phase I.2, and that all houses assigned to phase I.1 are Mesolithic. However, this interpretation is inconsistent with radiocarbon evidence from three other houses attributed to phase I.1 (houses 1, 9 and 37) suggesting

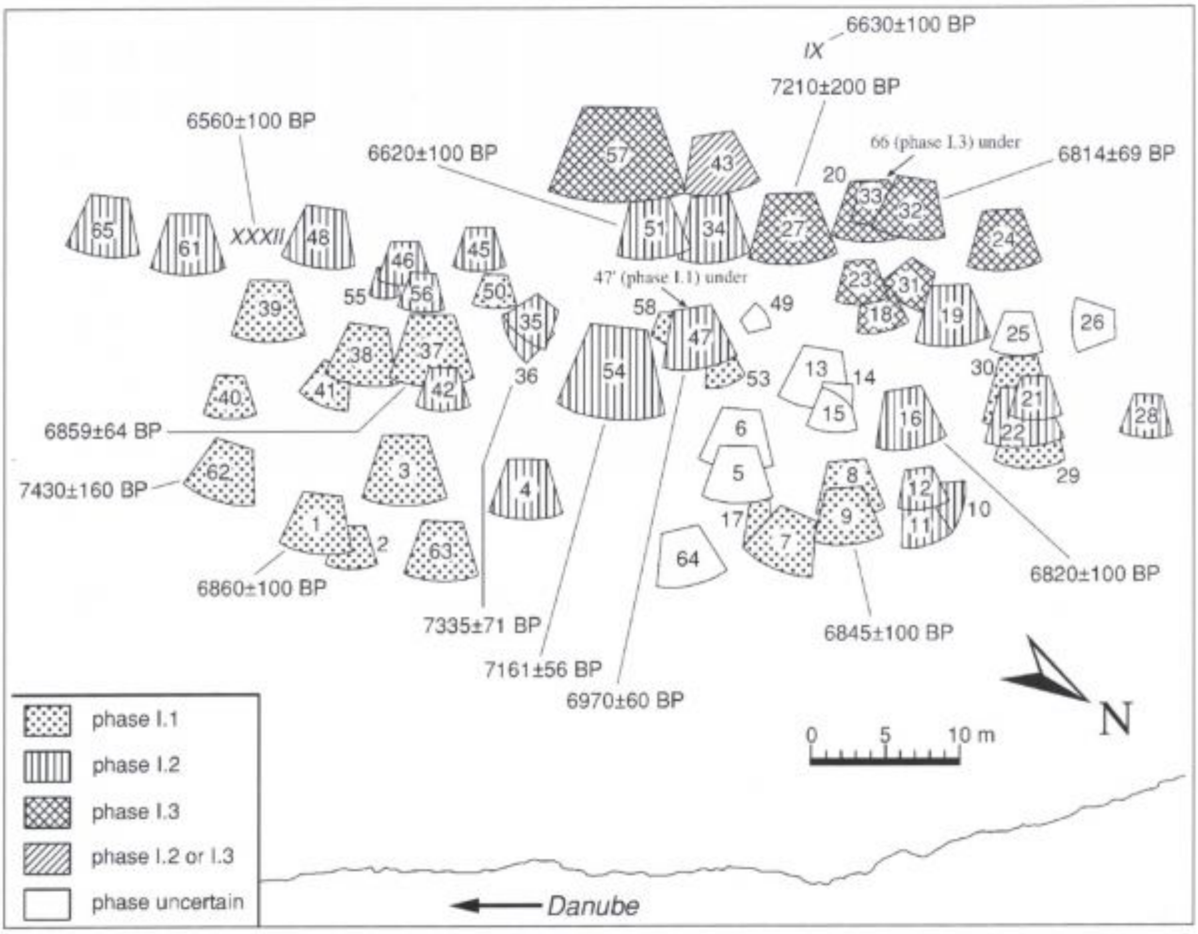

*Fig. 8. Lepenski Vir I site plan showing architectural phases and radiocarbon ages of houses based on charcoal samples (***after Radovanović 1996, with acknowledgement to Borić 1999 and Bailey 2000***). The ^{14}C ages of houses 36, 37 and 54 are weighted means of several measurements. The locations of two Lepenski Vir II houses (IX and XXXII) and corresponding ^{14}C ages are also shown.*

that they post-date the dietary change at 7150–7040 BP (Fig. 8).

The use of stable isotope data as a proxy dating tool may also contribute to a better understanding of the evidence from Vlasac. Five charcoal samples from Srejović and Letica's (*1978*) phase 1b gave ^{14}C ages of 6805–7000 BP. These ages were rejected because they were out of sequence with radiocarbon determinations for the succeeding phases II and III, and because they were not in accord with the excavators' belief that the contexts dated were Mesolithic. However, in European archaeology radiocarbon ages have often proved more reliable than chronologies derived from archaeological observations. The ages for "Vlasac 1b" are consistent with the presence of Early Neolithic (Starčevo) remains on the site. These have always been considered a very minor component of the archaeological record. However, as noted above, stable isotope evidence indicates that a significant proportion of the humans buried at Vlasac – the group 4 adults, representing 23% of the samples analyzed – had diets similar to the group 2 adults from Lepenski Vir, and may therefore belong to the same time-range of *c.* 7040±95 BP.

CONCLUSIONS

Reappraisal of a larger stable isotope data set for Lepenski Vir and Vlasac demonstrates a shift from a Mesolithic-type dietary regime, based largely on aquatic resources, through an intermediate phase, to one based largely on terrestrial resources that probably included a major agricultural component. Radiocarbon evidence suggests that the transition centred around 7040±95 BP (6156–5721 cal BC), and that agriculture was being practised in the Lepenski Vir–Vlasac area by 6800 BP (*c.* 5700 cal BC).

The stable isotope and radiocarbon data coupled with evidence of the stratigraphic relationships between burials and houses suggest that the trapezoidal plan houses of "LV I–II" span the time-range of the dietary change. This is contrary to previous interpretations of the houses as either exclusively Mesolithic or exclusively Neolithic. Moreover, the stable isotope evidence suggests that Lepenski Vir (and possibly Vlasac) was occupied continuously from the Mesolithic into the Early Neolithic.

For both Lepenski Vir and Vlasac, this paper has also highlighted apparent conflicts between archaeological sequences and radiocarbon based chronologies supported by stable isotope analyses. Future research must be directed toward resolving the issues that have been raised here.

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Documenta Praehistorica XXVII

The Mesolithic/Neolithic Transition in Greece as Evidenced by the Data at Theopetra Cave in Thessaly

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ABSTRACT – *The Mesolithic period was sparsely documented in some littoral sites in Greece until 1992, when it was first testified in Theopetra Cave, western Thessaly, in central Greece. Excavation data in Theopetra indicate a very normal and natural transition from the Mesolithic to the Neolithic, which is documented by (a) the presence of unbaked masses of clay in the Mesolithic layers and a few atypical and monochrome sherds found at the same layers could show the very initial samples of pottery technology. (b) The presence of domesticated sheep and goat in the Mesolithic zoo-archaeological material, and a good percentage of wild fauna in the Neolithic deposit, indicating a rather similar way of life in both periods; (c) the presence of cultivated hulled six-row barley and of wild eincorn, both testifying farming as a local development and not as knowledge that came from the Near East to Greece. (d) The biological homogeneity which derives from the DNA analysis of human bones of successive periods.*

IZVLEČEK – *Vse do leta 1992 je bilo mezolitsko obdobje v Grčiji redko dokumentirano v nekaj obrežnih najdiščih. Takrat pa smo ga prvič dokazali v jami Theopetra, ki leži v zahodni Tesaliji v osrednji Grčiji. Izkopavanja v Theopetri kažejo, da je bil prehod iz mezolitika v neolitik zelo normalen in naraven. To dokazujejo: (a) navzočnost nepečenih kep gline v mezolitskih plasteh in nekaj netipičnih in enobarvnih črepinj, ki smo jih našli v istih plasteh, bi lahko kazalo na prve začetke izdelovanja keramike; (b) navzočnost udomačene ovce in koze v mezolitskem zoo-arheološkem materialu in precejšen odstotek divje favne v neolitskih plasteh, kar kaže na dokaj podoben način življenja v obeh obdobjih; (c) navzočnost kultiviranega šestvrstnega ječmena in divjega eincorn žita, kar oboje priča, da se je kmetovanje razvilo lokalno in da znanje o tem v Grčijo ni prišlo iz Bližnjega vzhoda. (d) Biološka homogenost, ki izhaja iz DNA analiz človeških kosti, iz naslednjih obdobij.*

KEY WORDS – *Theopetra, Thessaly, Mesolithic, transition to farming.*

INTRODUCTION

The Mesolithic is the least investigated archaeological period in Greece. Two cave sites with Mesolithic finds (Zaimis and Ulbrich in Attica and the Peloponnese respectively) were excavated in 1920 by A. Markovits (*1933*), but until the1950's the Neolithic was considered almost the back end of Prehistory in Greece, as the two above caves were never included in discussions concerning the Mesolithic in Greece (*Galanidou in press*).

After Milojčić's Palaeolithic finds in the banks of the Peneios River in Thessaly in the same decade (*Milojčić et al. 1965*), the demand for a Mesolithic background that would complete the prehistoric chain in Greece had become a permanent claim of the investigations that followed during the 60's and the 70's. The deepest Neolithic layers, where sparse sherds were found, were then named "aceramic" in the hope that these would lead to the even earlier period, the Mesolithic, which was expected to be found with the characteristics of a trapezoid and microlithic technique known already from Europe. At the same time (1964), a littoral Mesolithic site, Sidari, on the island of Corfu yielded indeed microlithic finds (*Sordinas 1969*). Then, in the 70's, at Franchthi Cave, near the eastern coast of the Peloponnese, one more site with a Mesolithic deposit was attested (*Jacobsen 1976*), and so the picture of the prehistoric record in Greece led to the view that the Mesolithic was entirely a marine story. Thessaly was, of course, excluded from the map of the Mesolithic (*Perlès 1988; 1989; 1994; Runnels 1988; 1993*).

When the Mesolithic was found in Theopetra Cave as an intermediate deposit between the end of the Palaeolithic and the beginning of the Neolithic, it was first confronted with scepticism by many scholars, as it suddenly overturned the theory that made Thessaly deserted at the beginning of the Holocene, a model that was reinforced by a recent survey of Thessaly in 1987 carried out by the American School of Classical Studies at Athens under C. Runnels (*Runnels 1988*), according to which caves were uninhabited during the Palaeolithic in Thessaly, and there was a gap of some 23 Kyr in the area before the Neolithic. The presence of the Mesolithic period in Theopetra confirmed the belief of some Greek prehistorians (*Theocharis 1967; Kotsakis 1992*), who had laid down the idea of inseparable continuity between the Pleistocene and Holocene in Greece.

I must say here that, after Theopetra, two or three more Mesolithic sites were found in Greece, one in a cave on the island of Yioura in Sporades (*Sampson 1996a*), one in a cave at the gorge of Klissoura in mainland Argolid, the east Peloponnese, not too far from the coast (*Koumouzelis et al. 1996*), while one more at the Cycladic island of Kythnos (*Sampson 1996b*) is faced as Mesolithic by the excavator without ^{14}C dates yet. The Mesolithic in Yioura was found in sequence with the Neolithic but without Palaeolithic background, while in Klissoura the Mesolithic consists the roof of the Pleistocene deposits. In Franchthi and in Theopetra the Mesolithic is found between the Upper Palaeolithic and the Neolithic, but in Theopetra additionally there is a more complete Pleistocene sequence including Middle Palaeolithic assemblages, being for the moment the only site in Greece with all this sequence of deposits (*Kyparissi-Apostolika 1999a; 1999b; in press*).

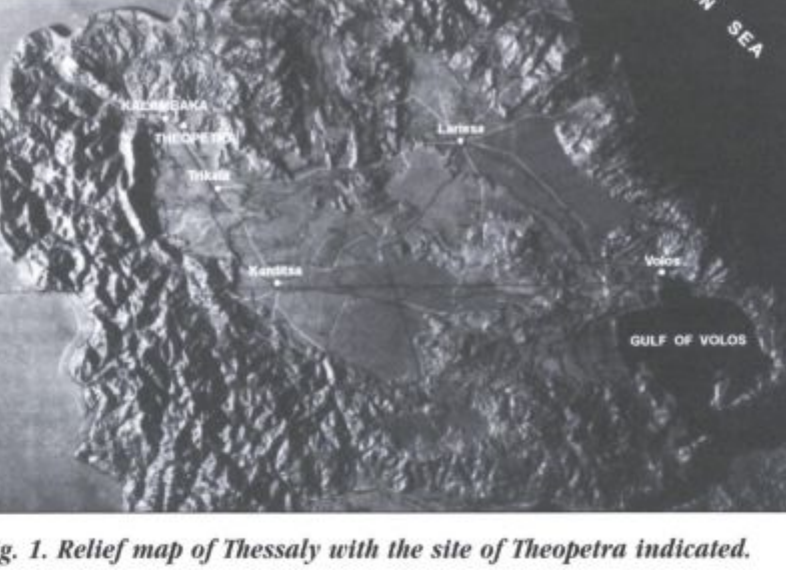

Fig. 1. Relief map of Thessaly with the site of Theopetra indicated.

THE CASE OF THEOPETRA

Location of the site

The cave of Theopetra is located on the north side of a limestone formation on the right of the road leading from Trikala to Kalambaka (Prefecture of Trikala, west Thessaly) and 3 km outside the latter (Figs. 1, 2). Its altitude is about 60 m above the plain and 300 m above the sea level. It lies between the edge of the Thessalian plain and the foothills of the east Pindus Mountains, being the natural border between Thessaly and Epirus. It has a roughly quadrilateral shape and measures somewhat less than 500 m^2. The entrance is large (17 x 3 m) and arched, oriented towards to the Byzantine monasteries of Meteora in Kalambaka. It is the westernmost prehistoric settlement of Thessaly (*Papathanassopoulos 1996.Map 9, No. 406*).

The excavation data

The Mesolithic deposit in Theopetra is recognised as a distinct yellowish-brown (Munsell 10YR 3/4–4/4) humid sediment, interrupted partly by fire remains, and it possibly reflects a rather humid climate. This deposit was not found in all the area of the cave and was absent from the central area, where large-scale erosion took place due to the invasion of large volumes of water from carstic aquifers which repeatedly filled the cave, eroding a huge amount of the autochthonous sediment. The above described yellowish-brown sediment lies at the surface of a consolidated sediment reflecting the last glaciation, and contains the end of the Palaeolithic after the last glaciation at its deepest deposition, and the Mesolithic at the rest, that is to say, the end of the Pleistocene and the beginning of the Holocene[1]. At first glance, this sediment seems homogeneous, reflecting a normal climatic sequence. However, it was interrupted by a harsh climatic episode, the so-called younger *Dryas,* which affected a burnt layer dated to 11 500 BP. After this episode, the Mesolithic in Theopetra begins (*Karkanas 2000; Karkanas in press*).

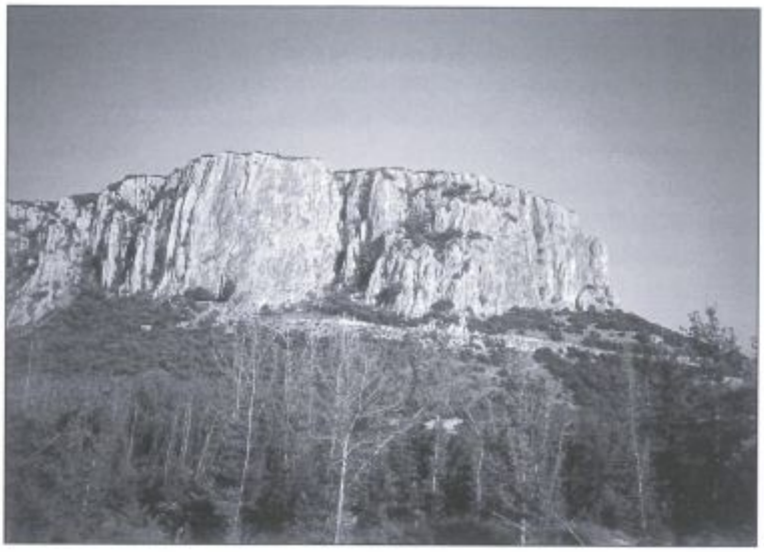

Fig. 2. View of the limestone balk where the cave of Theopetra is found.

A good number of ^{14}C dates so far fall into the Mesolithic period, with the oldest boundary touching the 9721± 390 BP (DEM 142) and the youngest the 7995±73 BP (DEM 360) (9940–8550/7060–6780 BC) (Fig. 3), covering about 1700–2000 years (*Facorellis and Maniatis in press*).

Among them there is the date of a Mesolithic skeleton dated from the bones to 8070±60BP (7050–7010 BC) (CAMS 21773, Fig. 3) being a clear Upper Mesolithic date. The skeleton belongs to a young woman, 18–20 years old, buried in a semiflexed position in a shallow pit (Fig. 4). The head looked straight in front and was at a higher level than the body, which was turned to the right of the dead, looking at the entrance of the cave. No morphological indications of pathological alterations were found macroscopically, while from the cranial radiography arose mild porotic hyperostosis, possibly as a result of iron depletion, but no acute anaemia, which could lead to death. The dental examination shows a healthy individual (*Stravopodi et al. 1999*). Four flint implements were found beside the skeleton, but it is difficult to assess whether they were intentionally placed with the body or were coincidentally part of the infill of the pit. Charcoal selected from the immediate vicinity of the skeleton gave two ^{14}C dates, 9274±75 and 9348±84 BP (8610–8340 and 8740–8470 BC) (DEM 315,316), while the dating of the bones already mentioned puts the buried individual about 13 centuries later, so the selected charcoal obviously belongs to the infill of the pit, which was dug into an older Mesolithic deposit. The finds of the Mesolithic deposit in Theopetra (lithic industry, bones, carbon) are dense compared to those from the last glaciation deposit, but sparse compared to the overlying Neolithic finds.

The lithic industry relied heavily on the locally available radiolarite, while local materials were also employed. There are large numbers of flakes, retouched forms including truncations, notches and flakes with alternate retouch, but no bladelets, no backed bladelets, no geometric microliths and possibly no practice of the microburin technique (*Adam 1999*). It must be stressed here that the analysis of the Mesolithic industry is in progress, the case though doesn't seem to be that of a typical Mesolithic one as it is known from Europe. It appears to be closer to the lithic phase VII of Franchthi (*Perlès 1990; 1999*), showing dissimilarities from phase VIII (the reappearance of backed and truncated elements) (*Adam 1999*).

From the study of the Neolithic industry (*Skourtopoulou in press*) there arises a clear continuity with the Mesolithic: (a) in the use of the same raw material, chocolate thessalic radiolarian flint, its sources found in the Pindus Mountains or as a secondary material (pebbles) found in alluvial deposits; (b) in the technology of the implements – the Neolithic is to a high degree a flake industry, as is the Mesolithic, and the cores show similarities. The technological continuity is also observed in the types of implements (a high percentage of notches and denticulates worked in flakes in dimensions bigger than the usual). Despite the aforementioned disturbance and erosion of the deposit in Theopetra, which does not allow any observations that derive usually from normal stratigraphy, it is obvious that elements known

1 In Theopetra and in the neighbouring Pindus Mountains is the southernmost point of Europe where the last glaciation is attested with characteristics of such severe climatic conditions (*Bailey and Gamble 1991; Karkanas 2000*).

Lab code	Pit	Depth	Age (yr BP)	Calendar age	Standard deviation
DEM–918	Λ8, Pass 4, Brown layer	0.24–0.37 m	7901±29	6818–6663 BC 7028–6649 BC	1σ 2σ
DEM–360	H6, Pass 10, Layer B	1.15–1.23 m	7995±73	7060–6780 BC 7080–6660 BC	1σ 2σ
DEM–583	I11, Pass 3, Western region Neolithic-Mesolithic boundary	0.57 m	8014±49	7060–6829 BC 7073–6706 BC	1σ 2σ
DEM–576	I11, Pass 3 Neolithic-Mesolithic boundary	0.77 m	8060±32	7078–6866 BC 7137–6829 BC	1σ 2σ
CAMS–21733	H6, Human skeleton, burial in situ	0.30 m	8070±60	7180–6830 BC 7300–6770 BC	1σ 2σ
DEM–120	I10 Eastern region	1.04–1.17 m	8524±57	7590–7540 BC 7650–7480 BC	1σ 2σ
DEM–578	I11, Pass 8, South-eastern region	1.37 m	8547±71	7650–7520 BC 7750–7480 BC	1σ 2σ
DEM–587	I11, Layer 1, Central region	0.60–0.71 m	8558±37	7599–7549 BC 7641–7529 BC	1σ 2σ
DEM–125	I10, Western region	1.56 m	8673±76	7780–7590 BC 7950–7580 BC	1σ 2σ
DEM–589	I11, Pass 6	1.18 m	8863±119	8210–7830 BC 8270–7650 BC	1σ 2σ
DEM–207	Γ9	2.13 m	9093±550	9120–7590 BC 10130–6820 BC	1σ 2σ
DEM–590	I11, Pass 7	1.27 m	9150±112	8530–8270 BC 8720–7970 BC	1σ 2σ
DEM–586	I11, Layer 2	0.80 m	9188±86	8520–8290 BC 8620–8250 BC	1σ 2σ
DEM–315	H6, Layer B, On human skeleton	0.73 m	9274±75	8610–8340 BC 8720–8290 BC	1σ 2σ
DEM–316	H6, Layer B, On human skeleton	0.73 m	9348±84	8740–8470 BC 9090–8300 BC	1σ 2σ
DEM–577	I11	1.37 m	9370±93	8780–8470 BC 9110–8300 BC	1σ 2σ
DEM–588	I11	1.23 m	9461±129	9120–8610 BC 9220–8350 BC	1σ 2σ
DEM–142	I10, Eastern region	1.17 m	9721±390	9940–8550 BC 10690–8210 BC	1σ 2σ

Fig. 3. List of radiocarbon dates concerning the Mesolithic and the Mesolithic/Neolithic transition.

from earlier industries are present in the Neolithic material in general.

One of the most important finds of the Mesolithic deposit in Theopetra is the presence of some unbaked clay masses, as well as of some monochrome atypical sherds within them. Their technological characteristics (the shaping and finishing of the surface) are primitive compared to the Early Neolithic examples, while in some cases they are slightly baked. At the beginning, we regarded as intrusive from the overlying Neolithic deposit, but as they continued to be found down to 45 cm below the Neolithic deposit, in parallel with unbaked masses of clay, and given the fact that the chromatic and component sedimentation of the Mesolithic deposit is absolutely distinct from that of the Neolithic, any intrusion from the one deposit to the other could be safely perceptible. My assessment is that they represent a very early pottery at the boundary of the Mesolithic/Neolithic transition (*Kyparissi-Apostolika in press*). Additionally, the presence in the Neolithic deposit of pottery characterized in the bibliography (*Theocharis 1967.127–143*) as "primitive painted pottery" belonging to the initial Early Neolihic before Sesklo, reinforces the possibility that we have here the very beginning of pottery technology in Greece. TL dating would clarify the period to which these sherds

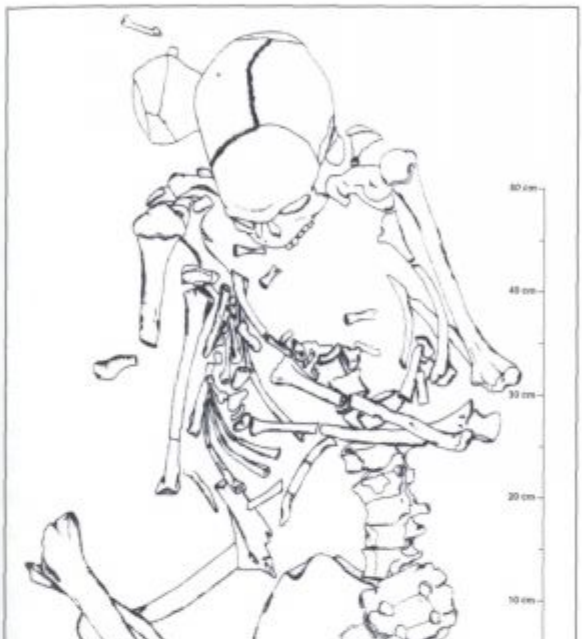

Fig. 4. Sketch of the Mesolithic burial found in Theopetra (drawn by M. Deilaki).

belong. The presence of unbaked clay is also noticed in the late Upper Palaeolithic deposits of Theopetra, while some cylindrical clay objects up to 7-8 cm long and 2-3 cm thick are also observed in the same layers, coming though from Mesolithic layers which eroded the Palaeolithic ones (*Kyparissi-Apostolika 1999 in press and Karkanas in press*). The presence of clay, either in unbaked condition or as sherds, is referred to also from other Pre-Neolithic sites in Greece (*Theocharis 1958; Perlès 1999; Vitelli 1993*) and in Europe (*Bahn 1978; Vandiver et al. 1990*), and so the beginning of pottery technology must be re-examined *for its starting boundaries*.

The archaeo-botanical material of Theopetra cave, the oldest ever recovered from excavations in Greece, plays a key role in the study of the Mesolithic, as well as in arguments concerning the Neolithization of Greece. The presence of cultivated *Hordeum vulgare ssp. exastichum* (hulled six-row barley) and of *Triticum boeticum* (wild eincorn), as well as of some wild legumes such as *Lens sp.* (lentil), *Vicia ervilia* and so on in the Mesolithic material of Theopetra is definite proof that farming must have started here. The same plants are found as cultivated species in the Neolithic material among other kinds of crops and fruits. The absence of the above plants from the Greek data in the past was one of the strongest arguments in the discussion that sought to regard farming as the result of Near Eastern population movements. Of course, we would not deny that people who were familiar with farming could have come from the Near East and possibly spread this knowledge to some population on Greek territory as well, but this territory, after Theopetra's finds, does not seem to be Thessaly.

According to palynological investigations (*Bottema 1979*), at the beginning of the Mesolithic the steppe vegetation was replaced by forest vegetation. This fits with the finds of the anthracological analysis in Theopetra (*Ntinou in press*) (the palynological analysis is not ready to give information yet), according to which deciduous species like *Ulmus sp., Prunus sp., Quercus* and *Fraxinus sp.* are present in the Mesolithic material, probably related to the development of forests in the early Holocene.

The picture fits also with the fauna species present in the Mesolithic of Theopetra, which are woodland species (wild boar and wild cat - *Felis sylvestris*) (*Rowley-Conwy and Newton in press*). The large carnivores that were present in the Palaeolithic strata disappear in the Mesolithic. The Mesolithic assemblage, however, is dominated up to 40% by small ovi-caprids, indistinguishable from domesticated sheep and goat, and it is possible that early Holocene hunter-gatherers acquired domesticated ovi-caprids from neighbouring groups with herd animals (*Newton in press and forthcoming*). The same question arises with the fauna of the Mesolithic strata in Yioura Cave, where ovi-caprids also seem to be domesticated (*Trantalidou in press*). A rather high percentage, around 11% of the Neolithic material in Theopetra belongs to the wild fauna, and some of the species (wild cat, red deer, wild boar and hare) feature also in the Mesolithic. This perhaps indicates a certain continuity of habitat type between the two periods. From the domesticated fauna of the Neolithic material, over 70% are ovicaprids, of which 70% are sheep, while pig and bovids are present with 8% each (*Hamilakis in press*).

Last, but not least, I would like to emphasize the biological homogeneity which derives from the DNA analysis of the Palaeolithic, Mesolithic and Neolithic human bones of Theopetra, and hence the possibility that the genetic gradient in Europe may not have originated from the Near East with the spread of farming, but may have been in place as early as the Upper Palaeolithic at least (*Evison et al. in press*).

CONCLUSION

Theopetra Cave, at the western end of the Thessalian plain and equidistant from the Pindus Mountains and the plain, is a hidden site not accidentally perceptible by travelers, as could be maintained for littoral cave-sites like Franchthi or the cave of Cyclope in Yioura. Hence, the hypothesis that it could be used for a while and then be abandoned for some thousand years and again be found by chance later and so on, in my opinion, must be excluded. Within this perspective, it is likely possible that once it was discovered, it was used by the same population and their descendants, who either used it as a permanent base or periodically, the kind of use changing according to the reasons that ruled the one or the other way.

As no vegetation changes that could reflect climatic changes are referred to in the palynoligical investigations (*Bottema 1979*) for the end of the Mesolithic and the beginning of the Neolithic, the transition from the one period to the other should be seen (a) in the establishment of pottery technology, (b) in farming knowledge, (c) in the faunal and floral sequence and, (d) in the biological continuity or discontinuity of the population.

As we have seen from the data of Theopetra Cave, all the above parameters lead to the hypothesis that they are the result of long-term attempts starting from the Palaeolithic onwards, and not knowledge that was taught to the population of Thessaly by people from the Near East. If we did yet not have proofs that Thessaly was populated before the Neolithic, as was estimated in previous decades, the model of exogenous new experience would work well. However, with the new data from Theopetra Cave it would be beyond any common sense to accept that the Palaeolithic and the Mesolithic people who lived in Theopetra Cave and exploited the environment for their survival had not observed nature and the properties which plants and soil and all other natural elements have, namely the same observations that led the population of the Near East to knowledge of farming. And it is possible that this is why, in western Thessaly (where Theopetra is located), there are the oldest Early Neolithic settlements, such as Prodromos and Magoulitsa (*Chourmouziadis 1971; 1972; Papadopoulou 1958, respectively*), while during later periods they spread to eastern Thessaly, closer to the coasts of the Aegean (i.e. Dimini, Pevkakia) (*Halstead 1980*). These first settlements were probably established by the descendants of Theopetra's population, and some of these people continued to live in Theopetra during the Neolithic also.

In my opinion, the poor presence of the Mesolithic in the Greek peninsula is the result of wrongly directed research, as it has been oriented to European and Anatolian models for the settlement pattern and the lithic industry typology. It is now time to turn to different models harmonised to the Greek environmental and climatic conditions of that period, which, I believe, will lead us to more Mesolithic installations. I believe that further research on the material of Theopetra, as well as new excavations that will follow, will prove definitively a model of indigenous Neolithic civilisation in Thessaly, a picture that derives from the excavation in Theopetra Cave.

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Documenta Praehistorica XXVII

Thessaly, Franchthi and Western Turkey: Clues to the Neolithisation of Greece?

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ABSTRACT – *Potential pathways towards neolithisation are discussed for two regions: Thessaly and the Peloponnese (Franchthi). Differences between North and South Greece in settlement patterns, subsistence and social structure are argued to reflect similar variations in a hypothesised West Anatolian Aceramic Neolithic. It is proposed to seek the neolithisation of Greece in an ultimate stress-situation in specific inland plains of West Anatolia. Traditional contacts of sites here with settlements along the West Turkish seaboard may have provided information on new land, the stimulus to consider migration as a possible solution, and the practical means of crossing the Aegean.*

IZVLEČEK – *V članku govorimo o možnih poteh neolitizacije v dveh regijah: Tesaliji in na Peloponezu (Franchthi). Razpravljamo o tem, da razlike med severno in južno Grčijo odsevajo podobne spremembe hipotetičnega zahodnoanatolskega akeramičnega neolitika tako glede vzorca naselitve, načina preživljanja kot tudi družbene zgradbe. Predlagamo, da začetke neolitizacije Grčije iščemo v skrajno stresnih razmerah v ravnicah v notranjosti zahodne Anatolije. Tradicionalni stiki med tukajšnjimi najdišči in naselbinami v zahodnoturškem primorju so morda prinesli podatke o novi deželi, spročili razmišljanja o migraciji kot možni rešitvi in zagotovili način za prečkanje Egejskega morja.*

KEY WORDS – *Anatolia; culture contact; Greece; migration; neolithisation*

INTRODUCTION

The often-observed difference between North and South Greece (for instance in settlement patterns, in material culture or as to pathways towards neolithisation – cf. *Perlès 1987.34; Demoule and Perlès 1993.364, 370; Halstead 1994*) may give clues to the nature and origins of the first farming communities on European soil. In an earlier paper I stated that the neolithisation of Europe was, in its initial stages, an "Aegean phenomenon," meaning that the actual impulse to establish permanent farming villages in Greece resulted from a long-lasting Aegean interaction (likewise, *Halstead 1996.299*). On the basis of the accumulated evidence acquired from the recent work carried out in North-western Turkey (*Özdoğan 1999; Roodenberg 1999a; 1999b*), I likewise proposed that the assumed bridge function of that area *vis-à-vis* the neolithisation of Europe had not much to credit it – the area, at the present state of research, being peripheral both to the developments taking place in Central and Southwest Anatolia and to those in Greece (*Thissen 2000a*). Here, I would like to put forward some hypotheses concerning the origin of the Greek Early Neolithic, integrating the evidence from Thessaly and Southern Greece (notably from Franchthi), and that from West Turkey. If the Greek North-South difference for the EN period is accepted, we may perhaps extrapolate this difference backward in time, *e.g.*, to the Aceramic Neolithic, which at Franchthi at least was not disruptive to the preceding Mesolithic stage (cf. *Chapman 1994.136; Halstead 1996.300*).

THESSALY

Evidence concerning the nature and the dating of the earliest Neolithic in Thessaly (inclusive of a PPN phase) is rather conflicting and not generous in hard facts. The conflicts appearing in the debate on the validity of a PPN stage (cf. *Nandris 1970; Theocha-*

ris 1973; Bloedow 1991; Bloedow 1992–1993) and, the absence of solid data particularly felt in the limited exposures and absolute chronological backing. The possibility of an autochthonous process of plant cultivation in Thessaly has recently been ventured on the basis of the Theopetra Cave data (*Budja 1999.132*; cf. also *Kyparissi-Apostolika 1998; 1999. 238*). Here, on the NW edge of the Thessalian Plain, in the Mesolithic deposit, several wild seeds and pulses have been identified, including *hordeum vulgare* subsp. *spontaneum*, and *triticum boeticum* (*Kyparissi-Apostolika 1998.249; 1999.237*). According to the excavator, the Mesolithic deposit also contained some sherds *in situ* (*Kyparissi-Apostolika 1998.249*). Unfortunately, at Theopetra there is a huge gap of 800 calendar years in the local sequence of the Mesolithic-Neolithic, at least as far as it has been fixed in ^{14}C dating (*Kyparissi-Apostolika 1999. 236–239*) (Fig.1). It is, therefore, impossible to check whether the knowledge and use of wild seeds and pulses led to domestication here; and whether the sherds suggest an independent early invention of the craft of pottery making potentially much along the same lines as hypothesised by Vitelli for 'Aceramic Franchthi,' *viz.* as representing a "rare and precious" product (*Vitelli 1993*). Barring the as yet preliminary data from Theopetra, it is presently safer to assume that the Mesolithic-Neolithic sequence in Thessaly is disruptive in time. And I share the view of several authors (*Demoule and Perlès 1993.364–365; Van Andel and Runnels 1995*) that the EN in Thessaly was disruptive also in the cultural sense – being a foreign intrusion by migrant farmers. Simultaneously, this might not have been the case for Franchthi (*vide infra*).

While the question of a PPN phase in Thessaly rests on unsteady grounds (largely due to the restricted areas excavated), it is a fact that the small component of much less sophisticated pottery occurring in the basal layers of Achilleion, Argissa, Gendiki, Nessonis, Sesklo and Soufli (the *Frühkeramikum*, or the Early Neolithic I) decreases in time, coinciding with an increase in technical ability in overall pottery manufacture (cf. *Wijnen 1981.33–34*). As Wijnen rightly assumes, these crudely made vessels themselves do not *represent* the first pottery-making stage, but are merely *part* of that initial stage (*Wijnen 1981.34*). The fact that a 'beginners' stage' and an 'advanced stage' are not archaeologically separable (in the chronological sense – hence the 'mix'), would rather point to rapidity on the part of the potters in mastering the different levels of expertise required. Archaeologically visible is the intense level of experimentation apparent from the EN Thessalian pottery concerning shaping, the use of slips and paints, and firing (*Wijnen 1993.323;* and contra *Bloedow 1991.43*).

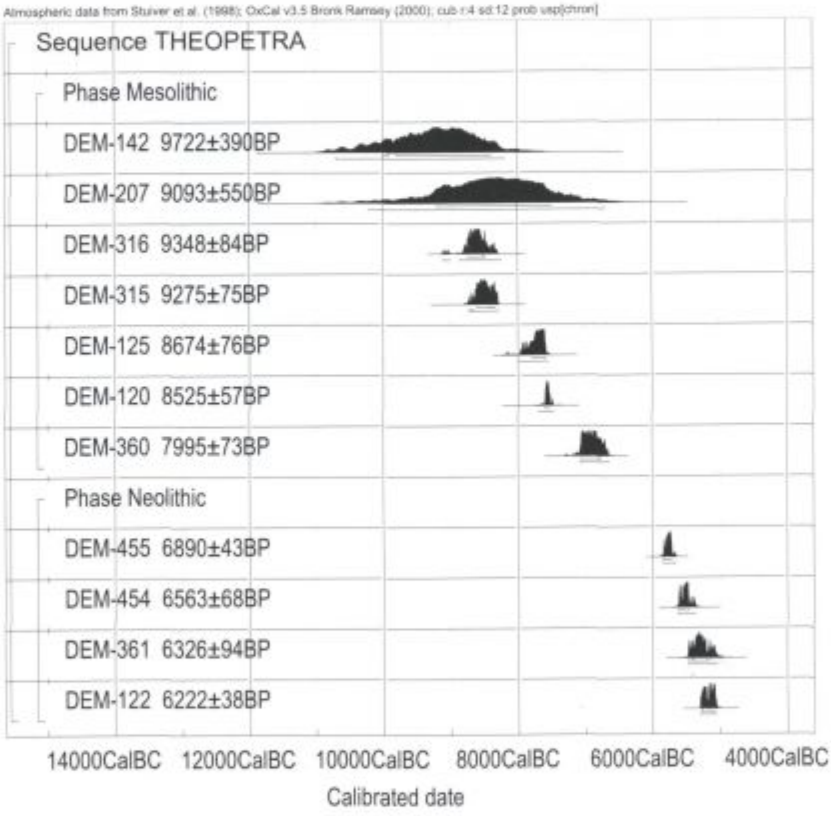

Fig. 1. Theopetra Cave radiocarbon dates for the Mesolithic-Neolithic, calibrated individually.

In line with the foregoing, it seems fair to assume that the idea to start manufacturing pottery was developed by the settlers upon founding the sites in Thessaly. Put otherwise, pottery was more or less a local invention, and possibly part of adaptation processes to cope with new environments and circumstances of living (pots used to "underline the social significance of hospitality," as Halstead has suggested [*1994. 206*]). If locally invented, then the knowledge of pottery, or the notion of its need, cannot have been part of the cultural world of those who ultimately risked the move towards Thessaly. Following Theocharis (*1967.173–174*) and Wijnen (*1981.97, 101–102*), Perlès in 1989 also suggested that the pottery of EN Greece was developed locally, and, consequently, proposed that the first Greek Neolithic be established during a pre-ceramic stage (*Perlès 1989.119*). Certainly the evidence from the PPN sites in the Near East makes it clear that there is no direct relationship between farming and the origins of pottery, and people had, of course, built up long experience in cooking foodstuffs without the knowledge or the need of containers made of baked clay (cf. *Pavlů 1997.28ff; Björk 1998.44*). The theory of Vitelli that the EN pottery was not used for cooking, but was instead non-utilitarian and high-status (*Vitelli 1989; Perlès 1993.377;* cf. *Halstead 1994.206*), is probably correct, viewing the absence of soot traces, and the dominant presence of ring- and pedestal bases (cf. *Wijnen 1981.33* for Sesklo).

The earliest Thessalian pottery consists of only a few different categories, including dishes and deep globular bowls, which typologically merge into holemouth bowls (Fig. 2). The use of vertically- or horizontally pierced knobs is limited to the bowls, while other handle types are not attested. Vessels are not larger than medium size, with neither rim diameters nor general height extending over 20 cm. Ring- and low ring bases are common. If we accept the general date for the Thessalian EN as starting at about 6300 cal BP[1] at the earliest (see below), then a correspondence with contemporary pottery concepts and use in the wider world (to be specific: Anatolia) is farfetched. The Konya Early Neolithic pottery (*e.g.*, Çatalhöyük East levels VI–0, the Beyşehir and Suğla Lakes sites), and by extension the NW Anatolian wares (Demircihüyük, Menteşe, Ilıpınar and the Fikirtepe sites) differ in a major way from the Thessalian assemblages in their discrimination of different types of cooking pots. S-shaped bowls, the preference for flat bases, and the use of alternative handle types in Anatolia, all suggest different ways of handling, positioning and using pottery. Open dishes of the Thessalian kind are not in general use in the Central and NW Anatolian assemblages, while, alternatively, Anatolian oval-mouthed shapes (possibly referring to original wooden or gourd prototypes), do not seem to have been present in Thessaly. Also, the possibly earliest pottery from SW Turkey, *viz.* that found in the Pamphylian site of Bademağacı and datable to the second half of the 7th millennium cal BC, appears to be based on a more diversified vessel repertoire and a handle system different from the Thessalian pottery (see *Duru 1999.Figs. 33–38, 42*).

The date for the beginning of permanent farming villages in Thessaly cannot be satisfactorily established with the Achilleion and Sesklo radiocarbon dates, which do not allow as fine-grained a resolution as one would like for this key phase in Euro-

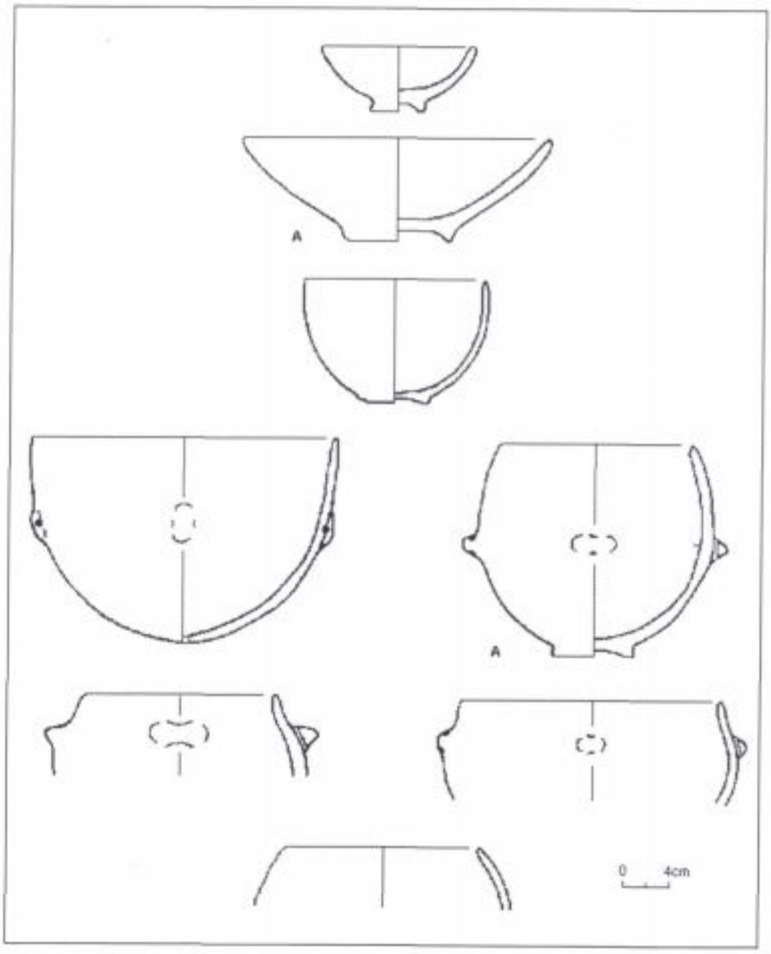

Fig. 2. Early Neolithic I pottery from Sesklo and Achilleion (marked "A"). Dishes, bowls and holemouth bowls/pots (after* Wijnen 1981.26 Fig. 11*).

1 Calibrations throughout this paper are made with help of the latest version of the OxCal program (v3.5) (*Bronk Ramsey 2000*), dependent on the most recent calibration curve INTCAL98 (*Stuiver et al.1998*).

pean prehistory. At Sesklo, combining the stratigraphic evidence collected so far from three trenches all located in the NE-sector of the Sesklo Acropolis,[2] the entire EN period including the PPN stage does not seem to have comprised more than three to four building levels (Tab. 1).

Virgin Soil

^{14}C dates come from several different Sesklo trenches, but only Trench 2 yields a larger, though by no means sufficient body of dates (Fig. 3).[3] When calibrated, agreement of the posterior distributions of the six Trench 2 PPN and EN dates is far below the statistically acceptable (34.8% where the threshold is set at 60.8%) (Fig. 4). A date much earlier than the 6300 cal BC threshold would, however, conflict in my view with the small number of individual building levels counted at PPN/EN Sesklo and EN Achilleion. For Achilleion, after a reanalysis of the stratigraphic sequence (*Thissen 2000b*), only two building levels appear to belong to the EN period. Achilleion yields a larger series of ^{14}C dates (nine for the combined levels Ia and Ib, eight for the combined levels IIa and IIb) (Fig. 5). When we combine the probability distributions of the calibrated dates of Achilleion Ia–Ib, assuming that the samples stem from a single event or from events occurring within a short period, then the earliest possible range at 2σ is set at 6240–6160 cal BC (Fig. 6).[4]

A pre-6300 cal BC date for the onset of the Thessalian PPN/EN would further be in disaccord with the most likely date for the beginning of the MN period at about 6000 cal BC. Finally, the limited thickness of the EN deposits at Sesklo and Achilleion does not suggest a very large time span for these levels. If we further know that the earliest possible range for the beginning of settlement at Nea Nikomedeia, based on a combination of the probability distributions of the calibrated dates, can be put at 6230–6150 cal BC (at 2σ), then again a pre-6300 cal BC beginning of permanent villages in Sesklo and Achilleion is not warranted (Figs. 7 and 8). The Nea Nikomedeia dates, likewise, conform rather perfectly to those of basal Achilleion, suggesting roughly contemporaneous events. In this respect, when acknowledging EN Thessaly as a coherent, culturally cohesive society (*Halstead 1994. 207*) with social barriers to external contacts (apart from those established and maintained by tradition - see below), this may stand in the way of seeing Thessaly as a root area for renewed colonization of the regions further north, notably of Macedonia. Indeed, cultural variance between Thessaly and Macedonia is visible in pottery, in settlement patterns and in commitment to the land (cf. *Thissen 2000a. 194; Fotiades et al. 2000.217*; for a contrary view, however, see *Wilkie and Savina 1997*).

Franchthi

In contrast to Thessaly, Southern Greece, or at least Franchthi, reflects a mobile, non-static society, not intent on exploiting the land, but the boundless sea. Franchthi Cave was used over an extremely long period, but discontinuously and fluctuating in intensity. An important place, as Chapman argues, for those who used the cave (*Chapman 1994.137*), it must have been only one of several (cf. Ulbrich Cave, Zaimis Cave) during the Palaeolithic, Mesolithic, and Aceramic (Initial) Neolithic periods. It is probably only a matter of time before similar sites will be found on the Turkish shores of the Aegean. It is even possible that this sense of mobility is still present in the first pottery Neolithic at Franchthi Cave and at Paralia, the small open-air site on the coast.[5] Thessalian patterns of tradition and place and of self-containment are not conspicuously visible at

period	building method	number of building levels	thickness of deposit
EN III settlement burnt			
EN II/III	pisé or mud brick	1–2 (?)	20 – max. 85 cm
EN I	like PPN	2–3 floors	40 – 50 cm
PPN	single stone foundations/pisé	1	30 – 60 cm
			(total thickness: 90 – max. 195 cm)

Tab. 1. Sesklo. Stratigraphic evidence from Trench 2, NE-sector Acropolis (after* Wijnen 1981.12, Fig. 5; Wijnen 1992*).

2 A trial trench of 2.5x2.5m, excavated in 1956 and 1957 (*Wijnen 1981.9, Fig. 4*); a trench dug in 1962, possibly trench Thita (*Bloedow 1991.23, Fig. 8*); and trench 2, excavated during 1963 and 1965 (*Wijnen 1981.12, Fig. 5*).

3 I am greatly indepted to Mies Wijnen for allowing me to use the Gröningen data of Sesklo.

4 The nine Achilleion Ia–Ib dates are exclusive of LJ-4449 and UCLA-1896A which come from test pit east. In addition, I have reassigned level II samples LJ-3328, LJ-3186 and LJ-3325 to level I instead on stratigraphic grounds.

5 cf. Jacobsen (*1984*), hypothesizing such patterns of mobility for the MN period.

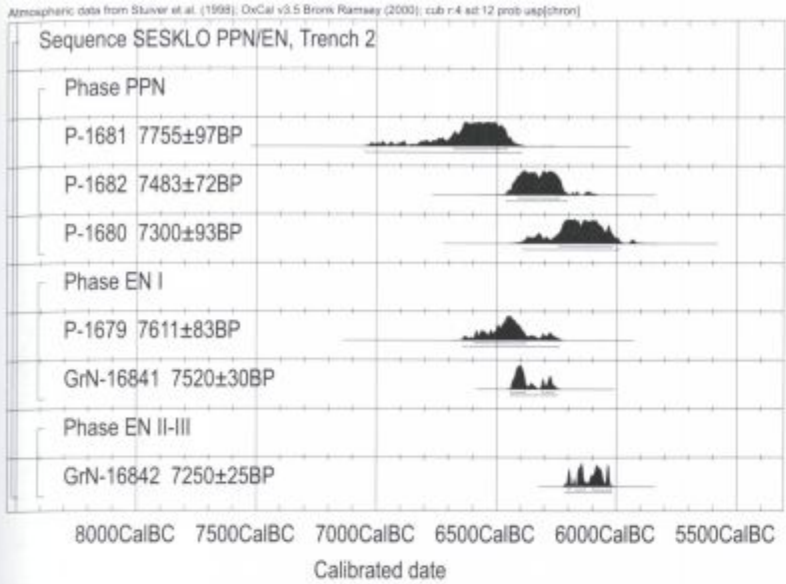

Fig. 3. Sesklo Trench 2 radiocarbon dates, calibrated individually.

Franchthi, or for that matter, in the other Neolithic sites in the Peloponnese and Central Greece (cf. *Demoule and Perlès 1993.364, 370*). *Tell* built-up, with its long-term association to localised space (cf. *Chapman 1989*) is quite rare in Southern Greece, and if occurring, is seemingly restricted to sites in key positions in relation to the sea (*e.g.* Old Corinth, Goniá, Lerna, Halai or Franchthi Cave itself in a sense) (cf. also *Cherry et al. 1988*). Moreover, settlement locations differ from Thessaly – in Southern Greece rocky preeminences are favourite spots instead of floodplains, terraces and fens (*Demoule and Perlès 1993.362; Van Andel and Runnels 1995*; but also *Wilkie and Savina 1997.201*). As Van Andel and Runnels have pointed out on the basis of their extensive surveys, the Argolid was "very thinly settled" during the EN period (and, indeed, during the ensuing MN and LN periods as well) (*Van Andel and Runnels 1987.67*). They also make clear that the EN inhabitants of Franchthi did not exploit their environment to the full. In stark contrast to Thessaly, the EN settlers in the Peloponnese "(...) failed to spread out to fill the space available (...)" (*Van Andel and Runnels 1987.69; cf. 75, Map 13*). Van Andel and Runnels consider the region's geographic setting "(...) well placed to maintain trade contacts throughout the southern Aegean and across the Peloponnese" (*1987.73*) – as the first reason for the Early Neolithic settling of the NE Peloponnese, not so much the traditional search for new fertile land. It is only during the Final Neolithic and the Early Bronze Age that people in the Argolid oriented themselves towards their hinterland: only then were the best soils of the region settled (*Van Andel and Runnels 1987.81–85*).

A reanalysis of the Franchthi Cave sequence, a thorough treatment of which falls outside the limits of this paper (*Thissen 2000b*), has led me to the following synopsis:
❶ Franchthi phase Int 0/1 is aceramic, following Jacobsen (*1969.352*), but in contrast to Vitelli (*1993.39*). Domesticated plant and animal species are already known. A set of five consistent ^{14}C dates makes it possible to date this stage somewhere within a range of 7000–6600 cal BC (Fig. 9). Franchthi Int 0/1 is roughly equivalent to Perlès' "phase lithique X" (*Perlès 1990.115ff.*) and to Hansen's "botanical zone V/VI and VI" (*Hansen 1991.163*).
❷ Franchthi phase Int 0/1 probably did not lead into FCP 1, a point which is confirmed by the pertaining ^{14}C dates, which show a gap of 200–400 years (at 1σ) between Int 0/1 and FCP 1. Given this discontinuity at the site, the knowledge of domesticates during Interphase 0/1 may have remained an isolated phenomenon, not leading to continued exploitation. It is, however, unlikely that the settling

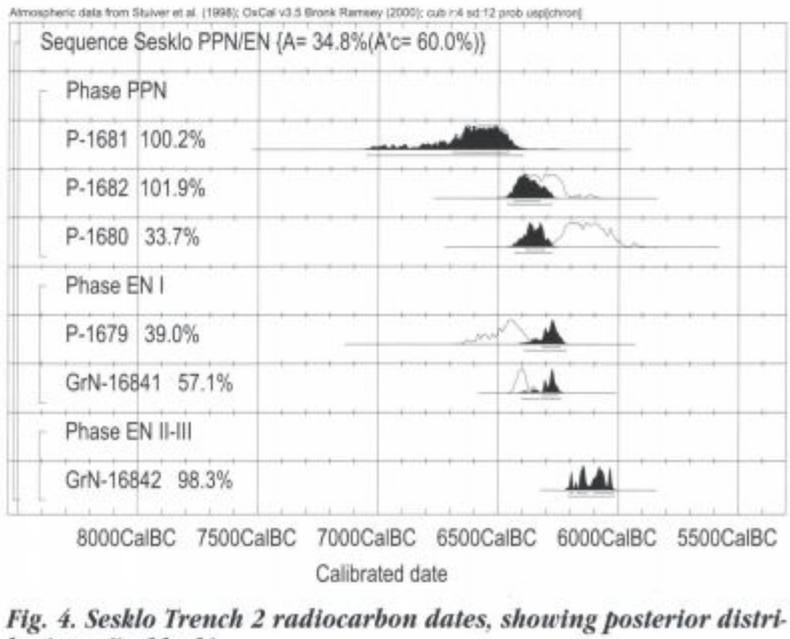

Fig. 4. Sesklo Trench 2 radiocarbon dates, showing posterior distributions (in black).

of Franchthi, and the introduction of domesticates at the site, including the absolute date at which the latter allegedly took place, are phenomena that are applicable or contemporary to other Greek regions, notably to Thessaly. The immediate density of sites in the Thessalian Plain, the continuity evident from their individual histories and the coherence shown by their material culture all point to a strong, rather sudden and lasting impact on the land. Franchthi phase Int 0/1, at the present state of research, would antedate the Thessalian PPN/EN by some 400 calendar years.

❸ Being perhaps a trial event, the NE Peloponnese with Franchthi lacked occupation for many centuries. Only by the 60th–59th century cal BC were pottery-Neolithic sites established in the Argolic Gulf: at Franchthi the Paralia site was founded, while the old Cave site was reused as well, as evidenced by contemporary deposits. The total duration of occupation in the cave as well as at Paralia during Franchthi phase FCP 1 may have been fairly short, given the shallow deposits and the absence of thick and consecutive occupation horizons, and given the absence of any development within the ceramic assemblage.

❹ In view of the gradual transition attested both in the pottery- and in the lithics development from FCP 1 over FCP 2, as well as similar patterns in faunal remains over FCP 1–2, the EN period at Franchthi most likely is not as early as suggested in the literature. Instead, FCP 1 could well immediately predate FCP 2, *i.e.* roughly at about 5900 cal BC.

❺ On the basis of the radiocarbon evidence, the MN period at Franchthi, represented by the FCP 2 and FCP 3 stages, appears to be of short duration as well - the absolute dates suggesting the 58th and 57th centuries cal BC (Fig. 9).

❻ The Franchthi FCP 1 pottery resembles rather perfectly the 'EN' assemblage retrieved from Old Corinth. There, what Weinberg classified as 'red monochrome' and 'coarse monochrome' wares have strict parallels in technique (paste, colour, firing) and form (including decoration and location of vertically pierced knob handles below the rim) with FCP 1. Also at Corinth continuity is noted for EN–MN (*Lavezzi 1978.427*).

❼ As pointed out by Lavezzi (*l.c.*), the EN–MN development at Corinth is comparable to Franchthi Cave, Lerna, Phlius and Asea, and even to Central Greece, *i.e.* Elateia and Halai. Similar EN–MN pottery groups have been acknowledged by Howell surveying Eastern Arcadia (*Howell 1970.103–108*).

❽ If the update of the Franchthi Neolithic (FCP 1) is correct, it opens the road to reconsidering the EN period of Southern Greece in general. Given the tight correspondences in the pottery assemblages of EN Franchthi and Lerna (cf. *Vitelli 1974*), as well as the links with other EN sites in the region, we have, I think, to reconsider the current temporal equation of the Southern Greek EN period with the Thessalian EN sequence. While, unfortunately, ^{14}C dates from EN sites in Southern Greece are lacking (except for the rather unreliable ones from Elateia [cf. the remarks on these dates by *Vogel and Waterbolk 1963. 182–183*]), Franchthi EN would rather date to a time frame during which, in Thessaly, the Middle Neolithic Sesklo period had already begun. Interpretation and explanation of the misleading archaic aspect of the Southern Greek pottery, well represented by Franchthi, of simple vessel forms (for example, deep

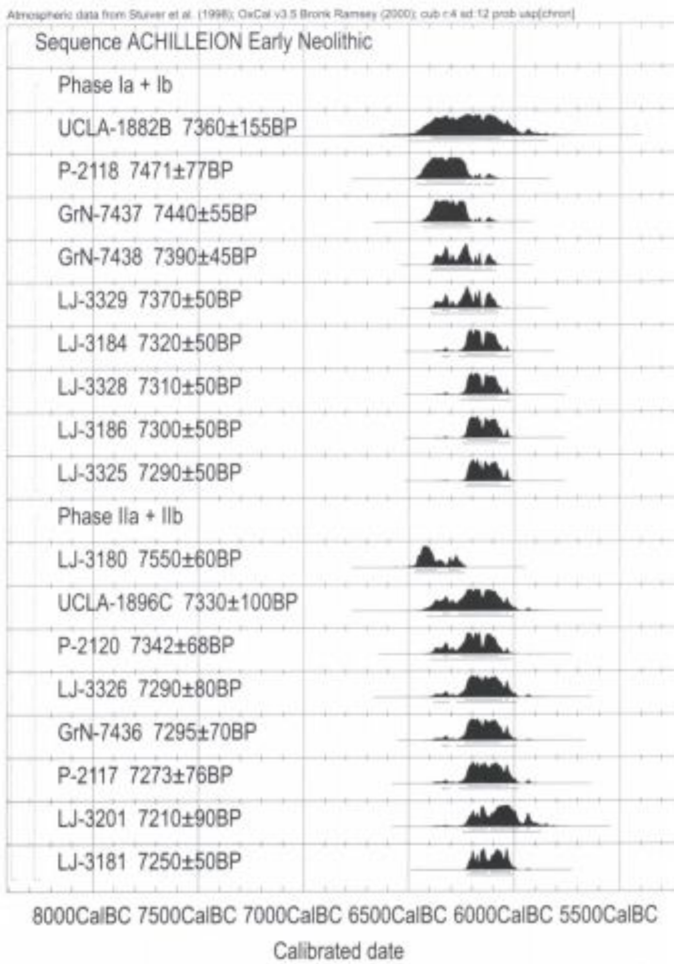

Fig. 5. Achilleion radiocarbon dates from the Early Neolithic levels (exclusive of LJ-4449 and UCLA-1896A from test pit east), calibrated individually.

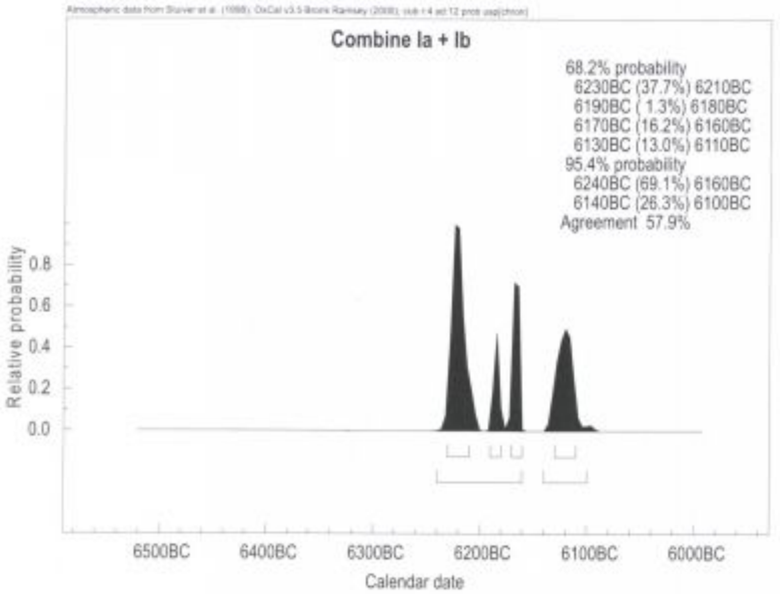

Fig. 6. Achilleion radiocarbon dates from the Early Neolithic levels (exclusive of LJ-4449 and UCLA-1896A), the probability distributions of level Ia-Ib combined.

hemispherical bowls), 'Early Neolithic' handle shapes such as vertically pierced knobs, and a limited number of ceramic categories, may profit from re-evaluating it from the perspective that 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 are possibly nothing more than a reflection of the different pathways that led to the neolithisation of both regions (see further below).

WESTERN TURKEY

Even compared to the scarcity of data on EN Thessaly and Southern Greece, West Anatolia is worse off, hard evidence (^{14}C dates, excavations) being virtually non-existent. Little work is done here, and consists almost solely of surface surveys. If I will, nonetheless, treat this area as a potential key region in the neolithisation of SE Europe, cq. Greece, I can only defend my position with the current adage that absence of evidence is not evidence of absence. It should be said beforehand that aceramic sites have not yet been attested in West Anatolia. The sites mentioned here are, on the basis of the surface pottery, cross-dated with the Hacılar evidence, and are tentatively assigned to the last centuries of the 7th millennium cal BC (Fig. 10).

Evaluating the present data on early site location in West Turkey, it is the diversity that is striking. Several sites are immediately on the Aegean seaboard, to note: Karaağaçtepe (Fig. 10, site 12) on the southern tip of the Gelibolu peninsula, Kumtepe (site 13), Coşkuntepe (site 11), Ayio Gala cave, Killiktepe (site 8), Limantepe (site 33), Milete (site 9); or on islets (Tavşan Adası [site 10]) and small peninsulas (Saplı Adası [site 5]). The orientation of these sites was evidently towards the sea, their position not on the edge of fertile alluvial plains suggesting that agriculture may not have been the dominant subsistence strategy. Several of these coastal sites are situated on rocky outcrops (*e.g.* Coşkuntepe, Tavşan Adası). By contrast, the inland sites yielding similar material culture assemblages are concentrated in several alluvial plains and side valleys of the Gediz and Büyük Menderes rivers: *e.g.*, the Akhisar and Manisa Plains (Fig.10, sites 40, 41, 44, 48, 49) (*French 1965; Dinç 1997*), the Torbalı Plain (sites 19, 20, 22, 26, 32, 35, 36) (*Meriç 1993*), the Akçay Plain (sites 6, 7) (*Akdeniz 1997*), or even the Alaşehir Plain (sites 43, 45-47, 50) (*Meriç 1993*).

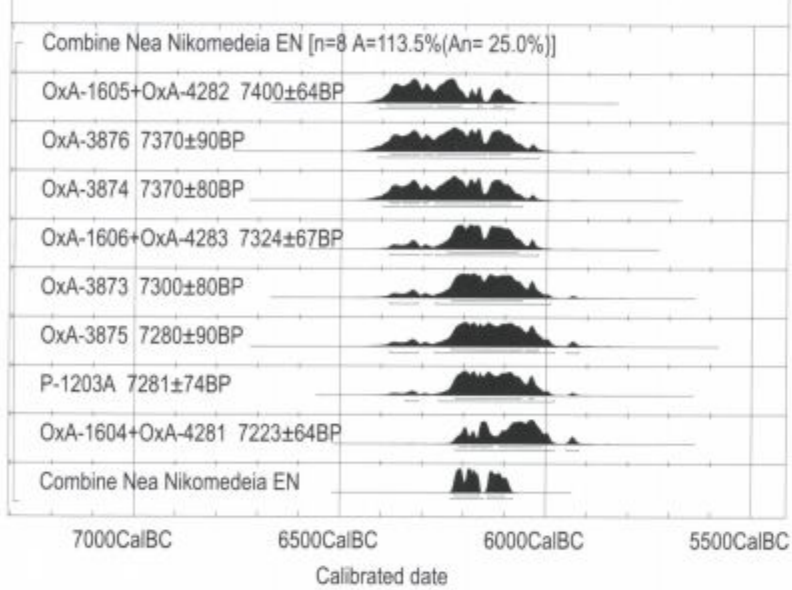

Fig. 7. Nea Nikomedeia radiocarbon dates (exclusive of Q-655, GX-679, P-1202 and OxA-1603+OxA-4280), calibrated individually.

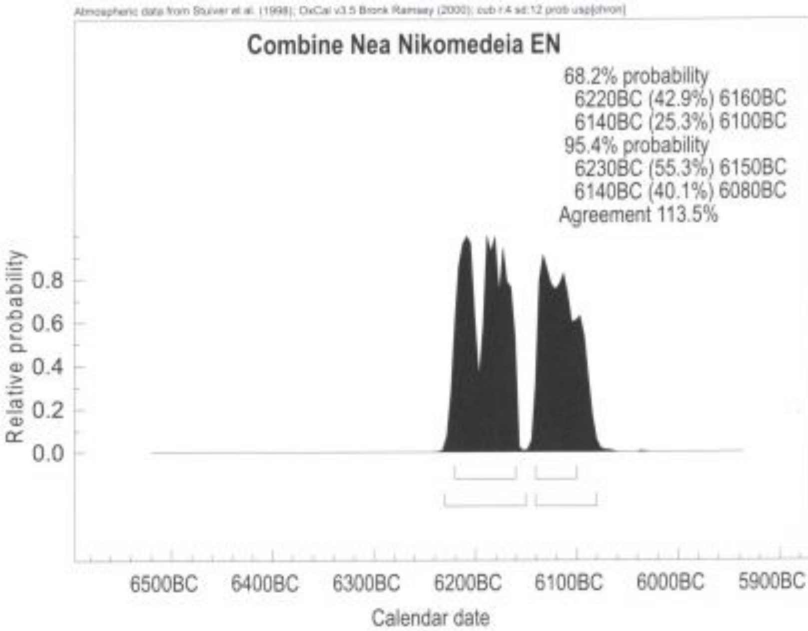

Fig. 8. Nea Nikomedeia radiocarbon dates (exclusive of Q–655, GX–679, P–1202 and OxA–1603+OxA–4280), the probability distributions combined.

From the density of early sites, these plains obviously represent key areas for the Neolithic-Early Chalcolithic periods in West Anatolia, and might very well have done so earlier, their success being dependent on the exploitation of the alluvial plain and the mountains around.

The obsidian from the West Anatolian settlements was probably all imported from Melos, although this assumption rests on the two analysed pieces from the site of Moralılar (Fig. 10, site 48) in the Akhisar Plain (*Renfrew, Cann and Dixon 1965. 235*). The lithics industry appears based on simple blades, but seems highly exploited as evidenced by Coşkuntepe (*Seeher 1990.11, 13.Fig. 2:11–16*). Indeed, the mountains have been used thoroughly for raw materials (cf. the use of pumice, volcanic stone from the area around Kula, and silex in Moralılar [*French 1965. 15; Dinç 1997.266–267*]).

While solid data are still lacking on the Turkish side, several correspondences between Thessaly and West Anatolia can tentatively be pointed out in support of a shared cultural background. If the survey data from West Anatolia are be trusted, individual regions of this large area were rather densely settled at least in the final centuries of the 7th millennium cal BC, both in the coastal areas and in large alluvial plains in the hinterland. A dualism in orientation, on the one hand to the sea, on the other hand to solid farming away from the Aegean, hidden behind coastal mountain ranges, is equally present both in Thessaly and in West Anatolia. At the same time, dependence on the sea was possibly felt also in the hinterland, if we may believe the Melian obsidian at Moralılar. West Anatolian sites, being usually not much larger than 100 m in diameter (cf. Hoca Çeşme or Coşkuntepe), would compare both in settlement location and in size to Thessalian EN villages. The picture sketched by Halstead for EN Thessaly, *viz.*, that of a thickly wooded region studded with small, but many sites may well be applicable to the West Anatolian plains (cf. *Halstead 1981; 1989*). His interesting point, that sheep/goat were foremost kept for their meat, as evidenced by the high death rate of young sheep, hence discarding pastoralism as a means of subsistence (*Halstead 1989*), is equalled and confirmed at least at Ilıpınar. Also here, sheep/goat were bred purely for meat (*Buitenhuis 1989–1990. 117–118*), while most of the animals were killed as sub-adults or young adults (*L.c.*). It is likely that similar patterns will become available when archaeological research finally focuses on contemporary sites in West Anatolia. In line with Halstead's findings for Thessaly, West Anatolian inland sites might also have relied primarily on arable farming to provide for the energy requirements of the population. In contrast, the West Anatolian coastal sites very probably acted as base sites for the Aegean navigators-fishers, and it is likely that several such locations did represent points of reference within a Transaegean network of places, much as might have been the case for Franchthi (cf. *Chapman 1994. 137*). These coastal sites may only have depended on farming in a very limited way and, to extend the speculation, may have depended on the inland villages for agricultural products in exchange for obsidian and raw materials from the sea.

Concerning parallels in material culture, both regions may eventually demonstrate affinity, although here again the lack of West Anatolian data is felt. Discussing the Thessalian evidence above, I have ventured the idea that Thessalian ceramic procedures were developed on the spot and not as part of the baggage of the immigrants. We must begin to reconcile, as pleaded for by Cauvin (*1994*), the facts of colonization with the possibility of cultural variation.

However, in the chipped stone assemblages of both Thessaly and West Turkey a *rapprochement* may exist in the parallel preference for a flake/blade industry. Neither the Thessalian toolkit, nor, for instance, that of Hacılar in the SW Anatolian Lakes District has much affinity with the sophisticated assemblages of the Konya Plain (*e.g.*, Çatalhöyük East). In addition, despite the fact that the obsidian of Hacılar may have been retrieved from the Acıgöl source, Mortensen, in his analysis of the Hacılar obsidian, was not able to relate it to the obsidian industry in the Konya region or to Mersin (*Mortensen* apud *Mellaart 1970.156–157*). Both in technology, in type range and in quantity, the Hacılar obsidian yielded highly different results. Lamellar pressure-flaking, well known at Çatal, was rare at Hacılar. While the Hacılar industry is based on blades (as that of Kuruçay, very close to Hacılar, see *Baykal-Seeher* apud *Duru 1994.108*), at Çatalhöyük fifty different types of tools and weapons have been distinguished, forty-three for Levels III–II alone (*Bialor 1962; Mellaart 1975.103*). At Hacılar, flint dominated the tool kit, *versus* 42% of obsidian (Çatal: 95% obsidian in levels III–II). In view of the cultural coherence of Western Anatolia and the Lakes Region, the remark by Mortensen that the flint and obsidian objects surveyed by French from Moralılar "bear a considerable resemblance to the chipped stone industry of Hacılar" (*Mortensen* apud *Mellaart 1970.157*) gains in importance.

DISCUSSION

The following discussion rests on two basic assumptions, first, the existence of an Aceramic Neolithic culture in West Anatolia depending for a large part on farming, but to be distinguished in an inland area, and a coastal area, with different commitments and subsistence bases, and second, the existence of a body of Transaegean navigators (hunters-fishers?) acting as know-how transmitters, suppliers of Melian obsidian and ultimately as a medium in transferring West Anatolian aceramic farmers to the Thessalian Plain.

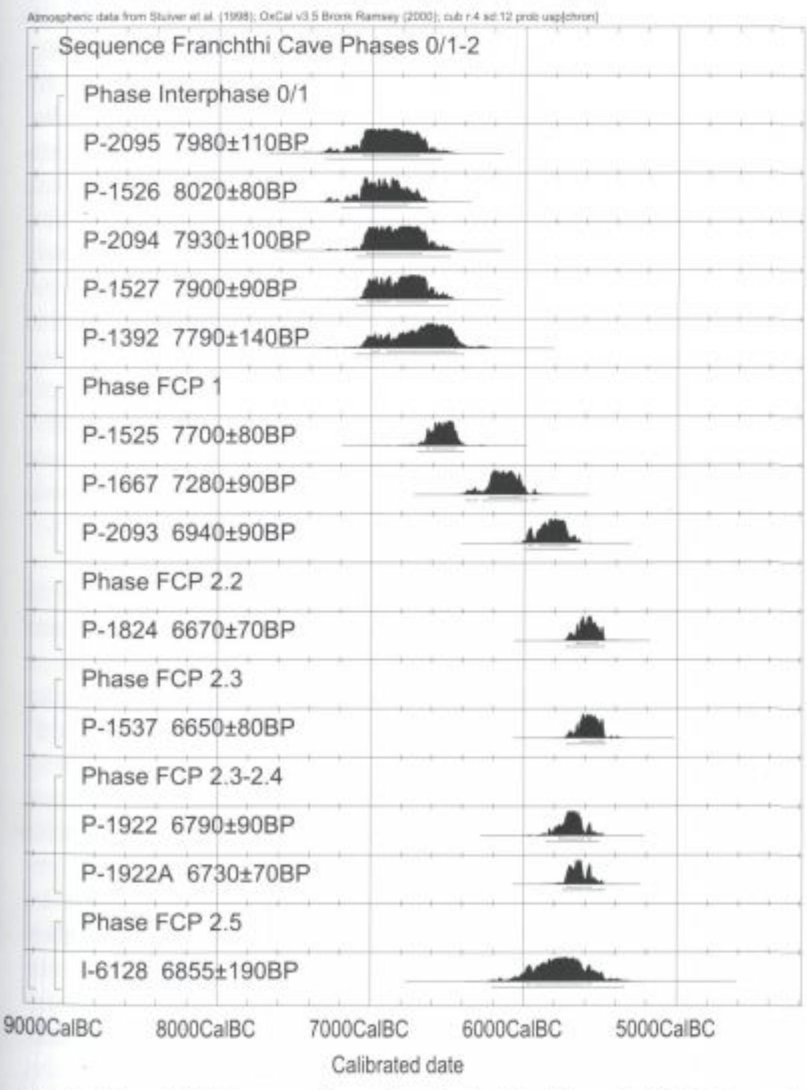

Fig. 9. Franchthi Cave radiocarbon dates for Phase Int 0/1, Phase 1 and Phase 2, calibrated individually.

In seeking for a possible origin of the Thessalian settlers, Perlès' remark that they deliberately ignored the local raw material sources (meaning those for quality flint, obsidian and jasper, not so much the directly utilitarian ones) is significant (*Perlès 1992.121, 124, 128*). Living in an obviously strongly socialised context, the first Thessalian farmers, in order to evade conflicts, depended on local exchange mechanisms (*Perlès 1992.121*). The *avoidance* of conflict, the success of which is archaeologically visible in the coherence of Thessalian EN culture, in the close proximity of sites over centuries and in the scarcity of burnt destruction horizons, and an *unwillingness* to engage in conflict might both find their basis in the to all appearances peaceful, non-aggressive milieu, with only a minor hunting component (cf. *Halstead 1994.206–207; 1996.304–305*).

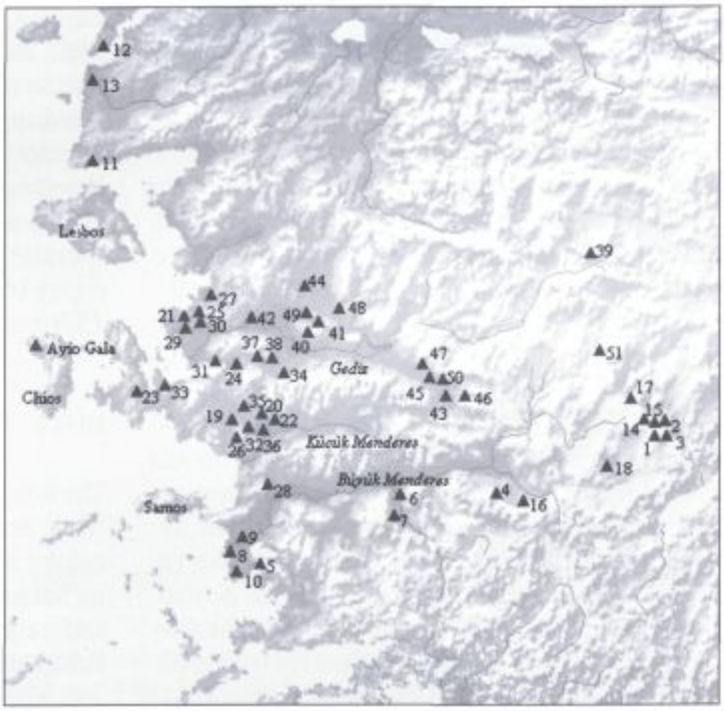

Fig. 10. Map showing Late Neolithic – Early Chalcolithic sites in Western Anatolia. 1. Ak Höyük. 2. Boz Höyük-Dinar. 3. Dinar Höyük. 4. Afrodisias. 5. Akbük-Saplıadası. 6. Hamidiye (Toygartepe). 7. Kavaklıkahve. 8. Killiktepe. 9. Milete. 10. Tavşan Adası. 11. Coşkuntepe. 12. Karaağaçtepe. 13. Kumtepe. 14. Çandar I. 15. Çandar II. 16. Karakurt. 17. Ömerköy. 18. Sürmeli Höyük. 19. Altıntepe. 20. Arapkahve. 21. Araptepe-Bekirlertepe. 22. Aslanlar. 23. Barbaros. 24. Bornova. 25. Bozköy. 26. Bulgurca. 27. Çaltıdere. 28. Gökçealan. 29. Helvacı-Höyücek. 30. Höyücek II. 31. Küçük Yamanlar. 32. Lembertepe. 33. Limantepe. 34. Nemrut Höyüğü. 35. Oğlananası. 36. Tepeköy. 37. Ulucak. 38. Yenmiş. 39. Akmakça. 40. Alibeyli. 41. Arpalı II. 42. Çerkeztevfikiye. 43. Gâvurtepe (Alaşehir). 44. Kayışlar. 45. Kemaliye. 46. Killik. 47. Mersinli. 48. Moralı (Moralılar Höyüğü). 49. Nuriye. 50. Yuvacalı. 51. Aliçli Höyük.

Conflict-evasion might be prompted by the initial foreignness to the land and by the concomitant necessity to keep together. Early Neolithic Thessalian society thus offers a picture of a densely occupied land of peaceful, undoubtedly hard-working (see *Sahlins 1972.Ch. 1*) farming villages or hamlets, keeping in close contact with each other and making use of each others', overlapping, raw material source areas. Not only in a material sense, but also socially, all villages are thus linked through a network of reliable integrative mechanisms maintained through local exchanges (*Perlès 1992.121*). Though internally dynamic, this society is self-contained and static externally *except for* a few important and specific, direct alliances established by tradition. The self-containment, and the probable intention on the part of the settlers to "make it" in the new land (an intention which would live on over the generations and find its consolidation and justification in the success of the exploit) would generate what Chapman has called the concept of "cyclical, or reversible, time" (*1994.139*). In such a concept of time – denying linear progression – tradition, and the maintenance of tradition, will become the yardstick for life, instead of time; tradition which causes to remain to the land, to the village and to the building plot (cf. *Chapman, l.c.*). As Perlès argues, in such a society there are social barriers to engage and maintain the circulation of goods and/or people over long distances, adding that such a society presupposes "a socially more neutral trading system, such as one based on recognised middlemen" (*Perlès 1992.121*). Direct alliances, whether or not mediated by "neutral" middlemen, might very well form the basis for the import of Melian obsidian so conspicuously and permanently present on Thessalian sites. Perlès argues convincingly that the Melian obsidian was probably not acquired through local initiative, as seems confirmed by the small amount of these materials on each EN site not being in proportion to the exertions of such distant trips. There is, furthermore, absence of local variation, the incoming material arriving in a worked state, while, additionally, the specialised know-how needed to circumnavigate the Aegean may not have been present (*Demoule and Perlès 1993.383*).

A similar constellation might well have existed in West Turkey: inland sites depending on middlemen for providing the Melian obsidian (and perhaps other "marine" resources); middlemen supplying information about the Aegean, about "available land" across the sea. If the existence of an aceramic farming society in West Anatolia is assumed (albeit not yet proven), this society, with its long ancestry, must have differed from what, in a later stage, was implanted in Thessaly; in fact, it is improbable that the social structure of the Anatolian inland communities were the same as those in Thessaly. Put otherwise: the Anatolian colonists did not apply the traditional social structure (perhaps viewed as one of the causes leading to migration, and therefore not to be reiterated) in the new land, where it was decided to 'stick together.' If we above followed Halstead, seeing the Thessalian pottery as structuring the laws of hospitality (*Halstead 1994.206*), it is perhaps this decision that stood at the basis of the willingness to make and use pottery, so indeed, following Perlès and Vitelli, primarily as a social construct, to tie the bonds between the different groups of settlers. It is even imaginable that the aceramic West Anatolian inland farmers knew about the new invention, either from the Konya Plain area to the East of them, or from the lakes area to the Southeast of them, but did not find any immediate use for them.

From Perlès' analyses and on the basis of the evidence discussed in this paper, several suggestions may be advanced, testable through excavations of some key sites both in inland West Anatolia, and along the Turkish Aegean seaboard:

- The EN Thessalian settlers are not identical to those who explored the Aegean, catching tunny-fish and exploiting Melos obsidian.
- These EN Thessalian colonists are farmers *pur sang*, not much depending on hunting, as well as not much acquainted with the sea and with marine life. Their ignorance or dislike of the sea and marine food may find its corroboration in their food habit patterns: most of the EN Thessalian sites yield very meagre evidence of the use of seafood (cf. *Wijnen 1981.54; Schwartz* apud *Wijnen 1981.112* for Sesklo). A major exception is the site of Pyrasos sitting immediately on the coast (*Wijnen 1981.57*).
- It is, among others, the Franchthi people who navigated the Aegean, who possessed the expertise to cope with the currents and winds and who may have acted as providers of the Melian obsidian, either directly to Thessaly, or more probably, by way of middlemen. The information supplied by Wijnen (*1981.78*) concerning the site of Nea Makri, on the coast of Attica, and the only site thus far yielding obsidian implements including cores and waste flakes, leads her to suggest that "people from this area shipped obsidian from Melos, knapped blades and then transported them over the country or exchanged them for other goods."[6]
- The people frequenting Franchthi Cave may have represented the filter through which the existence of fertile land in Thessaly became known in the region of origin of the Thessalian farmers. Moreover, the knowledge that the fertile land was roughly similar environmentally to the root country must have filtered through as well.
- The most logical option for the root country of the Thessalian colonists may be the plains in the West Anatolian *hinterland*. The farmers living here stood in contact with sites on the West Anatolian seaboard, *ergo* with the Aegean navigators, as proven by the Melian obsidian from Moralı.
- Given the absence of know-how on the part of the colonists in seafaring, it is tempting to assume that the transporting of the migrants was in the hands of the Aegean navigators.
- If the Thessalian farmers had their roots in West Anatolia, then the fact that they developed pottery only upon arrival in Thessaly, implies that they left West Anatolia at a time when they were still 'aceramic.' The development of pottery in Thessaly cannot therefore be related to cooking, as techniques of cooking without clay containers were known.
- By identifying the Thessalian settlers as rooting in West Anatolia, we may assume a long-lasting process of development in West Anatolia *before* the move across the Aegean was decided upon. A longer process of development is required in order to comply with the time needed to raise to conflicts, to become so overwhelmingly embedded in farming and in order to take the decision to solve the conflict by migration. This assumption, incidentally, might explain why the Thessalian Early Neolithic appears so balanced and mature (as both practising animal husbandry and plant exploitation, with hunting playing a minor role). This *longue-durée* perspective also would provide a framework within which to position the age and complexity manifest in the exploitation of the Melian obsidian (cf. *Perlès 1989.117*).

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6 Clear evidence of obsidian working is attested also at Neolithic Halai (*Coleman 1992.274*).

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Documenta Praehistorica XXVII

The Problems of Dating Prehistoric Axe Factories and Neolithisation in Turkish Thrace

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ABSTRACT - *Prehistoric axe factories or manufacturing areas have been found in the Sarköy region of Turkish Thrace. So far, they are unique in the prehistoric record of the Balkans and Anatolia. A typological and petrological analysis of the stone axe factories and investigations of their distributions are in progress. Early results show that all the axes are manufactured from the same rock – metabasite. The source of metabasite is the Western outcrops of Ganos Mountain. At the early Neolithic settlement of Hoca Çeşme, stone axes were made of the same rock as the Sarköy sources. In this paper, I discuss the problems of dating prehistoric axe factories, together with the wider problems of the early Neolithic period in Turkish Thrace.*

IZVLEČEK - *V turški Trakiji v regiji Sarköy so bile odkrite prazgodovinske delavnice oziroma področja, kjer so izdelovali kamnite sekire. Zaenkrat je to edinstven primer v prazgodovinskem zapisu Balkana in Anatolije. V teku so tipološke in petrološke raziskave kamnitih sekir iz delavnic in raziskave njihove razprostranjenosti. Raziskave zaenkrat kažejo, da so bile vse sekire izdelane iz iste kamnine – metabazita. Površinska nahajališča te kamnine ležijo na zahodnem delu hriba Ganos. Tudi v zgodnjeneolitski naselbini Hoca Çeşme so bile kamnite sekire izdelane iz enake kamnine. V članku razpravljamo o težavah pri datiranju prazgodovinskih delavnic sekir ter o širših vprašanjih zgodnjeneolitskega obdobja v turški Trakiji.*

KEY WORDS - *stone axe production; neolithisation; Thrace; Western Anatolia*

INTRODUCTION

According to R. Wagner, "in learning how to use tools, we are secretly learning how to use ourselves" (*Wagner 1975.77*). He claims that tool use is about the objectification of our skills as the controls which tools place on the relationship between humans and the environment. In prehistoric times, stone served as the main material for making tools. Only stones that met certain technological requirements were used and they were deliberately sought out. Stone is most intractable and the most difficult material to work on. Each tool took so much labour to produce that it was among the most valued of a person's possessions. The polished stone axe is a very significant tool type, especially in the Neolithic period. The polished stone axe provided a central symbol within Neolithic society because it effectively linked a whole range of spheres of human activity (*Tilley 1996. 114*). The axe was a basic tool in subsistence, an important exchange item linking together communities, personal status and prestige items in a community. The stone axes which circulated within society had a worth which would have been related to debt and kinship, and to the articulation of relationships between persons and groups (*Thomas and Tilley 1993.290*). According to Tilley: "the axe provided a durable symbolic medium for creating and maintaining social ties and dependencies through ritual and everyday activities" (*Tilley 1996.114*).

K. Kristiansen has argued that the axe links together agricultural production, exchange and ritual consumption and feasting (*Kristiansen 1984.79*). Ethnographical studies show that the leader in lineage groups in the Pokou, Ussiai and Matankol people of the Admiralty Islands is in possession of the axe/adze and can also pass it on to his successor (*Ohnemus 1998.152*). He holds the axe/adze in his hand while speaking and dancing in ceremony. On a sad occasion, such as death, the leader appears without his axe/adze. The axe/adze is also used in peacemaking talks or punishment. It stands for law and order, peace and joy. Among Australian Aboriginal societies, the stone axe was prominent in interpersonal relations, in the totem system and in the wider belief system (*Taçon 1991.194*).

Axes probably had important roles in ceremonial activities. In the Papua New Guinea highlands, the largest axes were valued especially for ceremonial and display purposes (*White and Modjeska 1978. 29*). During the mortuary feast of the Sabarl Islanders of Papua New Guinea, the dead paternal clan publicly presents five ceremonial axes to its maternal clan heirs. In absolute secrecy, the axes are used to construct in effigy the corpse of the honoured dead (*Battaglia 1983.291*). The axes were placed next to the dead against one another, with the heads facing in the same direction. They rest on their blades and points, resembling angels in the air. They are said to represent a human body reclining in its grave. The axes and the dead become intertwined in the grave. Then, the deceased was raised as it were from the grave and re-installed at the centre of reproductive life. This marks the beginning of his life as an ancestor and establishes him as a source of economic and spiritual aid for the living. The corpse is magically endowed with the power to reproduce axe blades; it becomes more than a representation of the ancestor, it becomes a concrete substitute for the 'child' as a reproductive unit of his/her society (*Battaglia 1983.298*).

The axes may serve as points of reference for broader belief systems. In Neolithic chamber tombs in Brittany, the deposition of particular types of stone axes is relatively restricted, especially of those obtained from great distances. By passing from hand to hand, over the distance from their sources, each axe would have built up its own genealogy, as myths became attached to them (*Kristiansen 1984.79*). The tomb may act to fix all of those myths in one location. Axes were so deeply connected with the person that the history of axe and person becomes intertwined. Thus the burial of the axes introduced the presence of this person to the depositional context (*Thomas and Tilley 1993.293*). In Neolithic chamber tombs in Brittany, some of the axes were deliberately broken (*Thomas and Tilley 1993.290–91*). Axes may be regarded as having biographies, like persons. They are born (produced), exchanged and destroyed (die). As Chapman argued, the relationship between fragmented objects and persons is an important, interpretative link (*Chapman 1996. 214; 2000*). Axes were deeply connected with the person, and when the body died, the axes were ritually destroyed.

In the centre of the chamber at Mané-er-Hroëk, Brittany, a large ring of jadeite and a huge axe was arranged so that its butt penetrated the ring. Behind the blade of the axe were two beads, and behind this were a perforated axe and a further bead. All these axes and beads are set along a north-south axis. According to Thomas and Tilley, the sexual symbolism is here quite explicit that all axes represent phalluses (*Thomas and Tilley 1993.291–293*). Among the Australian Aboriginal groups in the Yir Yoront of North Queensland and Western Arnhem Land, stone axes and other tools were recognised as belonging to men, especially older men, and embodying their ancestral power (*Taçon 1991.194–195*). The women and young had to borrow the axe from the older male. In the borrowing, the status, position and power of older males were reinforced. Aborigines also believed that the axes were formed from ancestral bones. In Sabarl Island society, the axes are personified persons and identified with the bodies of the persons making them (*Battaglia 1983. 295*). The axe blade is called "Hinona" – the "content" or "vital substance" of the valuable. In the context of the physical person, "Hinona" is the term for "genitals" and "right hand", a symbolism associated with economic and biological reproduction. The axe blade broadly represents the reproductive potential of a singular person (*Battaglia 1990.133*).

Factories or manufacturing areas are places where craft specialists perform a limited set of activities on a frequent, perhaps regular basis in order to produce items for exchange with other groups of people. Stone axe factories or manufacturing areas were recently found in Turkish Thrace. Although the field data are not complete, typological and petrological investigations of prehistoric stone axe factories show us the operational chain for prehistoric axe manufacture and the raw material from which the axes are made. In this article, I would like to discuss the problems of the dating of stone axe factories, together with the wider problems of the early Neolithic period in Turkish Thrace.

Prehistoric Axe Factories in Turkish Thrace

In 1989, a large number of roughouts was sold to Istanbul Museum by a farmer from the Sarköy region. Scholars working in Eastern Thrace were for a long time looking for the site from which these roughouts came. In 1995, the stone axe factory of Yartarla was found by M. A. Isin, director of Tekirdag Museum, and he demonstrated that the roughouts held in Istanbul Museum come from Yartarla. Later, two more axe factories or manufacturing areas, Hamaylitarla (Buruneren) and Fener Karadutlar, were found by O. Ozbek in the Sarköy region. A geo-archaeological project since 1997 has focused on the typology and petrology of axes and the wider questions regarding these sources (*Ozbek in this volume*). However, since there are no intensive archaeological surface surveys in the Sarköy region yet, it is possible that other such sites exist.

As a result of the investigation of prehistoric axe factories, two topographical locations can be distinguished. The stone axe factory of Yartarla is located ca. 14 km North-West of Sarköy, ca. 3 km north east of the village of Sofuköy. It is situated on a high terrace of the Kavak Suyu River. The Kavak Suyu River rises in the Ganos Mountain and descends westwards to the Gulf of Saroz. It has a flat, marshy, alluvial mouth. The Kavak Suyu runs through wide gorges, with steep sides that in some places rise vertically from the river, reaching a height of 200-250 m, at which Yartarla was formed. Hamaylitarla (Buruneren) and Fener Karadutlar are situated on well-watered lowlands at the southern foot of Mounts Helvaci and Sarikayalar. Hamaylitarla (Buruneren) is located ca. 17 km West of Sarköy and ca. 1 km west of the village of Kizilcaterzi. Fener Karadutlar is situated on Cape Ince, on the northern shore of the Sea of Marmara, ca. 1 km northwest of Hamaylitarla. The southern foot of Mount Helvaci, Kazanagzi stream and a number of small seasonal streams run into the Sea of Marmara, constituting flat, fertile cultivated land (Fig.1).

All the axe factories were found associated with prehistoric settlements. In all examples, roughouts, flakes and hammer stones were found in and around the prehistoric settlements. In three sites, all axes are manufactured from the same rock, metabasite, and the operational chain for prehistoric axe manufacture is the same.

The stone axe factories of Hamaylitarla (Buruneren) and Fener Karadutlar are situated at the rock source. The source is in western outcrops of the Ganos Mountains. However, Yartarla is about 3 km away from the source.

Problems of Dating Prehistoric Axe Factories

Although hundreds of stone axes are discovered at excavations each year in the Balkans and Anatolia, until now *no* prehistoric axe factories have been found. However, at the site of Divostin in Serbia, numerous unfinished axe specimens indicate the method of manufacture. In Divostin phase II, a working floor with roughouts, drilling pieces, flakes and also a large pit filled with the flakes of roughouts were found (*Prinz 1988.257-259 and Plan IIIa*).

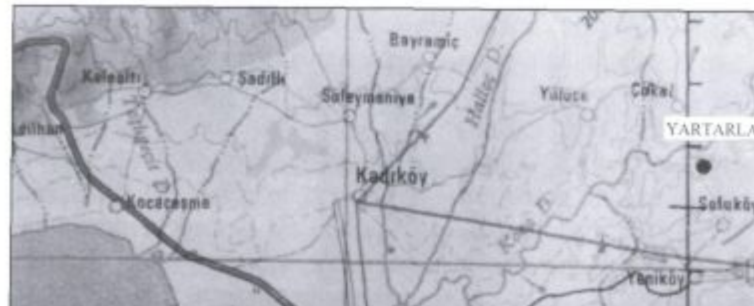

Fig. 1. Location map for Prehistoric axe factories in Turkish Thrace.

This concentration, Sector B, seems to indicate an area where stone axes were manufactured. Divostin phase II is dated to the Late Vinča Culture (4th millennium BC). In Obre II in Bosnia, the regular shapes of sixteen stone axes were found between two stone slabs in sounding D, together with two big flint knives, three bone awls and two round baked clay objects. This has been interpreted as an axe-making area (*Benac 1973.82 and Fig 13a*). A similar axe-making area was also found in sounding VII at Obre II (*Benac 1973.82*). Obre II, sounding D, is dated to the Classic Butmir Culture (4th millennium BC). However, the dates from sounding VII in Obre II fall within 5th millennium BC. In Bosnia, at the site of Kalošević-Malo Brdo a large number of flaked stone axe roughouts was discovered (*Chapman 1976.146*). The pottery on the site was found to date to the Late Vinča Culture. Kalošević-Malo Brdo is probably an axe-manufacturing site; however, there are as yet no detailed investigations.

The dating of axe factories in Eastern Thrace is problematic. No complete axes were found in the factories. In the settlement of Yartarla, Late Chalcolithic and Early Bronze Age sherds were collected. The settlement of Fener Karadutlar was completely destroyed by the building of a Byzantine church; only a few Early Bronze Age sherds were found. At the site of Hamaylitarla (Buruneren), early Neolithic sherds together with a few Early Bronze Age sherds were collected. It seems evident that, without excavations, it is difficult to date these stone axe factories. The petrological investigation of polished stone axes from excavated sites and surface collections in Eastern Thrace is still in progress. On the other hand, early results from the Early Neolithic site of Hoca Çeşme, near the town of Enez, showed that the polished stone axes of Hoca Çeşme was made from metabasite, probably from the Sarköy region. Pottery similar to that of Hoca Çeşme was also found in Hamaylitarla. The following discussions will focus on materials from the site of Hamaylitarla.

Grid no.	Neolithic pottery	E. B. A pottery	Chipped stone	Weight [g] (Neo. only)
1	136	2	0	1500
2	33	1	1	500
3	21	1	0	300
4	76	2	0	800
5	120	27	1	1200
6	10	12	0	200
7	6	2	0	60
8	19	6	6	300
9	10	9	2	200

Tab. 1. Summary results of Hamaylitarla.

Hamaylitarla (Buruneren) and Its Relations

Hamaylitarla was first discovered by M. A. Isin, director of Tekirdag Museum at the beginning of the 1990's and initially dated to the Early Bronze Age. In 1997, O. Ozbek and the author visited the site and found stone axe rough-outs, flakes and hammer stones together with Early Neolithic pottery. As a result of the geo-archaeological project of O. Ozbek, we understand that Hamaylitarla is an axe factory associated with prehistoric finds. The site of Hamaylitarla measures about 120x120 m. The stone axe factory is spread over 250 square meters. An area of 70x70 m was investigated, using alternately spaced 10x10 m grids (Tab. 1 and Fig. 3).

The vast majority of the Hamaylitarla pottery, up to 90%, is red slipped and burnished. Black and brown burnished sherds were found in smaller quantities. All pottery is handmade, thin-walled and with an abundant use of grit and sand-temper. A little chaff is usually present in the paste. A number of sherds are tempered with chaff only. Mica is rare or absent. The paste colours are black, buff or cream. The different tones of the red and pink slip (mainly 2,5 YR 6/6 Red) are applied on both surfaces or on the exterior surface only. Sometimes the firing was irregular, causing mottling and smoke staining on the surface. The thickness of the application varies greatly. Surfaces are usually burnished. Sometimes the interior surfaces are smoothed only. The range of shapes consists of deep bowls with S profiles, bowls with plain rims and flaring sides, straight-sided bowls, bowls with angle-necks and hole-mouth vessels. Vertically placed tube-like and knob-like tubular lugs, as well as crescentic lugs, are characteristic. Flat and ring bases were found. For decoration, bands in relief occur (Figs. 4 and 5).

Pottery similar to Hamaylitarla was also noted at Kaynarca, near the town of Gelibolu (*Özdoğan 1986; 1999.Fig. 43*). Recent surveys in Western Anatolia have revealed new Early Neolithic sites, such as Tepeköy, Araptepe, Höyücek II, Nemrut (*Meriç 1993*), Coskuntepe (*Seeher 1990*), Tepeüstü-Barbaros, Kyme-Ege Gübre and Bergama-Pasaköy. Similar wares and shapes occur especially at the sites of Araptepe, Tepeüstü-Barbaros, Kyme-Ege, Gübre and Bergama-Pasaköy (*personal observation*).

Hamaylitarla was dated to the Classic Phase of the Fikirtepe Culture by Özdoğan (*1997.21; 1999.214*). Before talking about dating Hamaylitarla, I would like to discuss briefly the Fikirtepe Culture. In the Marmara region, the Fikirtepe culture is the earliest Neolithic Culture in the regional sequence. According to Özdoğan and Efe, three evolutionary phases were distinguished on the basis of pottery (*Özdoğan 1997. 19; 1999.213; Efe 1996.51*). The earliest phase of the Fikirtepe Culture, called the Pendik phase or archaic phase, is known from the lower layers of the Fikirtepe and Pendik excavations (*Özdoğan 1997.21*). Pottery from this phase comprises brown-grey, dark grey and sometimes pale orange, reddish brown coloured, burnished wares. The most common shapes are bowls and jars with either simple convex sides or with a slight "S" curve. Hole-mouth vessels, exaggerated large lugs and vertically perforated knobs are also common. Decoration is rare, mainly consisting of incised lines. The most common motifs are parallel lines, triangles, squares and hatching.

The second phase is the Classic Fikirtepe Phase. It is best represented at Pendik and the upper horizon of Fikirtepe. According to Özdoğan, the transition between the first and the second phases is difficult to define (*Özdoğan 1997.21*). There is a gradual development in the pottery. The most common form is a bowl with "S" curved profiles and an oval mouth. Besides the heavy lugs, there are also tubular lugs. Four-footed rectangular vessels or boxes are very characteristic. There are also lids. The decoration is the same as in the previous phase, but the designs are more complex. During the Classic Fikirtepe phase, the red slipped, burnished wares began to appear. According to Özdoğan, Ilipinar level X represents the transition between the first and the second phases (*Özdoğan 1997.21; 1999.213*). Classic Fikirtepe pottery was also found in the Kütahya-Eskisehir Region, Inner Western Anatolia (*Efe 1995; Özdoğan 1997.21*).

The last phase of the Fikirtepe Culture is called Developed Fikirtepe or the Yarimburgaz 4 phase. This phase is characterized by elaborate decoration made by wedge-like excisions, often set directly behind one other or else set in zigzags. The designs are more complex, which Özdoğan called textile-like designs (*Özdoğan et. al. 1991*). Dark faced wares are common. The surfaces of vessels are mostly burnished, and occasionally a dark slip is applied. The red slipped and burnished wares rarely occur. The most characteristic shapes are short-or tall-necked jars with squat globular bodys. Developed Fikirtepe type sherds were also noted in Ilipinar level VIII. The sites of Demirci Höyük (*Seeher 1987*), Orman Fidanligi and Kanlitas (*Efe 1989/90; 1996*) in the Eskisehir region include typical developed Fikirtepe sherds.

Recently, L. Thissen proposed that differences in the main vessel shapes between sites on the Eastern Marmara coast and Ilipinar X may be related to differences in the subsistence base rather than indicating chronological variety (*Thissen 1999.32*). This means there could be considerable regional and chronological variation. According to Thissen and Roodenberg, the Iznik-Yenisehir region was settled by early farmers migrating from Central Anatolia (*Thissen 1999; Roodenberg 1993*). However, for Thissen, Fikirtepe sites on the Eastern Marmara coast show the simultaneous adaptation of farming techniques and pottery, probably as a result of contact with the Iznik-Yenisehir region (*Thissen 1999.38*). Özdoğan also agrees that Epi-palaeolithic populations on the Eastern Marmara coast adapted Neolithic elements (*Özdoğan 1998.450; 1999.215*).

Comparisons between the Iznik-Yenisehir region and the Eastern Marmara coasts show that the buildings of Fikirtepe and Pendik are oval huts with depressed floors and wattle and daub walls. However, the buildings of Ilipinar and Mentese are rectangular, constructed in wattle and daub. The subsistence of Ilipinar was mostly dependent on domesticates, while Fikirtepe and Pendik were based on mixed hunting, fishing and a stock breeding economy, with some agriculture (*Roodenberg 1995.167–168; Özdoğan 1989.203*). The chipped stone industries of both Fikirtepe and Pendik are both similar to the preceding Epi-palaeolithic tradition. Although Özdoğan argued that the chipped stone industry of Ilipinar is different from those of Fikirtepe and Pendik (*1997.23*), recent work shows that Ilipinar represent a continuation of a local Epi-palaeolithic tradition analogous to Fikirtepe and Pendik (*Thissen 1999.37*). Moreover, the chipped stone industries from Fikirtepe-type settlements in the Eskisehir region, such as Findik Kayabasi and Asarkaya, are also similar to the Epi-paleolithic tradition (*Efe 1995.108*).

^{14}C dates from Yarimburgaz Cave (*Özdoğan et. al. 1991*), Mentese (*Thissen 1999; Roodenberg 1999*) and Ilipinar (*Roodenberg et. al 1989/90; 1995*) are seen in Table 2. The Fikirtepe Culture can be dated to c. 6200–5700 cal BC.

Now I shall discuss some observations about the early Neolithic period in Western Anatolia and the

Marmara Region. I believe that these observations are directly related to the dating of Hamaylitarla and also correlations between Western Anatolia and the Marmara Region (Fig. 2).

① 90% of the Hamaylitarla assemblage is red slipped and burnished. The Fikirtepe Culture is marked by dark monochrome pottery. During the Classic Fikirtepe phase, red slipped and burnished wares began appearing. According to Özdoğan (*1999.213*), in the Classic Fikirtepe phase, red sherds comprise six to ten percent of the total assemblages. On the other hand, the excavations of Ilipinar and Mentese have not revealed red slipped and burnished sherds (*personal communication with L. Thissen*). In Western Anatolian sites, red slipped and burnished sherds similar to those of Hamaylitarla are found. This type of pottery is very common in Western Anatolia (*Meriç 1991; Harmankaya et. al. 1997*).

② Vertically-placed tubular lugs characteristic for the Lake District as well as Western Anatolia are attested at Hamaylitarla. Vertically placed tubular lugs do occur rarely in the Classic Phase of the Fikirtepe Culture (*only one published example: Özdoğan 1999. Fig.33, D.231*), but are not characteristic elements of the Fikirtepe Culture.

③ There are some similarities between Hamaylitarla sherds and the early phases of Hoca Çeşme. Before explaining these similarities, I would like to discuss Hoca Çeşme. Excavations at Hoca Çeşme-Enez, conducted by M. Özdoğan between 1990 and 1992, suggest the existence of a different Early Neolithic culture in Eastern Thrace, called Hoca Çeşme Culture by Özdoğan (*Özdoğan 1997*). Hoca Çeşme is a small mound on a natural rise overlooking the delta of the Meriç River, ca. 5 km east of the district centre of Enez. It measures about 80 x 70 m and the archaeological deposit is about 2 m thick (*Özdoğan 1993.182; 1998; 1999. 217–219*). Four phases were discovered in Hoca Çeşme. Phase IV is the earliest phase at Hoca Çeşme. The architectural remains of this phase were built immediately on the bedrock. Houses are oval, wattle and daub, hut-like structures, cut into bedrock some 30 cm deep. Their diameter varies from 5 to 6 m. The settlement was surrounded by a massive stone fortification wall around 1.20 m thick, and it sits right on the bedrock. Post-holes found just behind the wall indicate that the fortification wall was supported by a wooden structure (*Özdoğan 1998. 439*). The pottery of this phase is characterized by well burnished, thin walled red or black wares. Deep bowls with "S"-curves, vertically placed tubular lugs, crescent-shaped lugs, bead rims and flat bases are common elements of this phase. There are also a few zoomorphic vessels. Decoration is rare, mainly consisting of fine curvilinear or vertical bands in relief. There are also some grooved and incised sherds.

Hoca Çeşme phase III consists of two architectural layers. Houses

Lab. No.	Level	^{14}C Age BP	Cal BC (1σ)
Grn–15529	Yarimburg. 4	7330±60	6231 (6216,6167,6164) 6084
Grn–18745	Yarimburg. 4	6650±280	5797 (5615,5585,5561) 5322
Grn–24463	Mentese	7260±60	6213(6158,6143,6082) 6028
Grn–24461	Mentese	7170±60	6156 (6018) 5931
Grn–24462	Mentese	7050±35	5986 (5975,5950,5916) 5844
Grn–17046	Ilipinar X	7100±30	6006 (5988,5940,5929) 5920
Grn–15085	Ilipinar X	7100±50	6012 (5988,5940,5929) 5960
Grn–15087	Ilipinar X	7070±50	5992 (5981,5946,5921) 5844
Grn–17045	Ilipinar X	7025±30	5979 (5890) 5841
Grn–17048	Ilipinar X	7025±90	5992 (5890) 5794
Grn–17047	Ilipinar X	6925±70	5890 (5792)5724
Grn–15084	Ilipinar X	6440±50	5475 (5466,5444,5401, 5382) 5325
Grn–15077	Ilipinar IX	7020±50	5982 (5889,5846,5845) 5810
Grn–16144	Ilipinar IX	6935±35	5840 (5835,5834,5799) 5735
Grn–15078	Ilipinar IX	6920±70	5867 (5787) 5722
Grn–16145	Ilipinar IX	6800±90	5736 (5711,5678,5672) 5624
Grn–16146	Ilipinar IX	5330±80	4320 (4221,4163,4118, 4055) 4003`
Grn–17052	Ilipinar VIII	6995±45	5973 (5869,5861,5842) 5805
Grn–17054	Ilipinar VIII	6990±30	5890 (5866,5864,5841) 5807
Grn–17055	Ilipinar VIII	6980±45	5957 (5840,5816,5815) 5795
Grn–17051	Ilipinar VIII	6960±45	5879 (5838, 5822,5809) 5749
Grn–17056	Ilipinar VIII	6950±45	5870 (5837,5826,5806) 5742
Grn–16149	Ilipinar VIII	6890±90	5841 (5734) 5671
Grn–17053	Ilipinar VIII	6750±65	5718 (5658,5651,5640) 5565

Ref. University of Washington. Radiocarbon Calibration Program 2000

Tab. 2. The Fikirtepe Culture dates.

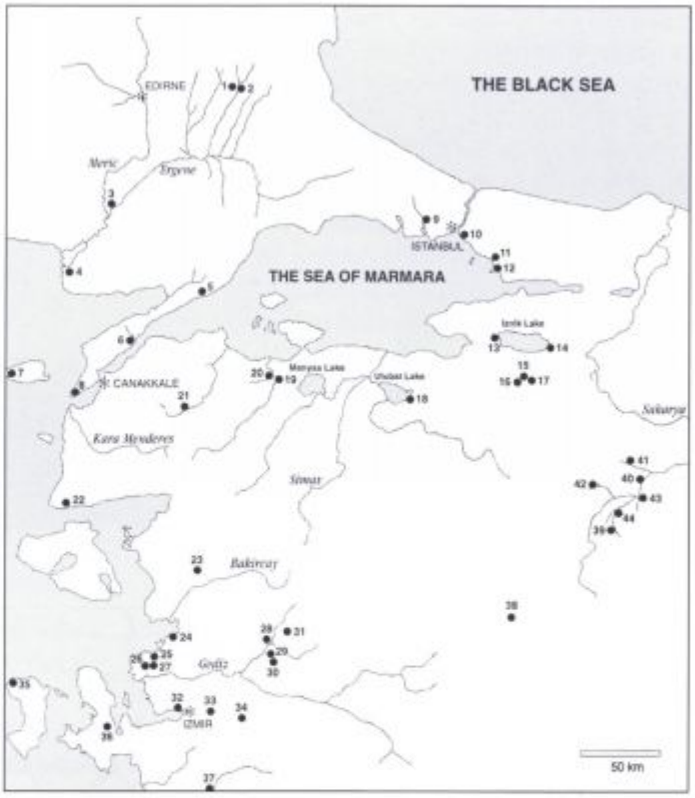

Fig. 2. Distribution of Early Neolithic Settlements in Western and North-Western Turkey: 1. Asagi Pinar, 2. Bulgar Kaynagi, 3. Maya Baba, 4. Hoca Çeşme, 5. Hamaylitarla, 6. Kaynarca, 7. Ugurlu, 8. Karaagactepe, 9. Yarimburgaz, 10. Fikirtepe, 11. Pendik, 12. Tuzla, 13. Ilipinar, 14. Hoyucek, 15. Marmaracik, 16. Mentese, 17. Yenisehir II, 18. Aktopraklik, 19. Taracci, 20. Yilanlik, 21. Calca, 22. Coskuntepe, 23. Pasakoy, 24. Caltidere, 25. Kyme-Ege Gubre, 26. Araptepe, 27. Hoyucek II, 28. Kayislar, 29. Nuriye, 30. Alibey, 31. Morali, 32. Kucuk Yamanlar, 33. Ulucak, 34. Nemrut, 35. Agio Gala, 36. Tepeustu-Barbaros, 37. Tepekoy, 38. Akmakca, 39. Asarkaya, 40. Orman Fidanligi, 41. Demirci Hoyuk, 42. Kanlitas, 43. Keskaya, 44. Findik Kayabasi.

are again oval in plan and the fortification wall still exists, but with some renovations. On the north western edge of the settlement, one house is different from the others. It is a big oval hut of 7 m diameter, and its floor was paved with small pebbles coated and painted in red. The pottery of phase III shows a gradual development in fabric and decoration. All the ware types of Phase IV continue, although they are slightly coarser and thicker. Red coating on black burnished ware appears. There are also red-black, and light cream-red-black mottled sherds. Vessel shapes are similar to the previous phase. However, the profiles are now more carinated and necked jars are slightly increasing.

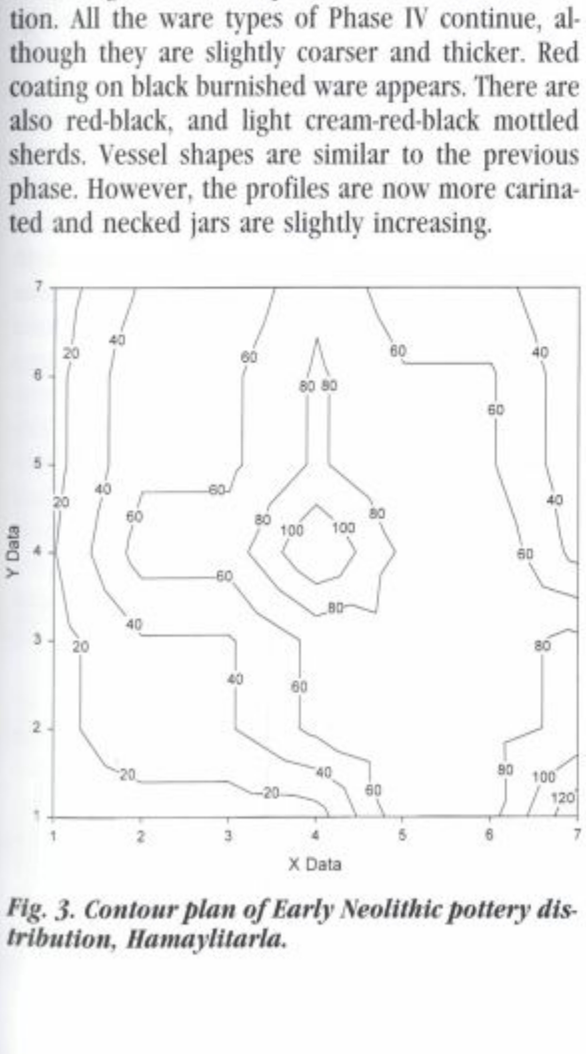

Fig. 3. Contour plan of Early Neolithic pottery distribution, Hamaylitarla.

Phase II consists of three architectural layers. This phase is marked by a change in the plan and construction techniques of the buildings. The houses are rectangular in plan, with plastered walls. There are domed ovens on raised platforms; round or rectangular bins and working platforms were found inside the houses. The fortification wall was still in use. The red and black wares of the previous phases were now noted in lesser amounts. In phase II, there is an increasing amount of reddish-brown and matt black sherds. The sherds are notably thicker. Some new shapes are attested, such as footed rectangular or triangular vessels with excised or incised decoration, and tall-necked jars sometimes with small handles. The decoration of the preceding phases continues. Fluting and intentional mottling also occur. There are also some red on cream, red on black, white on black and white on red painted sherds. According to Özdoğan, houses and pottery, especially white on red sherds of phase II, are strongly reminiscent of Karanovo I period of Bulgaria (*Özdoğan 1997; 1998.448*). A few red on buff painted sherds in Phase II are also similar to Early Sesklo painted sherds (*Özdoğan 1998.449*).

Phase I deposits have been considerably eroded by agricultural activity. In this phase, Toptepe phase I and the Kumtepe Ia-Besiktepe type of pattern-burnished bowls were found together with Karanovo III–IV types of sherds.

A number of ^{14}C dates are available at Hoca Çeşme (*Özdoğan 1997.28; 1998*). They are presented in Table 3.

Although there are some technological differences between the pottery of Hoca Çeşme and Hamaylitarla, a basic similarity between the sites cannot be denied. Deep bowls with S curves, vertically placed tubular lugs, crescent-shaped lugs and bead rims constitute links between both sites. However, some of the forms and decorations at Hoca Çeşme are absent in Hamaylitarla. On the other hand, Hamaylitarla pottery is slightly coarser than that of Hoca Çeşme. The pottery of Hoca Çeşme is elaborately made and the surfaces are lustrously burnished. It is not yet clear whether these differences in pottery are due to chronological factors (i.e. Hamaylitarla is earlier than Hoca Çeşme), cultural differences (i.e. the site of Hamaylitarla belongs to the Fikirtepe Culture, while Hoca Çeşme does not) or social variation (i.e. Hamaylitarla is a manufacturing site occupied by craft specialists only).

In addition, Özdoğan compares Hoca Çeşme to Western Anatolian sites (*Özdoğan 1997*). Above, I also compare Hamaylitarla to Western Anatolian sites, such as Tepeüstü and Araptepe.

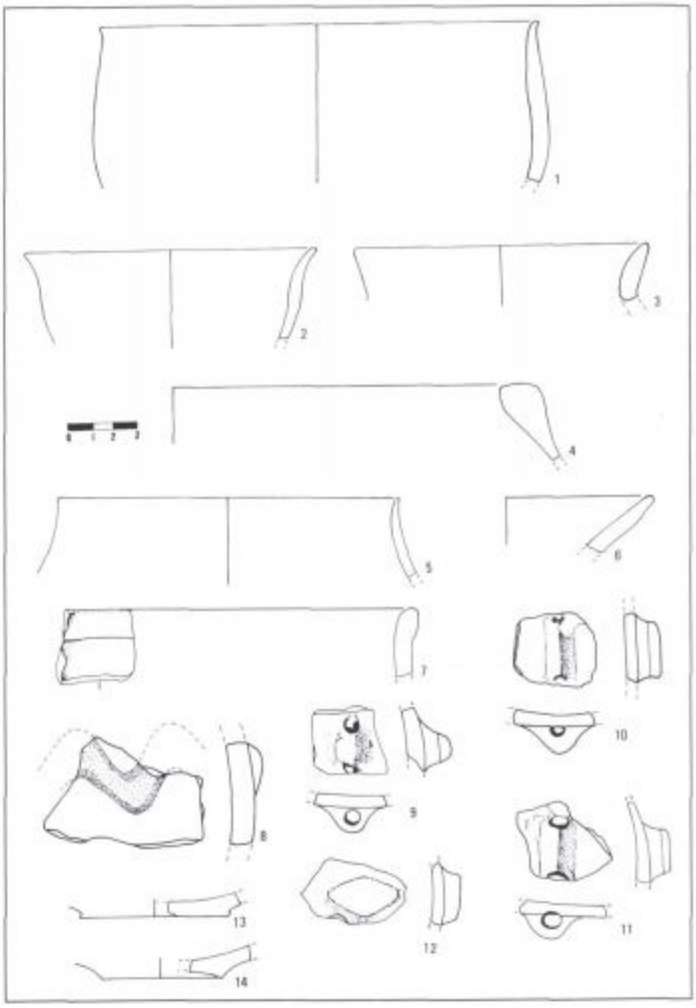

Fig. 4. Pottery from Hamaylitarla (Buruneren).

④ According to Özdoğan, Hoca Çeşme is an Anatolian colony in Eastern Thrace (*Özdoğan 1997; 1998. 450*). 'The pottery, small finds, the lithic technology, and the domesticates are unmistakably of Central Anatolian origin' (*Özdoğan 1997.26*). There is a close similarity in the pottery between early Hoca Çeşme and Hacilar IX–VI and Kuruçay 11–13. According to Özdoğan, the lithic technology is said to have characteristic traits of the Central Anatolian cultures (*Özdoğan 1997*). Connections with Anatolia are also documented by figurines and pseudo-stamp seals (*cf. Hacilar: Mellaart 1970.Fig. 187*). An analysis of the animal bones of the lower levels at Hoca Çeşme determined that all the animals were domesticated (*Buitenhuis 1994*). However, round building structures of the early Hoca Çeşme different from those in Central Anatolian settlements.

Lab. No.	Level	^{14}C Age BP	Cal BC (1σ)
Bln–4609	IV	7637±43	6473 (6459) 6439
Grn–19779	IV	7360±35	6233 (6224) 6110
Grn–19355	IV	7200±180	6229 (6056,6042,6028) 5845
Grn–19357	III	7135±270	6234 (6005,6003,5994) 5728
Grn–19780	III	6920±90	5886 (5787) 5718
Grn–19311	III	6960±65	5955 (5838,5822,5809) 5734
Grn–19781	III	6900±110	5886 (5741) 5665
Grn–19310	II	6890±280	6019 (5734) 5535
Grn–19782	II	6890±60	5837 (5734) 5718
Grn–19356	II	6520±110	5609 (5478) 5369

Ref. Univ. of Washington. Radiocarbon Calibration Program 2000

Table 3. Hoca Çeşme dates.

In the course of our survey on the island of Gökçeada, c. 20 km west of the coast of the Gelibolu Peninsula, we found a new early Neolithic site, Ugurlu, with pottery exactly similar to Hoca Çeşme (Fig. 6). Ugurlu is a low mound c. 900 m northeast of the village of Ugurlu in the western part of

Fig. 5. Pottery from Hamaylitarla.

the island. In Ugurlu, red and black slipped, well burnished, thin-walled sherds were found similar to those of Hoca Çeşme IV. Most of the forms are deep bowls with S profiles and bead-rims. There are a significant number of sherds with vertically placed tubular lugs, crescent-shaped lugs and ring-bases. There is also a piece of a zoomorphic vessel. In Ugurlu, red-black or light cream-red-black mottled sherds were also found as Hoca Çeşme III type. However, absent at early Hoca Çeşme are very long vertically placed tubular lugs. These types of lugs were also found at Ayio Gala (*Hood 1981; Fig. 6.13, 14*), Coskuntepe and Tepeüstü (*personal observation*). Ugurlu indicates that more Hoca Çeşme-type settlements exist. It is obvious that without any detailed knowledge of Western Anatolia, it is very difficult to interprete Hoca Çeşme.

⑤ When we compare the ^{14}C dates of Hoca Çeşme with the dates from other sites in southeast Europe, for instance, Achilleion and Sesklo in Thessaly, Hoca Çeşme IV–III dates match Achilleion Ia–IIIb and Sesklo (*Gimbutas et. al. 1989.24–25; Wijnen 1981. 131*). When we look at Nea Nikomedia in Macedonia, with the exception of one early ^{14}C date (8180±150 BP, Q–655), almost all the dates from Nea Nikomedeia match Hoca Çeşme IV–III (*Pyke and Yiouni 1996.195*). Özdoğan proposes an average age of Hoca Çeşme IV as 6400–6100 cal BC. Bloedow gave an age of 6481–6216 cal BC for Achilleion, 6489–6406 cal BC for Sesklo and 6469–6373 cal BC for Nea Nikomedeia (*Bloedow 1992/93.56*). When we look at Bulgaria, Hoca Çeşme IV is earlier then the Karanovo I horizon, and the ^{14}C dates of the Karanovo I horizon match those of Hoca Çeşme III. Although Hoca Çeşme II was correlated to Karanovo I by Özdoğan, all the ^{14}C dates of Hoca Çeşme II match with the Karanovo II horizon. Boyadziev gave ages of 6000/5900–5500/5450 cal BC for Karanovo I–II (*Boyadziev 1995*). In Bulgaria, excavations in the Struma valley and in north-eastern Bulgaria have been claimed to reveal sites with levels containing monochrome pottery, earlier than the Karanovo painted pottery horizon (*Stefanova 1996. 15*). Dark monochrome pottery was found at sites such as Kranitsi, Koprivets, Pomoshtitsa, Poljanitsa-plateau, Eleshnitsa and Slatina (*Stefanova 1996*) Only a few ^{14}C dates for this horizon are available, all from Poljanitsa-plateau: 7535±80 BP, 7140±80 BP, 7380±60 BP and 7275±60 BP (*Görsdorf and Bojadziev 1996.122*). Dates from the Poljanitsa Plateau more or less match early Hoca Çeşme. To sum up, it is clear that the earliest layers of Hoca Çeşme are contemporary with early Neolithic sites in Thessaly and Macedonia (Fig. 7). According to ^{14}C dates, early farming communities were settled simultaneously in South-Western Turkish Thrace, Thessaly and Macedonia.

Fig. 6. Pottery from Ugurlu.

⑥ Özdoğan argues that in Pendik, above the Fikirtepe horizon, there lies a prehistoric cemetery yielding early Hoca Çeşme wares (*Özdoğan 1993; 1999.217*). From this point of view Özdoğan suggested that Hoca Çeşme could be later than the Fikirtepe Culture (*Özdoğan 1993.185; 1997.Fig. 5*). According to Özdoğan's scenario of endemic movement, the full Neolithic was first established in north-western Anatolia, later followed by Hoca Çeşme in the northern Aegean (*Özdoğan 1997.19–27*). However, there is a chronological inconsistency in this hypothesis. The ^{14}C dates of Hoca Çeşme are earlier than those of the Fikirtepe Culture. Özdoğan argued that the first wave of an endemic movement took place during the pre-pottery Neolithic, originating in Central Anatolia (*Özdoğan 1997*). In this paper, I have not attempted to discuss this problem. On the basis of the second movement directly linked to late Çatal Höyük, the full Neolithic was established in the northern Aegean (*Özdoğan 1997.19–27; Budja 1999.133*). According to Thissen, the possible time range for the movement from Çatal Höyük to the northwest may set anywhere between 6500/ 6400–6300/6200 cal BC (*Thissen 1999.37*). However, as M. Budja has correctly argued, 'It is worth nothing that the founding of Hoca Çeşme (6400–6100 cal BC) fits with the exodus in the Konya plain in the period anywhere between 6500/ 6400–6300/ 6200 cal BC' (*Budja 1999.133*).

⑦ It seems Hamaylitarla pottery is much more similar to the Western Anatolian red slipped and burnished ware tradition than to Classic Fikirtepe. I believe that there are strong similarities and relationships between the Fikirtepe Culture, especially the Classic Phase and the western Anatolian red slipped and burnished ware tradition. western Anatolian Early Neolithic sites may be contemporary with the Classic Fikirtepe phase. As yet, no detailed Early Neolithic excavations have taken place in western Anatolia. Only future investigations can show us the similarities and dissimilarities in relationships between the western Anatolian red slipped and burnished ware tradition and the Fikirtepe Culture.

CONCLUSIONS

The problem of dating prehistoric axe factories and general questions concerning the Early Neolithic period of Eastern Thrace are outlined above. The finding of prehistoric axe factories in Eastern Thrace has aroused much interest, and so far is unique in the prehistoric record of the Balkans and Anatolia. Our work on axe factories is still at opening stage. Probably the most important question is how far

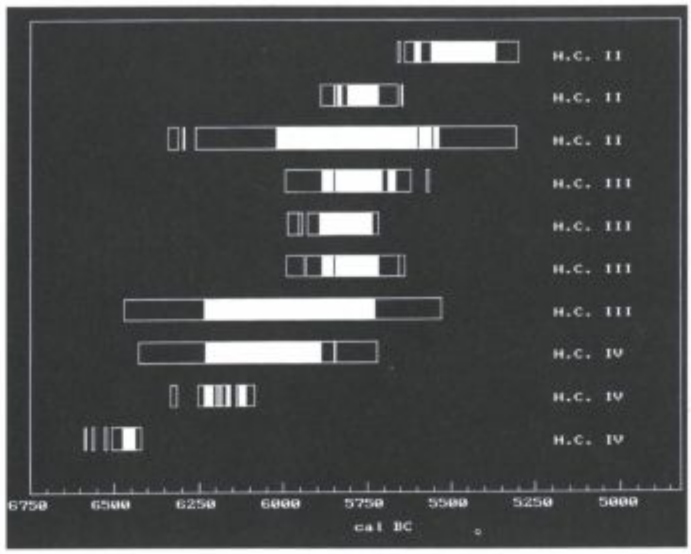

Fig. 7. Calibrated dates of Hoca Çeşme.

these axes were distributed from the source. The distribution of goods from sources to the people desiring them is an important function of the exchange system. Petrological investigations of polished stone axes from excavated sites and surface collections in eastern Thrace are still in progress. In the future, we will be able to define the distributional range of axes from the factories. However, early results show that at the early Neolithic settlement of Hoca Çeşme, stone axes were made of the same rock as the Sarköy sources.

It seems evident that there are still gaps in our knowledge of the transition to the Neolithic in eastern Thrace. New investigations carried out in north west Anatolia and eastern Thrace over the past few years have increased our knowledge. However, there is still not enough evidence to understand the complete picture of the transition to the Neolithic in the region. I believe that only proper excavations and intensive surveys, especially in western Anatolia, would help our understanding of the Neolithic transition not only in eastern Thrace but also in Europe.

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Documenta Praehistorica XXVII

A Prehistoric Stone Axe Production Site in Turkish Thrace: Hamaylitarla

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ABSTRACT – *Hamaylitarla is a prehistoric, polished stone axe production site, situated on a low hill dominating the Aegean Sea and the straits of the Dardanelles. This site is also a settlement yielding early Neolithic ceramics. The researcher gives brief information on his preliminary observations on the mound and its situation according to the rock outcrops in the region. In this paper, the first results of the petrologic analysis of the metamorphic rocks are also presented.*

IZVLEČEK – *Hamaylitarla je prazgodovinsko najdišče, kjer so izdelovali glajene kamnite sekire. Leži na nizkem hribu, ki se dviga med Egejskim morjem in ožino Dardanel. Na najdišču je tudi naselbina z zgodnjeneolitsko keramiko. V članku na kratko podajamo preliminarne rezultate o najdišču in njegovem položaju glede na površinsko razprostranjenost metamorfnih kamnin v regiji. Predstavljamo tudi prve rezultate petroloških analiz omenjenih kamnin.*

KEY WORDS – *Thrace; prehistory; polished stone axe production; chaine-opératoire; axe blanks*

INTRODUCTION

As in other early agricultural societies in Europe, polished stone axes also played an important role in the development of Neolithic societies in eastern Thrace. Despite the fact that much work still remains to be done on this subject, following the recent discovery of three prehistoric stone axe production sites in Thrace, the author intends to give information on one of them which is called Hamaylitarla.

The existence of the preferred source of metamorphic rock outcrops on the mountainside of Ganos (Sarköy) overlooking the Marmara Sea, was quite sound for the grouping of the three prehistoric sites. A two-year archaeological-geological fieldwork project, which began in 1997, provided us information about the extent and limits of the quarry sites and metamorphic rock outcrops profitable for the production of stone axes. Situated at a strategic position like the Gelibolu Peninsula[1], the diffusion of stone axes from the three prehistoric production sites of Fener-karadutlar, Yartarla and Hamaylitarla (Buruneren) would not have been so difficult. In this paper, we intend to give information about the preliminary results of our surface surveys of the early Neolithic[2] site of Hamaylitarla and its environment.

Being one of the earliest Neolithic sites in this region, it is probable that Hamaylitarla will shead light on roughout manufacturing knowledge in the production of stone axes.

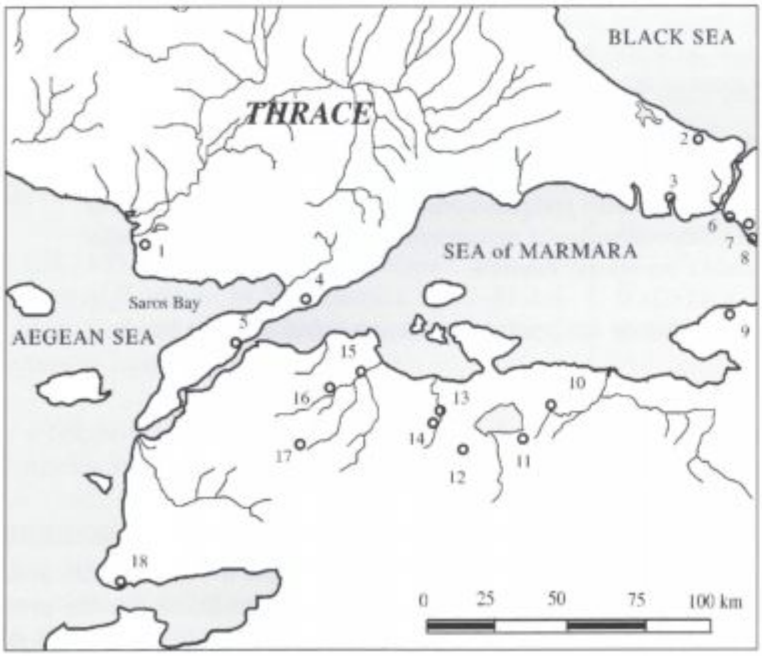
1 See Özdoğan (*1986*) for the first archeological field surveys and its results concerning this region.
2 For a detailed discussion of the relative chronology of the site of Hamaylitarla and the related sites in the same region, see Erdogu in this publication.

The locality and its regional context

The site of Hamaylitarla is situated 14 km West of Sarköy, a small town on the Marmara coast, near the town of Tekirdag. Before our first visit to the site in the spring of 1997, this place was only known as a flat mound, namely 'höyük', yielding ceramic finds[3]. The following year, after we had begun sourcing studies on the same area, we were able to locate outcrops of metamorphic rock. This led to sample collecting for a petrologic analysis on a 225 km^2 area.

It is worthwhile taking into consideration that the region is under close examination by specialists on tectonic bases with regard to seismic activity. Thus, we can say that the geological surveys that were slowed down in the last 20 years accelerated because of this fact. The Tekirdag depression within the Marmara Sea is an active strike-slip basin along the North Anatolian fault, which was the cause of the great "Izmit-Sakarya Earthquake", in 1999. The North Anatolian fault emerges again in southern Thrace, forming a 45 km long segment (the Ganos Fault) before re-entering the Aegean Sea in the Gulf of Saros. The region is affected by tectonic thrusts, which results in a displacement of 20 mm per year due to reduced Quaternary sedimentation (*Okay et al. 1999.129*). Thus, the raw material[4] of Hamaylitarla ground stones is a result of this fault. At present, the metamorphic rock outcrops can be observed on the slopes of Mount Ganos.

In 1998 and 1999, we aimed at locating the possible quarry sites in the region. At first, our intention was to find out what could fit the picture of a 'typical' ethnographic and archaeological model[5] of a raw material extraction site, as we are familiar with from New Guinea and Europe. However, it was rather interesting to realise that to find such localities was pointless given the plentiful occurrences of the raw material not very far from the site (Fig. 2). The raw materials near the sites were in the form of boulders sliding from the slopes of the hills of Sarikayalar. Thus, to put it briefly, only a kilometre from the site, one could easily reach the amount of rocks one needed. Nevertheless, the distance between the outcrops of metamorphic rocks and the site was about 5 km.



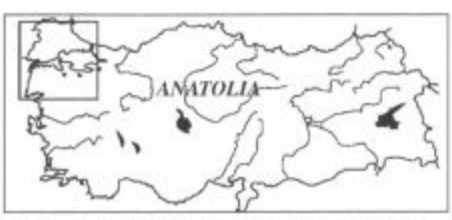


Fig. 1. Location of Hamaylitarla and the other important neolithic sites in the region: 1. Hoca Çeşme; 2. Agaçlı; 3. Yarımburgaz; 4. Hamaylitarla; 5. Kaynarca; 6. Fikirtepe; 7. Içerenköy; 8. Pendik; 9. Yalova-Göztepe; 10. Tepetarla; 11. Muslu Çeşme; 12. Üyücek; 13. Taraçcı; 14. Yılanlık; 15. Gavurtarla; 16. Anzavurtepe; 17. Çalca; 18. Coskuntepe.

DESCRIPTION OF THE ARTEFACTS

According to our laboratory analyses the material of the polished stone axes[6] was of a single type of rock: metabasite. The occurrence of the metamorphic outcrops on the slopes of Ganos Mountain was not abundant, despite some of the outcrops on a limited number of loci. On some

3 The site was already under protection by the local museum thanks to the efforts of M. Akif Isin, the director of this museum.

4 As this paper is not intended to discuss the petrologic analysis carried out on the samples obtained from the postulated quarry sites in the region, the author gives brief information on the matter. See Ozbek and Erol in press for the petrologic analysis.

5 See mainly Pétrequin and Pétrequin (*1993*) for a general assessment of ethnological studies in Indonesia and Pétrequin et al. (*1993*) for a brief history of the recovery of the Neolithic quartz mudstone axe quarries (Plancher-les-Mines) in France.

6 The term 'axe' is used here in a general sense, putting the axes and the adzes in one group: wood-working implements, whether they are used for tree felling or in carpentry in the settlements.

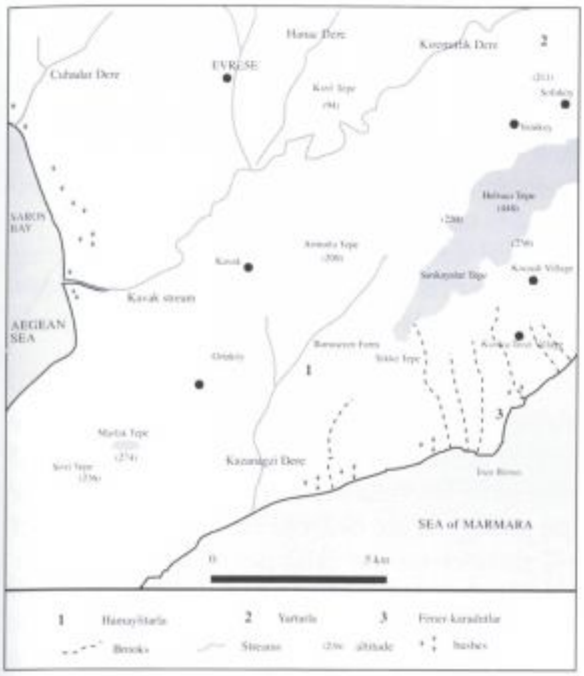


Fig. 2. Location of the production sites in Gelibolu peninsula.

parts of these inclination surfaces, one could easily notice the presence of metabasites as boulders, some weighing 1 kilogram and some 100 kilograms.

The Hamaylitarla production site seems to cover an area of 400 m^2, while the mound seems to spread over a 120 x 120 m field. We collected many roughouts, flakes, hammers and blocks from the locality, and following our laboratory analyses, we saw that they were of the same material.

As the mechanical properties of the stone played a big role in the production technique, what we observed was the intense practice of knapping and pecking. According to our experimental studies, we can say that with this raw material it is very difficult to orient any of the edges of an axe model. As the rock itself had no orientation in either the macro or micro (mineralogical) basis, it was also impossible to expect to obtain roughout blades right after the flaking process. The makers of these roughout axes also had no chance to saw the material. On the contrary, it is sound to say that pecking would take less time than sawing this rock.

One can say at first glance that the forms of the roughouts (Figs. 3, 4) reflect a close resemblance to the Lower Paleolithic quartz hand axes in general.

Axe roughouts

Their weights vary from 400 grams to 1000 grams. Most of them are waste material, as they were probably broken during the production stage (Fig. 3). If we take into account their mean sizes, we can estimate that they were planned to be 20-25 centimeters when finished. Most of them should be regarded as roughouts of big adzes, rather than symmetrical axes. Their cutting edges were left untouched after being flaked, and never pecked.

Hammers

Their weights vary from 150 grams to 800 grams. They are usually broken axe roughouts, transferred to hammers after they were broken. We did not see any of the sphere shaped hammers we came across at the other sites.

Flakes

The flakes are 50 to 200 gram pieces, and very difficult to notice during the collecting of the material (Fig. 3.5, Fig. 4.1). The quantity of flakes collected on this mound is also too small to make a statistical analysis.

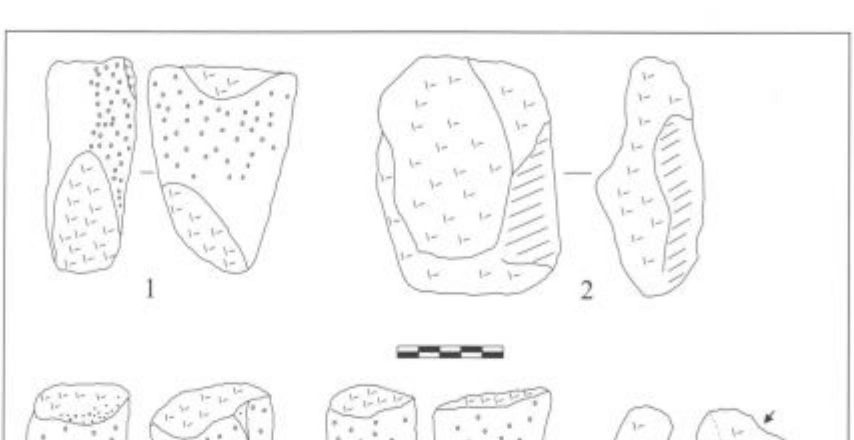


Fig. 3. The roughout manufacture of Hamaylitarla mound. Axe roughouts are broken during the production stage (No. 1, 3, 4). There are also a limited number of flakes (No. 5).

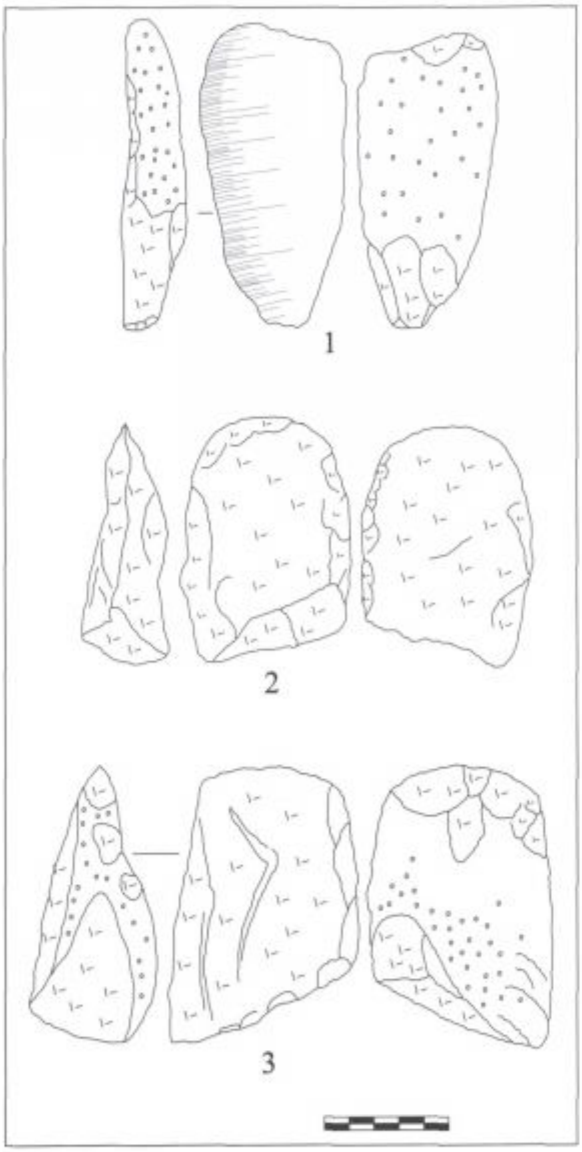


Fig. 4. The roughout manufacture of Hamaylitarla mound. Broken axe roughouts during production (No. 2, 3). Some of the flakes were knapped (No. 1).

CONCLUSION

The dating of our material is one of the most important problems in this study. As we could not open test trenches or start an excavation on the site due to the lack of an excavation team and sponsor problems, we can not discuss the material in a stratigraphic context for the moment. However, in the near future, we await a multinational excavation on the site.

We would like to express the fact that it is unwise to expect great help from typology in 'axe studies'. As is evident from the many studies held in different parts of the world with many different cultural contexts[7], the forms of axes do not change much with time. However, it is interesting to note that the finished axe material of the neighbouring excavated Neolithic site of Hoca Çeşme bears a close resemblance to the Hamaylitarla material, according to petrological analysis. The 20-25 cm (1242 gr.) long forms unearthed from this prehistoric mound generally fit the planned models of the Hamaylitarla roughouts in weight and in shape.

We expect that it will be possible to make a broader study of the region in the future. In addition, we will have more information about the paleogeography and geology of the Gelibolu Peninsula. This project will also increase our databases on the Neolithic settlements in the area.

ACKNOWLEDGEMENTS

The author wishes to express his thanks to the director of the Tekirdag Museum, M. Akif Isin for providing logistic support and for his active interest in our study. The survey team, headed by Onur Ozbek, were M. Akif Isin, Burçin Erdogu and Kenan Erol. Above all, our thanks are especially due to Marie-Claire Cauvin and Mehmet Özdoğan for encouraging the realization of this study.

7 It is worth mentioning the studies by Buret (*1983*) of the Neolithic sites of Switzerland, and Moundrea-Agrafioti on the Neolithic sites of Greece (*1981*).

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Documenta Praehistorica XXVII

The Late Starčevo and the Earliest Linear Pottery Groups in Western Transdanubia

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ABSTRACT – *Although the Western Part of the Carpathian Basin, Transdanubia must have been one of the most important areas as neolithisation is concerned, research has failed to clarify some key factors. In this paper, possible traces of the Late Mesolithic forager groups are collected, indirect hints of the existence of a population that could have had an influence both on the northernmost limit area of the late Starčevo culture and on the formation of the oldest Transdanubian Linear Pottery Culture. The hunter-gatherer groups are assumed to have controlled the prehistoric flint mine at Szentgál, Northern Transdanubia, supplying late Starčevo villages as well as early Linear Pottery settlements at a great distance with red radiolarite raw material. Besides a new late Starčevo site at Babarc, found in 1997, the systematic excavations at Pityerdomb in Western Transdanubia are discussed in detail, which might be of essential importance in understanding the process of neolithisation around Lake Balaton.*

IZVLEČEK – *Čeprav je zahodni del karpatskega bazena (Transdanubija) eno najpomembnejših področij, povezanih z neolitizacijo, pa dosedanje raziskave niso uspele pojasniti nekaterih ključnih dejavnikov. V tem članku smo zbrali možne sledi o poznomezolitskih lovsko-nabiralniških skupnostih, to je posredne namige o obstoju populacije, ki bi lahko vplivala tako na skrajno severno mejo področja kulture Starčevo, kot tudi na oblikovanje najstarejše transdanubijske kulture LTK. Predvideva se, da so lovsko-nabiralniške skupnosti obvladovale prazgodovinski rudnik kremena v Szentgálu v severni Transdanubiji in so vasi pozne kulture Starčevo kot tudi zgodnje naselbine LTK na velike razdalje oskrbovale s surovino – rdečim radiolaritom. Podrobno obravnavamo novo najdišče pozne kulture Starčevo v Babarcu, ki so ga odkrili leta 1997, in sistematična izkopavanja v Pityerdombu v zahodni Transdanubiji, kar bi lahko bilo bistvenega pomena za razumevanje procesa neolitizacije v okolici Blatnega jezera.*

KEY WORDS – *Transdanubia; neolithisation; boundary; new transitional site*

INTRODUCTION

When regarding the neolithisation process of the Carpathian Basin (Fig. 1), we must face the old problem first which occurs in the research of each prehistoric period. Namely, the area east of the Tisza River has been traditionally much more investigated during the last century, than Transdanubia. The Neolithic heritage of the Alföld region has always been more spectacular, with the enormous number of rich settlements and find assemblages, not to speak of the earliest tell mounds and the rich grave goods in the Tisza region. This abundance of information is also valid for the earliest phase of the Neolithic. The intensive occupation of the river meanders of the Tisza, Körös and Berettyó by the Körös culture people also implies extremely rich find assemblages: one single settlement pit might contain several ten thousand pieces of pottery, even though the internal chronology of the Körös culture is still problematic. It might not be mere chance that the first thorough investigations concerning the late Mesolithic brought success precisely in the Northern Alföld, along the area of the Körös culture's northern limit, where a possible Mesolithic/Early Neolithic contact had been theoretically presumed earlier. The settlement of Jásztelek I., excavated and published by R. Kertész, is the first real hint of the possibility of contacts between indigenous and newcomer groups also in the Carpathian Basin (*Kertész et al. 1994; Kertész 1996*).

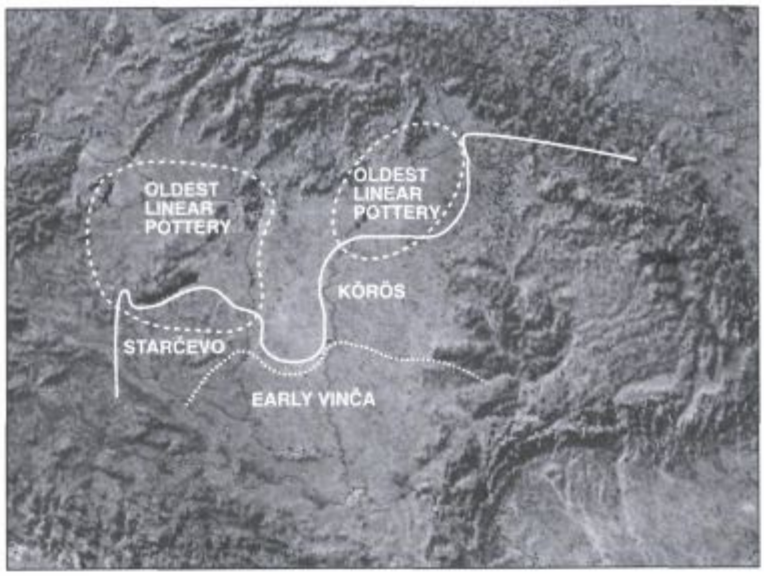

Fig. 1. The distribution of the Körös-Starčevo and early Linear Pottery cultures in the Carpathian Basin.

The situation in the Western part, in Transdanubia, is far less understood. The term 'Early Neolithic' means here, as in the Alföld region, at least two integer phases: the life of the Starčevo culture in the Southern part and the formulation of the oldest Linear Pottery ware culture in the Northern part. Concerning the Mesolithic presence in Transdanubia, we are in a less advantageous position than in Eastern Hungary. That is, our knowledge is still based mainly on scattered surface finds, which, especially in the supposed later Mesolithic phase, may well belong to the earliest Neolithic find assemblages of destroyed settlement features, where the coarsely fired pottery had already diminished. According to colleagues with a good knowledge of flint typology, the finds from Kaposhomok, south of Lake Balaton could perhaps be attributed to Late Mesolithic groups (*Pusztai 1957. Fig. 2*). This can be assumed mainly from their geometric microlithic character, which can be ranged to the Tardenoisien, and is considered one of the latest Mesolithic assemblages in the area (*Dobosi 1972.41- 42*). Be that as it may, there remains the great problem of how the Northern Transdanubian hills were settled during the late Mesolithic. If we take the numerous indirect hints of their existence into consideration, the problem becomes even greater, as we shall see below.

THE LATE STARČEVO CULTURE

In the Transdanubian Early Neolithic, the identification and description of the Starčevo settlements as well as the research into their chronological position versus the earliest TLP groups were the greatest steps forward. This was thanks to N. Kalicz and J. Makkay, who carried out several small sondages and field research in the late sixties, although their term 'Medina-phase' for the transition between the two cultures today belongs to the forgotten and outworn categories (*Kalicz 1978-79b; Kalicz, Makkay 1972*).

As it is known from the detailed publications of N. Kalicz and also from his monograph published in 1990, the settlement pattern of the Starčevo culture cannot be compared to that of the Kőrös, as the former is far less intensive (*Kalicz 1977-78; 1978-79a; 1983; 1990.39-40*). This is reflected not only in the number of settlements, but also in their extent. Kalicz concluded by assuming a few smaller population groups who never stayed in one place for long. According to his observations, two important consequences can be drawn about the Starčevo culture: (a) it appeared from the South in the Linear B phase, according to the periodisation by Dimitrijević, and survived until the final, Spiraloid B phase of the culture, even though only four sites could be then dated to this phase; (b) its area distribution area reached only to the southern banks of Lake Balaton.

In recent years, both statements have had to be corrected. That is, two new settlements of the Starčevo culture have been excavated: Gellénháza-Városrét and Vörs-Máriaasszonysziget (*Simon 1994; 1996; Kalicz, Virág, Biró 1998*). Both belong to the latest phase on the one hand, and both lay on the northern borderland of the culture on the other. Moreover, the site at Gellénháza-Városrét has modified this border by some 50 km to the north and west, as it lies near Zalaegerszeg, in the Zala hills in Western Transdanubia. So the number of Spiraloid B settlements has increased from 4 to 6.

Two years ago a settlement of the same phase, Babarc (No. 10), came to light in South Eastern Transdanubia (Figs. 3, 4). The settlement pits of Babarc

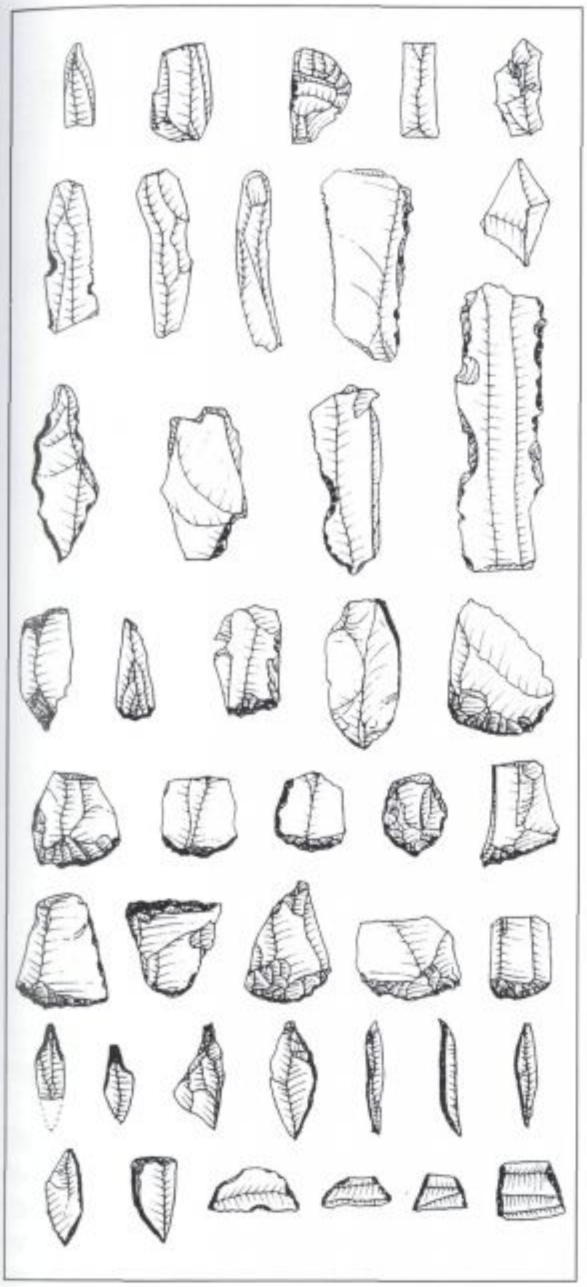

Fig. 2. Kaposhomok – lithic finds (after R. Pusztai, re-drawn by T. Marton).

are again unimportant because of their large quantity, rather than because each new site might become a piece in the chain needed for a better understanding of the complicated processes within the early Neolithic (*Bánffy in press*). However, some interesting problems emerge also on the basis of their dating.

First, the site of Babarc lies next to the village of Lánycsók, where until now the most large-scale excavations of the culture have taken place (*Kalicz 1977–1978*). However, all the Lánycsók features, including the famous four-headed altarpiece can be dated to the so-called classical (Linear B, "Ghirlandoid", Spiraloid A) phase, and none of them survived in the late phase. By that time they must have moved and built their new settlement somewhere in the vicinity. Thus, it is not impossible that in Babarc the heritage of the Lánycsók people was found, from a period of some generations later.

The other point of interest is that, as has been said before, we do not know many *late* Starčevo settlements in Transdanubia. The four original ones lie to the north and west: Kaposvár-Deseda, Dombovár-Kapospart and Harc-Nyanyapuszta are located in South Eastern Transdanubia, but not far from the Southern banks of Lake Balaton, while Becsehely lies at the westernmost edge of Southern Transdanubia. Not to speak of the two newly found sites, Vörs and Gellénháza, which have even modified the northern and western distribution limits of the Starčevo distribution area. Now, on the basis of the new finds, two territorial groups of the late Starčevo culture might be drafted in Transdanubia. Babarc belongs to a group which is strictly bound to its southern relatives beyond the Drava River: its best parallels can be found in Croatian sites such as Podgorac or Vinkovci-Gradska Zona (*Minichreiter 1992b.43–49*). Many typological features from Kaposvár and Dombovár still resemble this southern typed version of the late Starčevo. In contrast to the above stylistic and typological features, the two late Starčevo settlements in the Northwest, Vörs-Máriaasszonysziget and Gellénháza-Városrét, seem to belong to a slightly different group, with less evidence of direct Balkan contacts. As to the excavators, a number of these features become typical in the oldest Linear Pottery culture (e.g. deeply incised linear patterns), which occurs in an uncommonly high quantity, compared to the whole Starčevo area (*Kalicz, Virág, Biró 1998. 163–164*). Similarly, in Gellénháza, the character of the pottery and some find groups strongly resemble those of the earliest Linear Pottery in the vicinity, as discussed below (*Simon 1996; Bánffy 2000.376*). In the case of a cultural formation such as the Starčevo culture, which remained almost identical over a vast geographic area, from Macedonia to the Pannonian hills, these differences observed at the northwestern boundary cannot be neglected! However, the differences could be hard to analyse without a new settlement from the westernmost part of Hungary, which seems to be the first site of the transitional phase between the Starčevo and the earliest Transdanubian Linear Pottery Ware culture and thus, gives a new aspect to research into neolithisation in Western Transdanubia.

PITYERDOMB

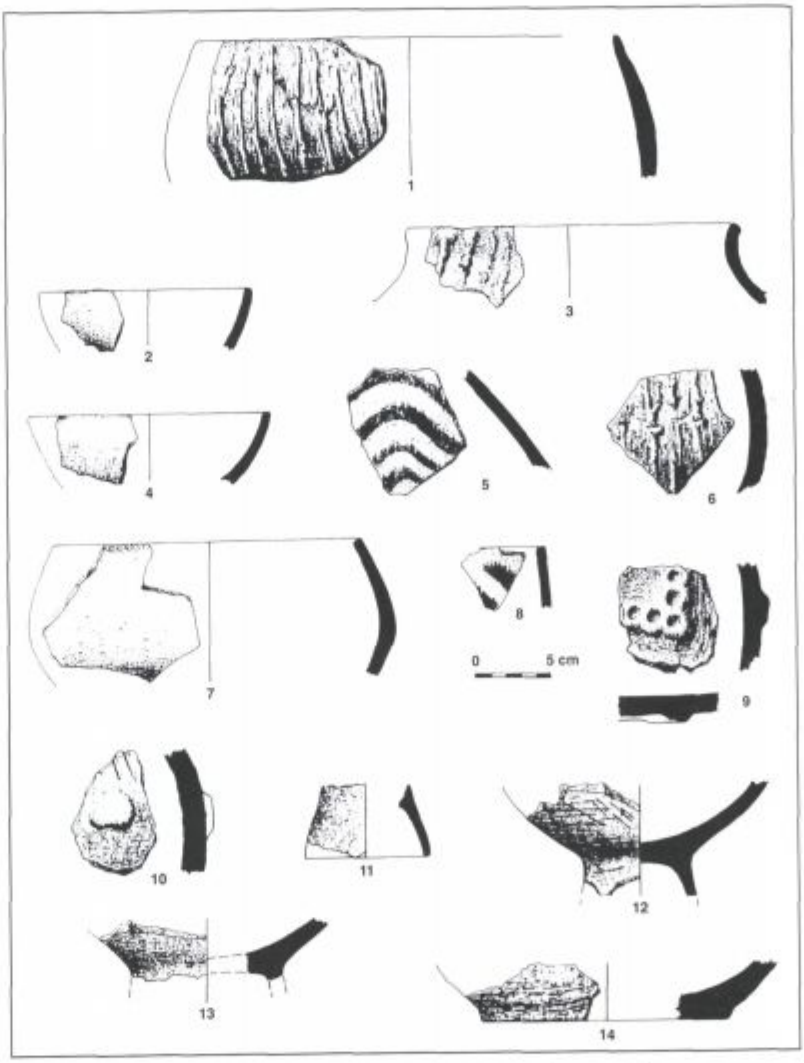

Fig. 3. New finds of the late Starčevo culture from Babarc.

In the course of our third microregional programme, a small plain along the upper flow of the River Kerka and the surrounding hills were investigated, close to the Slovenian border, north of the town of Lenti (Fig. 5). Among the sixty new sites ranging from the Neolithic to late medieval times, the early Neolithic period proved the greatest surprise. East of this, that is, a microregion which already been investigated (No. 2 in Fig. 5) was totally uninhabited by Linear pottery people. We explained this gap by the distribution area of the culture, and thought we had gone beyond it to the west. Remarkably enough, in the Kerka valley, even farther to the west, twelve of the sixty sites belong to Linear pottery culture. The settlement pattern must have been so dense up to this period that the inhabitants of one village at a hilltop could well catch sight of the next settlement built on a neighbouring hill. What is more, off-site evidence of agriculture and land use was distributed between all the Linear Pottery settlements, in the form of lost flint tools and small household refuse, probably taken with farmyard manure to the cultivated fields. Today, the region consists of small, cultivated areas and grazing land, surrounded and divided by large forests. This area lies at the foot of the Eastern Alps, so even the summers are humid and cool, unlike the average climate in Hungary. In spite of the continuous forests, the largest in Hungary, the first traces of the destruction of indigenous forests could be assigned to as early as the beginning of the West Transdanubian Neolithic, roughly the middle of the 6th millennium BC (*Kertész-Sümegi 1999.18*). One of the settlements, Pityerdomb, near the modern village of Szentgyörgyvölgy, was excavated between 1995–1998, and provided important new data on the problem of neolithisation in Western Transdanubia. The site is located on the top of the hill in the hilly area between the Zala hill-country and the Alps, which consists of old, acidous clay with a very thin layer of humus. The small settlements were concentrated on the top of the hill and on its northwestern slope, at a height of some 220 m, not far from the Szentgyörgy creek, which flows at the foot. The highest area has been eroded. The excavated area, nearly 1000 m^2, which covered almost the whole site – i.e. the part that has been preserved – brought the traces of two houses to light, lying a certain distance (some 30 meters) from each other (Fig. 6). Between the houses, archaeological features were almost totally absent. This probably means there were two focuses to the settlement. As we shall see below, on the basis of the finds, it was impossible to tell whether the two farming units differed in age. Nevertheless, according to measurements in other Central European Linear Pottery sites, the distance between the Pityerdomb houses does not differ from the average, and might be even less. In Langweiler 8, for example, the distance between two coeval houses was measured at not less than 66 m, while in Langweiler 9 almost double this distance could be measured! (*Lüning 1982.147–148;* See also *Coudart 1998.108*).

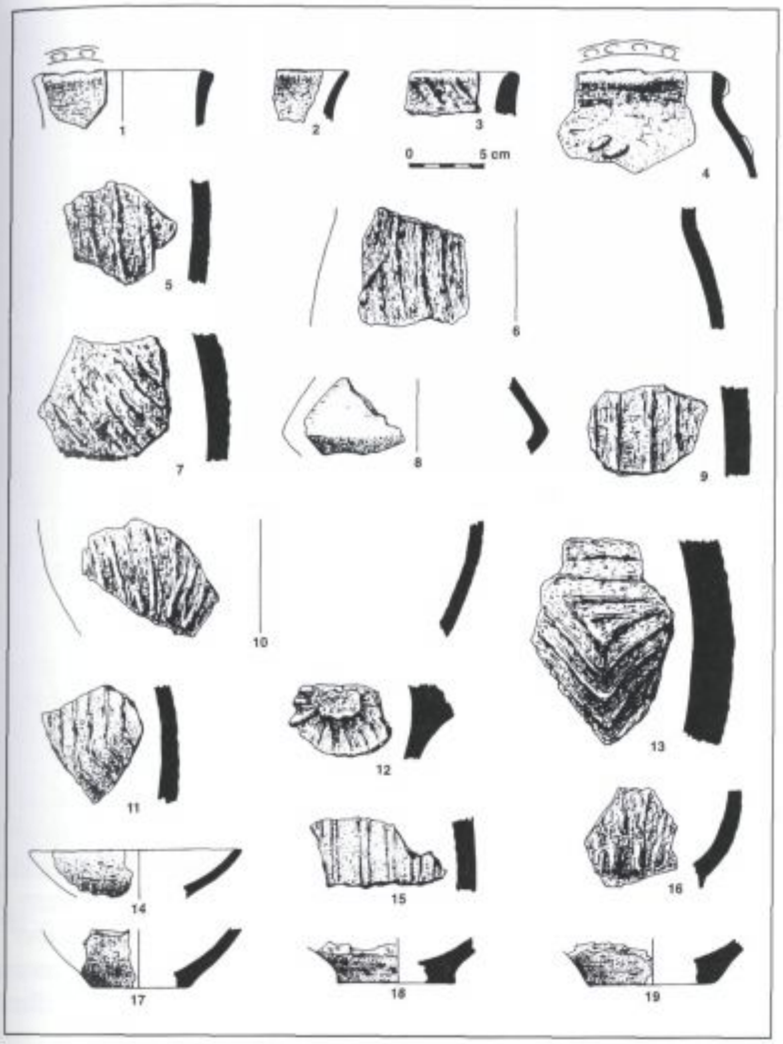

Fig. 4. New finds of the late Starčevo culture from Babarc.

can well be estimated: both between 8.50–10.0 times some 13.0–14.50 meters. This shape and size can be perhaps considered one of the most archaic types in Linear pottery architecture, where we do have the central part of later long houses, while the two outer rooms are missing. It is to be noted that some Körös houses are known, e.g. one belonging to its late phase from the Middle Tisza region, which appear to be close parallels to the shorter Linear pottery typed houses in Pityerdomb (e.g. Tiszajenő-Szárazérpart: *Selmeczi 1969*). Given the present state of our knowledge, it is hard to tell whether the northern Starčevo groups also built similar houses, since only pits or systems of pits containing workshops are known, while no dwellings have come to light as yet (*Petrović 1986–87; Minichreiter 1992a; 1992b. 11–38*). All features were oriented precisely towards north. This was the case also with the most typical feature type in Pityerdomb: long ditches alongside the house's walls (Fig. 8). In the filling of these long pits the stratigraphy of the settlement could be well observed. The profiles showed that soon after having dug the pit, the lower part was buried quickly. Above this more-or-less sterile layer there is one layer with plenty of finds. Finally, in the course of a serious fire, the burning parts of the roof and the walls fell in and covered not only the area of the house itself, but also the ditches. The direction of their fall can still be seen, showing the *in situ* character of the assemblages (Fig. 9).

Thanks to the lack of deep ploughing, the features at 25–30 cm below the present surface remained undisturbed. The upper layer consisted of heavily burnt wattle and daub, which covered the rich finds: pottery and lithic material, as no bones survived in the acidous clay. Although the floor within the houses has not been burnt, in some places a certain walking level could be observed, not to speak of the finds which lay on this floor and helped identify it. Inside the houses we could also observe shallow pits, or rather small deepenings, in which the remains of large storage vessels were found (Fig. 7). Fireplaces were found both inside and outside the houses, but larger and deeper storage pits were always dug outside. A round pit, located to the southwest of House 2, (Feature Nr. 17) can probably be considered a workshop for flints.

Both houses were of similar size. In spite of the imperfect circumstances, according to both the site location and financial means, the forms and the sizes

The pottery was generally fired at a low temperature. Consequently, the profile of the wall is red-black-red: the usual characteristic of the early Neolithic throughout South East Europe. The organic tempering was almost always completed with sand. The vivid red colour sometimes occurs with dark greyish spots, similar to late Starčevo house ware in Northern Transdanubia. Black topped pottery is also typical: important chronological information.

Pedestalled vessels occur in a larger number, belonging to two types: one is higher and conic, while the other is quite low, resembling a footring.

Pots and other storage vessels are often covered with 'Schlickwurf' barbotine type or with the barbotine arranged with fingers in lines or different patterns. Buckles and twin-buckles are often finger-pressed on their top, or divided by cuttings. Linear patterns made with nail imprints are also a frequent form of coarse ware decoration. However, linear motifs, which can be three parallel lines or spiraloid, "voluted" motifs, are extremely rare.

Fig. 5. The three microregional research areas in Western Transdanubia (1: Little Balaton area, 2: Hahót valley, 3: Kerka valley). Key site: Szentgyörgyvölgy-Pityerdomb.

Although the pottery surface was considerably worn by the acidic soil, a fairly high ratio of thin-walled fine ware is clearly observable. As to their types, most are small bowls and mugs, both often carinated. The upper part of the vessel is quite frequently concave. Both the inner and outer surfaces of the fine ware are polished, wherever it these survived. It is to be noted that a high percentage of these vessels show a kind of highly polished wine-red slip, a most typical characteristic of the Balkan Karanovo I–II, the Körös-Çriş and the Starčevo cultures (Fig. 10). Another important type of decoration on the surface of fine vessel was preserved in better condition. This is a group of finely polished lines (*einpolierte Ware*), often in the form of concentric circles, semicircles or small lines on the corner point of biconic, carinated bowls. According to N. Kalicz, this decoration occurs only in the late Körös-Starčevo millieu and the earliest Transdanubian Linear pottery culture (*Kalicz 1994.68; 1995*).

An important difference from other early LP settlements in Transdanubia is the ratio of linear decorated vessels. In contrast to the Bicske phase and also in the newly published site at Budapest-Aranyhegyi út (*Makkay 1978; Kalicz-Kalicz-Schreiber 1992; Kalicz 1995*), in Pityerdomb linear, decoration occurs on no more than 0.5 percent of the whole pottery assemblage.

Black painting was present in the Pityerdomb pottery. Given the worn surfaces, mentioned earlier, they can hardly be seen on the potsherds after they dry, but they were present on the wet finds, especially when they lay deeper than 50 cm below the present surface. In some cases, the spiraloid motifs could also be perceived, although usually in the form of an imprint in the soil visible after the lifting of the pottery fragment. There are two more indicators of the use of black paint: one voluted vessel was a container for black paint, with a thick layer inside and smudged traces of it appearing even on the outside (Fig. 11). Finally, a small clay leg, probably broken off from a four-legged vessel, was used

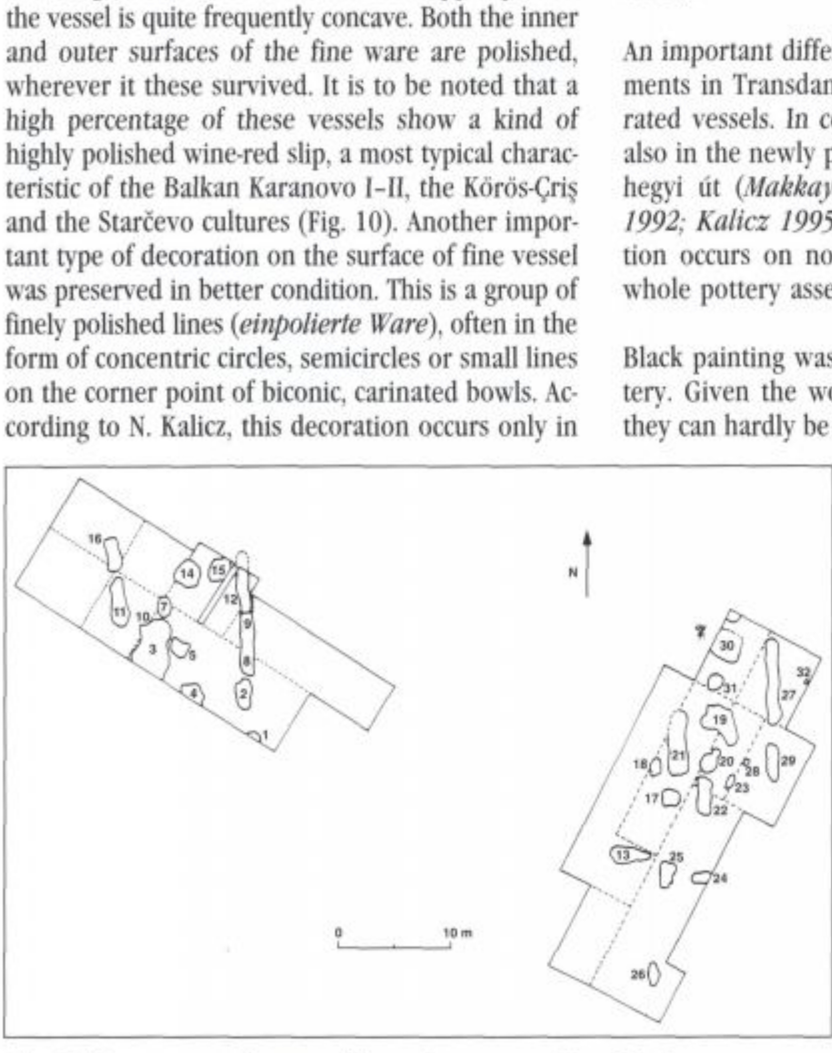

Fig. 6. The excavated area with two houses at Pityerdomb.

Fig. 7. Pityerdomb, finds at the floor surface.

secondarily as a pintadera: the same black paint covered its broken surface.[1]

Among finds that can be associated with cult life at the settlement there was a spiraloid, "voluted" fragment, which has a handle in the form of an upraised human hand. The whole pot, probably having two hands placed symmetrically on both sides, is probably an anthropomorphic vessel, typical of the earliest Linear pottery culture (Fig. 12). On the other hand, another fragment, representing a human leg, with a smoothed surface and delicate linear decoration, can be compared with legged human vessels from the Starčevo tradition (Mostonga I, II and Donja Branjevina, *Karmanski 1977.Pl. 33; 1990.Pls. 1/1, 4/1-9;* Circea, *Nica 1977.Fig. 12/3;* Ostrovul Golu, *Lazarovici 1979.Pl. X/27*).

The most unique find from Pityerdomb is an almost intact clay figurine of a bovine-type animal, probably an ox (Fig. 13). The finely elaborated, asymmetric linear decoration, together with the early Neolithic typological features and the wine-red, polished body surface might perhaps symbolise the formulation of the Central European "Neolithic type of thinking" in the context of early Neolithic Balkan traditions (*Stanković 1989-90; Ciobotaru 1998.Pls. 1/9, 10*).

The immense quantity of lithic finds all come from the prehistoric mine of Szentgál near Veszprém, in North Eastern Transdanubia (Fig. 14). The character of the assemblage is microlithic.[2] The high number of cores and splits, as well as the feature south-west of house 2, probably a workshop for flints, suggests that flint must have been imported in the form of raw material from the Szentgál mine to Pityerdomb, where the chipped stone artefacts were prepared. The kit was probably made for each household. The same raw material, the red radiolarite, is typical also of coeval and somewhat younger sites of early LP settlements in Western Transdanubia. Similarly, the Szentgál radiolarite also occurs in the same period in Eastern Austria and Southern Germany. This

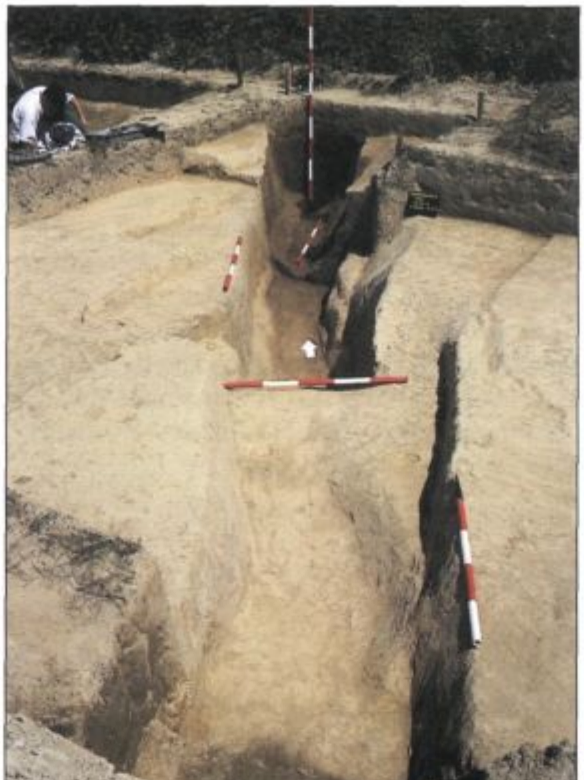

Fig. 8. Pityerdomb, the long ditch along House 1.

1 The chemical analysis was partly made in the MÁFI, Budapest, where the results speak about a certain organic, resin-like material, probably from a tree. A more detailed analysis was promised from Salzburg.

2 Oral communication by Katalin T. Biró. The lithic finds will be evaluated by her.

Fig. 9. Pityerdomb, burnt wattle and daub remnants fallen down, in situ.

fact clearly shows that the Szentgál stone was a raw material of high value at the time of the earliest Neolithic period; its long distance trading had a strong influence on the direction and intensity of the neolithisation process in Central Europe. Along the Transdanubian rivers the L-pottery traders reached the Danube and also regions such as Moravia and the Munich Basin. However, the L-pottery population was not the first to use this raw material in the region, as we shall see below. The detailed and final proceedings of the Pityerdomb assemblages have not been completed, like the finds of Gellénháza and Vörs. So all I am going to say now are not conclusions, but much more some tentative statements which must be confirmed or dismissed later.

First, there is a strong resemblance between the pottery of Gellénháza and that of Pityerdomb. This concerns the method of firing, the tempering and the surface of the vessels, the plastic and slightly incised decoration (*einpolierte Ware*), the majority of the biconic, strongly carinated forms, the polished fine ware and also the coarse ware. What is more, there is a unique clay weight, having an amorphous pear form, which occurs in a greater number both in Gellénháza and in Pityerdomb, but to my knowledge, nowhere else yet. This weight has a hole in each end, but is never completely perforated. These typological parallels as well as the similar geographical preferences suggest not only a possible synchronicity, but also live contacts between the late Starčevo people and the inhabitants of Pityerdomb. What is more, a series of assemblages found earlier, and partly published, can also be placed in this category (Fig. 15). In his contribution to the first Hungarian Topography volumes, N. Kalicz found and/or identified numerous surface finds coming from a well definable site or from small sondages, all of which he dated to the earliest phase of the TLP. The finds from Balatonszepezd, Révfülöp, Vonyarcvashegy, Sármellék, Zalavár all lie along the northern bank of Lake Balaton or close to it. To the same group might belong the pit from Garaboncófalu, in the Little Balaton region, which was found and excavated later, in the course of our first Transdanubian microregional programme.

The sites at Vöröstó and Mencshely in the Southern Bakony mountains, near Szentgál are of special importance, because the lithic assemblages earlier found on the surface can well be ranged to the final Mesolithic, on the basis of to their microlithic Tardenoisien character (*Mészáros 1948; Dobosi 1972*). Only after a small-scale rescue excavation did it become clear that at least a part of the flint show sickle glow, hence they must have belonged to some early Neolithic farming groups (*T. Biró 1991.55*). However, there is a slight contradiction between this latter statement and the Linear Pottery finds found together with sickle blades in the course of the rescue excavation, since the potsherds published belong for the most part to the developed, so-called 'Keszthely' phase of the culture (*Regenye 1991*). I cannot exclude an earlier population group at Mencshely and Vöröstó, whose settlement traces were destroyed by the 'Keszthely' phase site. In my opinion, the question of whether the archaic types in the lithic assemblage belong to the 'Epialeolithic' or the early

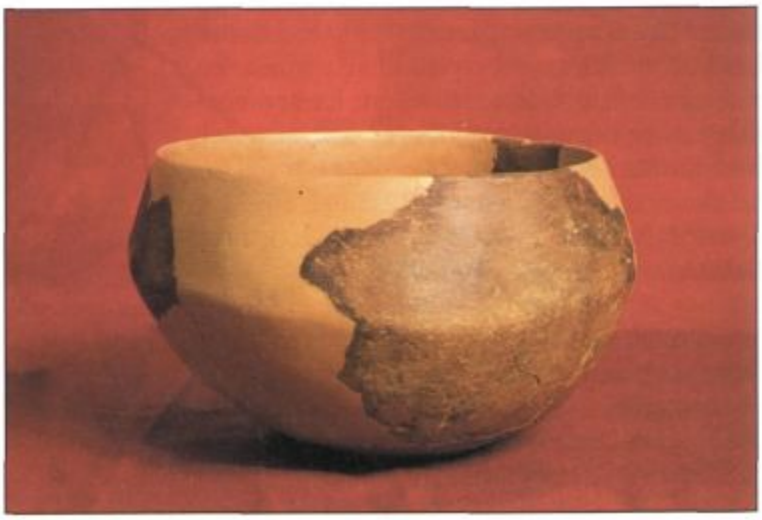

Fig. 10. Pityerdomb, dark red slipped and polished ware, with fine polished incisions.

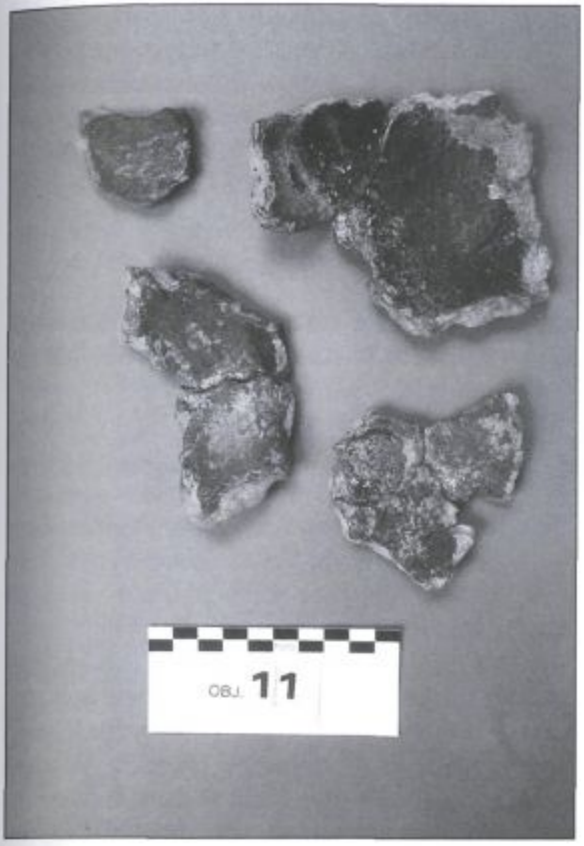

Fig. 11. Pityerdomb, a pintadera, containing black paint.

Neolithic is almost irrelevant, since even in the early Linear Pottery community the use of exactly these types must have been adopted from local earlier, hunter-gatherer groups. This opinion might be supported by the evaluation by J. Regenye and K. T. Biró, as follows: 'A small part of the Mészáros collection is reminiscent, typologically, of Epipaleolithic forms as well. This impression would coincide with the existence of rich and very early LBC (*Linear Pottery, E. B.*) groups in the Balaton highlands, a region unusually rich in stone tools within Hungary.' (*Biró-Regenye 1991.352*).

Finally, the finds from Tapolca might also belong here, including the altarpiece fragment known to the excavators as 'the wheat-eyed Goddess' (*Sági-Törőcsik 1990; Eöry-Sági-Törőcsik 1991*). Indeed, the eyes of the human head are formed with two grains of *triticum dicoccum*, a domesticated plant.

It is perhaps also possible to range the site of Brunn II, near Vienna, to this group, which seems to be an earliest Linear Pottery settlement. Here, some features such as the house designs resemble the Linear Pottery types, but the eponymous linear decoration on the pottery is missing (*Lenneis 1995.14–16; Stadler 1999*). This is not to exclude the notion that the differences in the two territorial late Starčevo groups and the transitional assemblages in the northern periphery respectively are caused by a certain presence of late Mesolithic (Mencshely-Vöröstó?) groups there. This presence cannot be proven yet in a direct way, but the above-mentioned criteria suggest their participation in the neolithisation process north of the Starčevo distribution area.

As is more or less known, especially since the research work carried out by D. Gronenborn, all the earliest Linear Pottery groups in Transdanubia, but also to a not inconsiderable extent thoss in Central Europe, appreciated and used the Transdanubian Szentgál raw material (*Gronenborn 1994; 1999*). The red radiolarite from the Bakony Mountains, in Northern Transdanubia must have become actually as precious in Western Hungary, and more than one thousand kilometres to the northwest, as the Tokaj obsidian for the Alföld region. As mentioned above, the approximately one and a half thousand flints and nuclei in Pityerdomb all come from the Szentgál mine, about 200 kilometres distant. The excavator, P. Stadler claims, this is also the case at the Brunn settlement, at an even greater distance from Szentgál. The people of the late Starčevo settlement at Gellénháza also used the same raw material, and the same flints are found in those Transdanubian Starčevo settlements where lithic material is used. (See the article by K. T. Biró in *Kalicz, Virág, Biró 1998.*) Concerning this, it is important to mention that Szent-

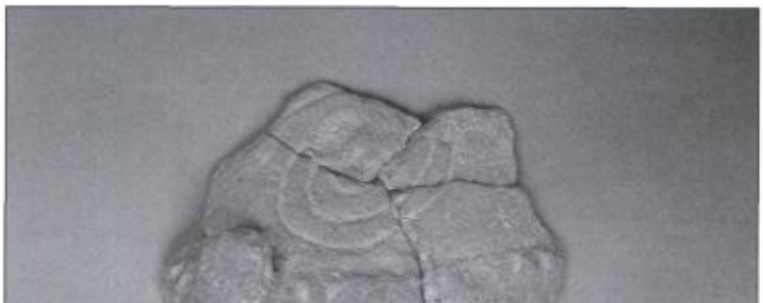

Fig. 12. Pityerdomb, vessel with a human hand application.

Fig. 13. Pityerdomb, zoomorphic figurine.

gál lies far outside, to the north of any modified Starčevo area. Consequently, if the Starčevo people had access to this raw material, they must have known about it from a group of people about whom we hardly have any firm knowledge yet, apart from some guesses, as in the case of Mencshely and Vöröstó. We can consider that they ruled over the northern Bakony forests, conducted some sorts of of exchange with the Starčevo inhabitants and also, that they must have had an influence on the character of the earliest Linear Pottery culture. Thus, it is likely that traces of an important boundary can be identified along the Balaton coast and westwards in Transdanubia.

CONCLUSION

To sum up, it is likely, that the Körös-Starčevo-Criş culture, i.e. all formations of the early Balkan Neolithic which reached the Carpathian Basin, developed according to geographic differences with a different rhythm, but meanwhile each of them had similar basic features in later life. As is known, the area which was most thoroughly investigated, but meanwhile provoked the greatest debate, was the Middle Tisza region in connection with the so-called 'Proto-Vinča' problem and the formation of the earliest ALP, the Szatmár II group. This debate was and still is certainly not independent of the uncertainties in the Starčevo-Vinča transition in the core area. The two most important opinions reflect totally antagonistic views: the first emphasises local development, without any external impact (*Leković 1990*); while the other regards the southern impulses as the most important element, not excluding even migrations (*Garašanin 1979; Lichardus-Lichardus-Itten 1989–90*). I regard the opinion of J. Chapman as one of the simplest and not independently, the most logical opinion of a somewhat combined model, which he formulated in his monograph some decades ago (*Chapman 1981. 34*). This model might also sound likely because it has numerous analogies within the prehistory of Europe.

Last, but not least, I should like to draw attention to an ecological model published recently by R. Kertész and P. Sümegi (*Kertész, Sümegi 1999*). This model finally makes clear why the Körös and the Starčevo cultures stopped at a borderline which does not coincide with any natural geographical barriers, neither in the Szolnok-Berettyó line in the centre of the Tisza region, nor at or around Lake Balaton in Transdanubia. In their publication there is a map showing the northern limits of the common climatic, petrological and ground soil potentialities that together were necessary for Körös-Starčevo-typed food production (*Kertész, Sümegi 1999.18, Fig. 3*). The line is not straight because of some environmental mosaics, but roughly it represents the real borders of the early Neolithic distri-

Fig. 14. Pityerdomb, lithic finds.

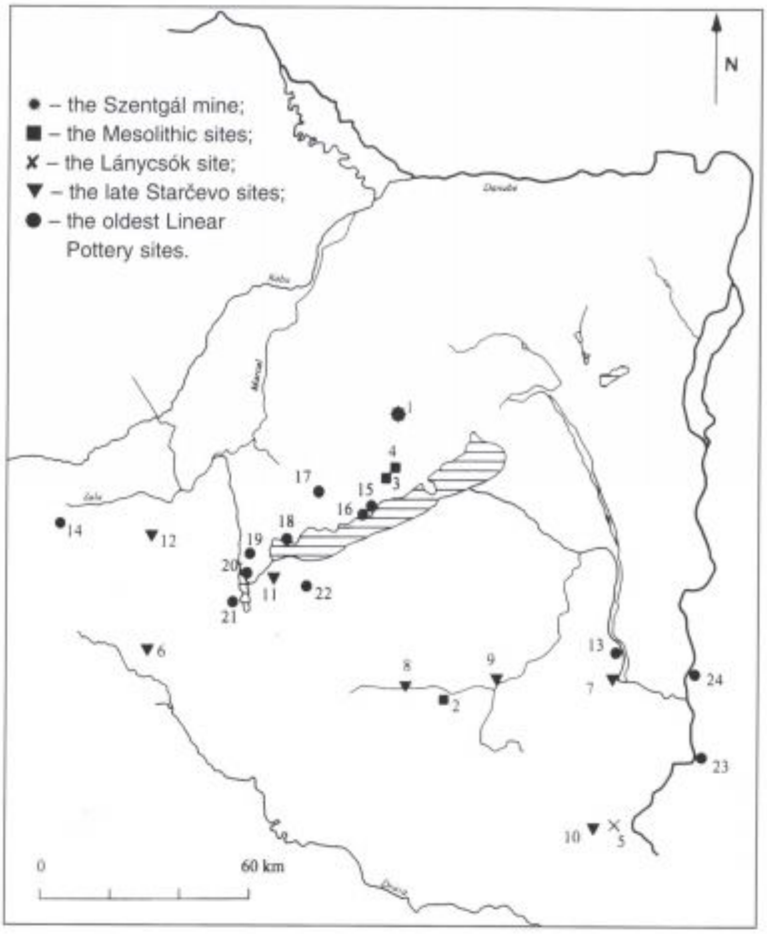

Fig. 15. The late Mesolithic, Starčevo and Earliest Linear Pottery sites in Southern and Western Transdanubia. Sites mentioned in the text: 1. Szentgál (prehistoric mine), 2. Kaposhomok (probably late mesolithic), 3. Mencshely (late mesolithic, or this tradition), 4. Vöröstó (late mesolithic, or this tradition), 5. Lánycsók (classical Starčevo), 6. Becsehely (late Starčevo), 7. Harc-Nyanyapuszta (late Starčevo), 8. Kaposvár-Deseda (late Starčevo), 9. Dombovár-Kapospart (late Starčevo), 10. Babarc (late Starčevo), 11. Vörs-Máriaasszonysziget (late Starčevo), 12. Gellénháza-Városrét (late Starčevo), 13. Medina (earliest LP), 14. Szentgyörgyvölgy-Pityerdomb (earliest LP), 15. Balatonszepezd (earliest LP), 16. Révfülöp (earliest LP), 17. Tapolca (earliest LP), 18. Vonyarcvashegy (earliest LP), 19. Sármellék (earliest LP), 20. Zalavár (earliest LP), 21. Garabonc-Ófalu (earliest LP), 22. Kéthely (earliest LP).

bution area in the Carpathian Basin. This line should represent the 'Central European agro-ecological barrier', north of which it was impossible to continue the southeast European mode of food production. Thus, the early Neolithic groups of southern origin slowed down and finally had to stop. This pause for breath might have given time to the local, indigenous Mesolithic groups living to the north of them in the contact zone to learn most of the Neolithic inventions without a total assimilation and absorption into the Kőrös-Starčevo civilisation.

It might be too early to draw any important conclusions from the above model from the archaeological point of view. Nevertheless, it is not unlikely that the settlements of the Pityerdomb type reflect just this mode of neolithisation: the adoption of the Neolithic way of life whilst preserving some traces of the old values. In my opinion, this sketchy hypothesis will have a good test, which is different from the certainly necessary and useful natural scientific analyses. This would be an analysis of the few hints reflecting something of the way of thinking and the symbolism of the Starčevo and the Pityerdomb-typed early Linear Pottery archaeological material. It is to be hoped that this will help build a bridge between many of the problems associated with the neolithisation of the Carpathian Basin.

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Documenta Praehistorica XXVII

Measuring Change: the Neolithic Pottery Sequence of Vinča-Belo Brdo

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ABSTRACT – *This paper examines the pottery sequence of the famous neolithic tell site of Vinča, Yugoslavia. In earlier research its stratigraphy of 9 m had been considered to be of only limited chronological value, since the excavator failed to document the position of finds in regard to actual layers, and recorded only the respective spit of the excavation. Theoretical considerations and a statistical analysis attempt to evaluate which chronological resolution can be achieved using the old find material. Recent radiocarbon dating of stratified samples from the old excavation is used to establish an absolute time scale for the stratigraphy. The stratigraphic information is used to reduce the statistical error of these dates caused by the calibration process. Finally, the quantitative change in pottery type frequencies is compared with the interpolated rate of sedimentation. This comparison makes it possible to distinguish between innovation or stagnation phases in the production of pottery and differences in the accumulation rate of settlement debris.*

IZVLEČEK – *V članku se ukvarjamo s keramiko iz znamenitega neolitskega tel najdišča Vinča v Jugoslaviji. V zgodnejših raziskavah so smatrali, da ima 9-metrska stratigrafija najdišča le omejeno kronološko vrednost, saj izkopovalci niso dokumentirali lege najdb glede na dejanske plasti, ampak so zapisovali le odgovarjajoče režnje. S teoretičnim razglabljanjem in statističnimi analizami poskušamo oceniti, kakšno kronološko ločljivost lahko dosežemo z najdbami starih izkopavanj. Z novejšo radiokarbonsko datacijo stratificiranih vzorcev iz starih izkopavanj smo izdelali absolutno časovno skalo stratigrafije. Stratigrafske podatke uporabljamo, da zmanjšamo statistično napako teh datacij, ki jih povzroča kalibracijski proces. In končno, kvantitativno spremembo v pogostosti tipa keramike primerjamo z interpolirano stopnjo sedimentacije. Ta primerjava omogoča ločevanje med inovativnimi in mirujočimi fazami v proizvodnji keramike ter med razlikami v stopnji akumulacije črepinj v naselbini.*

KEY WORDS – *Vinča; Neolithic; stratigraphy; seriation; radiocarbon dating*

THE SITE

The tell site of Vinča Belo Brdo near Belgrade (Yugoslavia) is among the best-known archaeological sites of south-eastern Europe. Not only has it become the type-site of the Vinča culture, with its approximately 9 metres of cultural deposit, it also scores among the longest stratigraphic sequences of the European Neolithic. Since the excavator, M. M. Vasić, published his four volume *Praistorijska Vinča* between 1932 and 1936 (*Vasić 1932; 1936a; 1936b; 1936c*), Vinča has remained not only a key point of reference for the research on Balkan Neolithic, but also an object of controversial debate. The publication of Vasić, while being well ahead of its time with regard to the thoroughness of the documentation and classification of finds, failed to describe with equivalent accuracy the structural remains uncovered during the excavation. The excavation method consisted in removing horizontal levels of 10 cm thickness and marking on most finds the vertical distance from an arbitrarily chosen zero point. However, none of the finds and only a few observed houses were recorded in their horizontal position. Thus subsequent research concentrated mainly on chronological and typological analyses of the find material (*Holste 1939; Milojčić 1943; 1949a; 1949b; Garašanin 1951; 1979*), whereas few studies attempted to reconstruct the position of structures and the sequence of building phases (*Korošec 1953; Jovanović 1960; 1984; Chapman 1981; Stalio 1984*).

By grouping the artificial levels of the type-site in intervals of 1-1.5 m, several phasing systems have been developed which were gradually regarded and used as being valid for the whole area of the Vinča culture. The two main chronological systems of M. Garašanin (*1951; 1979*) and V. Milojčić (*1949*) concur in their major stratigraphic divisions at ▽ 8.0, 6.0 and 4.1 m, while minor subdivisions are assumed at ▽ 7.5, 7.0 and/or 6.5 m respectively. The type spectrum in their periodisations comprises almost exclusively material published by M. Vasić (*Vasić 1932-36*), but neglects his personal selection of "relevant" types and artefact attributes for publication. The diagnostic types of Vinča culture in the Garašanin and Milojčić system thus appear as a rather arbitrary selection from the bulk of restored vessels from the type-site. For their selection, neither absolute frequency nor stratigraphic distribution are specified. Especially in a stratigraphic sequence of contested reliability, as in Vinča-Belo Brdo, conclusions based on single occurrences of types and elements may be quite misleading if their overall distributional characteristics have not been analysed beforehand.

A systematic quantitative study of pottery types and elements in their stratigraphic distribution thus appeared a promising approach for reassessing the chronological validity of the Vinča sequence. On more general methodological grounds the aim was to test which chronological "resolution" can be achieved in a stratigraphic analysis restricted to given 10 cm-levels without reference to the real sedimentation and construction layers.

REAL AND ARTIFICIAL STRATIGRAPHY

A model was developed to analyse theoretically the distorting effects of a find recording system in regular vertical steps superposed on a realistic settlement stratigraphy (Figs. 1a, 1b). The unknown percentage of material that differs in age from the bulk of finds in each 10 cm-level is defined in the present study as "stratigraphic contamination". Theoretically, we can distinguish two types of contamination: the first is caused by the unintentional overlapping of adjoining layers (Fig. 1b: A, B), the second by intrusions of far later (unrecognised deep pits) or far older artefacts, which result, for example, from finds in sediment re-used as building material (Fig. 1b: pit from layer 2 in level C). Obviously, the remaining chrono-

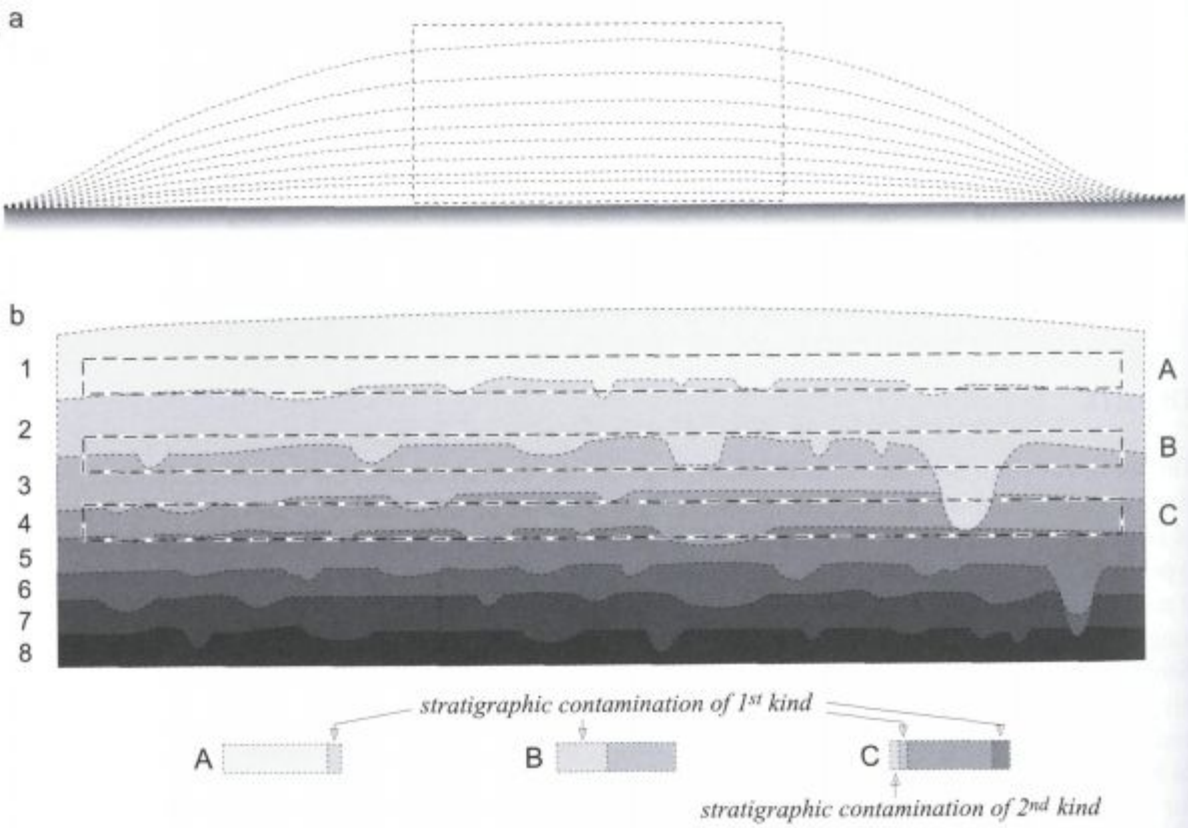

Fig. 1. Idealised tell stratigraphy (a) and enlarged section (b), showing possible superposition of layers and excavation units.

logical value of a contaminated stratigraphy depends on both kind and quantity of contamination. Figure 2 illustrates the likely effects of stratigraphic contamination on an idealised vertical distribution pattern of diagnostic types. Contaminations of the first kind will result in a flattening or shifting of unimodal distributions of the types concerned (Fig. 2b). A certain amount of intrusive sherds (contamination of the 2nd kind, Fig. 2c) will show up as a bimodal or even polymodal stratigraphic distribution of some types. Beyond a certain critical threshold contaminations of both degrees will distort the unimodal type distribution patterns up to a total loss of stratigraphic information – the state of *chronological entropy*. Inversely, a pattern of overlapping unimodal type distributions will only be detected in a given stratigraphy when there is comparatively little contamination.

STATISTICAL ANALYSIS OF STRATIGRAPHIC UNITS

Since the same model of overlapping unimodal frequencies is the methodological basis of seriation techniques, our approach applies seriation as a tool for testing the stratigraphy of Vinča-Belo Brdo. However, unlike its usual applications, seriation is used here in reverse: instead of chronologically ordering a number of closed find units, we examine the chronological "closedness" of a number of find complexes, the sequence of which is predetermined stratigraphically. The seriation technique chosen is correspondence analysis (CA), a powerful statistical tool (*Greenacre 1989; Madsen 1988; Djindjian 1991.181–186*) sensitive in the detection of distorting factors in a generally seriable data matrix.

Before being submitted to seriation, however, the pottery sample of Vinča-Belo Brdo required reclassification and further statistical pre-treatment. A sample of about 3400 pottery fragments served for a new classification of vessel shapes, decoration and handle types. Among the most numerous vessel category of bowls, amounting to 80 % of all fragments, 180 types could be distinguished, organized into 23 type groups. It is well known that archaeological types are artificial groupings not (necessarily) corresponding to functional or aesthetic classes in the potter's mind. Such a highly differentiated classification system, as developed here, intends to resolve a morphological continuum in the smallest discrete entities attainable in order to reproduce quantitatively the time scale in terms of pottery change. However, a classification should allow for an average type frequency that is still statistically meaningful. The types of pottery shape which are used in this study show a minimum frequency of 5 and an aver-

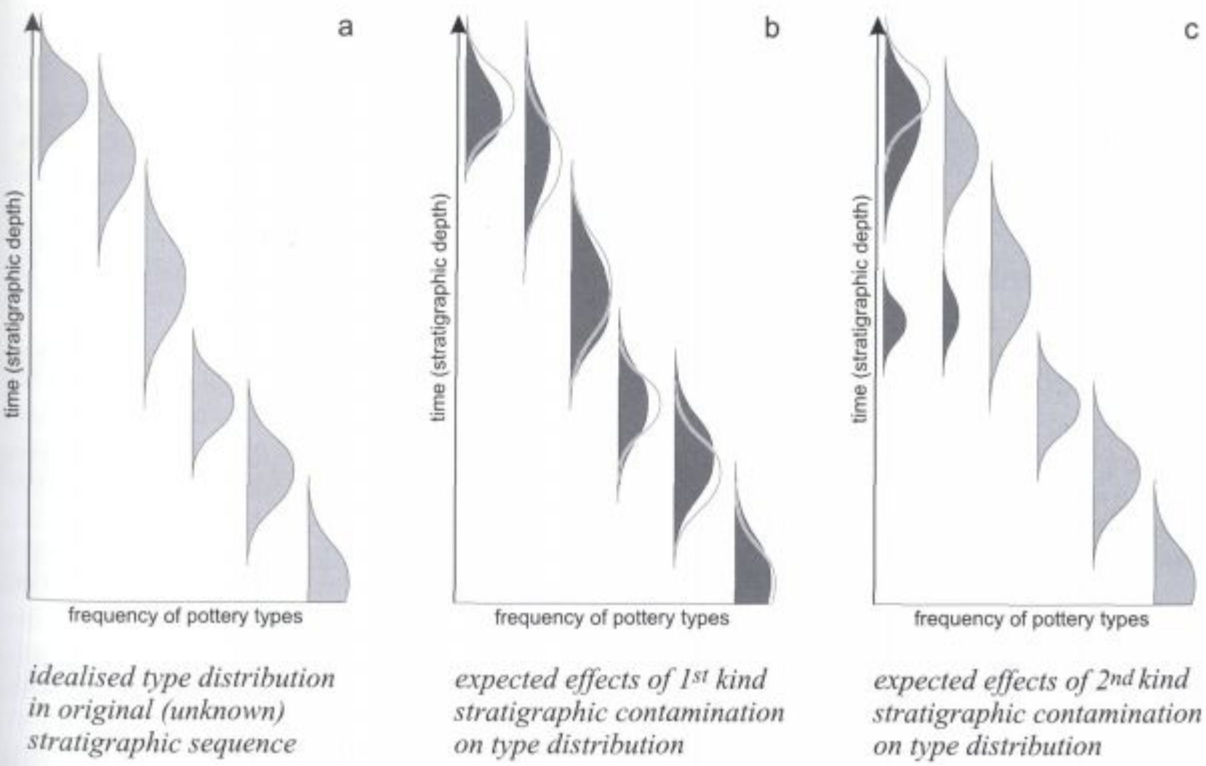

Fig. 2. Effects of stratigraphic contamination on vertical type distribution.

age of 10, with many of the chronologically most significant types exceeding 20 occurrences.

A sub-sample of 950 vessel fragments was subjected to a metric analysis: the coordinates of crucial profile points and the length, angle and curvature of the intermediate profile sections were recorded. On the basis of these measurements and derived proportions a number of cluster, variance and discriminant analyses were performed to verify the visual classification of the whole sample. Vessel decoration was classified, separating its components into (1) decorative technique, (2) decorative motif/pattern, (3) composition of one or several decorations (in zones, repetitive, alternating, limiting) and (4) position of the decoration on the vessel (rim, shoulder, lower part, interior). All four components could be shown to vary throughout the stratigraphic sequence, i.e. to have some chronological value.

As a further step, the analysis of stratigraphic frequency distribution provided information for the assessment of the chronological significance of shape types and decorative elements. Obviously, not every type or variant of vessel shape or decoration can be expected to show significant chronological variability. Many formal or technical details of pottery production may vary for functional or simply individual reasons. Even in a schematic stratigraphy, as in Vinča, the vertical distribution of types and elements can be regarded as a coarse indication of their variability in time. In order to minimize the effects of stratigraphic contamination types with obvious bi- or polymodal distribution were excluded. Only those shape types were included in the CA, whose interquartile range (central part of stratigraphic distribution without lowermost and uppermost 25% of occurences) did not exceed 1.4 m, a value that was chosen on the basis of dispersion diagrams. A similar selection was performed on decorative motifs and techniques, where only few types passed the interquartile criterion. In general, morphological variability of Vinča pottery proved to be a far better indicator of time than decorative variability.

The seriation of a stratigraphic sequence can be visualised as the attempt to sort a number of find boxes (each containing the material of a single stratification unit) whose identification labels have been lost. Such an experiment can only be successful if (a) the stratigraphy encompasses sufficient time to allow for substantial change in artefact types, (b) the type classification is detailed enough to reveal slight and gradual change, (c) the sample size is sufficient to enable differences in the type percentages to attain statistical significance, (d) the chronological variation *in* the given units is considerably smaller than *between* them. In other words, they should show a sufficient degree of chronological homogeneity.

The seriation matrix used in the present study measured the relative frequency of 204 pottery types and decorative elements in 39 stratigraphic units. These units comprise pottery samples of the excavated 10 cm levels from ▼ 9.3 to 5.0 m, some of which in our analysis had to be paired or grouped to compensate for the small sample sizes. A number of pits discovered in the lowermost horizon at Vinča were also included, which rather traditionally than convincingly have been interpreted as semi-subterranean dwellings (*Korošec 1953.40; Stalio 1984.34–36*). Figure 3 shows the relative frequency of shape and decoration types in the stratigraphic units as ordered by the first *eigenvector* of correspondence analysis. Not only is a general pattern of shifting stratigraphical distributions obvious, but there are also differences in their specific range. Decoration techniques or motifs (M..., DT...) have much longer lifespans than pottery shapes (S..., A.., F.., K.., T..). While the central part of the frequency distribution is well ordered in a diagonal way, some extremely early or late isolated occurrences suggest a certain amount of stratigraphic contamination of second degree.

Figure 4 represents the distribution of unit scores in the plane of the first two *eigenvectors* of CA. The diagram shows a fairly symmetrical arrangement of the units in the shape of a parabola, a statistical indication of a data matrix that can be diagonalised very well (*Greenacre 1989.226–231*). Obviously, a pattern of overlapping unimodal type frequency distributions can be discovered in the sequence of 10 cm levels at Vinča.

Looking more closely we see that the seriation sequence starts in the lower left corner with pit Z (an almost pure complex of the preceding Starčevo culture), followed by a group of other pit contents. Very closely clustered are the lowermost levels above the sterile loess subsoil from ▼ 9.3 to ▼ 9.0 m. Projected on the first *eigenvector* which we interpret as time scale there is almost no chronological difference. Separated by a gap, the pits W, M and K are grouped around the (reversed) levels ▼ 8.9 and ▼ 8.7 m. After another interruption the levels from ▼ 8.5 to ▼ 8.0 m appear in perfect stratigraphic order, while the levels from ▼ 7.8 to ▼ 7.1 m cluster in two

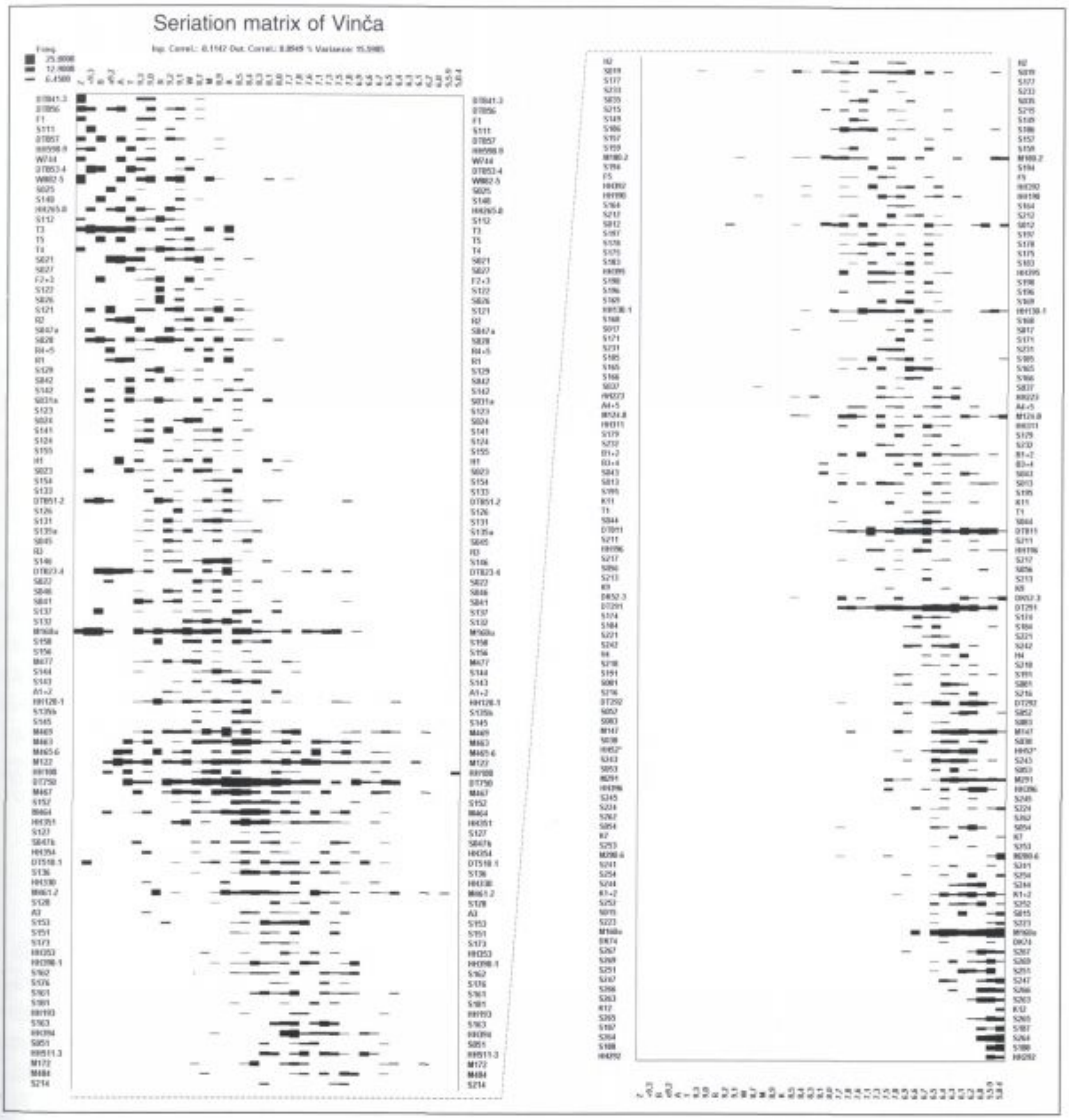

Fig. 3. Abundance matrix of pottery types and attributes in stratigraphic units, seriated by Correspondence Analysis.

groups rather than in stratigraphic sequence. From ∀ 7.1 m up to ∀ 5.0 m the stratigraphic units are once again arranged by CA in correct order, with the exception of level ∀ 6.2, being slightly misplaced. Apart from the levels between ∀ 7.8 and ∀ 7.1 m, which will be discussed below, the given stratigraphic sequence of Vinča Belo Brdo can thus be reproduced statistically on the basis of type combinations only. Furthermore, the ability of CA to space data points in a two-dimensional plane according to their similarity/dissimilarity allows borderlines between cultural phases to be defined empirically rather than to be drawn arbitrarily. Thus we can distinguish phases 1 to 7 in Vinča with a threefold subdivision of phase 5 (a, b, c) and a possible subdivision of phase 2 (Fig. 4). These supposed phase boundaries derived from gaps in the eigenvector plot were subjected to further statistical testing. A one-way analysis of variance confirmed that there are significant differences in type frequency between all of the phases except 2a and 2b. These two sub-phases, however, could be separated by a discriminant analysis, which reproduced the given groups (stratigraphic units combined to phases) perfectly (100% correctly classified), using three canonical functions calculated from type frequencies,

Since stratigraphy and type seriation represent functions of real time, we may compare them in a cor-

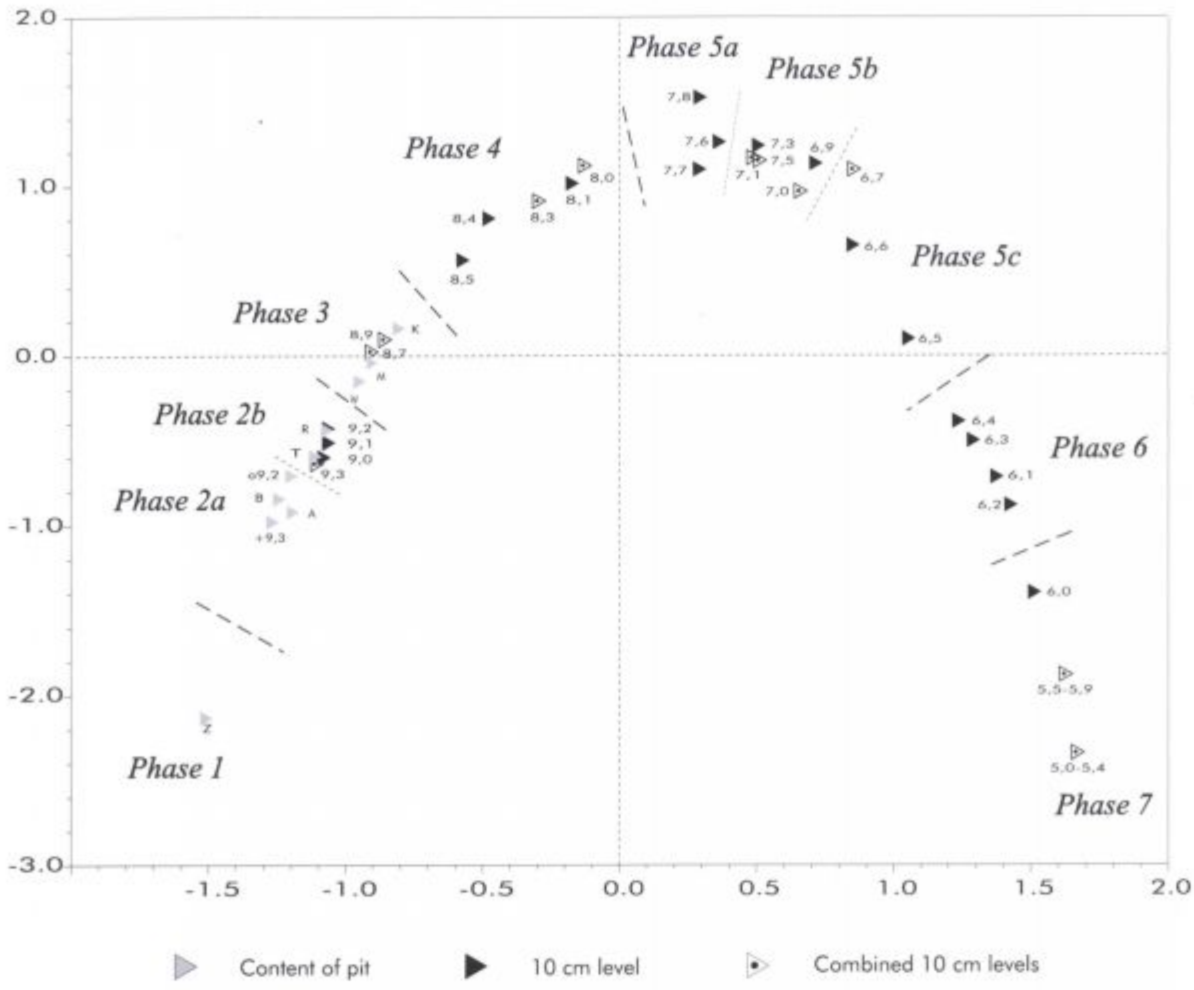

Fig. 4. Stratigraphic units in the plane of the first two eigenvectors of CA.

relation diagram (Fig. 5). A polynomial regression curve was calculated which suggests a very high non-linear correlation (r = 0.99) between stratigraphic position and similarity in type composition expressed by the first eigenvector of CA. Especially interesting are the residuals, i.e. the points lying at a greater distance from the regression curve. In the lower left corner of Figure 5, three groups of pits (shaded triangles) are discernible: the pits at ▽ 9.3 and ▽ 9.2 m as well as A and B according to their type composition appear earlier than their stratigraphic position would suggest. The pits W, M and K, despite being discovered at almost the same depth, contain considerably later types. An intermediate position is assigned by the first eigenvector to pits T and R.

Statistical analysis thus suggests that the pits in the lowest level of Vinča-Belo Brdo do not form a chronologically homogenous "pit horizon" as was assumed hitherto. Instead, several pits were probably dug from different levels (accordingly with different fill), which the excavator presumably recognised only when the lighter sterile loess subsoil had been reached (between ▽ 9.0 and ▽ 9.4 m). The correlation diagram also shows several adjoining stratigraphic units which are indistinguishable on the basis of their type contents and therefore deviate from the regression curve: the levels of ▽ 9.2-9.0 m, ▽ 7.8-7.7 m, ▽ 7.5- 7.1 m and ▽ 6.8-6.6 m in Figure 5 appear piled up, instead of being spread along the regression curve.

Several conclusions can be drawn from these results. Firstly, the chronological resolution of Vasić's schematic, 10 cm levels is far clearer than generally assumed; in large patches of the stratigraphy even a difference in depth of only 10 cm is chronologically meaningful. Secondly, the contamination effects caused by unrecognised pits and/or the crosscutting of sedimentation layers which do not run horizontally (cf. Fig 1b) cannot be considered serious enough to discredit the whole stratigraphic sequence. Thirdly, when based on CA and statistically tested, the grouping of stratigraphic units into phases can be regarded as methodologically sound.

CULTURAL DYNAMICS AND THE GROWTH OF TELL SETTLEMENTS

Chronological blocks based on a combination of stratigraphy and typology can thus be resolved into a pattern of gradually shifting type composition by seriating the artificial stratigraphic units. Since correspondence analysis can not only sort find complexes on an ordinal scale, but reproduces geometrically in few dimensions the overall (dis)similarity pattern of the units (and types), we can attempt to analyse a problem which is crucial to many archaeological find sequences: the problem of cultural dynamics. The refined chronological resolution enables a quantification of the change in find composition between adjoining units on a stratigraphic scale. This stratigraphic scale, however, is proportional to the real time scale only if we have evidence to assume an uninterrupted continuous accumulation of settlement debris at a constant rate. Unless tell accumulation can be shown to be a linear function of time, differential change between adjoining stratigraphic units can always be interpreted in an ambiguous way: Greater dissimilarity can be caused by cultural innovation, or by lower accumulation rate. Inversely, greater similarity in the type composition of two layers can result from cultural stagnation or from increased accumulation of sediment. The only way to resolve this ambiguity is to establish an independent time scale by means of absolute dating.

In contrast to its central importance for relative chronology, until now the type site contributed very little to the absolute dating of Vinča culture (*Breunig 1987.107; Todorović and Cermanović 1961. 101–102*). In 1991, a number of unworked bone and antler finds with documented stratigraphic positions were subjected to radiocarbon analysis. A promising, mathematically sophisticated approach has recently been published as an attempt to reduce the additional statistical error caused by the calibration process (*Buck et al. 1991; Buck, Litton, Smith 1992*). Bayesian probability theory is used to incorporate archaeological information in the calibration procedure. An application of this calibration approach, using the program OXCAL (*Ramsey 1994*), appears in Figure 6, in which 13 radiocarbon dates are arranged in reverse stratigraphic order. The open areas signify the probability distributions of all samples calibrated independently. The comparatively broad spread of their estimated ages results not from the measurement procedure itself, but from marked wiggles in the calibration curve between 5300 and 5000 cal BC. The application of *a posteriori* probabilities means

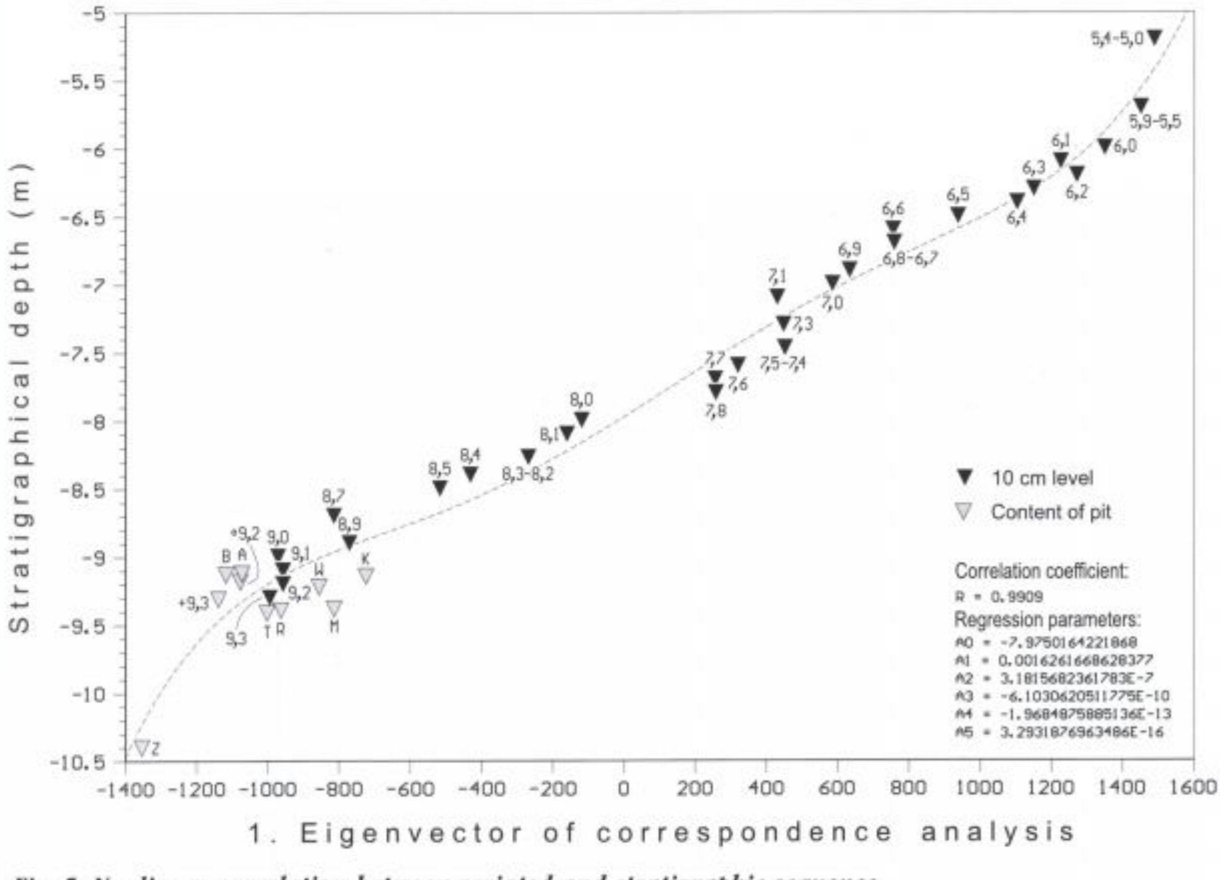

Fig. 5. Nonlinear correlation between seriated and stratigraphic sequence.

the use of stratigraphic evidence in order to exclude mutually overlapping parts of the respective probability distributions. We know, for example, that there should be a considerable difference in age between the samples from levels ▽ 8.7 and ▽ 7.0, which is not obvious from the calibrated radiocarbon dates. When their stratigraphic succession is taken into account, the posterior probabilities of calibrated dates (the solid areas in Figure 6) are much narrower than if calibrated independently.

Combining calibration with archaeological context information also means that the selection or rejection of samples becomes a crucial factor. Three of the 13 displayed radiocarbon dates in Figure 6 show a considerable deviation from the general trend; the sample Hd-14184 (pit at ▽ 9.3 m) appears too young, while the samples Hd-16733 (▽ 7.0 m) and Hd-17776 (▽ 6.9 m) produce excessively old age estimates. A tentative exclusion of these three dates leads to a somewhat different appearance in the remaining samples when calibrated sequentially (Fig. 7). The oldest date (▽ 8.7 m) now shows a much broader probability range (5415–5215 cal BC at the 95% level), which has shifted towards the older (left) part of the diagram. The general trend appears less steep than in Figure 6 and more s-shaped. Depending on the data subset and calibration approach used, we can estimate the maximum absolute time span for phase 3 to 6 (Vinča A2–B2) from either 5400 or 5250 to around 4850 cal BC. Unfortunately, two stratigraphically older samples could not be dated, and sample Hd-14184 from the pit at ▽ 9.3 m remains doubtful, as it yielded an even younger age than levels ▽ 8.5 and ▽ 8.4. So the beginning of Vinča culture at the type-site is still difficult to express in absolute dates.

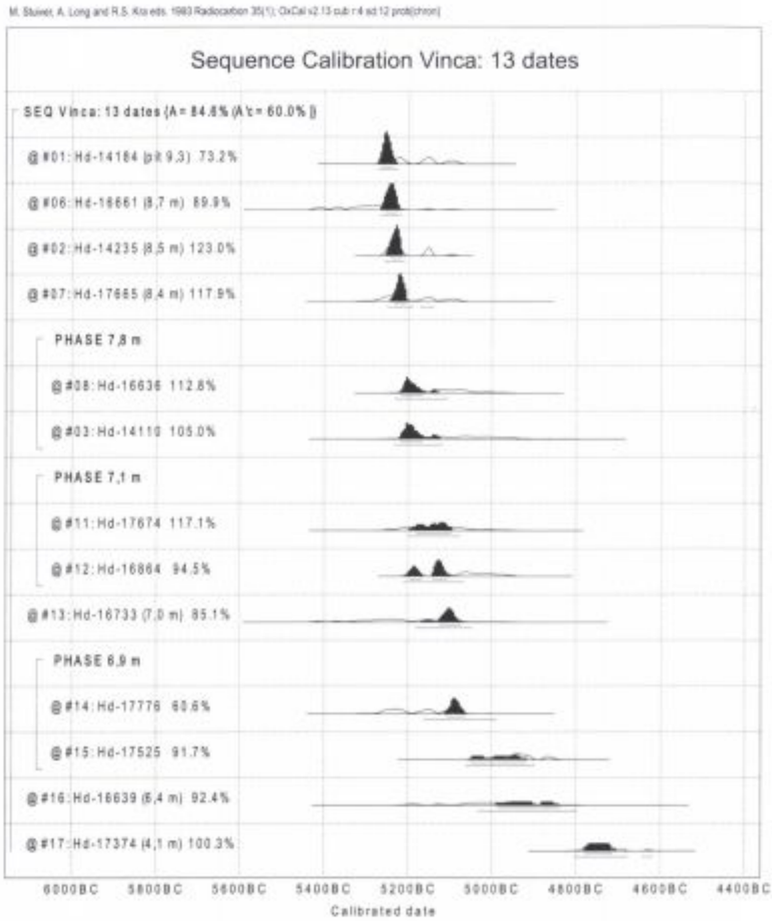

Fig. 6. Sequence calibration of 13 radiocarbon dates from Vinča.

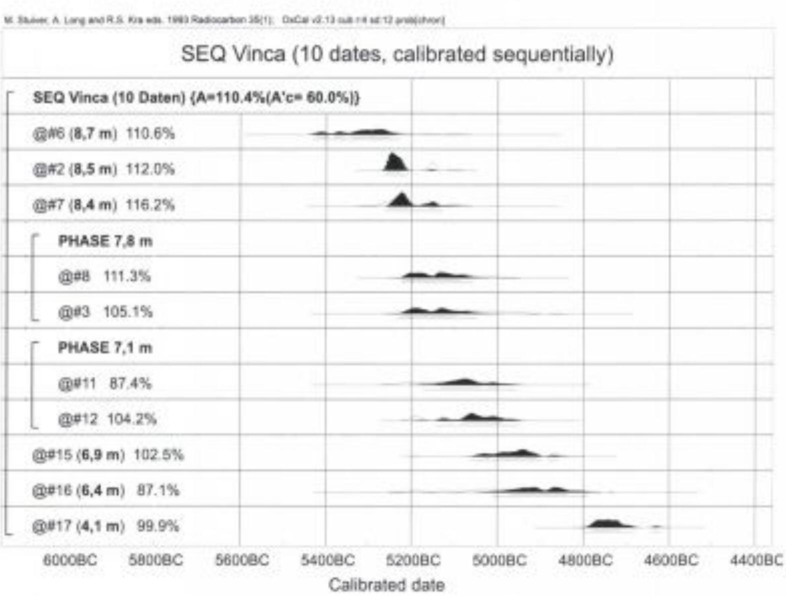

Fig. 7. Sequence calibration of 10 radiocarbon dates from Vinča.

Both radiocarbon data subsets are fairly small for assessing the absolute time scale of the settlement growth with sufficient accuracy. Nevertheless, a tentative correlation of the rate of both sediment accumulation and typological change with stratigraphic depth is proposed in Figure 8. The differences of the calibrated upper and lower 68 percent ranges of stratigraphically neighbouring dates were averaged, and then their vertical distance was divided by the mean time difference. A coarse extrapolation of the sediment accumulation rate can thus be achieved. The two data subsets only differ considerably below ▼ 7.1 m, where the exclusion of two unrepresentatively old dates reduces the accumulation rate by almost 50 percent. Below ▼ 8.5 m, the decision to accept or reject the radiocarbon date from the early pit at ▼ 9.3 m means to assume an either very slow (solid line) or extremely rapid (broken line) sedimentation process. The subset comprising 10 stratigraphically coherent dates shows a more balanced general trend of increasing sedimentation rate with time, a tendency that is markedly interrupted between ▼ 7.1 and ▼ 6.4 m.

The rate of change in pottery composition is expressed by the difference between adjoining stratigraphic units in their first component score of correspondence analysis. For this purpose the same matrix of type frequencies as in Figure 3 was submitted to a *detrended* CA (*Greenacre 1989.232*) in order to express the "typological distance" by one vector only. The shaded histogram in Figure 8 represents the degree of dissimilarity between neighbouring stratigraphic units. Negative values signify that stratigraphic units have been reversed as a result of the seriation. Once again, the coincidence of the phase boundaries with peaks of typological dissimilarity is obvious. The central issue of Figure 8, however, is the correlation between sedimentation rate and typological change, which leads us once again to the question of cultural dynamics and/or accelerated settlement growth. Starting from the bottom, we can see a coincidence of slow sedimentation (according to dating model 2) with a high rate of pottery change between ▼ 8.7 and 8.5 m. Increased sedimentation above this level correlates with decreasing change in the type assemblages until ▼ 8.1 m. Between ▼ 8.0 and 7.8 m, the highest degree of dissimilarity of all adjoining levels can be observed, followed by a marked drop. For the overlying 70 cm of tell accumulation, only small differences between neighbouring levels occur, which made it difficult for the seriation to sort these units in the correct order with respect to their type composition. Above ▼ 7.1 m, a similar pattern reappears as below ▼ 8.0 m: low sedimentation correlates with higher rates of change. Accelerated sedimentation, occurring around ▼ 6.4 m, is met by a peak in typological change.

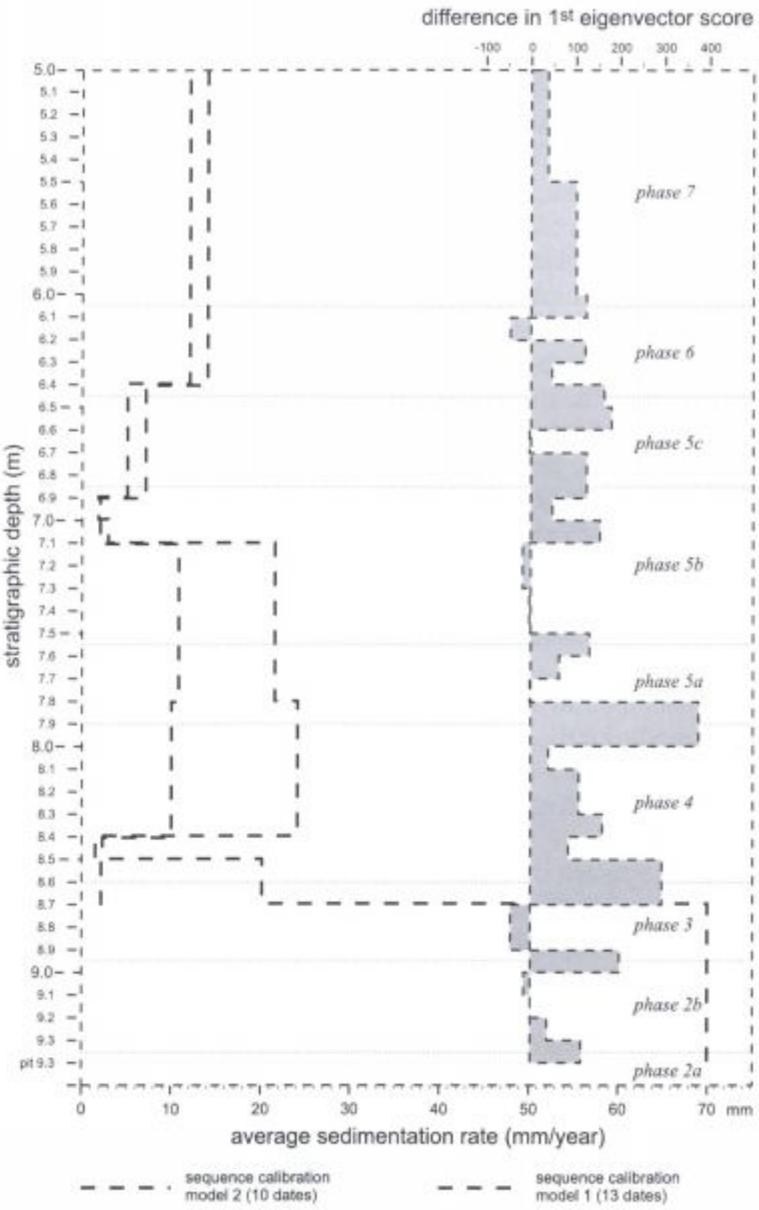

Fig. 8. Correlation of interpolated sedimentation rate and typological change.

Three basic patterns can be observed in Figure 8: the rate of sedimentation and typological change between stratigraphic units can be negatively correlated as between ▼ 8.4 m or around ▼ 7.0 m. Such an inverse relation would be considered normal, as artificial stratification units from slowly sedimented layers comprise more time and therefore greater differences in type composition. Between ▽ 8.4 and ▽ 7.1 m sedimentation and typological change are uncorrelated: in the lower part, moderate change coincides with a constantly high sedimentation rate. Between ▽ 8.0 and ▽ 7.8 m sedimentation remains almost constant, the exceptional dissimilarity in the type composition of these two levels can thus only be explained as an *innovation horizon*. It coincides with the end of the first building phase, represented by 6 houses discovered between ▽ 8.3 and ▽ 7.9 m whose horizontal position is unknown (*Stalio 1968; 1984.35–37*). The overlying 70 cm of sediment appear to have been accumulated at still the same speed as before, but there was little change. The type composition remains fairly homogenous and the stratification units are therefore difficult to distinguish statistically. So apparently this period has to be interpreted as a *stagnation phase* rather than as *compressed time* caused by rapid sedimentation.

Even more difficult to interpret is the pattern above ▽ 6.6 m. Obviously, there is a certain amount of innovation occurring around ▽ 6.5 m, the effect of which is, however, counterbalanced by increased sedimentation above ▽ 6.4 m. The interpolation of settlement growth is probably not accurate enough here, because it is based on only two radiocarbon dates from the levels ▽ 6.4 and ▽ 4.1 m. On the other hand, however, some of the few known and published house inventories come from the levels ▽ 6.8 to 6.5 m, and during the following 50 cm until ▽ 6.0 m a major replacement of pottery types is well documented (*cf. Garašanin 1979.150–152; 1973.95–96; 1993.13–15*). This could plausibly have resulted from a destruction and levelling horizon after the end of the settlement around ▽ 6.6 m, which accumulated half a meter of debris in a comparatively short time. On top of it, probably the first houses of the next building phase were constructed, the positions and contents of which unfortunately are not documented. The premature occurrence of new pottery types below ▽ 6.0 m could result from pits belonging to the later settlement, which were not recognised during excavation.

The combined statistical analysis of the gradual change in pottery type frequencies and recent radiocarbon results may thus help to distinguish between cultural dynamics and the accumulation process of settlement debris. Interestingly, some discontinuities in the development of the pottery, which CA revealed, correspond quite well with building phases, which were reconstructed with reference to the unpublished notes and sketches of the excavator (*Korošec 1953; Stalio 1968; 1984*). Phases 5b and 5c of the present study (Fig. 4) coincide with B. Stalio's settlement III, while her settlement IV covers both phases 6 and 7. The stratigraphic boundaries of phase 5a to 7, as defined here, show surprisingly good accordance with Korošec's layers IIa, IIb, IIc, IId and III (*Korošec 1953.41–44*).

Many problems and open questions about the sequence of building phases in Vinča-Belo Brdo can be solved only by means of new excavations, which would require large areas and a corresponding investment of funds. But for the time being, a statistical analysis of both relative and absolute chronology, based on the old finds, can improve our understanding of the settlement history of one of south-eastern Europe's largest tell sites.

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Painted Pottery from East Macedonia, in North Greece: Technological Analysis of Decorative Techniques

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ABSTRACT - *Neolithic pottery from East Macedonia displays a considerable variety of surface finishing, ranging from through burnishing, painted, applied, incised, excised and impressed decoration. Methods of surface treatment, although widely used as the main criterion for the classification of ceramic wares, have received little attention. Pottery is usually described in terms of decorative motifs, colour variation or colour combination, but the technological processes responsible for these effects are, in most cases, ignored. The usual assumption is that similar results can be obtained by means of similar technological processes. This assumption is questioned by the present work, on the basis of a study of a large sample of painted ceramics from East Macedonia covering the whole of the Neolithic period. The material has been studied macroscopically and microscopically (polarising microscope and scanning electron microscope). A number of refiring tests were also carried out. The analysis so far indicates that there was great variation firstly, in the raw materials and techniques used by the potters for the production of painted motifs, and secondly, in the conditions prevailing during firing.*

IZVLEČEK - *Neolitska keramika iz vzhodne Makedonije kaže veliko raznolikost pri obdelavi površine, ki obsega tehnike okraševanja, kot so loščenje, slikanje, apliciranje, vrezovanje, izrezovanje in vtiskovanje. Čeprav se metode obdelovanja površine na široko uporabljajo kot glavni kriterij za klasifikacijo keramičnih posod, jim niso posvečali veliko pozornosti. Keramiko običajno opisujejo glede na motive okraševanja, barvo ali barvne kombinacije, večinoma pa prezrejo tehnološki proces, s katerim so izdelovalci dosegli omenjene učinke. Običajno domnevajo, da s podobnim tehnološkim procesom dobimo podoben učinek. V članku to predpostavko postavljamo pod vprašaj na osnovi raziskave velikega vzorca slikane keramike iz vzhodne Makedonije skozi vse neolitsko obdobje. Material smo raziskovali makroskopsko in mikroskopsko (polarizacijski mikroskop in vrstični elektronski mikroskop (SEM)). Opravili smo tudi številne teste s ponovnim žganjem. Analize zaenkrat kažejo, da gre za veliko raznolikost tako v surovini kot v tehnikah, ki so jih lončarji uporabljali za slikanje motivov. Velike razlike pa smo našli tudi v načinu žganja.*

KEY WORDS - *Neolithic Macedonia; painted pottery; technological analysis; firing of pots; petrographic study; chemical analysis; SEM; refiring test*

INTRODUCTION

East Macedonia is the area between the Strymon and Nestos Rivers, in Northern Greece (Fig. 1). The earlier Neolithic levels excavated so far are dated to 5500–5200 BC (the late Middle Neolithic period). This phase is represented by the lower levels of the site of Limenaria on the island of Thassos (*Malamidou and Papadopoulos 1993*), as well as those of Sitagroi (Sitagroi I: *Renfrew et al. 1986*) and Dimitra (Dimitra I: *Grammenos 1997*). Late Neolithic I, dated to ca. 5200–4800 BC, is represented by Sitagroi II, Dimitra II, Dikili Tash I (for Dikili Tash see *Treuil 1992*) and the lower levels of Krioneri (*Malamidou 1997*) and Promachon-Topolnitsa (*Koukouli et al. 1996a*). Late Neolithic II, starting around 4800/4600 BC, is represented by Sitagroi III, Dimitra III, Dikili Tash II, Paradeisos (for Paradeisos see *Helstrom 1987*), the upper levels of Krioneri and Promachon-Topolnitsa, and the site of Kastri in Thassos (*Koukouli 1972*). The end of this phase is estimated to be around 3800 BC. Apart from the excavated sites mentioned so far, ceramic material attributable to the Late Neolithic has been found, through surveys,

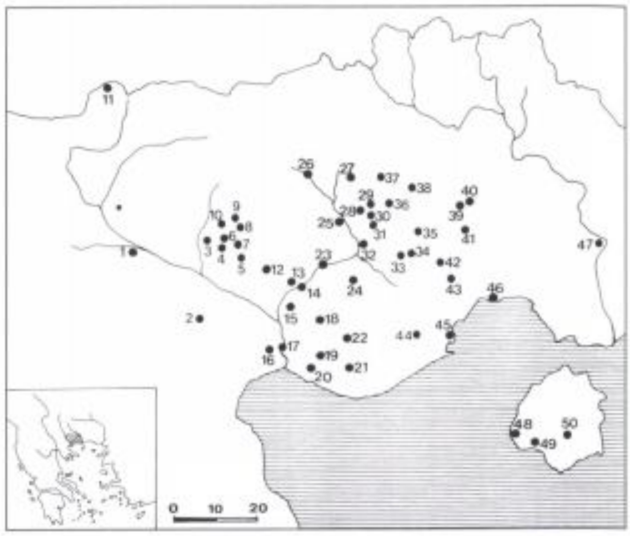

Fig. 1. Map of East Macedonia and Adjacent areas showing the Neolithic sites discussed in the text: 1. Kastri Srimonikou, 2. Zervochori, 3. Monovrisi, 4. Chriso, 5. Toumba, 6. Fakistra, 7. Prof. Ilias Pentapolis, 8. Gradiskos, 9. Agio Pneuma, 10. Neo Souli, 11. Promachon, 12. Tholos, 13. Airi Bairi, 14. Dimitra, 15. Fidokoriphi, 16. Krioneri, 17. Hill 133 Amfipolis, 18. Mikro Souli, 19. Galipso, 20. Lakkovikia, 21. Akropotamos, 22. Podochori, 23. Agista, 24. Nea Bafra, 25. Megalokabos, 26. Maara Cave, 27. Petrous, 28. Bournar Basi, 29. Milopotamos, 30. Zoodochos, 31. Kalos Agros, 32. Sitagroi, 33. Sikia, 34. Kalabak Tepe, 35. Doxat Tepe, 36. Arkadikos, 37. Xiropotamos, 38. Kalifitos, 39. Kirgia A, 40. Kirgia B, 41. Kefalari, 42. Dikili Tash, 43. Polistilo, 44. Sibolo Cave, 45. Nymphs Cav., 46. Kara Orman, 47. Paradisos, 48. Maries Cave, 49. Limenaria, 50. Kastri.

at a large number of tell sites (i.e. Polystylo, Mikro Souli, Podochori, Toumba etc., see Appendix D in *Grammenos 1991*).

Most of the East Macedonian settlements are located in the well-drained fertile plains of the region. Common to all sites is their proximity to a water source, which is usually a river or lake (*Andreou et al. 1996*). Since most of the excavations are small-scale operations, information on the layout of the settlements is scarce. An exception to this is the site of Dikili Tash, where a number of parallel, rectangular houses with internal ovens and platforms, an abundance of pots, stone and bone tools have been revealed by the recent excavations (*Koukouli-Chryssanthaki et al. 1996b*). The houses, separated by small lanes, are dated to the LN II period. A very clear picture of the organisation of the Neolithic household is also offered by the architectural remains of the LN I strata of the same site (*Koukouli-Chryssanthaki et al. 1996b; Treuil and Tsirtsoni 2000*). Furthermore, important data on the organisation of a Middle Neolithic settlement have been obtained through the recent excavations at the site of Limenaria (*Malamidou and Papadopoulos 1993*).

A characteristic of the Neolithic pottery from East Macedonia is the great variation of painted vessels. Late Neolithic pots in particular, when compared with contemporary material from Central or West Macedonia show a much greater variation and elaboration in the colour of the motifs and the surface of the vessels, as well as in the decorative patterns and the forms of the pots (*Grammenos 1997*). Despite this, the methods of surface treatment have received little attention. The usual assumption is that similar results can be obtained by similar technological processes. This assumption is questioned by the data discussed in the present work. In fact, study of the ceramic material from a number of East Macedonian sites has shown that a great variety of raw materials and techniques, some of which are rather complicated, were used by the Neolithic potters to decorate their pots.

Data for the present work were obtained through the macroscopic examination of a large sample of ceramics, the microscopic examination of 51 thin sections, the refiring of 75 sherds, and the chemical analysis of 9 samples [1]. The presentation of the data will follow a chronological order: material from the Late Neolithic I phase will be presented first, followed by the LN II data.

LATE NEOLITHIC I

During the early part of the Late Neolithic (LN I) a whole new range of painted wares emerge. These vessels, amounting to 10%–12% of the ceramic assemblage, are mainly painted with a brownish pigment on a buff-coloured surface. Despite their rather limited appearance, vessels display a great variation in the colour of their pigment, background and fabric. Thus a number of wares have been identified by researchers to classify the material: brown-on-cream, brown-on-buff coloured surface and brown-on-white slip (*Keighley 1986; Grammenos 1997*). Except for

1 Chemical analysis and examination with the Scanning Electron Microscope (SEM) was conducted by Dr. V. Kilikoglou (Laboratory of Arcahaeometry Institute of Material Science NCSR "Demokritos", Athens)

the vessels decorated with dark pigment on a clear-coloured surface there are, in minor quantities, pots decorated with red or purplish-brown pigment on a red-coloured background (orange-on-orange and red/brown-on-red ware respectively: *Keighley 1986. 353*). Still, these wares are considered very general and many sherds could not be assigned to any category, due to their colour variation (*Keighley 1986. 354–357; Grammenos 1997.Cat. 12 in Tab. 1*). It will be argued in the following paragraphs that this polymorphy of painted vessels results from the variety of techniques and raw materials used by the potters to decorate the pots.

Another criterion used by researchers for the classification of the material is the decoration of the vessels. Fragments with very thin linear motifs were assigned to the brown-on-cream and red/brown-on-red ware (Akropotamos style: *Keighley 1986.352–353; Grammenos 1997.Categs. 2,6,7,8,9 in Tab. 1*). Motifs are in narrow lines, about 3–4 mm wide, and there is a rich display of spirals, concentric circles, parallel lines and ladder elements (*Keighley 1986. 352*) (Fig. 2). All examples are made from fine-textured fabrics. Brown-on-buff or brown-on-white sherds are reported as being decorated exclusively with motifs of broad thickness (6–9 mm). Among the design characteristics are thick wavy lines, parallel lines, concentric circles, thick arcs etc. (*Keighley 1986.354–356*) (Fig. 3). The fabric of these vessels can vary from fine to medium-coarse textured.

Recent research, however, has shown that the distinction of the vessels according to the width of their motifs is oversimplistic and conveys a biased picture of the material (*Tsirtsoni 2000*). Vessels can have their entire surface decorated either with bold or thin-lined motifs (Figs. 2.1, 5). In other cases, however, a single vessel can combine both types of decoration (Fig. 2.2). In the present work, the term "Akropotamos style" will be used to describe the thin lined motifs, but it should be kept in mind that the results of the vessels with Akropotamos style decoration may be applicable to vessels with bold motifs and vice-versa.

Vessels decorated with a brown pigment on a grey/buff-coloured background

Two elements are of importance for the decoration of these vessels. Firstly, the colour of the pigment, and secondly, the colour of the background bearing the decoration.

The pigment is basically dark brown, but colours vary from light brown to black. Research for the present work has shown that in the production of the dark colour of the decoration two different methods were used:

α. Vessels were painted with an iron-based pigment that acquired a dark colour by being fired in reducing conditions (iron reduction technique). This complex technique can be summarised as follows: during firing, both the decoration and the body of the vessels turn black as they are fired in a reducing atmosphere. Under these conditions the sintered, iron-based pigment will retain the dark colour, in contrast with the body which, by being more porous, is re-oxidised (*Farnsworth and Simmons 1963.391*). It is the first time that this technique has been identified in Neolithic East Macedonian pottery.

β. Vessels were painted with a manganese-based pigment, a material that can produce a dark colour irrespective of firing conditions. In comparison to the iron reduction technique, the use of a manganese-based pigment is a rather simple technique.

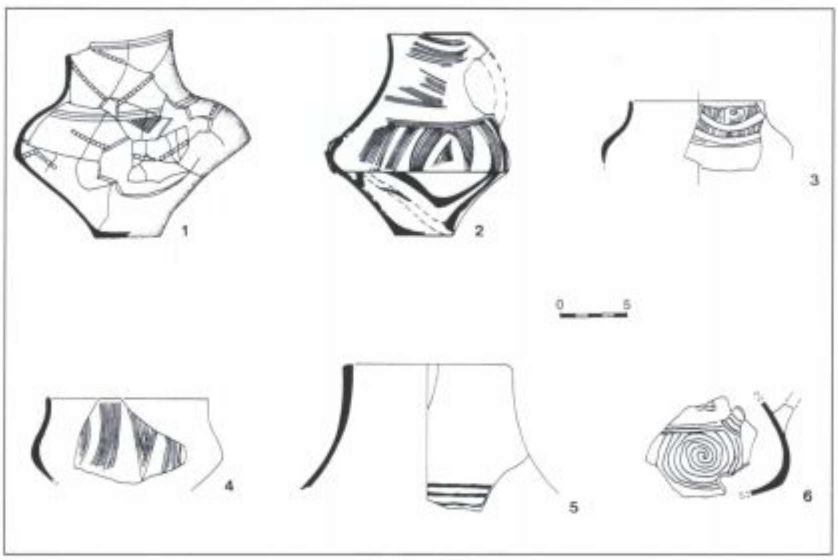

Fig. 2. Late Neolithic Painted Vessels: 1. Brown-on-cream from Dimitra (**Grammenos 1997.Fig. 10.88*****); 2. brown-on-cream from Dikili Tash (*****Tsirtsoni 2000.Fig. 4*****); 3. red/brown-on-red from Sitagroi (*****Keighley 1986.Figs. 11.12, 8*****); 4. red-on-red from Dimitra (*****Grammenos 1997.Fig. 21.320*****); 5. brown-on-cream from Sitagroi (*****Keighley 1986.Figs. 11.12, 6*****); 6. red-on-red from Dimitra (*****Grammenos 1997.Fig. 21.313*****).***

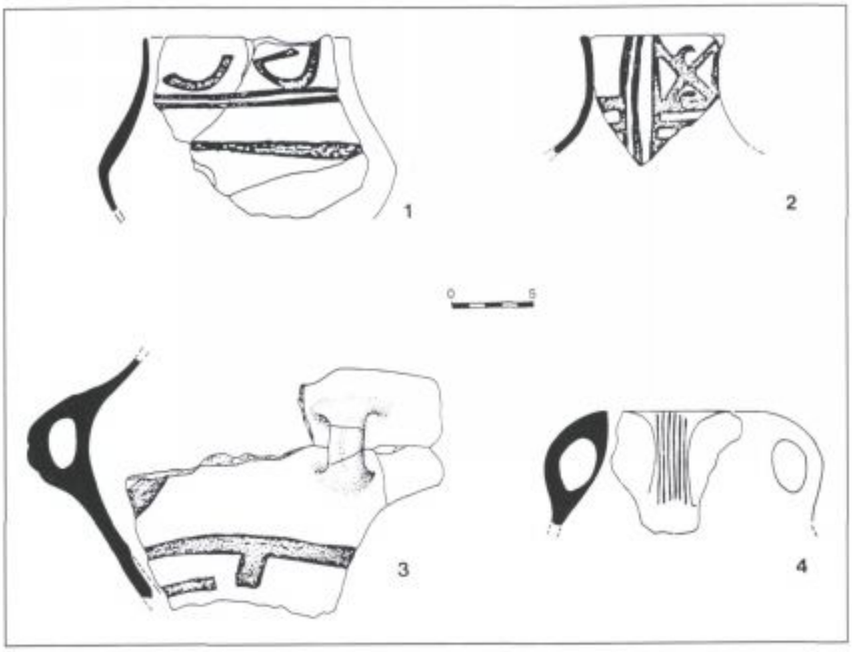

Fig. 3. Late Neolithic Painted Vessels: 1. brown-on-grey from Dimitra (**Grammenos 1997.Fig. 20.304*****); 2. brown-on-grey from Dimitra (*****Grammenos 1997.Fig. 20.308*****); 3. brown-on-grey from Dimitra (*****Grammenos 1997.Figs. 21.310*****); 4. vessel decorated with a post-firing organic coating from Dimitra (*****Grammenos 1997.Fig. 20.306*****).***

As for the whitish background, various raw materials such as kaolin or calcareous based slips were used by the early Late Neolithic potters (see the section below). In other cases, vessels remained unslipped, but acquired a buff-grey coloured surface through the control of the firing atmosphere.

Iron-based pigment

We can begin our presentation with the data on the iron reduction technique. The data were obtained through refiring tests, chemical analysis and macroscopic examination of the material.

The refiring of 30 sherds with brown motifs (20 Akropotamos-style, 10 with bold motifs) was carried out in a Labertherm furnace in an oxidising atmosphere from 25°C to 900°C (Tab. 1). After refiring, the bold motifs (Munsell soil colour notations 10YR 3/1; 10YR 3/2) of four sherds from the sites of Mikro Souli and Podochori acquired a clear red colour (Munsell soil colour notations 2.5YR 4/8: see Fig. 4). In the remaining sherds the motifs retained their dark colour. According to the characteristics described above, it appears that the decoration of the four vessels from Mikro Souli and Podochori was produced through the iron reduction technique. The change of colour, from brown to red, indicates that the iron-based pigment was not thoroughly reduced. For a successful result, two variables must be controlled by the potters: first, the quality of the pigment, and second, the firing conditions.

The preparation of fine-textured pigments is very important because coarse and grainy pigments are difficult to vitrify (*Aloupi and Maniatis 1990*) and during the oxidising phase of firing they will re-oxidise more easily than the fine textured ones. At the same time, the pigment must be applied in thick layers, since such layers sinter more effectively than the thin ones (*Jones 1986. 765*). Equally important for the vitrification of the pigment is the control of firing conditions, mainly temperature and duration of firing. The duration of reducing conditions is also of great importance. Analysis of two of the refired sherds (one from Mikro Souli and one from Podochori) showed that their pigment is fine textured, but it remained porous since it was thin (5–10 μm), and the firing temperature (800°C–850°C) and perhaps the duration of firing were not enough for its complete vitrification.

As for the twenty-six sherds retaining their dark motifs after refiring in oxidising conditions, the results of the refiring test are not conclusive. The sherds were either decorated with a manganese-based pigment, or with a thoroughly reduced ferruginous material.

Mikro Souli and Podochori are situated in the western provinces of East Macedonia, not far from Dimitra. Macroscopic examination of the painted vessels from Dimitra indicates that the iron reduction technique was also used there: quite often the brown motifs of brown-on-buff or brown-on-white pots are, in places, red. At Dikili Tash, a site further east, similar features have been noticed both on vessels with broad motifs (Fig. 5) and on those with the Akropotamos-style decoration. Since manganese based pigments do not shade to red or brown (*Farnworth and Simmons 1963.394*), it has to be concluded that the vessels were decorated with an iron-based pigment fired in reducing conditions.

The discoloration of the motifs can be attributed to local draughts of air that did not permit the maintenance of fully reducing conditions. The non-uniform thickness of the pigment material may also be responsible for such features. Motifs, mainly the bold ones, are quickly executed, and often the relief of the decoration is varied on a single vessel. As already mentioned, thicker layers can retain their colour better than thin.

Manganese-based pigment

The brown-black pigment was also produced through the application of manganese-based materials. MnO_2 was identified by the chemical analysis of four sherds with Akropotamos style motifs (two from Dikili Tash and Mikro Souli, respectively: see Tab. 1). Similarly, Gardner has identified the brown pigment of the Akropotamos style sherds from Sitagroi, as an iron oxide-manganese based material (*Gardner 1980. 109*). The use of manganese pigment for the production of the bold brown-black motifs of the East Macedonian sites is not documented, but on the basis of the discussion in the previous section it cannot be excluded.

Pure manganese coatings do not ordinarily contain sufficient fluxing materials to sinter or vitrify, and so if they are applied to the surface of the vessels they will be fugitive. But the brown-black motifs of the Neolithic vessels have been permanent. According to Shepard (*1976.42*) the successful bonding of a manganese pigment could be due to the following reasons: (1) polishing, (2) the presence of impurities, mainly clay, (3) protection by a post-firing coat (lacquer-like substances or resins of various plants). The use of a post-firing, protecting coat is not reported from any Neolithic site. The burnishing lustre of the Late Neolithic I vessels varies from good to poor. It seems, however, that the durability of the dark pigment of the vessels should be attributed mainly to the presence of clay. The sherds analysed in the present study (including the LN II black-on-red ware: see section below) were painted with an extremely fine-textured material containing MnO_2, Fe_2O_3 and high amounts of alumina (that is, a clay-based material). Although iron was most probably naturally present in the clay used for the preparation of the pigments (i.e. a ferruginous clay), manganese-ore had to be added by the potters.

Sample studied macroscopically	Thin sections	Refired sherds	Chemical analysis and SEM
Akropotamos LN		7 (5 Akropotamos 2 Bold br. decor)	
Dikili Tash LN	31 (23 undecorated 2 Bl/red 1 Bl/white 5 Graphite)	17 (5 Akropotamos 2 Bold br. dec.) 9 Graphite 1 "Bitumen"	3 (2 Akropotamos 1 Br/white)
Dimitra LN		4 (2 Bl/red 2 Graphite)	1 Bl/red
Galipsos LN	2 Bl/red	6 (2 Akropotamos 1 Polychrome)	
Kalambaki LN	4 (2 Bl/red 2 Graphite)	5 (3 Bl/red 2 Graphite)	
Kalifitos LN		1 Graphite	
Mikro Souli LN		2 Bold br. decor	3 (2 Akropotamos 1 Bold br decor)
Nea Bafra LN	2 Bl/red	5 (2 Bl/red 3 Graphite)	1 Bl/red
Podochori LN		2 Bold br decor	1 Bold br decor
Promachon-Topolnitsa LN	10 (3 Akropotamos 1 Graphite 1 "Bitumen" 2 incised décor 1 black topped 2 undecorated)	6 (3 Graphite 3 "Bitumen")	
Sitagroi MN and LN		10 Graphite	
Toumba LN	2 Bl/red	10 (5 Akropotamos 2 Bold br decor 2 Bl/red 1 bichrome)	

Tab. 1. The ceramic material and the analytical methods employed in the present work.

Buff-grey background

The background of the LN I painted vessels ranges in colour from grey-cream, white, very pale brown or buff. Such colours can be produced either by the application of a slip or by controlling the firing conditions, both of which methods were often used in combination by the East Macedonian potters to produce their painted pots.

The clay fabric of the Akropotamos-style vessels is cream-grey, very light brown, or reddish-yel-

Fig. 4. Sherds from Mikro Souli and Podochori decorated by the iron reduction technique. After refiring, in an oxidising atmosphere at 900°C, the brown motifs acquired a clear red colour.

low. In the first case, the motifs appear to have been applied to an unslipped, carefully burnished surface. Vessels made from very light brown, or reddish-yellow coloured materials usually have a thin, cream-beige slip. In most of the cases the slip is worn out, being preserved only in small spots. Gardner, in her analysis of the Sitagroi material, identifies this white layer as kaolin slip (*Gardner 1980.109*). Twenty Akropotamos-style sherds with cream-grey and very pale brown fabric (the colour of surfaces and fabric ranging from Munsell soil colour notations 10YR7/2 and 7/3, 7.5 YR 7/2 to 10YR 6/3) were refired, for the present study, in oxidising conditions at 900°C (see Tab. 1 and the previous section on iron deduction technique). After refiring, their fabric acquired a reddish-yellow colour (Munsell soil colour notations 7.5 YR 7/6 and 6/6 and 5YR 6/8) indicating that the grey, very pale brown fabric was produced by firing the pots in conditions that did not permit their full oxidation. Furthermore, refiring showed that all sherds had a thin, whitish, matt slip, except for two sherds which were only burnished. Similar results were obtained after refiring ten sherds with bold brown motifs on a buff, very light brown background. All sherds acquired a clear reddish-yellow colour. Five were covered with a thin slip, which macroscopically appears similar to that applied on the Akropotamos-style vessels. Four sherds with Akropotamos-style decoration (two from Dikili Tash and two from Mikro Souli) were analysed by V. Kilikoglou. Three were covered with a calcareous-rich slip, ranging in thickness from 10–20 μm. The fourth calcareous slip was thicker, reaching 30–40 μm.

The whitish slip, even when well preserved, is usually thin and cannot conceal the reddish colour of the fully oxidised body. It seems then that despite the use of a slip, firing the vessels under conditions which did not permit their full oxidation was important for the successful production of a cream-grey, very light brown background. Chemical analysis of four of the refired sherds showed that the pigment used for their decoration is manganese-rich (see previous section on manganese-based pigments). Thus, firing in non-oxidising conditions was not aimed at the production of the dark motifs, but at the production of the desired background of the decoration.

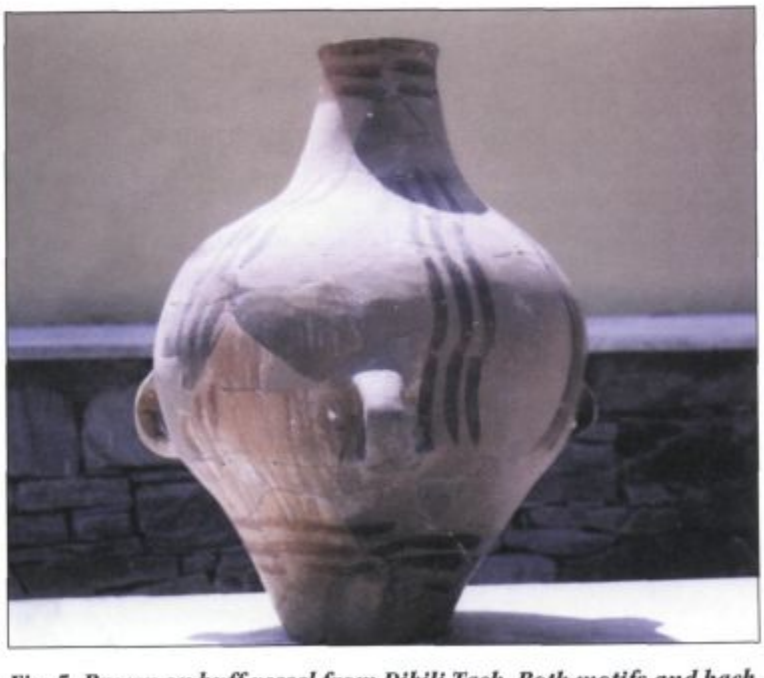

Fig. 5. Brown-on-buff vessel from Dikili Tash. Both motifs and background are, at places, red. This discoloration can be attributed to local drafts of air that did not permit the maintenance of fully reducing conditions.

Vessels decorated with a red pigment on a red-coloured background

Pots with red, red/brown motifs on a red coloured surface (orange-on-orange and red/brown-on-red wares) are present, although in minor quantities, in Late Neolithic I levels (Figs. 2.3, 4, 6). For the production of the red motifs an iron-based pigment was used which acquired a clear red colour by firing in oxidising conditions. Under the same conditions the fabric of the vessels turned red and was used as the background of the decoration.

Vessels with red/brown (orange-on-orange and red/brown-on-red wares) and dark brown decoration (brown-on-cream, brown-on-buff and brown-on-white wares) have comparable motifs (thin or bold lines), similar forms and fabrics (*Keighley 1986.353; Grammenos 1997.39–41*). They differ mainly in the colour of their decoration. Based on this, someone could propose that the red/brown motifs were the result of firing accidents: potters were aiming at the production of brown-on-buff effect, but since they could not control the firing conditions, produced the red-on-red vessels. Although this may be the case for a few vases, it seems that the clear red colours of most of the red, red/brown-on-red vessels should not be attributed to firing accidents.

Sometimes, iron-based and manganese-based pigments were combined by the potters to produce a polychrome effect (red and black motifs on a red background). Such vessels are rather rare: a few sherds have been found at Dimitra, Toumba, Galipsos, and Promachon-Topolnitsa (*Grammenos 1997; Koukouli et al. 1996a*). Some of these sherds (from Dimitra, Toumba and Galipsos) were examined under stereoscopic microscope. In all cases the red and black pigments appear to have comparable relief. This seems to exclude the use of the iron reduction technique, in which, by varying the thickness of an iron-rich pigment and changing from a reducing to oxidising atmosphere, a dichromatic effect can be produced (*for a theory on this see Jones 1986.765*). Support for this conclusion lies in the fact that after refiring (in the same conditions as the vessels with brown-black motifs) the motifs of two sherds from Toumba and Galipsos did not lose their original colours.

Vessels decorated with an organic material applied after firing

Such vessels have been found in the recent excavations of Promachon-Topolnitsa, a site on the Greek-Bulgarian border (*Koukouli et al. 1996a.753*). The decoration, which consists of stripes, wavy lines or groups of parallel lines, was executed with a soft, thick, black-coloured material, which adheres well to the surface of the pots.

Three decorated sherds were refired, in an oxidising atmosphere at 320°C for 30 minutes. After firing, the motifs were still present, but assumed a very pale grey colour. After firing at 450°C for 30 minutes, the decoration disappeared (Fig. 6; *Yiouni et al.1994*). Since this temperature is low (far below the temperature-range at which ceramics are fired), it can be concluded that the black colouring material was an organic coating applied after the original firing of the vessels. Macroscopically, the material appears as bitumen, but this has to be verified by further analysis[2].

Fig. 6. Refiring of sherds from Promachon-Topolnitsa decorated with an organic coating. In the clear coloured chips of two of these sherds the organic material disappeared after refiring at 450°C, for 30 minutes. The pink-red slip of the third sherd was not affected by the firing.

2 Bitumen is either an originally mineral pitch or any of several hard or semisolid materials obtained as asphalitic residue in the distillation of coal tar, wood tar, petroleum etc.

Similarly decorated vessels were also identified among the ceramic material from two other settlements: Dikli Tash and Dimitra (Fig. 3.4; *Yiouni 2001*). These are the first documented instances for the use of this technique in Macedonia. It is very probable, however, that this practice was more widespread. Sherds from the Late Neolithic Servia (in West Macedonia) are decorated with a colouring material which, according to the excavator's description, has the characteristics of an organic coating applied after firing (*Yiouni 2001*). It should also be pointed out that the scarcity of this type of decoration might not reflect the original distribution of this ware. Taphonomic processes or the vigorous cleaning of the sherds can easily destroy the post-firing application.

Vessels with similar decoration have also been found at two Bulgarian settlements situated north of Promachon: Damyanitsa and Balgarcevo (20 and 80 km respectively to the north: *Grabska-Kulova 1993; Pernicheva 1995*). Analysis of one sherd from Damyanitsa showed that the colouring material was bitumen (*Wagner and Graf 1993*). Deposits of bitumen exist in the area around Damyanitsa, but Wagner and Graf cannot exclude the possibility that the material was obtained as a residue in the distillation of organic substances.

Firing of Late Neolithic I painted pottery

According to the discussion so far, it is clear that firing played a major role in the final appearance of the LNI painted vessels from East Macedonia. By controlling the firing conditions, potters could modify the colour of the motifs and/or the background of the decoration. In the present section we will try to reconstruct the firing techniques used by the potters on the basis of the macroscopic examination of the material, the estimated firing temperatures of the analysed sherds and the available remains of firing structrures.

Starting our discussion with the vessels decorated with brown motifs, it is easy to conclude that these vessels were not fired in open firings. In such a procedure the positioning of fuel and vessels before firing can affect the flow of air (*Rye 1981.98*), but during firing it is very difficult to control the atmosphere and to change it at will from oxidising to reducing. It is true that the control of the firing conditions by the LN I potters was not very strict and the changes in atmosphere were not always successful, but still the overall appearance of the vessels is not compatible with an open firing.

So vessels were fired either in pits (where fuel and vessels are not separated), or in kilns (where fuel and vessels are separated). When pits are simple depressions in the ground they do not offer any significant advantages compared to open firings. More sophisticated structures, however, such as a circular wall or a three or four-sided enclosure, are known ethnographically. The fuel and vessels are often placed in alternating layers, and air access may be provided by holes in the walls at or near ground level and by passages let through the setting (*Rye 1981. 98*). Thus, pits may achieve higher temperatures and sustain them longer than open firings. Moreover, pits provided with an air inlet offer better control since air can be excluded easily during firing (*Shepard 1976.216–217*). In a kiln firing, of course, the firing atmosphere and the rate of heating can be controlled more effectively.

Macroscopic examination of the painted vessels indicates that they were, most probably, fired in pits. The basic indication for such a firing is the discoloration of their motifs. The change in colour, on a single vessel, from brown to red is compatible with a pit firing because it suggests that the firing conditions were not strictly controlled, as would have been expected in a kiln firing. Moreover, the painted vessels have often grey-coloured, smoked areas, a feature suggesting that, during firing, the vessels were not separated from the fuel. The available estimated temperatures of the analysed sherds are also within the range attained by pit firings. As can be seen from Table 2, the mean temperature is 850°C, although some vessels were fired at even higher temperatures (1000°C–1100°C).

So far, the discussion has been restricted to the data obtained from the analysis of fired ceramics. But what do we know about the firing structures themselves? An oven from Dikili Tash, similar in shape to the domestic ovens from the site, has been identified as a structure used for firing vessels since it contained a number of pots mixed with charcoals (*Seferiades 1983.643, Fig. 6*). In this case, vessels and fuel were placed in the same chamber. Re-examination of the data, however, and comparison with the architectural remains from the recent excavations of the site question this interpretation (*Tsirtsoni 2000*). According to the new interpretation, it appears that the vessels were not standing on the floor of the oven, but on a near-by clay platform (a common feature accompanying the ovens at the site of Dikili Tash). Another structure that could have been used for firing pots was found at Krioneri. A cylindrical

Site/Ware	Temperature Range (°C)	Scientific Method of Estimation
Dikili Tash 1 Akropotamos-style	800–900	Scanning Electron Microscope (V. Kylikoglou)
Dikili Tash 2 Akropotamos-style	1100	"
Mikro Souli 2 Akropotamos-style	1050–1080	"
Mikro Souli 3 Akropotamos-style	800–900	"
Mikro Souli 1 Bold. Br. Décor	850	"
Podochori 1 Bold. Br. Décor	800–850	"
Dimitra 5 sherds of Akropotamos-style	750–850	X-Ray Diffraction (Kessissogloy and Mirtsou 1997)
Dimitra 2 sherds of Akropotamos-style	900–950	"

Tab. 2. Firing temperatures of Late Neolithic I painted vessels.

pit (1 meter in diameter), with an opening at the side (0.40 m wide), was dug by the Neolithic inhabitants at the edge of the settlement (*Malamidou 1997.515, Fig. 5*). It contained some undecorated sherds mixed with ashes and charcoal. The interior of the pit was burned, whereas the opening was blocked with stones and earth. Although the contextual data are not fully conclusive for the use of this pit for firing pots (i.e. absence of whole vessels inside the pit and lack of pottery wasters in the surrounding area), theoretically it could have provided the conditions needed for the reduction of the iron-based pigments.

The contemporary vessels decorated with red motifs (orange-on-orange and red/brown-on-red ware) could also have been fired in similar structures, although an open firing cannot be excluded. The same can be proposed for the vessels decorated with an organic coating applied after firing.

LATE NEOLITHIC II

Vessels painted with a dark brown or red pigment (brown-on-cream, brown-on-buff, brown-on-white, orange-on-orange and red/brown-on-red wares) continued to be produced, although in decreasing frequency, in Late Neolithic II (Tab. 3). This phase, however, is characterised by the presence of two distinctive wares: the black-on-red and graphite decorated vessels.

Black-on-red ware is characteristic of the East Macedonia, since it is restricted mainly to this region. Appearing sporadically in LN I (*Grammenos 1997.Tab. 1; Keighley 1986. 358*), black-on red vessels are more common in LN II (Tab. 4). In Central and West Macedonia black-on-red vessels are sporadically present (*Grammenos 1991.126*). In Thrace, this ware is found at the settlements of Paradeisos (*Hellstrom 1987*) and Paradimi (*Bakalakis and Sakellariou 1981*), being rare at Makri (*Efstratiou 1991.600*).

Graphite, the mineral form of carbon, has an early appearance in the East Macedonian region. Grey lustre and grey-channelled wares are present in the late Middle Neolithic and early Late Neolithic (Sitagroi I and II levels). These vessels are covered by graphite, which produces a smooth, glittering and "soapy" surface (*Keighley 1986.346*). Graphite, painted and excised with graphite (vessels combining painted and excised motifs) are characteristic of the LN II levels. They are present at all East Macedonian settlements, increasing in frequency as we move eastwards. At Dimitra, for example, such vessels amount to 5%-17% of the decorated pottery, but they are far more common at Sitagroi and Dikili Tash, where they comprise 75% or more of the decorated pottery (Tab. 4). In Thrace, graphite-decorated

Site/Ware	Temperature Range (°C)	Scientific Method of Estimation
Dimitra 8 Bl/Red sherds	900–950	X-Ray Diffraction (Kessissogloy and Mirtsou 1997)
Dimitra 1 Bl/Red sherd	750–850	"
Dimitra 1 1 Bl/Red sherd	850–950	Scanning Electron Microscope (Kilikoglou)
Dikili Tash 3 1 Bl/White sherd	1000–1100	"
Nea Bafra 1 1 Bl/Red sherd	850–950	"

Tab. 3. Firing temperatures of black-on-red and related Late Neolithic II painted vessels.

vessels are common at Paradeisos and Paradimi, but rare at Makri (*Efstratiou 1991.600*). Only sporadic examples are reported from a few Central Macedonian sites (*Heurtley 1939.133, no. 128–9*). In contrast to the black-on-red pottery, which has a very limited spatial distribution, graphite decorated vessels are characteristic of the Gumelnitsa-Karanovo VI cultural complexes of Bulgaria and Romania (*Demoule 1993.382*).

Black-on-red

The black motifs were painted either on the clear red, fully oxidised surface of the pots, or on an iron-based slip. The complex decoration of the vessels has been divided into two styles, I and II. Style I, displayed on a wider range of vessels, consists of various curvilinear and rectilinear patterns, various filled motifs (rectangles, triangles) and combinations of all three (*Evans 1986.400*) (Figs. 7, 8). Style II consists of broad curvilinear lines which often give a floral appearance (Fig. 9). Black-on-red vessels are usually open, large-sized pots with rounded or flaring walls. Jars are also present.

All the analyses so far show that the black decoration was executed with a manganese-based pigment. This material decorated the vessels from Sitagroi and Dikili Tash (*Gardner 1980.123; Courtois in press*). Similarly, manganese has been identified in the chemical analysis of two black-on-red sherds from Nea Bafra and Dimitra (Tab. 1).

During the macroscopic examination of the pottery from East Macedonia an interesting feature was noticed among the black-on-red pottery from Dimitra and Krioneri. Black-on-red vessels sometimes have a milky-white, transparent layer, which was applied on top of the painted decoration. Traces left on the surface of one sherd from Dimitra which was not carefully covered with this material, indicate that the transparent slip was wiped in various directions with a soft material (probably cloth). Furthermore, whereas the white layer is micaceous, both the red slip and the black pigment are free from mica. Chemical analysis of this sherd, showed this thin (3–5 μm), fine-textured layer was applied before the firing of the vessel.

It is the first time that such a practice has been reported for a Greek Neolithic ceramic material. Perhaps it was restricted to sites near the river Strymon (both Dimitra and Krioneri are situated there), since it seems to be absent from settlements further east (i.e. Dikili Tash). What are the reasons for the application of this extra layer? Colour contrast and the reduction of porosity should be excluded as possible explanations as the material was applied to slipped and painted surfaces. Nor can it be proposed that it was used to protect the black pigment, since chemical analysis of the sherd from Dimitra showed that the colouring material is not a pure manganese coating, but a clay-based solution enriched with manganese. One probable explanation is that, by applying this extra layer, the potters could rapidly produce a lustrous surface. Black-on-red vessels are often open, large-sized pots. Burnishing these pots is more time-consuming than simply covering their surface with a liquid suspension.

Graphite decorated pottery

Graphite is also applied on large vessels with flaring or carinated walls (*Evans 1986.398*). Closed pots, often smaller in size, were also painted with graphite. The decorative style varies from rather simple lines to various complicated combinations of straight or curvilinear motifs: spirals, meanders, circles, triangles and lozenges (*Evans 1986.397*) (Figs. 10.1, 3, 4). In the vessels excised with graphite, painted motifs are combined with excised linear patterns filled with white or red-coloured paste (Fig. 10.2).

Graphite is a soft, grey, laminar form of pure carbon occurring in high-grade metamorphic rocks as a final product of the carbonisation of organic substances. Due to its silvery appearance graphite pigment can be relatively easily recognised by macroscopic examination. So far, this material has been identified, by X-ray diffraction, on specimens from Karanovo in Bulgaria, Dikili Tash and Sitagroi in East Macedonia

Site	Graphite Painted (% of decorated pottery)	Black-on-Red (% of decorated pottery)	Vessels with dark brown motifs (% of decorated pottery)
Dikili Tash	75%	1–5%	–
Sitagroi	79%	21%	–
Paradeisos	90%	10%	–
Krioneri	15%	60%	15%
Dimitra	5–17%	28–58%	52–9%

***Tab. 4. Relative amount of black-on-red and graphite decorated vessels.** (**Data from Demoule 1993; Evans 1986.Tab. 2.1; Hellstrom 1987; Malamidou 1997; Grammenos 1999.Tab. 1*).**

(*Jones 1985.768, Tab. 9.6a*). In her study of the material from Sitagroi, Gardner concluded that two different methods were used for the execution of the decoration: graphite was either rubbed on the surface of vessels (like a crayon), or it was applied, with a brush, in a liquid suspension (*Gardner 1980.124; Evans 1986.397*). These differences must have been dictated to a great extent by the nature of the raw material. If it is pure, graphite can be used as a crayon. Otherwise, it has to be refined before it can be used for decorative purposes (*Yiouni 2001*). A refiring test carried out for the present study indicates that pure graphite was rarely used by Neolithic potters. Thirty sherds with graphite decoration from a number of East Macedonian sites (Tab. 1) were refired at 850°C, in an oxidizing atmosphere. The maximum temperature was retained for 30 to 60 minutes. Apart from two sherds (both from the site of Promachon) unaffected by the firing, in all other cases the pigment appears as a white residue, occasionally preserving some metallic sheen. Since graphite is burned at rather high temperatures, it seems that the colouring material of the refired vessels was not pure graphite.

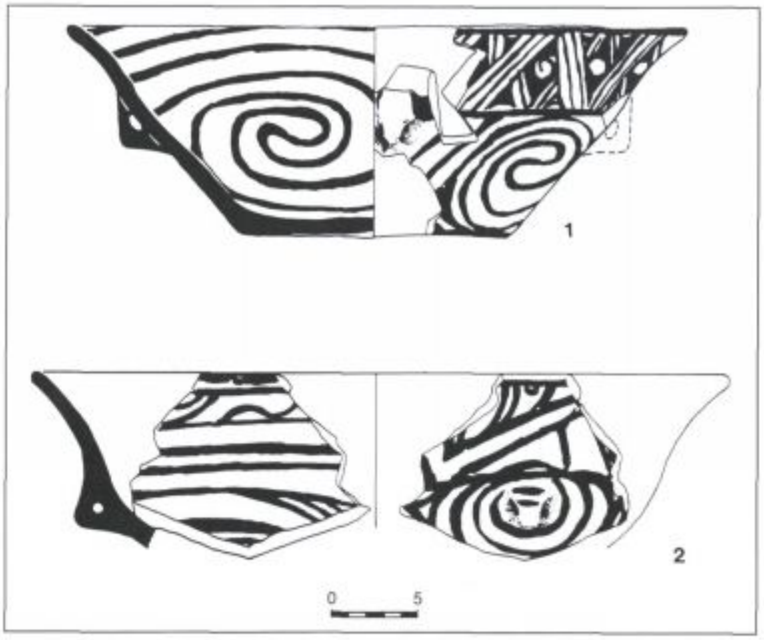

Fig. 7. Black-on-red vessels from Sitagroi (**Evans 1986.Fig.12.8*****).***

Graphite decoration occurs mainly on black or dark brown-coloured surfaces (*Evans 1986.397; Seferiades 1983.653*). Thus, the silver colour of the pigment is more pronounced. The dark coloured background was not achieved by the application of a slip, but through the control of firing conditions. This conclusion is based on the following observations: the black colour of the surface(s) extends deep into the vessel's cross-section; in other cases the entire cross-section is dark. Furthermore, after refiring in an oxidising atmosphere, all sherds (30) acquired clearer surfaces and cross-sections.

The linear patterns of the vessels excised with graphite are filled with a white or red-coloured paste. At Sitagroi both calcium carbonate and kaolin were used as a white infill, the red paste being ochre (*Gardner 1980.128*). Potters from Dikili Tash were using a paste rich in calcium oxide (CaO), sometimes containing white mica (*Courtois in press*). These materials were most probably applied after the original firing of the vessels (*Gardner 1980; Yiouni 2001*).

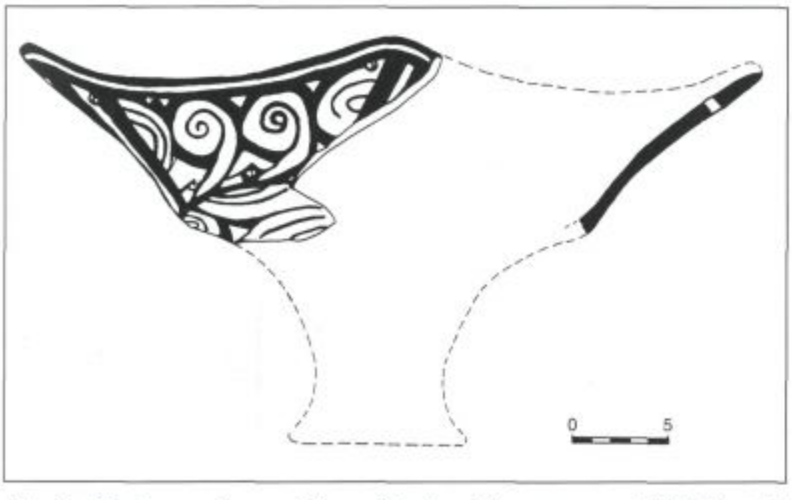

Fig. 8. Black-on-red vessel from Dimitra (**Grammenos 1997. Fig. 30. 457*****).***

So, the production of graphite-decorated vessels required a combination of various techniques. Extreme examples of this practice are the pots combining graphite painted patterns, with excised motifs, the production of which can be summarised as follows: first the potters painted the motifs, and with a sharp tool produced the excised patterns. The painted sections of the pots were burnished. During firing, the vessels acquired a dark-coloured background, and after firing, the paste filling the excised motifs was applied.

The firing of Late Neolithic II painted vessels

In her study of the Sitagroi material Gardner, distinguished two groups (Type I and II) of graphite decorated ware (*Gardner 1979*). Type I is found north of the Rhodope Mountains, and Type II, south of the mountains, on the Drama Plain in east Macedonia. According to Gardner, pots from the southern region (Type I) were fired at rather high temperatures (1000°C or even more, according to refiring tests) and the quality of their pigment is very good (grainy, with a crystalline metallic sheen). In contrast, vessels found in Bulgaria were painted with a thin, fugitive pigment, and were low fired (lower than 750°C, according to Garner's refiring tests).

Subsequent research on graphite-decorated vessels from Greek Neolithic sites does not support Gardner's conclusions. The estimated firing temperature of two sherds from Dikili Tash is lower than 750°C (*Maniatis and Tite 1981.57–9*). Both vessels were fired in non-oxidising conditions. Kessissoglou and Mirtsou reached the same results after the refiring of a number of sherds from Dimitra (*Kessissoglou and Mirtsou 1997.89, Tab. 1*).

As mentioned above, thirty sherds from a number of east Macedonian Neolithic sites were refired by the author. In most cases the graphite pigment was

Fig. 9. Black-on-red vessel from Sitagroi (*Evans 1986.Fig. 12.9.3*).

burned off when fired at 850°C, or even at lower temperatures. The fabric of the sherds was also affected, since seven sherds (from Nea Bafra, Sitagroi and Dikili Tash) were vitrified. Graphite-decorated vessels were most probably manufactured from non-calcareous clays and, in contrast with the refiring test, were originally fired in a non-oxidising atmosphere. Since the firing of non-calcareous clays in reducing conditions lowers (by 50°C) the temperatures at which vitrification starts (*Maniatis and Tite 1981.61*), it is quite probable that some of the sherds were originally fired at temperatures lower than 850°C. Thus the analyses of the graphite-decorated pots suggest that these vessels were regularly fired in a non-oxidising atmosphere at rather low temperatures. A pit firing could facilitate the production of black coloured surfaces because of the ease of excluding air. It should be pointed out, however, that open firing of the vessels cannot be excluded.

Instead, open firing can easily be excluded for the contemporary black-on-red ware. These vessels have clear red-coloured surfaces and cross-sections. When tapped, they produce a clear, crystalline, sound. These characteristics indicate that the pots were thoroughly fired in oxidising conditions at rather high temperatures. Indeed, the estimated firing temperature from a number of analysed sherds is around 900°C (Tab. 3). An interesting feature of the black-on-red vessels is the rarity of smoked areas on their surfaces. According to these characteristics, an open firing can be excluded, but is it possible to propose that these vessels were fired in kilns?

Kilns represent a major advance toward ensuring success in firing pots. Updraft kilns are simple, enclosed firing chambers in which the heat moves upward from underneath the pots and is then vented outward. While many types of complex kilns exist, simple ones used by traditional potters usually have open tops through which the kiln is loaded. The maximum temperatures these kilns attain usually range from 900°C to 1000°C (*Rice 1987.160*). Apart from sustaining temperature as long as is needed, the other main advantage of a kiln firing is that both the atmosphere and the rate of temperature rise can be controlled (*Rye 1981.98*).

The remains of structures that could be interpreted as kilns are absent from the Greek Neolithic sites. Taking into consideration the limited scale of the excavations, this absence is not a sound argument against the existence of kilns. Turning to the fired vessels themselves, it can be seen that the consistency of high firing temperatures and the control of the firing atmosphere are compatible with kiln firing. The technology of the vessels is also supportive of such a firing. As mentioned above, black-on-red vessels are often large and have complex shapes (Figs. 7, 8, 9). Furthermore, black-on-red vessels were regularly made from extremely fine-textured fabrics (*Renfrew et al. 1986.155*). Firing such vessels can be very risky. In a kiln firing, however, pots can be heated slowly and evenly to complete the drying process. The need for temper in the clay is not so great because, the rate of shrinkage is more controlled (as the rate of temperature rise can be controlled). In contrast, graphite decorated vessels were regularly made from medium to coarse-textured fabrics (*Renfrew et al. 1986.158*). Such fabrics facilitate the building and drying of large, complex forms and can withstand abrupt changes in firing temperature.

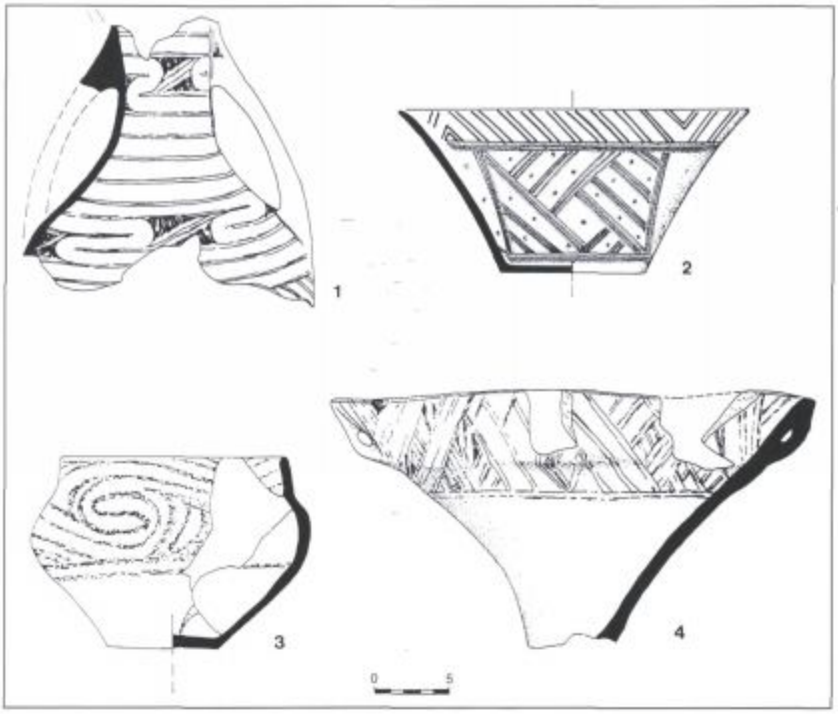

Fig. 10. Graphite decorated vessels: 1. and 4. from Sitagroi (**Evans 1986. Figs. 12.5, 1 and Fig. 12.4*****); 2. excised with graphite from Dikili Tash; 3. from Dimitra (*****Grammenos 1997.Fig. 19, 267*****).***

CONCLUSIONS

During LN I there was great variation in the methods and raw materials used to decorate pots. Dark brown, the preferred colour of decoration, was produced either through the use of manganese-based materials or through the reduction of iron-based pigments. More rarely, the dark motifs were produced with an organic material applied to the surface of the vessels after firing. Manganese-black and the iron reduction technique are widely known in East Macedonia. In contrast, the post-firing organic coating, despite its sporadic appearance at Dikili Tash and Dimitra, is characteristic mainly of the site at Promachon-Topolnitsa (a site divided by the Greek/Bulgarian border) and the neighbouring Bulgarian site of Damyanitsa (being rare at Balgarcevo).

The grey-buff colour of the background of the decoration was produced either through the application of a slip (kaolin or calcareous material) or by firing the vessels in non-oxidising conditions. Since in many cases the slip was very thin, the manipulation of firing conditions was imperative for the achievement of the desirable grey-buff colour. Red motifs, less common than the dark brown, were produced by the application of an iron-based pigment fired in oxidising conditions.

In all cases, the manipulation of firing conditions was decisive for the successful appearance of the decoration. The reduction of iron-based pigments, in particular, is a complex method requiring the careful preparation of the colouring material and organisation of firing conditions (control of atmosphere, temperature and duration of firing). These vessels were fired in pits, most probably provided with an air inlet (as the structure excavated at Krioneri). The discoloration of motifs from brown to red indicates that the potters were not always successful in their attempts.

Characteristic of LN II are black-on-red and graphite-decorated vessels. Although these wares have many similarities in vessel form and decoration, they have pronounced differences in the fabric used for their manufacture, the raw materials used for decoration and the firing sequence.

Graphite-decorated vessels were made from medium to coarse-textured clays which could not withstand firing at high temperatures. In contrast, the fine-textured fabrics of the black-on-red vessels were regularly fired at rather high temperatures (around 900°C). This means that, for each ware, there existed specific recipes of clay fabrics, and potters systematically collected raw materials that would produce the desired results. The same is true of the earlier LN I painted vessels, since potters collected clays that could acquire, by being fired in slightly reducing conditions, a grey-buff colour. In the LN II period, however, there was a strict dichotomy between the clay fabrics used in the black-on-red and graphite decorated vessels.

Completely different raw materials were also used for the decoration of these two wares: manganese-based pigment and an iron-rich slip for the decoration of the black-on-red vessels. The graphite-based pigment was often combined with a variety of post-firing pastes (ochre, kaolin or calcareous-based paste). It is interesting to note that manganese and graphite are common in the mountains surrounding the Drama Plain and that very often they are found in juxtaposition[3]. Despite this, the black background of the graphite-decorated vessels was produced through the manipulation of firing conditions and not by the application of a manganese-based slip. A pit or even an open firing could provide the conditions for the successful firing of graphite-decorated vessels. A kiln firing is proposed for the black-on-red vessels. Due to the complexity of firing techniques this proposal must be considered as preliminary and has to be confirmed by future research. It is undeniable, however, that the firing sequence of black-on-red vessels was carefully organised and strictly controlled.

Given the basic differences outlined above and taking into consideration that the whole technological sequence is very complex, it could be proposed that these two wares were not manufactured by the same potters changing at will from one ware to the other (*see also Courtois in press*). As can be seen from Table 4, both wares are present at all east Macedonian sites, but their distribution follows an opposite pattern. Graphite-decorated vessels are rare at Krioneri and Dimitra (that is, in the western part of east Macedonia), but increase dramatically in frequency as we move eastwards. In contrast, black-on-red vessels are more common at the western sites. In the western region, vessels decorated with dark brown motifs are also present. At Dimitra, in particular, such vessels are extremely common in the early levels of LN II (amounting to 52% of the decorated pottery). Black-on-red and vessels with dark brown motifs have many similarities in the texture and colour of the clay fabrics used for their manufacture.

It should be stressed, however, that the pattern of production of the Late Neolithic painted wares may not has been so simple (that is, the production of black-on-red in the west and of graphite decorated pots in the east) as appears from the data presented above. It has already been seen that the black-on-red decoration of the vessels from Krioneri and Dimitra was sometimes covered with an extremely thin (3–5 μm), whitish slip. This feature seems to be absent further east. A research program combining the petrographic and chemical analysis of a large sample of ceramics and raw materials is needed to better define the organisation of the production of the Late Neolithic painted vessels from east Macedonia.

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3 Dr. I. Chatzipanagis (Institute of Geological and Mining Research, Thessaloniki), pers. comm. 1998.

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Documenta Praehistorica XXVII

On the Bailiandong Culture

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ABSTRACT – *The Bailiandong cave site was discovered in 1956, and was excavated and a preliminary study made of it by Beijing Natural History Museum and Liuzhou Municipal Museum from 1980 to 1982. A supplemental study from 1991 to 1993, funded by the Chinese National Science Foundation, found that its deposit included five continuous cultural strata from the Late Palaeolithic to the Neolithic with a transitional phase, and established a new framework for the Bailiandong Cultural Series. The Bailiandong cave site has incalculable value in attempts to explore how the Palaeolithic was transformed into the Neolithic in Southern China.*

IZVLEČEK – *Najdišče v jami Bailiandong so odkrili leta 1956, ga izkopali in med leti 1980 in 1982 pod vodstvom Prirodoslovno-zgodovinskega muzeja iz Pekinga ter Mestnega muzeja iz Liuzhouja objavili preliminarne rezultate. Nadaljne raziskave med leti 1991 in 1993 je financiral Kitajski nacionalni sklad za znanost. Odkrili smo, da je med jamskimi depoziti pet kontinuiranih kulturnih plasti od poznega paleolitika do neolitika, ki vključujejo tudi prehodno fazo. Izdelali smo nov okvir za bailiandongško kulturno zaporedje. Jama Bailiandong je neprecenljive vrednosti pri raziskovanju preoblikovanja paleolitika v neolitik na južnem Kitajskem.*

KEY WORDS – *China; Guangxi Province; Bailiandong cave; Palaeolithic; Neolithic; transition*

INTRODUCTION

Bailiandong (White Lotus Cave) is located 12 km southwest of the city of Liuzhou (109°20' E, 24°15' N) and 2 km from the famous Liujiang Man site in Guangxi Province (Fig. 1). The Bailiandong cave is situated on Mount Baimian (White Face) and was discovered in 1956 when Pei Wenzhong (Pei Wenchung) was surveying near the Gigantopithecus cave site. Isolated cultural remains were found in disturbed layers in Bailiandong cave, and were classified as late Palaeolithic by Jia Lanpo (Chia Lan-po) and Qiu Zhonglang in 1960 (*Chia and Qiu 1960*). The Liuzhou Municipal Government designated it in 1961 as being among the key relics under municipal protection.

From 1973 to 1980, Liuzhou Municipal Museum studied the relics several times and made a number of small-scale excavations, which recovered both, cultural and fossil mammalian remains (*Zhou and Yi 1982*). In 1980 and 1982, the Beijing Natural History Museum and Liuzhou Municipal Museum jointly conducted excavations and a preliminary study, which led to the conclusion that the cave site includes five continuous cultural strata from the late Palaeolithic to the early and middle Neolithic, with a transitional phase. The archaeological materials from the cave are referred to as the Bailiandong Cultural Series (*Zhou 1984; 1986*). In 1985, the Bailiandong Cave Science Museum was founded and opened.

In 1991 funding was secured from the China National Natural Science Foundation (CNNSF) for further investigations over three years in an effort to explore the dating and ancient ecological environment of the cave's sediments and to establish a new framework for the Bailiandong Cultural Series. These investigations have resulted in a number of breakthroughs (*Yi et al. 1994; Zhou 1994*).

THE GEOLOGICAL STRATIGRAPHY

The cave is located on the southern slope of Mount Baimian, 152 meters above the erosional plain of the ground surface. It has a half-hidden entrance facing south and a long inner passage to the north. The 3 metre thick deposits can be divided into eight layers in the eastern part of the cave and ten layers in the western part (*Liu and Xie 1994*). Layer 7 of the eastern deposit is a thick calcareous concretion. In the western deposit, Layer 3 and the upper part of Layer 4 form another thick calcareous concretion, which merges with that of Layer 7 of the eastern deposit in the centre of the cave. This concretion has been dated to 18 500–20 000 BP based on ^{14}C dates, and represents the driest and coldest period of the Late Glacial period (Figs. 2–4).

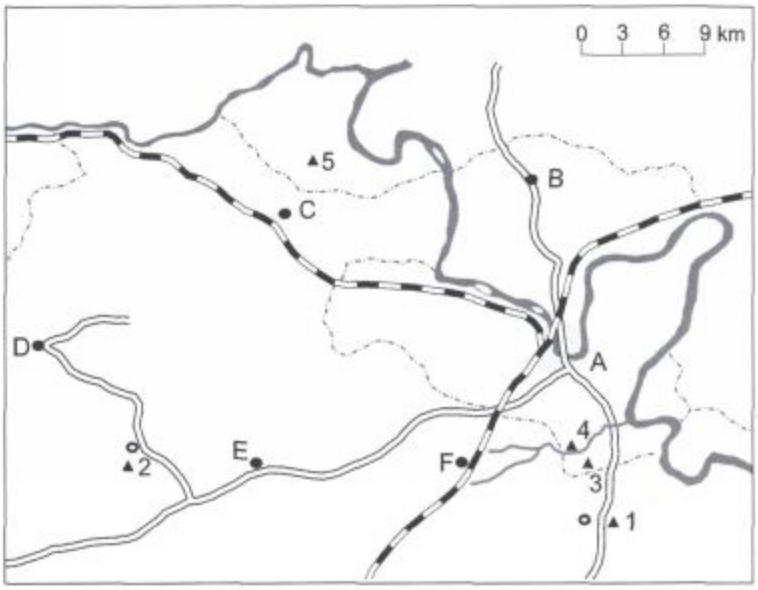

Fig. 1. The Localities of Fossil man in the Liuzhou Region: 1. Gigantopithecus Cave Site of Liucheng, 2. Liujiang Man Site, 3. Bailiandong Cave Site, 4. Douledong Cave Site, 5. Ganqianyan Cave Site, A. Liuzhou, B. Saikwan, C. Lonmon, D. Tobo, E. Shantu, F. Qinde.

By means of uranium-series and ^{14}C, especially AMS ^{14}C determination, a number of quite valuable dating figures have been obtained (*Yuan and Gao 1994*) which amply prove that the deposit inside Bailiandong cave is composed of regularly successive strata (Tab. 1).

The stratigraphic study and a spore-pollen analysis (*Kong et al. 1994*) have fully revealed the tendency of changes in the ancient ecological environment and climate of Liuzhou region since 30 000 BP which was synchronised with global changes in the ancient climate (Tab. 2). In fact, the Bailiandong deposits and relics have clearly demonstrated that the cave is a type of rare reservoir of global climatic information in the southern subtropics since the Late Pleistocene Glacial period. The recovery of data on the ancient ecological environment of Bailiandong cave is actually a background to the research of exploring the birth of agriculture in South China.

		East 1	7080±125 BP	Holocene		Atlantic Time
		East 2	9520±90 BP			Boreal Time
West 1	10 310±290 BP	East 3	11 160±580 BP	Late Pleistocene	Late Glacial Epoch	Allerød Time
		East 4	13 550±590 BP			Bolling Time
West 2	12 775±180 BP	East 5	13 905±250 BP			Würm II
		East 6	14 650±230 BP			
West 3	18 450±410 BP	East 7	19 645±200 BP			
West 4	19 910±180 BP	East 8	20 240±660 BP			
West 5					Würm	Paudorf
West 6	28 000±2000 BP					
West 7						Würm I
West 8						
West 9						
West 10	37 000±2000 BP					

Tab. 1. Dating Figures of the Main Layers of Bailiandong Cave.

Age	Western Deposit		Eastern Deposit	Ancient Climate and Ecological Environment	
Holocene	West 1 (0.2–0.56 m) Greyish-brown mildclay Upper 10310±290 BP	West 2 (0.4 m) Milk-yellow flowstone Top Layer 12780±180 BP	East 1 (0.2-0.32 m) Flowstone with pottery flakes Calcareous mildclay 7080±125 BP	Great warm epoch of the Holocene. The appearance of many subtropical evergreen broadleaf forest, graminaeceous, fern and water plants.	Atlantic Time
			East 2 (0.3 m) Milk-white flowstone 7140±60 BP and calcareous mildclay 9520±90 BP		Boreal Time
Late Glacial Epoch			East 3 (0.3–0.37 m) Greyish-yellow mildclay 11160±580 BP	Subtropical evergreen broadleaf forest, the climate was beginning to turn warm and humid.	Alerød Time
			East 4 (0.38 m) Yellowish-brown mildclay 13905±250 BP		Bolling Time
			East 5 (0.01–0.04 m) Greyish-white flowstone 13905±250 BP		
Late Pleistocene / Würm	Lower 17680±300 BP	Bottom Layer 19145±180 BP	East 6 (0.48 m) Brown mildclay 14650±230 BP	Appearance of the subtropical evergreen broadleaf forest and modern fauna.	Würm II
	West 3 (0.15–0.35 m) Yellowish-brown thick flowstone (upper sideward stone dike) 18450±410 BP		East 7 (0.44 m) Yellowish-brown thick flowstone (upper-sideward stone dike) 11670±150 BP 19645±200 BP		
	West 4 (0.5 m) Yellowish-brown thick flowstone (lower sideward stone dike) Top Layer 19910±180 BP 21575±150 BP Bottom Layer 26680±625 BP		East 8 (>1 m) Red-brown mildclay 20240±660 BP	The climate was cold and dry and characteristic of the maximum period of the Late Glacial epoch. Mixed forests of temperate mountain conifer and subtropical broadleaf in the low lands. Cold or temperate conifer forest in the mountains. Warmth-loving mammals migrate to the south.	
	West 5 (0.3-0.5 m) Redish-brown mildclay		(Bedrock not yet reached)		Paudorf
	West 6 (0.1 m) Yellowish flowstone 28000±2000 BP				
	West 7 (0.18 m) Yellowish-brown mildclay			The climate was beginning to turn cold. Temperate broad leaf forest. Stegodon-Ailuropoda fauna.	
	West 8 (0.1 m) Greyish-yellow flowstone				
	West 9 (0.12 m) Brown mildclay				
	West 10 (0.15 m) Milk-yellow flowstone 37000±2000 BP (Bedrock not yet reached)				Würm I

Tab. 2. Schematic Chronology based on Geological Stratigraphy and Paleoenvironmental data of Bailiandong Cave Site

THE ARCHAEOLOGICAL DATA

Large quantities of mammalian fossils have been found in the cave's deposits. The bones are very fragmentary and may represent the food remains of the prehistoric occupants. One thousand five hundred bones and teeth were found in the eastern deposits and 2000 in the western. Most of the teeth are isolated specimens: 150 derive from the eastern deposits and 240 from the western. The mammalian fossils identified were from 23 species. These are: *Rhizomes sp.*, *Hysterics subcristata*, *Macaca sp.*, *Homo sapiens sapiens*, *Martes sp.*, *Paguma larrvata*, *Vulpes cf. vulgaris*, *Ursus sp.*, *Arctonyx collaris*, *Ailuropoda melanoleuca*, *Sus scrofa*, *Bubalus sp.*, *Pseudaxis sp.*, *Muntiacus sp.*, *Cervus sp.*, *Lijiangocerus speciosus*, *Ovis sp.*, *Rusa unicolor*, *Rhinoceros sinensis*, *Stegodon sp.*, *Elephas sp.*, *Muridae gen. et sp. indet* and *Vespertilionidae gen. et sp. indet*.

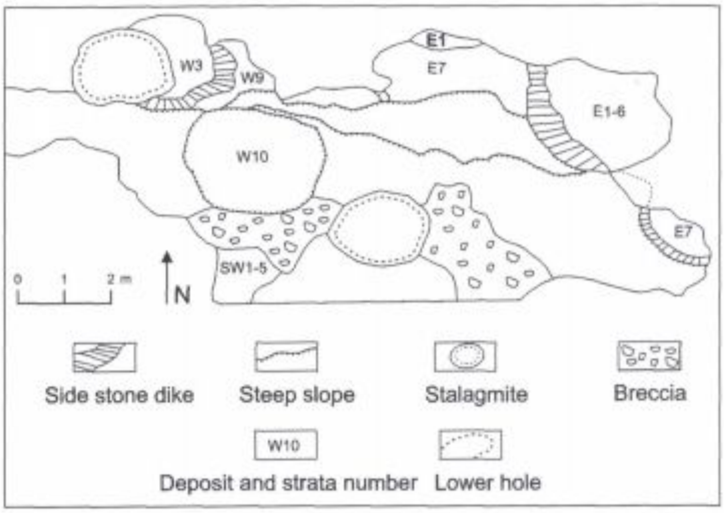

Fig. 2. Plan of the Bailiandong cave Site.

A number of extinct species and two isolated human teeth were recovered from Layer 7 of the western deposit. The human teeth, which comprise the right molar of a young female and the left third molar of a middle-aged male, are attributable to *Homo sapiens sapiens*.

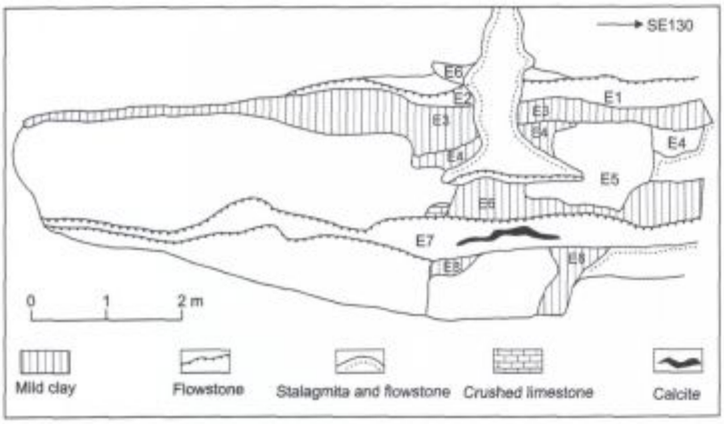

Fig. 3. Section of Eastern Deposits of the Bailiandong Cave Site.

The faunal assemblage from the western deposit represents the fauna of Stegodon-Ailuropoda with *Homo sapiens sapiens*, while the eastern deposit consists solely of modern mammalian specimens. Shells from five species of snail (*Viviparus dispiralis, Bellamys leei*, *Helix sp.*, *Semosulcospira sp.* and *Unio douglaside*) were found in the upper layers of the cave. Layers 5 and 7 in the western deposit contain only a few snail shells. In addition, two species of fish (*Cyprinus carpio* and *Mylopharyngodon*

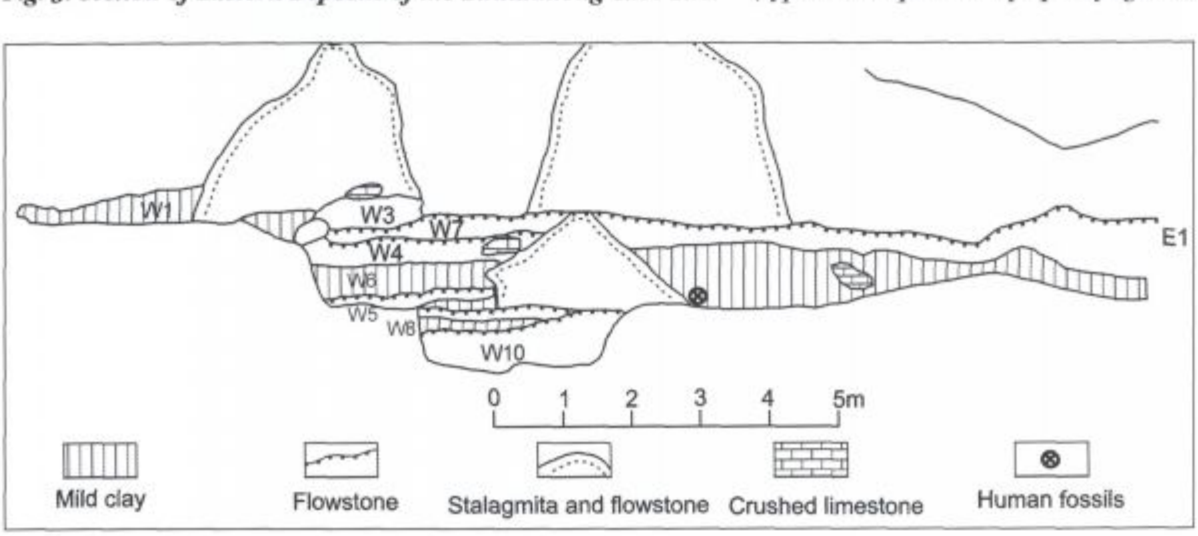

Fig. 4. Section of Western deposits of the Bailiandong Cave Site.

piceus) were also found along with frog (*Rana sp.*), turtle (*Testudinidae indet.*) and bird limb bone remains (*BSCM and BNHM 1987*).

Of the 500 chipped stone artefacts found at the site, 258 have been studied in detail. These specimens comprise cores, unused and used flakes and modified tools. The large tools were made on cobbles and pebbles, while the small tools were manufactured on flakes of black flint. Most of the small tools were found below the western thick calcareous concretion and a few pieces derive from the snail shell layers in the eastern part of the deposit. Bone, antler and polished horn tools have also been recorded. Three ground stone tools, including two completely ground and one ground only at the edge, and two perforated decorative objects were found in the upper layer of the eastern deposit. In the eastern deposit a few fragments of crude cord-marked pottery were found in the top layer.

The small flint tools were not made with the typical indirect percussion manufacturing technique (*Chen 1983; Chia 1978; Zhou 1974*), but with the anvil technique applied in the Danawu tradition in Yunnan (*Zhou and Zhang 1984*). There are three broken weight stones - perforated pebbles that were found separately in Layer 1 of the western deposit, Layer 6 and Layer 3 of the eastern deposit. One specimen in Layer 3 is completely ground. Two hearths were found in Layer 5 of the western deposit (Figs. 5-9).

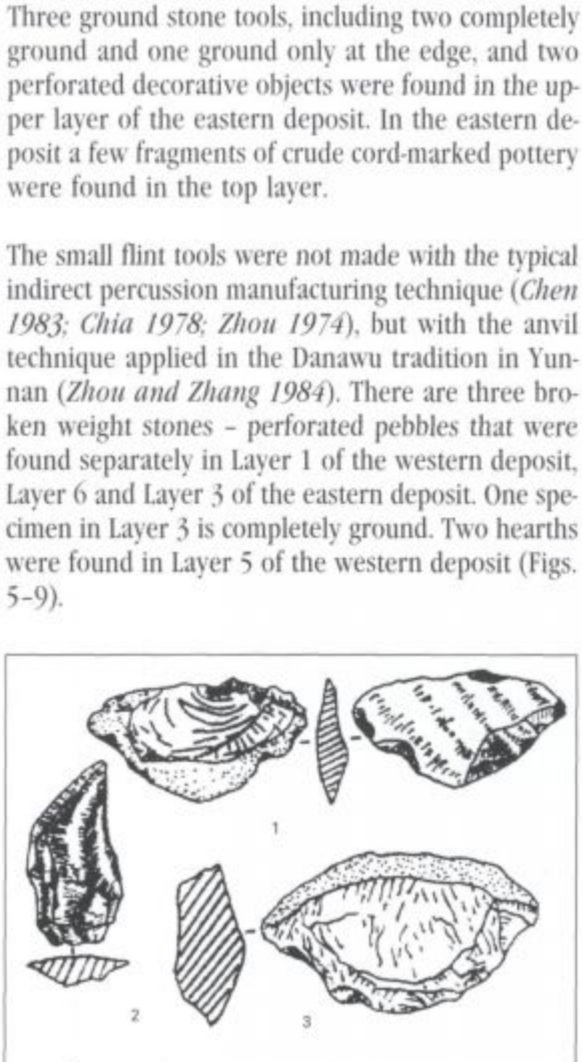

Fig. 6. Stone tools from West layer 5: 1. and 3. srapers; 2., 5. and 6. utilized flakes; 4. thumbnail scraper (black flint).

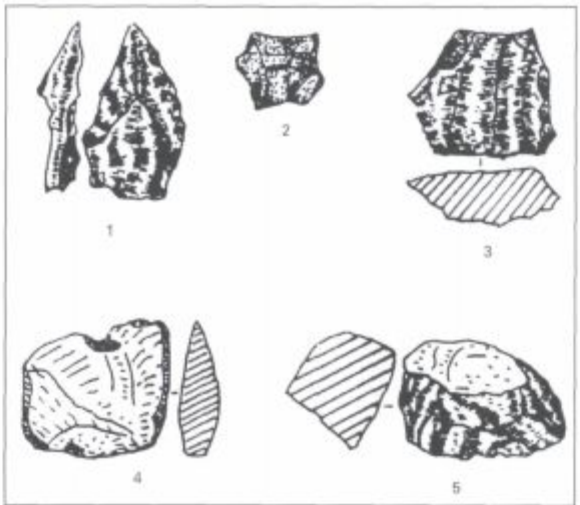

Fig. 5. Stone tools from West layer 7: 1. arrow-head (black flint); 2. utilized flake; 3. scraper; 4. sraper; 5. chopper.

The artefact layers of the cave can be subdivided into five cultural strata as follows:

Cultural Stratum 1 - Layers 1 and 3 of the eastern deposit are grayish-yellow mildclay and flowstone and contain pottery flakes. They also contain snail shells, ground stone tools, perforated decorative objects, weight stones and pottery. Between Cultural Stratum 1 and Cultural Stratum 2 there is a thin calcareous concretion in Layer 3 dated to 11 160± 580 BP.

Cultural Stratum 2 - Layer 4 of the eastern deposit is yellowish-brown mildclay. It contains snail shells, stone tools and horn tools with polished edge and point.

Cultural Stratum 3 - Layer 6 of the eastern deposit is a brownish mildclay. It contains snail shells, ash, red burnt clay, burnt bones and stones. This layer also includes one crude weight stone, crude pebble tools and hematite powder. This layer is always found overlying thick, hard travertine and overlain by another distinct travertine (calcareous concretion).

Cultural Stratum 4 - Layer 4 of the western deposit is a shallow yellowish-brown mildclay; the upper portion is a calcareous concretion. Large numbers of very small flint tools, including an arrowhead, a small crude polished cutting tool and some spokeshaves were found here as well as crudely made pebble tools.

Cultural Stratum 5 - Layers 5 and 7 of the western deposit are red-brown and yellowish-brown mildclay. Layer 5 contains a few snail shells. Very small flint artefacts and pebble tools in Layers 5 and 7 are typical of the Late Palaeolithic.

The artefacts found in the deposits of the cave can be put in the following order, from the oldest to the most recent: (a) Typical Palaeolithic stone tools, (b) Small and very small flint tools, (c) Crude pebble tools, (d) Crude weight stone, (e) Crude ground tools and (f) Crude pottery. According to the lithic, faunal, spore-pollen analyses and the stratigraphic dates, the Bailiandong Cultural Series may be divided into three cultural phases.

Phase I – Late Palaeolithic (Cultural Stratum 4 and 5): The lithic artefacts are predominantly characterised by specimens typical of the Late Palaeolithic. The main subsistence mode was hunting large game and gathering plant food.

Phase II – Mesolithic (Cultural Stratum 2 and 3): This is a transitional phase (from Palaeolithic to Neolithic) characterised by unifacially worked pebble tools (choppers) and crudely made ground tools. The appearance of large numbers of snail shells and chopping tools, which may have been used to crush the shells, is evidence of the intensification of riverine resource procurement. The occurrence of a weight stone is related to primitive agricultural activities. This transformation of subsistence patterns occurred during the Late Pleistocene to the beginning of the Early Holocene, perhaps over a period of several thousand years.

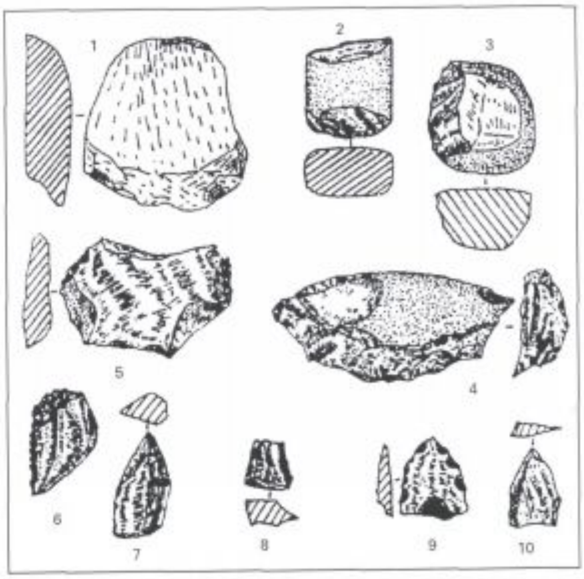

Fig. 7. Stone tools from West layer 2: 1. – 4. choppers (black flint artifacts); 5. and 6. srapers; 7. graver; 8. core; 9. arrowhead; 10. point.

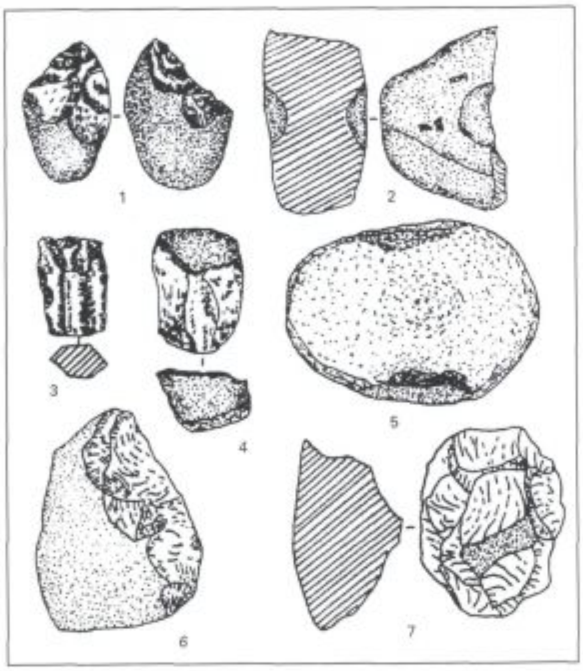

Fig. 8. Stone tools from East layer 2: 1. chopping tool; 2. perforated pebble (weight stone); 3. cores; 4. cores; 5. pebble for grinding hematite powder; 6. chopping tool; 7. chopper with high-back.

Phase III – Early and Middle Neolithic (Cultural Stratum 1): In this phase riverine adaptation is still well developed, but the appearance of completely ground stone artefacts including weight stones and crude cord-marked pottery represents evidence of the Neolithic at Bailiandong.

The patterns of development of human adaptation shown in the cultural phases and data on the ancient climate and ecological environment at Bailiandong are of incalculable value in attempts to explore how the Palaeolithic transformed into the Neolithic. In addition to justifying the conclusions reached by former researchers, such as that the Bailiandong site contains continuous cultural strata from the Palaeolithic to the Neolithic with a transitional phase, using the most recent research results on the Bailiandong Cultural Series it has become possible to establish a new framework (Tab. 3).

After inspecting a number of other sites of similar age in South China, including Yunnan, (*Aigner 1981; Hu 1977; Lin and Zhang 1978; YPM 1977; Zhang et al. 1978*), Guizhou, (*Cao 1982a; 1982b; Li and Zhang 1981; Li and Cai 1986*), Guangxi (*Chang 1977; GZARM 1983; He and Qing 1985; Chia and Woo 1959; Li and You 1975; Li et al. 1984; Pei 1935; Pei 1965; Wang et al. 1982; Wu et al. 1962; Zhao et al. 1981*) Guangdong (*GPM 1959; Huang et*

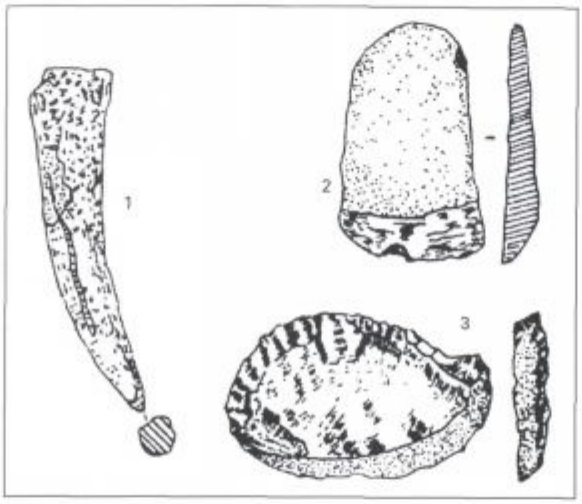

Fig. 9. Antler and stone tools from East layer 4: 1. end-ground antler; 2. edge-ground flat pebble; 3. chopper.

al. 1982; Qiu et al. 1986; Song et al. 1981), Sichuan, (*Pei and Woo 1957; Yang 1961; Zhang 1977*) and Jiangxi provinces (*JACR 1963*) (Tab. 4), it can be concluded that none of these contain evidence of three succeeding cultural phases beginning at more than 30 000 years ago.

CONCLUSION

Based on the cultural framework established for Bailiandong, the author has conducted a synthetic study of the relevant contemporary archaeological materials of South China and drawn up a possible picture of the Mesolithic age of this region:

❶ The faunal assemblages according to Layers 4 and 6 of the eastern deposit of the Bailiandong cave mainly consist of modern mammalian species such as deer and buffalo. The few extinct species include taxa such as elephant and rhinoceros. At the time of human occupation, the flora was temperate broadleaf forest in the lowlands and boreal conifer forest in the mountains. This is also reflected in the colour of this deposit, which is brownish instead grey (like the upper layers).

❷ The lithic industry of the Mesolithic in South China was predominantly characterised by two types of technique. One technique was the manufacture of crude choppers and chopping-tools for which quartzite was the main material selected. The second technique produced finely made flint tools, axes with polished cutting edges and a number of terminal pieces of deer antler exhibiting traces of polish. Many of the tools were apparently used for specific functions, including crude agricultural tools (such as weight stones), tools for grinding food (seeds and roots) and crushing snail shells, and tools for grinding hematite powder. At a few sites (such as the Miaoyan - Temple Cave near Guilin) in South China, the earliest pottery is dated to 15 000 BP (*Yuan et al. 1995*)

❸ Based on the evidence from Phase 2 of the Bailiandong Cultural Series, the Mesolithic of South China is dated to 18 000–12 000 BP and it may be divided into two sub-phases: the first (earlier) is significantly characterised by the occurrence of crude perforated pebbles (e.g. weight stone), and the second (later) by partly polished stone, bone and horn tools. The palaeo-climate and environment varied dramatically during the terminal Pleistocene and the beginning of the Holocene, and witnessed the emergence of new subsistence patterns.

❹ The social economy began to transform during the Mesolithic from a hunter-gathering subsistence pattern to one of agriculture. During this transfor-

Cultural Phases	Phase 1	Phase 2	Phase 3
Components	5th & 4th Cultural Strata	3rd & 2nd Cultural Strata	1st Cultural Stratum
Layer	West 7, 5 & 4	East 6 & 4	East 3 & 1
Time Span	30 000–18 000 years ago	18 000–12 000 years ago	12 000–7000 years ago
Cultural Stages	Late Palaeolithic	Transitional (Mesolithic)	Early & Mid Neolithic
Periods of Each Cultural Phase	A. Subphase B. Subphase	A. Subphase B. Subphase	A. Subphase B. Subphase
Occurrence of Typical Articles of Each Subphase	A. Chipped stone implements with Palaeolithic traits & tiny flint stone artefacts. B. Primitive ground articles & arrowheads.	A. Roughly made pebble tools & primitive holed pebbles, and hematite powder. B. Edge- or end- ground tools	A. Overall ground stone tools & primitive pottery. B. Pottery flakes

Tab. 3. New Framework of Bailiandong Cultural Series.

Bailiandong Cave	Bailiandong Cultural Series					
	Phase I		Phase II		Phase III	
	Cultural Strata 5 and 4		Cultural Strata 3 and 2		Cultural Stratum 1	
	Upper Palaeolithic		Mesolithic		Early & Middle Neolithic	
Possible Corresponding Sites	LiuJiang	Liujiang Man	Laibin	Qilinshan	Wannian	Xianrendong
	LiuJiang	Gangqinyan	Liuzhou	Sidouyan	Wuyuan	Qingtan
	Duan	Jiulengshan	Liujiang	Chenjiayan	Guilin	Zengpiyan
	Guilin	Baojiyan	Chongzuo	Aidong	Liuzhou	Dalongtan
	Hanyuan	Fulin	Yangchun	Dushizidong	Xinyi	(Upper Cultural Level)
	Chenggong	Longtanshan	Fengkai	Huangyandong	Naihai	Maomaodong
	Tongliang	Zhangretan		(1-3 Sites)	Wannian	Hsichiaoshan
	Baise	Shangsong	Wuming	Baqiao		Xianrendong
		Village		Baxun		
	Leipin	Chilinshan		Tengxiang		
	Tongliang	Zhangrentang	Guilin	D-Cave		
	Changgong	Longtanshan		Miaoyan		
	Tzeyang	Wangshanqi	Liuzhou	Dalongtan		
	Tobo	Ganqiangyan		(Lower Cultural Level)		
			LiJiang	Mofaiqiao		
			Puding	Baiyanjiao		

Tab. 4. Bailiandong Cave and Possible Corresponding Sites.

Fig. 10. Stone tools from East layer 3: 1. utilized flake; 2., 4. and 5. choppers; 3. chopping tool; 6. perforated pebble (ground weight stone); 7. and 8. perforated decorated objects; 9. ground cutting tool; 10. fragments of cord-marked pottery.

mative age of the Mesolithic, subsistence was still predominantly characterised by hunting and gathering, although the procurement of riverine food resources was well developed and incipient agriculture may have occurred.

❺ Mesolithic settlements were located near karst caves and rock shelters in the vicinity of streams or rivers.

❻ The human remains of the Mesolithic of South China often exhibit morphological features of the Oceanic Negritos. For instance, the Dalongtan hominids that lived in the Dalongtan shelter-like cave which consists of two cultural strata. The human fossils were excavated from the upper most layer of the lower cultural stratum, and have been dated to 12 000±220 BP, which means that the Dalongtan specimen represents a hominid transitional between Liujiang Man of the Late Palaeolithic (*Woo 1959*) and Zengpiyan Man of the Neolithic (*Zhang et al. 1977*). The Dalongtan cranium No. 2, which is relatively well preserved, belongs to a male about 30 years of age. Morphologically it displays the main traits of Mongoloids, and also shows some racial traits typical of Oceanic Negritos. Observation of the morphological features and analysis of the measurements have concluded that the traits of Dalongtan Man probably resulted from the genetic mixing of southern Chinese hominids with people from farther south (*Zhou and Zhang 1994*).

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The Mesolithic in South China

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ABSTRACT – *The history of the study of the Mesolithic in China is longer than sixty years. In south China many cave sites relating to the Mesolithic have been found. Typological implements excavated in these sites imply that the cultural transition in this period was closely related to climatic changes that cause environmental diversification, and inevitably lead to changes in humans' mode of subsistence. Although the discussion of the existence of Mesolithic culture in China is still a controversial topic to many Chinese archaeologists, the author insists that archaeologists pay more attention to the subsistence mode of ancient people in this transitional period, than become immersed in the traditional historiographic orientation.*

IZVLEČEK – *Zgodovina raziskav mezolitika na Kitajskem je dolga že več kot šestdeset let. V južni Kitajski so bila odkrita številna jamska najdišča, ki so povezana z mezolitikom. Izkopani predmeti iz teh najdišč kažejo, da je bil kulturni prehod tega obdobja tesno povezan s klimatskimi spremembami, ki so povzročile spremembo okolja, kar je neizogibno vodilo v spremenjen način preživljanja takratnega človeka. Čeprav je razpravljanje o obstoju mezolitske kulture na Kitajskem za mnoge kitajske arheologe še vedno sporno, avtor članka vztraja pri mnenju, naj arheologi posvečajo več pozornosti načinu preživljanja starodavnih ljudi v tem prehodnem obdobju, in naj se ne poglabljajo toliko v tradicionalno zgodovinsko usmeritev.*

KEY WORDS – *South China; Mesolithic; pebble tools; hunting-gathering; broad-spectrum food*

INTRODUCTION: MESOLITHIC STUDIES IN SOUTH CHINA[1]

The history of the studies of the Mesolithic in China has not been more than seventy years since the archaeologists began to pay attention to this topic in the mid-1930s (*Zheng 1936.20, 54*). In 1934, Prof. Pei, one of the earliest Chinese archaeologists, surveyed three limestone caves, namely Baqiao, Baxun, and Tengxiang, in Wuming County, and D cave in Guilin, Guangxi Province[2] in south China, and found some pebble artefacts. He thought some of these stone implements bore a few characteristics similar to those of the Hoabinhian Culture, the famous Mesolithic in North Vietnam, and implied these could belong to the Mesolithic (*Pei 1935.393–412*). Also, these sites were further identified as Mesolithic by the archaeologist An twenty years later (*An 1956. 36*). From then on, the study on Mesolithic in China never stopped. In 1960s and 1970s, more findings relating to the Mesolithic were found in South China. These include: Gaitou Cave, Chenjia Cave in Liujiang, Aidong Cave in Congzuo County, Guangxi Zhuang Autonomous Region (*Jia et al. 1960.64–68*); Qingtang in Yingde County, Guangdong Province (*Peng*

1 According to the accepted common practice, 'South China' geographically refers to the area of Pearl River Valley, which covers from eastern Guangdong in the east to the eastern edge of the Yungui Plateau in the west, and from Wuling Mountains in the north to Hainan Island in the south. Accordingly, South China in this article includes the whole area of Guangdong Province and Guangxi Zhuang Autonomous Region, the main body of Pearl River Valley, which is about 0.41 million km^2.

2 In this article Guangxi Province refers to as the same place as Guangxi Zhuang Autonomous Region.

1961.585–588); Dongyan Cave in Guangxi (*Wu, Xin-zhi 1962.408–411*); Zengpiyan Cave in Guilin, Guangxi (*Working Team For Cultural Relics of Guangxi Zhuang Autonomous Region 1976.20*). After 1980, more systematic surveys were done in south China, in which more Mesolithic sites were found, such as Dushizai in Yangchun, Huangyan Cave, Dongzhongyan and Luojiyan in Fengkai County, Guangdong (*Song et al. 1981.292–293; 1991.1–12*); Miaoyan Site in Guilin, Liyuzui Site in Liuzhou, Guangxi (*Liuzhou Museum 1983.769–774*); II second stratum in Bailian Cave in Guangxi (*Yang 1991.154; Kong et al. 1994.147–155*); Luosha Cave in Guangdong (*Zhang 1994.300–308*), and Niulan Cave in Yingde, Guangdong (*Qiu, Li-cheng et al. 1999.1–111*). Most of these sites are limestone caves located at branches of Xijiang River Valley and Beijing River Valley (Fig. 1).

Generally, all of these sites are located in valleys and small alluvia basins of perennial rivers. Most of them are found in caves of limestone hills, which are topographically common in mountainous areas in south China. The typological findings of these limestone caves are pebble tools including chipped scrapers, choppers, stone gravers, and holed stone, bone implements, remains of mussels and shells, shell tool, and animal bones. At some site are found a few stone arrows and flint microlithics (Fig. 2). Radio-carbon dating shows the earliest date of these Mesolithic remains is more than 15 000 BP (Bailian Cave) and the latest date is earlier than 9000 BP (Zengpiyan Cave), which means the cultures of these sites exist between the last stage of the late Pleistocene and the first stage of the early Holocene.

THE SUBSISTENCE OF MESOLITHIC PEOPLE IN SOUTH CHINA

A systematic and dynamic review of Mesolithic findings at these sites in south China exposes the socio-economic structure and the subsistence style in this period.

The culture of this period obviously not only carries some old characteristics of Palaeolithic culture, but also some new elements for Neolithic culture, which is mostly shown in the composition of implement typology. In south China, the dominance of large and medium sized pebble tools had existed for a long time since the early Palaeolithic. One of the examples is that of pebble tools found in the terraces along the You River in Guangxi, which is dated to as early as 700 000 BP (*Huang et al. 1990.105–112*). The pebbles were selected by ancient people from a nearby riverbed. The technology of these pebbles is simple, since most of them are one-side chipped and have wide and flat tops and deep flake scars. Choppers, scrapers, hammers, and drills are common types of pebble implements. While pointed tool, tools for sculpture are seldom found. The composition of these tools had lasted from the early to late Palaeolithic in this area. While in Mesolithic times, the skills of making pebble tools were not only inherited, but also obviously improved: pebble

Fig. 1. Localities of Mesolithic Sites in South China: 1. Wuming County (Baqiao, Baxun and Tengxiang Caves); 2. Gaitou Cave; 3. Chengjia Cave; 4. Aidong; 5. Qingtang; 6. Dongyan Cave; 7. Zengpiyan Cave; 8. Dushizai; 9. Huangyan Cave; 10. Dongzhongyan Cave; 11. Luojiyan; 12. Miaoyan Cave; 13. Liyuzui; 14. Bailian Cave; 15. Niulan Cave.

Site	Location	Stratified Deposit	Main Findings	Radio-carbon dating (BP)
Liyuzui	Liuzhou City, Guangxi Province	Lower layer	Chipped pebble tools, stone artefacts with polished edge, holed stones, a few bone tools, animal bones such as needle, awl, and knife, mussels, a little piece of cored sandy pottery	12 880
Zengpiyan Cave	Guiling City in Guangxi Province	Early stratum	Chipped pebble tools, stone artefacts with polishing edge, hole stone, grinding stones, mussel bones, animal bones, sandy pottery shards	More than 9000
Bailian Cave	Liuzhou City, Guangxi Province	Middle layer (II period)	Chipped pebble tools including choppers, scrapers, holed stones, stone artefacts with polishing edge, flint microlithics including arrows, points, two-sided scrapers, one-sided scrapers, and stone gravers, shells, animal bones	15 910
Huangyan Cave	Fengkai County, Guangdong Province	Middle layer	Quantity of pebble scrapers, pebble choppers, and hammers, stone awl stone artefacts with polishing edge, a few holed stones, shells, animal bones	10 950
Dushizai	Yangchun County, Guangdong Province	Upper layer	Chipped pebble tools, stone artefacts with polishing edge, bone tools, shells, bone arrow	11 500
		Middle layer	Chipped pebble tools, holed bone tools, bone tools, shells, animal bones	14 260–15 350
Niulan Cave	Yingde County, Guangdong Province	Middle layer	Chipped pebble tools, stone artefacts with polishing edge, holed bone tools, shell net-weights, shells, animal bones, silicinized remains of rice	10 450

Fig. 2. The main Findings in some Mesolithic Sites in south China.

tools were usually made in oblique, straight, and sharp edge. Almost all the angles of the oblique-edged pebble tools are more than 750. Meanwhile, the chipped and flake scars on the oblique-edged tools are more systematically distributed than those on the pebble tools of Palaeolithic. In Huangyan Cave and Dushizai site, hundreds of such artefacts are excavated, and dominate the stone artefacts (Fig. 3). Interestingly, the dominance of and the manufacturing skills for the pebble stone are very similar to those of Hoabiahian culture in Southeast Asia. Another interesting phenomenon in some sites in south China is the emergence of holed stones. Hole stone artefacts are obviously part of composite implements, and can be regarded as the model of some advanced tools in Neolithic.

These pebble tools are closely related to the ecology at that time if we look at climate changes. In the early part of the Holocene, the last ice age ended, and as the glaciers slowly melted away the weather became hot and humid in the subtropical region including south China and Southeast Asia. The widely distributed and most appropriate materials available for these tools in hot and wet south China were bamboos, woods, and lianas. In view of the function of traditional tools in the Palaeolithic, large pebble choppers were not suitable for processing these raw materials. Instead, people tended to use a different pebble tool, a pebble similar to that in the Palaeolithic, but with an oblique edge. We guess that these kinds of tools were used as intensive and efficient choppers to process bamboos, woods and liana

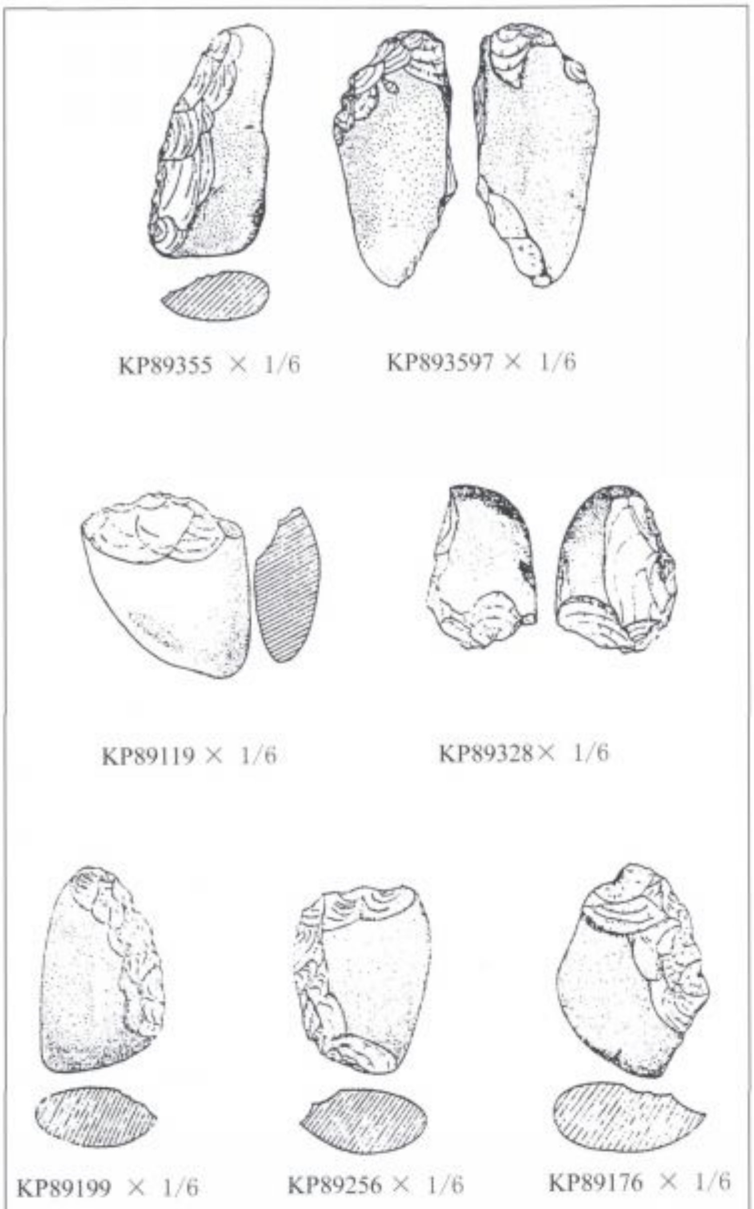

Fig. 3. Choppers from Huangyan Cave, Guangdong Province.

plants. Hence, the oblique-edged pebble tools are evidence of the adaptation of human beings to the new ecology in Mesolithic times.

In the early Holocene, humans had an opportunity for foraging since more aquatic species were reproduced as the sea level and water level inland in south China rose along with a global rise in temperature. As a result, ancient people were attracted to living in caves which were not very high in relative altitude from the ground (the relative altitude of the entrances of the caves in Figure 1 ranges from several metres to twenty metres) and close to rivers, lakes, and the seashore. Thus, gradually, fishing and gathering were developed.

Another factor of socio-economic development manifested is the large amount of remains of shells of oysters, clams, and mussels. In almost every cave, accumulated mounds of discarded shells were excavated. This reflects that people at that time had learned to intensively utilise aquatic resources by gathering shellfish along lakesides, streams, and coastlines. Fishing in the environment in Mesolithic times was easier than hunting, since seasonal changes did not have too much influence on aquatic molluscs in the environment, and consequently did not affect human engagement in fishing. Conversely, hunting-gathering production is dependent on seasonal changes. But a question arises here: how could ancient people fish easily with their relatively undeveloped technology? Contemporary ethnographical data can help answer this. In northeast China, some minorities nowadays merely use a harpoon made from the branch of a tree, or a small wicker basket to fish easily in shallow brooks. We can imagine that ancient people in the Mesolithic understood how to catch fish in a simple way or by using naturally occurring tools, such as branches with forks, as human do now. Consequently, people began to use bones or shells as implements, such as mussel knives and bone knives.

Furthermore, this hunter-gatherer economy brought about the budding stage of agriculture. As is well known, there are several theories/hypotheses about the origin of agriculture and animal domestication. Whatever they are, all of them need some pre-conditions. Objectively, there must be an appropriate ecology that offers food resources and an environment for the domestication of plants; subjectively, population, human skills in getting food, primitive thoughts, values and customs, and social organisations can affect human attitudes to domestication. With the changes of climate and ecology in south China in the period between the late Pleistocene and early Holocene, more food resources were available and there was surplus food. It is not surprising that hunters and gatherers thought to apply their learning of the regulations of plant and animal rearing in different season. Thus, human practice laid the foundations for the domestication of plants and animals.

Recent findings in the Pearl River Valley support this assumption. In the middle stratum of Niulan Cave in Guangdong Province, archaeologists found small holed pebbles used as fishnet weights, shells, mussels, fish bones, and tortoise shell. All these remains suggest people at that time lived in a pleasant environment with rich food resources. The most exciting find is the silicinized remains of rice, of which the ^{14}C is dated as early as 12 000 BP. The rice was analysed by scientists and recognised as neither Indica nor Japonica. Some archaeologists insist that south China is one of the key zones where ancient people in Mesolithic times began to domesticate rice (*Ding 1957; Tong 1984.21–30*). The rice remains in Niulan Cave add further evidence to suggest that ancient people might have tried to cultivate rice 12 000 years ago.

Also, the density of these sites in the Mesolithic period is greater than that in the Paleolithic. In Fengkai County, west Guangdong Province, three caves of this period are found in the area of 2 km^2 in a small river valley. In of these, Huangyan Cave, more than 900 pebble tools were excavated in an area of 300 m^2 (Fig. 3). Similar finds were also made in Niulan Cave in Yingde County, Guangdong. The large mount of pebbles implies that ancient people in this region lived in groups of considerable size and for a long time. Actually, in the Mesolithic period, south China was covered in tropical and subtropical forests, where rich resources of plants and animals for food selection were available, and this attracted groups of people to stay in place for a longer time. They gradually understood that they could have enough food without seasonal migration. Changes in mobility consequently caused changes in patterns of settlement and social organisation. Women had more energy and time than before to raise children, which reduced the probability of infant mortality. The result of this was an increase in population. Also, they had more time to work together when they settled down. This offered them the opportunity for a division of labour between men and women and the old and young.

All in all, we can imagine ancient people had to endure a long, complicated, and tortuous process to acquire the necessary experience of plant and animal husbandry. However, the evidence of human behaviour, thoughts, and religion in south China at that time is not so encouraging. To understand better the socio-economic organisation in the context of the transition to farming we need more archaeological data.

DISCUSSION AND CONCLUSION

For more than half a century, the concept of the Mesolithic has been a controversial topic in China. Some Chinese archaeologists do not agree that there was a Mesolithic Period in China. They have two reasons for believing the Neolithic evolved directly out of the Palaeolithic (*Jia 1991.53–54; Zhang 2000.6*). One reason is that there are no representative Mesolithic artefacts found in China. While in Europe, the Mesolithic has been well recognised for a long time as microlithic and arrows are regarded as the representative tools. Actually, a few microlithic tools are found in some sites, such as the lower layer of Bailian Cave (2668–2800 BP) and the fourth layer of Liyuzui (18 388–21 217 BP) in Guangxi Province, although they do not dominate the composition of stone artefacts. However, the pebble tools make up a large percentage of the artefacts and this may be the crucial difference between the Mesolithic in South China (as well in Southeast Asia) and that in Europe, which was due to the different climate and ecology of the two regions. We cannot deny the existence of the Mesolithic in South China just because there are not so many microlihtics and arrows commonly found at all the sites.

Another reason is that a few pottery sherds are found in some Mesolithic strata, such as in Liyuzui site and Zengpiyan Cave site, where pottery are dated earlier than 8000 BP. Traditional Chinese archaeologists define any of these findings as Neolithic culture if they are associated with the pottery. But archaeological contexts have shown the appearance of pottery production in South China before the Neolithic. At Miaoyan Cave in Guangxi (Fig. 1, site 12) five pottery fragments were found. The thermoluminescence dating of these fragments is as early as 15 000 BP (*Chen 1999.156–157; Qi 2000.54*). Obviously, the Neolithic could not have been identified about 15 000 years ago, if the appearance of pottery is judged as its symbol. The appearance of pottery means nothing more than a revolutionary technology of human beings to make more portable artefacts and their engagement in settlement. Only by studying Mesolithic times can we study how pottery originated.

Some archaeologists make the criticism that this close and short-term view to negate the existence of

Mesolithic in China comes the traditional Chinese cultural-historical methodology, which usually emphasises the importance of the origin, distribution and relationship of archaeological findings, especially the typology of implements, and pays little attention to the dynamic of human culture and events (*Chen 2000.11–22*). Analysing the process of the transition from the Palaeolithic to the Neolithic, archaeologists should know clearly that the Neolithic revolution constitutes a profound change from the specialised hunting of herd animals to a broad-spectrum economy. People adopted a mixed resource strategy involving plant collecting, hunting and fishing. Namely, the nature of this transition is the subsistence mode of ancient people, regardless of whether there are lithics, arrows, and pottery.

Actually, Chinese archaeologists never stop their studies on the transition from Palaeolithic to Neolithic. Due to new archaeological finds in the last decade and the re-analysis of old materials, the study of Mesolithic culture in south China has made a breakthrough, which exposes a trace of a cultural transition from Palaeolithic to Neolithic.

Fortunately, more and more Chinese archaeologists are beginning to criticise to the traditional historiographical orientation, and are turning their eyes to this research area with new perspectives. At a Conference on Mesolithic Culture, the first seminar on this topic in China, held in Yingde City, Guangdong Province, in December 1999, archaeologists reported their new findings about the transitional culture from the Palaeolithic to the Neolithic and other related issues. Many of them agreed that more intensive research and co-operation on how Palaeolithic culture shifted to Neolithic culture are necessary. More active excavation should be done, and re-analysis and systematic research on the old findings should not be neglected. Obviously, archaeologists focusing upon Mesolithic culture in China have a long and difficult way to go, but their prospects will inevitably be bright.

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The Dating of Chinese Early Pottery and a Discussion of Some Related Problems[1]

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ABSTRACT – *This paper examines the radiocarbon dating of Chinese early pottery. It is suggesting that the earliest pottery in eastern Asia can be dated to 17 000 years BP, in the period of the last Pleistocene glaciations in Eurasia.*

IZVLEČEK – *V članku raziskujemo radiokarbonske datacije zgodnje kitajske keramike. Menimo, da lahko najzgodnejšo keramiko v vzhodni Aziji datiramo v čas 17 000 BP, to je v obdobje zadnje pleistocenske poledenitve Evrazije.*

KEY WORDS – *China; Palaeolithic; Neolithic; pottery; AMS radiocarbon dating*

INTRODUCTION

The invention of pottery is a milestone in the history of human civilization. The uses of pottery made a great improvement in the conditions of ancient human life and increased the adaptability of humanity to nature. Therefore, prehistorians and archaeologists always pay great attention to the discoveries of early pottery. Some archaeologists consider the appearance of pottery as a boundary between the Palaeolithic and Neolithic. Sites of early pottery have been unearthed in Japan, Russia, Mongolia, China and elsewhere in Asia since the corded pottery with an age greater than 10 thousand years was excavated at the Fukui Cave site in Japan in the 1960's. The early pottery found in different sites in China gave earlier radiocarbon ages than those in other countries and attracted the particular attention of academia. This article gives a brief introduction to the discoveries and dating of Chinese early pottery and discusses some related problems.

DISCOVERIES OF CHINESE EARLY POTTERY

Many sites of early pottery have been excavated in China successively since Xianrendong site was unearthed at Wannian County in Guangxi Province in the 1960's (Fig. 1 and Tab. 1). All this pottery proved to be older than 10 thousand years according to different dating measurements. The sites of Zengpiyan, Liyuzui, Miaoyan, Yuchanyan, Xianrendong, Diaotonghuan, Nanzhuangtou and Yujiagou have very clear stratigraphical and periodical sequences. The early pottery discovered on Yuchanyan, Miaoyan, Xianrendong and Diaotonghuan sites have the same technological characteristics of those found in South China. Nanzhuangtou and Yujiagou pottery represent the typical styles of North Chinese pottery production.

The cave site of Yuchanyan, also called Toad Cave, is located in Baishizhai village in Dao Xian, at the north side of Nanling Mountain, in the Southwest of Hunan Province. This cave is 5 meters high above the modern surface and faces southeast, with a capacious hall at the entrance of the cave, which admits much sunlight. There is an open plain in front of the cave. The site was excavated twice, in 1993 and 1995, over an area of some 100 m^2 and to a depth of 1, 2 to 1, 8 metres. The cultural continuity from Palaeolithic to Neolithic has been determined. The artefact assemblages consist of (a) stone tools – scrapers, cutters, points, etc., (b) bone tools – chip-

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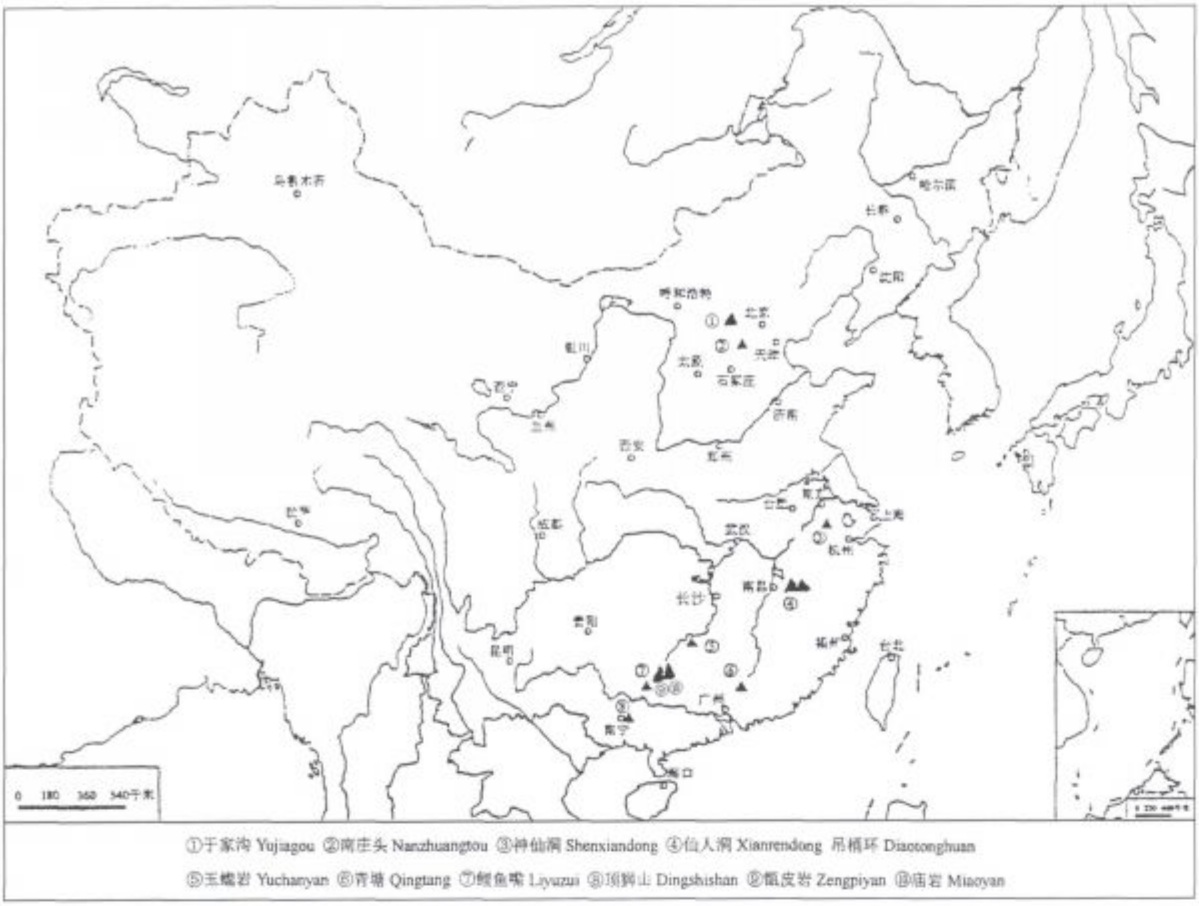

Fig. 1. The distribution of the sites of early pottery in China.

ped horn shovels, polished bone shovels and awls, (c) perforated shells and notched teeth. Traces of burning have been detected on the artefacts. However, the most important discoveries in Yuchanyan site are early pottery – coarse sandy wares, dark brown in colour and rice husks. The largest inclusion was identified as sandy grain, about 2 cm in diameter. The pottery discovered in 1995 was restored as a wide-mouth cauldron with pointed round bottom. Decoration consists of a corded pattern in a rough texture inside and outside of vessels. Four grains of rice were collected in 1995 being identified as a domestic species with the character of a wild species. Abundant rice phytoliths were also recovered from the soils of the cultural deposit, accompanied by a large quantity of animal and plant fossils, including 28 species of mammal, 27 birds, 5 fishes, 33 kinds of shells, terrapins, insects and so on, and more than 17 species of plant (*Yuan 1996*).

Xianrendong and the Diaotonghuan are two cave sites, 800 metres distant from each other. They are located in Dayuan Xiang Village in Wannian Xian County, in northern Jiangxi Province. They are situated within a small, swampy Dayuan basin. The Xianrendong cave faces southeast. A small river flows from east to west in front of the cave. Four excavations were carried out, in 1960, 1964, 1993 and 1995. The Diaotonghuan cave is situated at the top of a small limestone hill about 60 metres high. A full-scale excavation was carried out in 1995. Both of the sites have abundant cultural deposits, belonging to the period of the Late Palaeolithic to the Early Neolithic. A considerable quantity of archaeological remains were discovered at the two sites in 1995, including 625 stone objects, 318 bone artefacts, 26 perforated shells, 516 pottery fragments, thousands of animal and a number of human bones. The stone tool assemblage consists of scrapers, points, choppers, multi-edge blades and micro-blades made from flint and quartz chips. Bone and antler tools comprised spades, awls, needles, arrowheads and fish darts. The pottery fragments were fired at low temperature, with brown coloration. Large grains of feldspar and quartz mark the fabrics. The basic shape looks like a cylinder jar with round bottom and upright mouth or something like a round-bottomed vessel with swelling belly and slightly wide flared mouth. Both the inside and outside of the vessel are decorated with stripes in a basket pattern. Most of the animal bones from these sites belong to deer, making up 80% of the assemblage, followed by pig and fowl (including chicken) bones. The analysis of pollen and phytoliths give evidence of the existence of wild rice and cultivated rice at both sites (*Zhang and Liu 1996*).

At Diaotonghuan site the prospecting trench at a depth of 5 metres was divided into 16 stratigraphic zones, from zone A to zone P (*MacNeish and Libby 1995*). Table 1 provides the representative cultural remains for the six upper zones (*Zhao 1997 (1998)*).

Zones	Representative Cultural Remains
B	Pottery with geometric impressions. Predominance of ground stone tools.
C	Early pottery made by the coiling method.
D	Early pottery made by the section modelling technique.
E	Primitive ceramics.
F	Ground stone tools. But chipped stone tools and bone artefacts are dominant, which continues through Zone C.
G	Chipped stone tools and bone artefacts.

Tab. 1. Cultural remains for the six upper zones of Diaotonghuan site.

The Miaoyan cave is located on a small limestone hill, situated in an eastern suburb in Guilin, in Guangxi province. This cave is about 150 metres above sea level and 13 metres above the ground. An archaeological team from Guilin carried out an excavation in 1988. An area of 50 square metres was excavated in the cave. A total of 6 well-defined stratigraphic zones were identified in a 2.4–2.9 meters thick cultural deposit, which covered the remains of the transitional period from the Palaeolithic to the Neolithic. There were abundant stone and bone tool assemblages deposited. The early pottery was documented in the layer 5. There were five undecorated fragments in grey and brown colour deposited. Some of them had soot on the surface and quartz and carbon granules mixed in the clay matrix.

Nanzhuangtou site was found in Xushui County, Hebei Province, located at the eastern foot of Mount Taihangshan, on the western edge of Northern China fluvial plain, at an altitude of 214 metres (*Baoding Institute of Cultural Relics 1992*). It is an Early Neolithic site covering the area of 300 square metres. The site was excavated in 1986 and 1997. Besides ash pits and fire evidence, certain cultural remains, such as a grinding stone and saddle-querns, bone awl, bone arrow, antler-awl, perforated crabstick, and wood pieces were found. There were also identified large quantities of animal and bird bones, snail and clamshells, foliage, seeds etc. Sand and mica have been identified as main inclusions in 20 pottery fragments. The bodies are about 0.8–1 cm thick. They were made at low temperature with a loose texture. Most of them are grey, and a few are red and brown. Most of them are jars with flat bottoms on which we can see the evidence of firing and smoking, and some look like little bowls (*Li 1998*).

Yujiagou Site was found in Hutouliang County, Hebei Province, located on a northern branch of Sanggan River. From 1995 to 1997 the Department of Archaeology at Beijing University carried out excavations at this site in cooperation with the Institute of Cultural Relics in Hebei Province. We found overlapping cultural layers from the Late Palaeolithic to the Early and Middle Neolithic within the 7 metres of deposit. There were plenty of stone tools, such as scrapes, points, arrows and very many microliths. Pottery and bone tools were also found, accompanied by a large quantity of animal bones. The pottery was found in a grey and yellow-silver sand layer 3. The fragments are sandy ware, of red and brown colour, among which the largest piece seems to be the bottom of a flat object (*Institute of Cultural Relics in Hebei Province 1998; Zhou 1999*).

DATING OF CHINESE EARLY POTTERY

The dating of potsherds and related archaeological strata has been completed at the Laboratory of Archaeometry and Conservation at Beijing University and the Laboratory in the Institute of Archaeology at the Academy of Social Sciences. These potsherds were excavated at sites in Yuchanyan, Miaoyan, Xianrendong, Diaotonghuan, Nanzhuangtou and Yujiagou, and others. The results of series dates are list in Tables 2, 3, 4, 5, and 6.

The dating samples were collected from different layers at different sites and different kinds of samples were treated with different pre-treatment methods. For example, we used sherds to date directly the sites at Yuchanyan and Miaoyan. At first, we analysed carbon sources in the pottery and followed different procedures to collect different carbon components. For the pre-treatment procedures see Figure 2. The components of humic acid and residue were dated and the results of these dates agreed with the

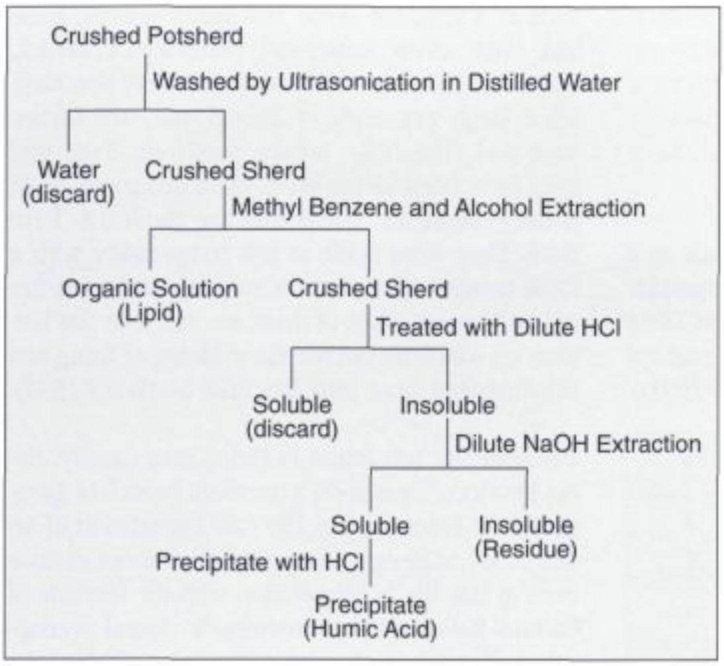

Fig. 2. Pre-treatment procedure of potsherd for radiocarbon dating.

dates of different kinds of samples from the same layers. See tables 2 and 3.

All of the radiocarbon dates younger than 20 thousands years in this article were calibrated by OxCal v 3.5 with intcal 98. The calibrated age of the earliest Chinese pottery is about 17 thousands years BP. So far, potsherds older than 10 thousand years have been found at many sites in different countries in East Asia, such as China, Japan and Russia (Tab. 6). This fact gives us very important information for research on the origin of pottery in the world and the relationship between human activity and the environment in the late Pleistocene.

DISCUSSION ON SOME RELATED PROBLEMS

One of the important questions for discussion in the field of prehistoric historiography and archaeology is the origin of pottery. Until now, there have been many academic viewpoints. One is that the primitive people invented the basket container by spreading some earth and wattle from all kinds of foliage on it. By accident, the wattles were burned and a basket made of clay is left. That was the invention of pottery. The other standpoint is that the pottery is going with the origin of agriculture. Agriculture has close relations with residential settlement. Only settled residents have the need to use pottery. The appearance of pottery in western Asia happened after the invention of agriculture. From Chinese ancient literature we can also read "Shennong people invented agriculture earlier than pottery" (*Song et al. 1983*). Other scholars have stated firmly that the invention of pottery was not related to agriculture (*Clark 1952*), because in some areas pottery appeared before agriculture and some peasants did not use pottery (*Child 1956*). We believe that pottery is something that is closely related to people's daily life. And the clay used to made pottery can be found here and there. At present, pottery dating earlier than 10 000 years BP can be found not only in China, Japan and Russian, but also in western Asia and Africa. All this evidence proves that the invention of pottery did not happen in a single place. Regarding the primitive resident's use of early pottery, it is used not only by primitive peasants such as those living in western Asia, but also by people taking up collecting and hunting such as the early inhabitants of Japan in "a cord pattern cultural Age". This indicates that the invention of pottery as related to agriculture is not absolutely sure. Judging from the study of the early pottery found in China and Japan, the primitive people who invented the earliest pottery were still engaged in an economy of gathering and hunting. From the pottery excavated at the site of Yuchanyan,

Lab. No.	Zone	Material	Method	^{14}C Age (BP) 5730	^{14}C Age (BP) 5568	Calibrated Age (BC)	Remains
BA95058	3E	Charcoal	AMS-^{14}C	14080±270	13680±270	15350–14500	Potsherds, Grains of Rice
BA95057a	3H	Humic Acid from Potsherds	AMS-^{14}C	12320±120	11970±120	13150(0.45)12650 12500(0.55)12100	Potsherds
BA95057b	3H	Potsherds Residue	AMS-^{14}C	14810±230	14390±230	16150–15400	Potsherds

Tab. 2. Radiocarbon Dating at the site of Yuchanyan at Dao Country in Hunan Province.

Lab. No.	Zone	Material	Method	^{14}C Age (BP)		Calibrated Age (BC)	Remains
				5730	5568		
BA92030-1	2	Shell	AMS-^{14}C	12730±370	12370±370	13800–12300	
BA92033-1	3M	Shell	AMS-^{14}C	12630±450	12270±450	13700–12200	
BA92034-1	4M	Shell	AMS-^{14}C	13710±270	13320±270	14950–14100	
BA92036-1	5L	Shell	AMS-^{14}C	18140±320	17630±320	20150–19100	Three Potsherds from 5M
BA92037-1	6L	Shell	AMS-^{14}C	20920±430	20330±430	Out of Range	
BA94137a	5	Humic Acid from Potsherd	AMS-^{14}C	15560±500	15120±500	17300–15900	Potsherds
BA94137b	5	Potsherd Residue	AMS-^{14}C	15660±260	15220±260	17200–16300	Potsherds
ZK-2839	Right 2	Shell	^{14}C	12707±155	12350±155	13700–13100	
ZK-2840	Left 2	Shell	^{14}C	13547±168	13170±168	14650–14000	
ZK-2841	5	Shell	^{14}C	17238±237	16750±237	19000–18100	Three potsherds from 5M

Tab. 3. Radiocarbon Dating at the Site of Miaoyan at Guilin in Guangxi Province.

Xianrendong, Diaotonghuan, Miaoyan, Liyuzhui (*Liuzhou City Museum 1993*), Zengpiyan, Yujiagou and some other places, we can conclude that the early pottery was made by mixing some irregular quartz and granule of feldspar or dolomite. There is soot on the surface of some pottery. Whether their bottoms are round or flat, they were used for cooking, called *guan* or *fu*. Although we do not have enough evidence to prove what kind of things the cooked food were, we still can conclude that one of the main uses for this early pottery was cooking rice (in Northern China people collected *millet* and *proso*) from the evidences of rice phytoliths and grains of early cultivated rice found at Yuchanyan, Xianrendong and Diaotonghuan (*Zhang, Yuan 1998; Zhao 1997 (1998)*).

Lab. No.	Zone	Material	Method	^{14}C Age (BP)		Calibrated Age (BC)	Remains
				5730	5568		
BK86120	$T_1$⑤–⑥	Wood	^{14}C	9875±160	9600±160	9750–9150	Potsherds, Stone Tools & Bone Tools
BK86121	$T_1$⑤–⑥	Wood	^{14}C	9690±95	9420±95	9250(0.56)9110 9000(0.33)8890 8880(0.11)8830	Potsherds, Stone Tools & Bone Tools
BK87093	$T_1$⑤–⑥	Wood	^{14}C	9810±100	9530±100	9600(0.04)9560 9390(0.96)9140	Potsherds, Stone Tools & Bone Tools
BK89064	1m East of $T_1$⑤–⑥	Wood	^{14}C	9850±90	9570±90	9600(0.07)9560 9390(0.93)9210	Potsherds, Stone Tools & Bone Tools
BK87086	On Middle of North Wall in $T_3$⑤	Mire	^{14}C	9980±100	9700±100	9690(0.04)9660 9630(0.96)9280	Potsherds, Flakes & Charcoal
BK87075	Bottom of $T_1$⑥ Ash Pit	Charcoal	^{14}C	10510±110	10210±110	10900(0.96)10350 10300(0.04)10200	Potsherds, Antlers etc.
BK87088	Bottom of $T_1$⑥	Mire	^{14}C	10815±140	10510±140	11070(0.75)10840 10800(0.25)10690	Potsherds, Stone Tools & Bone Tools

Tab. 4. Radiocarbon Dating at Nanzhuangtou at Xushui County in Hebei Province.

Zone	Sample No.	Depth (m)	Soil Type	TL Age (KaBp)
Top of Layer 2	Y–2–80	0.82	Grey-black Clay	2.13
Bottom of Layer 2	Y–2–16	2.08	Grey-black Clay	6.07
Top of Layer 3a	Y–3a–54	2.60	Brown-yellow Fine Silt	6.95
Top of Layer 3b	Y–36–23	4.28	Brown-yellow Pulps	11.12
Top of Layer 6	Y–6–42	5.60	Grey-green Calcareous Silt	12.19

* The potsherds of early pottery were discovered at the top of forth layer. TL age of potsherd is 11.60KaBp.

Tab. 5. Ages of TL at the Site of Yujagou at Yangyuan County in Hebei Province (*Zhengkai 2001*).

be accepted by for people living inland. However, it is reasonable to imagine that this pottery was used for cooking. Some scholars have pointed out that, "In Southern China the early food which needed to be cooked is not wild rice, plant seeds or roots, but aquatic food which is rammish and cannot be eaten without cooking such as snail and clam" (*Zhou 1994*). This opinion is not absolutely correct, but the appearance of early pottery going with large quantity of snails and clams in southern China can certainly provide us new clues for our discussion on the origin of pottery in this region.

At the above sites, where we found rice phytoliths and paddy remains, a large quantity of snail and clamshells were excavated. According to the quantity statistics, at Yuchanyan the categories of snail and clam totalled 33 (*Yuan 1999*). Also, we found the same instances at the site of Zengpiyan, Liyuzhui and Huangyandong and some other cave sites. The appearance of a large quantity of snails can prove that cooking rammish and fresh aquatic foods such as snail, clam and fish, is one usage of early pottery. Eating the rammish aquatic food is acceptable for people living near the sea, but it absolutely cannot

The appearance of early pottery provided us new clues for our discussion on the relations between humans and living conditions in the Late Pleistocene. However, it was quite a normal opinion among academics that pottery was invented with the origin of agriculture and stockbreeding in Eurasia in the warmer Holocene (*Pei and An 1986*). So far, the earli-

Lab. No.	Zone	Material	Method	^{14}C Age (BP)		Calibrated Age (BC)	Remains
AA–13393	Gasya, Lower layer, Upper part	Charcoal	^{14}C	11 190±90	10 875±90	11 400(0.26)11 300 11 260(0.74)11 050	
LE–1781	Gasya, Lower layer, Bottom	Charcoal	^{14}C	13 340±120	12 960±120	14 400–13 750	Potsherds, 1.2~1.7 cm thick
AA–13392	Khummi, Lower layer, Lower part	Charcoal	^{14}C	13 650±100	13 260±100	14 700–14 150	
AA–13391	Khummi, Lower layer, Middle part	Charcoal	^{14}C	10 650±110	10 345±110	10 940(0.77)10 670 10 530(0.23)10 430	
GaK–949	3rd layer in Fukui Cave at Nagasaki in Japan	Charcoal	^{14}C	12 760±350	12 400±350	13 900(0.57)13 100 12 900(0.43)12 300	Cordoned Pottery
	See above	Charcoal	^{14}C	13 070±500	12 700±500	14 500(0.83)13 100 12 800(0.17)12 400	Cordoned Pottery
	Odaiyamamoto I Kanita town in Aomori Perfecture in Japan	Charcoal	AMS ^{14}C	14 180	13 780	14 570	

Tab. 6. Radiocarbon Ages of Early Pottery in Russia and Japan.

est pottery in eastern Asia can be dated to 17 000 years BP, in the period of the last Pleistocene glaciations in Eurasia. It shows that the invention of pottery in eastern Asia was not connected with the warmer climate, at least. It could be the human adaptation to bad climate that accounts for the relations between the climate and the invention of pottery. However, it can be proved probably that even in 17 000 BP the ancient people at the end of the late Pleistocene had an extraordinary ability to acclimatize themselves to the environment and to made great progress in technology.

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Documenta Praehistorica XXVII

Anthropological Approaches in Neolithic Studies in Iran

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ABSTRACT – *The Mesolithic/Neolithic transition in western Iran are reconsidered in the light of recent anthropological approaches in Neolithic studies in Iran and a brief review of the chronology of the Neolithisation process in Zawi-Chemi, Shanidar, Palegawa, Tepe Ganj Dareh, Karim Shahir, Tepe Asiab, Tepe Abdol Hosien, Tepe Alikosh, Tepe Jarmo, Sarab and Tepe Guran are presented.*

IZVLEČEK – *V članku ponovno pretehtamo prehod iz mezolitika v neolitik v zahodnem Iranu v luči najnovejšega antropološkega pristopa k raziskavam neolitika. Podajamo tudi kratek kronološki pregled procesa neolitizacije v najdiščih Zawi-Chemi, Shanidar, Palegawa, Tepe Ganj Dareh, Karim Shahir, Tepe Asiab, Tepe Abdol Hosien, Tepe Alikosh, Tepe Jarmo, Sarab in Tepe Guran.*

KEY WORDS – *Neolithisation processes; Western Iran; Ethno-archaeology*

INTRODUCTION

After a long period, during which the subsistence of human society was founded on hunting and gathering, came a new era in human history marked by the first appearance of rural society. In the full sweep of human history, no development has had a greater effect than the introduction of agriculture.

Approaches in historical anthropology claim culture to be the primary source of changes and transformations. Every change, taking place in different social fields such as politics, economic etc., is therefore a direct consequence of cultural transformation. This means culture and cultural transformation play fundamental roles in engendering development. Anthropological studies have also provided many useful illustrations, for example the first revolution in the history of mankind, known as the Neolithic revolution (*Child 1936*). It was a transformation that led people from an economic system of hunting and gathering to a productive economic system of foraging and farming. As a result of this transition, new social organisations appeared; all this took place around 100 00 BC in the Middle East. The outcome was the first appearance of a more developed society, organised as a village community (*Braidwood 1975*). The advent of a more developed community, which transpired some 4000 years after the appearance of villages and was followed by a series of cultural inventions such as the discovery of metal, the invention of writing and other technological advances, in fact took place in the wake of the development of village cultures. This mutation seems to have appeared for the first time in the Near East, especially in the hilly regions adjacent to the area of Near- and Middle East, that Breasted called the "Fertile Crescent" (*Peake, Harold and Fleure 1927*). The piedmont hills and lower inter-mountain valleys of the Zagros located in the Western part of Iran are an ideal location for animal and plant domestication. This area has been one of the favourite places of archaeologists and environmental specialists for at least three centuries. The zone suggested lies above hot and almost rainless flood plains, yet below the cold and damp mountains peaks. Ranging in elevation from 300 to 1500 meters, with rainfall between 250 and 500 mm per year, this region was ideal for naturally irrigated agriculture. According to Van Zeist's and Bottema's, as well as Wright's studies of four sites in the central Zagros at Lalabad, Nilofar, Zaribar and Mirabad, the climate of the region before 9000 BC was colder and drier than it is today (*Wright 1977.281–381*). The area that nowadays supports an open forest of oak and pistachio trees contained the late Pleistocene Artemisia Steppes (*Van Zeist and Bottema 1977*). As the climate of the Zagros region became warmer and wetter at the end of Pleistocene, different flora communities developed in the area of the oak and pistachio open woodland, which included the wild progenitors of potentially domestic wheat and barley. According to Wright (*1977*) the Zagros mountain region of diversified habitat was an attractive area for certain wild animals and for the people who hunted them. The Epipaleolithic and Neolithic civilisation in the Near and Middle East have been linked culturally and spatially; this enables us to observe the evolution of the Neolithic phenomenon in it's domestic regions in the Jordan Valley and Greater Mesopotamia (*Cauvin 1978*). However, one of the questions we have to face is the chronology and classification of the excavated sites that span through several millennia (10 000–6000 BC). The systems of classification in Zagros were based on technological, economic and cultural criteria, as well as on absolute chronology. The traditional classification, which is founded on the evolution of stone tool technology (objectified as Palaeolithic-Mesolithic-Neolithic sequence), cannot answer all the questions concerning the detection and description of different Neolithic phases and stages of civilisation. Therefore, we intend first to define different periods relevant to this study and thereafter try to present some aspects of the principal stages of the Neolithization.

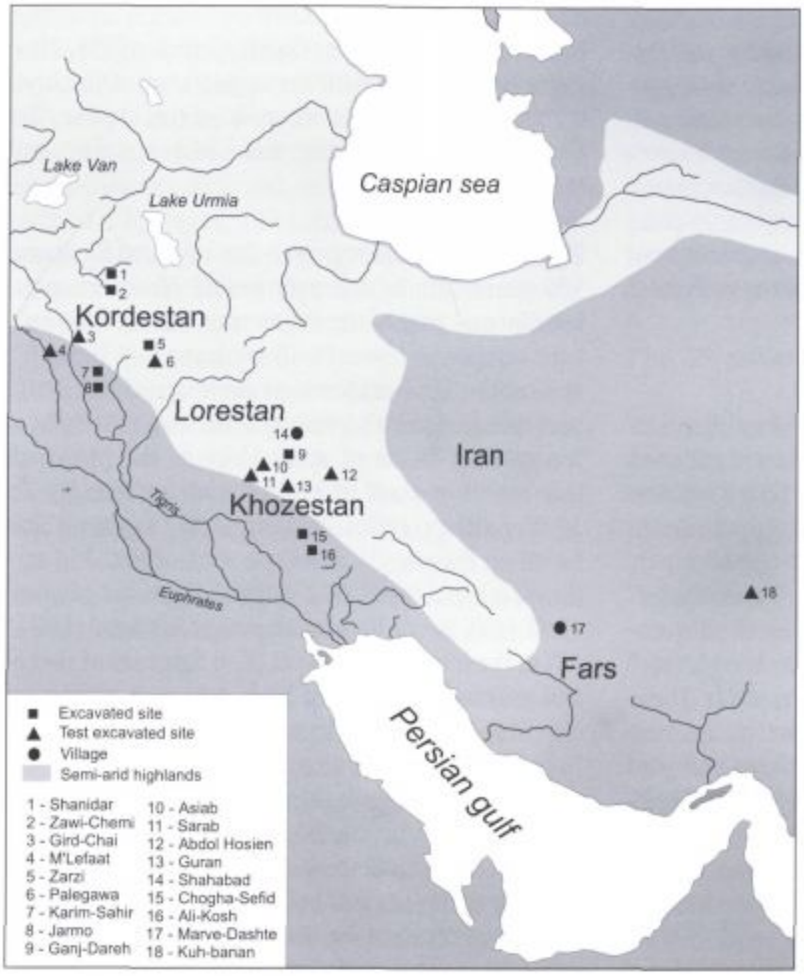
THE PRINCIPLE TRAITS OF DIFFERENT SEQUENCES AND A BRIEF REVIEW OF THE CHRONOLOGY OF THE NEOLITHISATION PROCESS IN IRAN

Braidwood, after several seasons of excavating many Neolithic sites in the foothills of the Zagros mountains, formed a sequence founded on socio-economic evolution to represent the different stages known since the upper Palaeolithic: (a) intensive food gathering, (b) incipient food production and (c) developed farming communities (*Braidwood 1975–98*). This perspective on evolution has great historical merit. For the first time, the relation between humans and their natural environment was accentuated. Braidwood also thought the key to all questions concerning Neolithisation would fit all the Near- and Middle East. But after 1960, some intensive studies in the Levant (Palestine, Syria and Anatolia) provided new data on the transition from a hunting-gathering to a farming society. The excavations at Mureybet, Aswad, Jericho and Çayönü showed some layers dated with ^{14}C that differed from the Zagros sites. It is perhaps necessary to point out that the Epipaleolithic (Zarzian) stone tool industry was based on microliths having only a few geometric forms, such as the crescent and the triangle.

9th to 7th millennium BC

The most significant period in our region is between the 9th and 7th millennia BC. A uniform complex of economic and socio-cultural changes was completed during this period. A special brief period, called Zarzian, is of great importance, because it links the end of the Mesolithic with the beginning of the Neolithic. Around the 9th millennium BC the first signs of Neolithisation process appeared on Mt. Zagros, in Kordestan, with the indisputable augmentation of wild sheep, the appearance of "grinding stones" and round stone structures. This phase is represented in Zagros by layers marked as Zawi Chemi B, Shanidar B1 and the upper layer of Palegawa. Information about the latter is scarce, but we have some significant data about Zawi Chemi and Shanidar.

Zawi-Chemi – the multilayered open-air site, located on an extensive terrace, was explored in 1958 and 1960 (*Solecki 1980*). The stratigraphy, more than two metres high, consists of a sequence of cultural horizons with depths ranging from 215 to 50 cm. The horizon at a depth of 120 cm provided a radiocarbon date of 10870±300 BP (W–1681). Perkins (*1964*) claimed that the sheep and goats were raised on the site especially in its later phase (100–50 cm). However, the new information allows us to create alternative explanations of the excessively large numbers of young individuals. The dominant sheep and goats are always accompanied by red deer, although the latter loses its significance towards the top of the sequence. The flint material was accompanied by the remnants of a rich ground stone industry and sheep and goat husbandry, which prompted Rose Solecki to determine the assemblage as Proto-Neolithic. According to Kozłowski, "further evidence" of such an evolution could be the presence of partially polished axes documented in the uppermost level of the stratigraphic sequence (*Kozłowski 1996. 101–116; Hole 1994.105*). However, we failed to find a true axe in the Washington collection, although we examined most of the finds classified by



Rose Solecki as such. Although the stone industry from Zawi-Chemi perfectly matches the early Neolithic Iraqi standard represented in the region of Nemrik, M'lefaat and Jarmo, there was a lack of the other elements of the PPN package. Tokens, clay figurines and stone vessels are absent, and we believe the lower part of Zawi Chemi's stratigraphic sequence should have been determined as the final Zarzian, more or les contemporaneous with Natufian civilisation in the Levant. Because of the incorrectness in identifying the stratigraphic sequence, it is impossible to date precisely the "proto-agriculture" phase and to identify the appearance of polished stone axes as well as the beginning of the processes of animal and plant manipulation in the region. However, we can be almost sure that all these innovations must belong to the upper part of level B at Zawi-Chemi.

Shanidar – the cave site is located at the southern part of Baradost Mountain at an elevation of about 822 metres. It overlooks Shanidar valley and is a short distance from the Great Zab River. The cave is still occupied during the winter months by local villagers and their livestock, mainly goats (*Redman 1978.62*). It is large, having about 1000 square metres of floor space, and prehistoric deposits as much as 13 metres deep. The deposits have been divided into four major archaeological levels (A–D) spanning the past 100 000 years. The oldest is Mousterian (level D) and the youngest is early Neolithic (level A). The Upper Palaeolithic layers (Baradostan) were superimposed by a deposit that has been divided into two cultural strata (B1 and B2). Rose Solecki has determined the lower layer as being Epipaleolithic or Zarzian (level B2) and the upper one as Proto-Neolithic (level B1). There is some similarity between the tool assemblages of levels B1 and B2. The stone tool industry in general is similar to that found at the nearby open air site of Zawi-Chemi. However, the uppermost level of this site (A) contains materials that range from the Neolithic to the present. Information about the bone tools of Shanidar B1 is limited; what we do know is that the celts/ axes have not been found. This could be an argument to support the thesis that this layer is older than Zawi-Chemi B. The available ^{14}C dates also support this hypothesis, placing Shanidar B1 level in the 9th millennium BC (10 600±300 BP) (W-667). It is interesting that grinding stones, which could be associated with gathering, were more abundant in Shanidar B1 (*Hole 1987*).

Palegawa – in the rock shelter of Palegawa, located very close to the Iraqi border (see map), a microblade industry of rectangles, triangles, trapezoids and lunates has been discovered in the Epipaleolithic layer. A few obsidian tools like in the Shanidar B2 assemblage have been identified, while the nearest obsidian source is located near Lake Van in Turkey, about 250 km away (*Reedman 1978.64*). The animal bone assemblage consists of gazelle, red deer, wild cattle, goat and probably sheep and domestic dog (*Turnbull and Reed 1974*). As far as we know, the final Zarzian in Kurdistan must have ended round 8000 BC. The contemporary sites of this period have not been found in Khuzistan, although we found the site Kuh-Banan further to the southeast, which might be coeval to Zarzian period in the western part of Iran (*Rafifar 1993*). The site was unfortunately not excavated properly and the radiocarbon dates and data on subsistence strategies and architecture are not available. So, the stone tool assemblage provides the only information we have. The artefacts showed some Natufian characteristics, which could have been defined according to Huckried (*1961*) by the presence of "geometric microliths" and "sickles" to suggest harvesting activities.

From 8000 BC to 7300 BC

This period was the most important part of the Neolithisation process in this region, because it included the transition from a sub-nomadic to sedentary and agricultural society. All the sites of this period are situated in Zagros, five of them in the northern part in Kurdistan (Zawi-Chemi B, Zarzi A, Karim Shahir, Gird Chai and M'lefaat) and at least three in the central part in Kermanshah (Ganj Dareh, Asiab, Abdol Hosien) have been completely excavated. These eight settlements were used as seasonal camps. The economy of residents was based on sheep and goat breeding. There are some indications for initial agriculture, though hunting and gathering continued to be main economic resource. However, according to Van Zeist, grains of morphologically domesticated barley have been found on the base level of Ganj Dareh (*Smith 1986.32*) and, if the report is confirmed, the cultivation of barley in Zagros would appear earlier than animal domestication, as in the case of Çayönü in Anatolia (*Dollfus 1989.44*). The structures discovered at these sites, with the exception of Tepe Ganj Dareh and Karim Shahir, display round buildings that stood until the end of the 8th and the beginning of the 7th millennium. One of the best examples is the construction of the first occupation phase in Tepe Abdol Hosien, which is round and up to one metre thick (*Pullar 1979*). This round and "primitive" architecture does not appear either in the rest of Iran or in Turkmenistan (*Aurenche 1982*). The appearance of real masonry is placed in the beginning of the 7th millennium. It is worth mentioning that the chronology of these sites is problematic and should be reconsidered.

The end of the 8th and beginning of the 7th millennium BC

This period is contemporaneous to PPNB in Levant. The number of known sites belonging to this period is higher than in the preceding period. They appear in all parts of Zagros and also in Khuzistan. Generally this period is characterised by first indications of agriculture, which is manifested for the first time in the "level D" of Ganj Dareh (*Smith 1975*). This event is associated with the appearance of the first rectangular houses that are made of rectangular *plano-covex* mud brick that show real complex and solid masonry.

Tepe Ganj Dareh – was probably occupied for about 500 years without a longer period of desertion at least by one part of the inhabitants during the year. Four occupation levels (A–D) are known. In "level D" appear the first evidence of tools associated with harvesting: a sickle, grinding tools and especially a "*receptacle*" made of mud which is the principal innovation in plant processing and storage (*Smith 1976; LeMiere 1986*). Numerous clay figurines are found on the site: 65 anthropo-zoomorphic, 113 anthropomorphic and 812 animal figurines (*Eygun 1992.110*). According to Schmandt-Besserat (*1974. 12*) in the most ancient level (E) 6 figurines of sheep and goat were found, together with some geometric clay objects, spheres, discs and cylinders. However, Hole (*1987*) believes that the evidence of domestication of cereals, animals and the new type of architecture cannot be considered as an argument for permanent settlement. Also, the very high altitude of the settlement (1400 m) is unfavourable for the earliest permanent habitation. The chronology of different sequences of Ganj Dareh has not been determined. The radiocarbon sequence seems unreliable: the first ^{14}C analysis dated the base level (E) to about 8450±150 BC (Gak-807) and the upper levels (A–D) to about 7300–7000 BC (*Smith 1976*). The analysis of four carbon samples performed in 1971 put the dates close to 6500 BC. Smith refused the dates and believes even the younger layers at Ganj Dareh belong to the 8th millennium BC (O.c.)

Karim Shahir – an open-air site excavated in 1951, is located on an eroding escarpment in the Iraqi province of Kirkuk. The artefact assemblage consists of chipped and ground stones and organic remains, while pottery is completely absent. The sample of 896 cores, representing the pattern of simple forms dispersed in all levels and all around the settlement has been examined recently and attributed to a single occupational period (*Howe 1983; Hildebrand 1996.169*). Human figurines are rare, only two having been found (*Besserat 1974.11*).

Tepe Asiab – a PPN open air site in the Kermanshah region near Ganj Dareh, it was excavated by Howe in 1959–60 but remains unpublished. Excavations yielded some chipped and ground stones, charcoal and burned human bones as well as few intrusive pottery fragments (*Hildebrand 1996*). The basal deposit has been dated to 9755±85 BP (*Howe 1983*). It is worth noting that the artefacts deposited in different layers in southern pit have been treated as a consistent artefacts assemblage for analytical purposes. However, 110 cores from have been examined, analysis is still in progress and final results are yet to come. Human figurines of minute size are rare, asexual and extremely schematised. Amorphous figurines have outstretched arms; others have legs and arms like stumps, and a plaque-like face with a pinched nose and a scatter of circular reed incisions. The meaning of these figurines is unknown (*Schmandt-Besserat 1974.12*). The number of animal figurines is equally small; at best, perhaps four can be identified. One of them represents the head of an unidentifiable little animal, fashioned without a body, and having a pinched nose and ears.

Tepe Abdol Hosien – is located about 55 km southeast of Ganj Dareh in Luristan, it is probably contemporary with the sites mentioned above. If so, it suggests that formally aceramic groups with or without mud brick buildings may already have been cultivating barley and emmer wheat. Tepe Abdol Hosien also yielded a large number of bullet-shaped cores, which is a sign of pressure-blade technology (*Pullar 1990*).

Tepe Alikosh – is located on the Deh Loran plain in southwest Iran and was excavated by Hole in 1961–63. Two trenches and a large pit were divided into six stratigraphic zones (A1–C2) attributed to the "era of early dry farming and caprine domestication" (*Hole, Flannery and Neely 1969*). The earliest occupation phase (Boz Mordeh) was dated to the end of the 8th and the beginning of the 7th millennium BC (7500 to 6750 BC). It is characterized by simple mud brick rectilinear structures and by significant use of obsidian tools comparing to contemporary sites in Zagros (Asiab, Ganj Dareh and Abdol Hosien). The abundance of bullet cores at Tepe Alikosh shows a much greater development in pressure blade technique than sites of Zagros area. Whereas an elevation of 300 metres might be considered as a lower limit for the distribution of potential domesticates in this region and therefore for early dry farming, the elevation at Alikosh, which contains evidence of early plant and animal domestication, is fixed at 145 metres below the limit. The subsistence strategy was based on the combination of wild and domestic resources. A small percentage of the seeds found were of cultivated varieties of two-row hulled barley and emmer wheat, neither of which is indigenous to the region (*Redman 1978.167*). Sheep were herded in much smaller numbers than goats. Hunting and fishing presented another major component of the subsistence activities of these early villagers (L. c). However, the northern Khuzistan is an excellent area for winter grazing, a fact that may have had a great deal to do with the beginning of food production there.

The 7th millennium BC

The number of sites at Zagros increases in this period. There are four most important sites located in western Iran. The first is in Kurdistan, two others in central Zagros, and the last on the Deh Loran Plain.

Tepe Jarmo – is situated in the Kurdish hills of western Iran at an altitude of about 800 m. It was the first village to be discovered and described (by Braidwood) and therefore it became a kind of a prototype of the early village society in the Near East. Qulat Jarmo's deposit spanned about nine metres in depth, of which the remains of the Neolithic settlement are preserved to a depth of about 7 metres and cover about one fifth of a hectare. There were as many as twelve layers of architecture identified, representing a community of 150 people over a period of several hundred years. The number of people was obtained when substantial architecture, constructed largely of pressed mud, was estimated. The people of Jarmo grew barley and two different sorts of wheat. They made flint sickles to harvest the cereals, used mortars or querns in which to grind them, ovens in which they might have been parched, and stone bowls out of which they could eat their gruel. They domesticated goats, sheep, dogs and in the latest levels, pigs (*Braidwood 1975.127*). The buildings, which were rectilinear, consisted of several rooms, many of which had small courtyards. The walls of the houses were made of padded mud, often set on crude stone foundations. According to Braidwood, the Neolithic village probably looked much like a simple Kurdish farming village of today, with its mud-walled houses and low mud-on-brush roofs (*Braidwood 1975.129*). Jarmo has been identified as a permanent settlement. The site has been dated to approximately 6750 BC. It is interesting that portable pottery does not appear until the uppermost settlement layers, and it was not distributed over the entire site. Pressure technology in making stone tools gradually replaced the old tradition of blades and microliths, which was still very strong. In the upper part of the settlement deposit, where the pottery appeared, the microlithic tools - geometrically shaped microliths - comprise almost 60% of the whole assemblage. The majority (97%) are trapezoids (*Hole 1983*). It is worth mentioning that round 6500 BC a specific obsidian tool appeared in Jarmo. We named it "fabrictor" and it is not known on any other contemporary site in Zagros. The point is that the nearest obsidian source is more then three hundred miles to the north. (*Braidwood 1975.129*).

One of the most characteristic features of the Jarmo assemblage is the quantity and variety of clay objects. More than 5500 of them were discovered during three seasons of excavation. Part of the assemblage consists of anthropomorphic and zoomorphic clay figurines. Braidwood believed they favoured the figurine of a markedly pregnant woman, expressing some sort of fertility spirit. Clay pieces shaped into definite and recognizable forms occur in the earliest levels and persist throughout the settlement phases. The total number of preserved zoomorphic figurines is about 1100 pieces. The number of human figurines has not been reported. However, according to Vivian Broman Morales none of the clay figures was found in a context that could suggest pottery use or even production (*cfr. Braidwood 1983.370*).

The ***Alikosh phase*** (6750 BC) of Tepe Alikosh has been determined as contemporaneous with the lower aceramic levels in Jarmo. The architecture developed into larger buildings that had more solid construction. There is evidence of a substantial community, perhaps with a greater degree of sedentism and bigger dependence on domesticates available. Sheep bones were abundant, though the hunting of large ungulates continued. Wheat and barley became more significant. Clay figurines increased in number and in variety of forms, a goat-like representation being very typical and widespread. Flint artefacts were abundant, especially blade tools and sickle blades. The microlithic tools grow scarce, although the quantity is still twice that of the microliths from the Zagros region (Jarmo aceramic phase). There are some geometric forms in the Alikosh assemblage that could differ significantly from the Deh-Loran and Kurdish industry. On the other hand, the "lamelles a'dos" and "troncature" that are relatively rare in Deh-Loran (18%) represent nearly 75% of the microliths in Jarmo, and the bladelets with discontinued retouch which frequently appeared in Alikosh phase (80%) are completely absent in Jarmo (*Rafifar 1996. 414*). The microliths in Deh Loran are characterised by a high quantity of end scrapers, borers and sickle blades. Some of them are obsidian, but we should not forget that the nearest obsidian source to Deh Loran is more than 900 km away.

Sarab - the middle and late Neolithic site of Sarab is located 7 km east of Kermanshan at an elevation of 1300m, which is higher than Jarmo (*Braidwood, Howe and Reed 1961*). Braidwood conducted the first excavations in 1961, but field documentation was unfortunately mislaid. Three small sondages were dug by the Mahidasht project in 1978. These confirmed that there were two periods, a middle Neolithic and a late Neolithic. The ceramic assemblage of the middle Neolithic consists basically of buff ware in a limited range of shapes. Some of the pottery is painted, usually in a variation of the "tadpole" design known from Jarmo and Guran. A small percentage is painted with geometric patterns along the rim and base, with the centre of the vessel left undecorated (*Levine and Young 1986*).

According to J. Braidwood it was thought at first that Sarab might have been inhabited only seasonally, but the evidence for restricted seasonal settlement is not so clear (*1975.130*). Braidwood's excavations did not reveal substantial mud-walled architecture, but the evidence from animal bones suggested a year-round occupation of at least some of the village's inhabitants. Some of the people may have moved from one site to the other in pursuit of pastures, while the others remained at home to continue activities that could be carried out during the summer. Curiously, Jarmo, a Sarab-like site in Northern Zagros lacks some of the very characteristics that define Jarmo as a settlement. Sarab has flint and obsidian, and also pottery, clay figurines, stone bowls and bracelets, and even goats, sheep and wheat, but its architectural traces are of wretched reed huts at best.

More than 2400 clay objects have been found at Sarab (*Broman Morales 1990*). The human figurines comprise the largest category (650 sp.) of realistically modelled pieces among the classified clay material. According to Vivian Broman Morales, this is partly due to the inclusion of three types of abstract form that she considers representing females (O. c. 16). The key example for this type is in the National Museum in Tehran. The legs or "shells" of the figures are beautifully decorated with parallel-line nail incisions which are followed by a row of tiny circular punctuates that were produced by a hollow stem like that of a straw. Twenty-one other figurines of this type are covered with different kinds of decoration. The category of animal figurines follows with three identifiable types: dog (33 sp.), pig (42 sp.) and horned animal (sheep or goat, 255 sp.) and three other types that are not identifiable, probably representing small animals (258 sp.). Some objects have geometric forms, and the presence of stone objects such as beads and labret like studs has resulted in a few imitations of these forms in clay.

Tepe Guran - is situated in Lurestan at 950 m altitude and has been excavated by Mortensen (*1974*). This site yielded a long sequence of early village material: twenty-one levels have been identified, which make up from 6 to 7 meters of occupation debris dated roughly from 6500 to 5500 BC. The earliest settlers lived in wooden huts in which traces were found of what may have been matting on the floor. At this level we have some evidence of semi-permanent occupation, with domestic goat already present. No evidence for the existence of agriculture has been found. The three lowest levels at Guran do not contain ceramic remains. In later levels, mud-walled houses predominate and there is abundant evidence of both farming and gathering as well as of development of pottery production. Painted pottery appeared in higher layers (R, Q and P) of Tepe Guran (*Mortensen 1974.22*). This standard painted ware is decorated with red strokes that resemble small tadpoles, a style of painting also found on the pottery in the upper levels of Jarmo and in other early villages in Zagros. Flint and obsidian tools were made on flakes and blades, some of which were characterized as microliths (*Redman 1978.172*). Level "V" is defined as the oldest (8410±200 BP, k-1006); it contains 2% of obsidian. On the other hand, we do not have any obsidian in level "U". In level "T", dated to about 6350 BC, obsidian tools represent 45% (36 pieces of 80 in total) of the industry. In level "S" there were only 6% and in level "R" no obsidian tools have been identified (*Renfew et al. 1966.58*).

Mohammad Jaffar phase

During the latest occupational phase in Tepe Alikosh (6000–5600 BC), there were many innovations, including the introduction of pottery and, it is obvious that the number of sites in Zagros area increased. Building techniques improved and the agricultural tools specified depending on task they were meant for. Sickels are not often found in the aceramic layers of sites discussed above, though they became abundant together with numerous blades, bladelets, end scrapers and borers. There are also evidences for polished axes and domesticated sheep, goats as well the agriculture. In Zagros area appeared rectangular houses with several rooms as a frequent type of architecture. From now on the society of western Iran can be defined as rural village society. In the period round 6500 BC we notice the appearance of a special type of tool, so called *"fabricator"* (the distinctive *"Çayönü tool"*) in Zagros. The tool, made from obsidian, was found at Jarmo in Zagros only. It might suggest that there were commercial and cultural relations between Zagros and eastern Turkey as well western Iraq, where the distinctive tools were produced at Magzaliyeh at the same time (*Bader 1979*).

ETHNO-ARCHAEOLOGY IN IRAN – CASE STUDY: LURISTAN

As is well known, ethno-archaeology is often used to help archaeology explain the past with analogies derived from observation of the present (*Freeman 1968; Watson 1979*). In western Iran several ethno-archaeological studies have been made due to the long-term interest in the transition from foraging to food producing systems. However, F. Barth (*1952*) was one of the first ethnographers to investigate several tribal communities in southern Kurdistan. There was Braidwood's team, working in Iraqi Kurdish village in the years 1960–1961, but W. M. Sumner performed the first ethno-archaeological research in a village in the southern part of Zagros (Marv Dasht region). He believed that there is a correlation between population and settlement area, which could be used to estimate ancient populations by recent analogy (*Sumner 1979.164–174*). C. Kramer was working on household size and wealth in Shahabad village in western Iran. She states that "The Shahabad data are relevant to certain classes of archaeological materials from the Zagros region for periods in which we have evidence suggesting the existence of variations in socio-economic rank". Another point that she observed and discussed was the correlation between archaeological changes and family structure. She claims residential architecture is closely bound to the needs of nature and number of inhabitants and suggests that archaeologists and social anthropologists alike should further explore the relationships between architecture and the domestic cycle (*Kramer 1979.139–163*). Hole's ethno-archaeological project in Luristan in western Iran provides a broad overview of his data on contemporary nomadic camps and the pastoral type of material culture, suggesting a venue for future research with such groups (*Hole 1979.192–218*). Hole's visit was organised with help of an Iranian assistant S. Amanolahi. They travelled widely through Luristan, questioning people about the economic, social and cultural aspects of their life. They joined one camp of nomads making their annual migration from winter to summer pastures. Hole believes that we can learn much about changes in vegetation, dietary habits, social practices, technology and about influences from outside through interviews, and that pastoral nomads required essentially the same equipment as used by villagers today. The majority of this equipment was probably available by the time domestication began more than 10000 years ago. He thinks that the basic difference between tribal villagers and nomads today is in the amount of equipment and in the style of housing. He also suggests that nomadic treks were usually short and took advantage of closely juxtaposed areas of environmental diversity. Hole adds that modern nomads may be entirely independent of agriculturalists, which could mean that specialised stock-raising could have developed independently of agriculture.

Our ethnographic study in several villages in Luristan yielded some interesting information about the traditional form of life of some nomadic and sedentary populations. One of the examples is a village that lies at about 1900 meters above sea level, approximately midway between Izeh (in the Eastern part of Khuzistan plain) and province of Ardel in the southwest part of Bakhtiyari region. The village itself covers an area of approximately 20 hectares extending along two sides of a river that flows throughout the year. It is set in a valley with excellent climate, and surrounded by the beautiful Bakhtiyari Mountain. The nearest communication is a third rate road almost 20 km away, which is only used at annual migrations. As often in the Zagros area, people depend on stock raising (cattle, sheep, goat, also donkeys) and agriculture (barley, wheat, rice, vegetables and orchards, limited to several wild fruits such as fig, pomegranate and grapes). Half of the population is supported by approximately 10 hectares of arable land. In 1989 the village was occupied by 135 people living in 33 families, every one of them descended from a clan of the Bakhtiyari tribe. As to architecture, two kinds of dwellings are recognisable. The first one, the winter residence with one or two rooms and a small storing place, is built of stone and mud with combinations of *chineh*. Wooden beams and twigs, capped with mud and rolled annually, are the most common roofing materials; most roofs are flat. Summer residences are black tents, one for each family, situated approximately 200–500 metres apart. These kinds of tens are also made by the people of Houfel of goat wool, which is weaved by the village women. This type of village can be placed in the category of simple societies. This classification is supported by indices showing primitive societies such as (a) absence of writing and literature (b) low population density, (c) simple productive system, (d) democratic tribal organisation, (e) lack of disorders caused by entropies (f) the existence of primitive culture which does not develop historically (*Lévi-Strauss 1969*). It should be mentioned that this village never came in touch with any form of civilisation, such as religious, health, etc, and the majority of the inhabitants never left the area. Its presence in this area could be traced back some 200 years. The community continues to live only with help of entirely indigenous cultural resources (*Rafifar and Asgary 1989*).

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Documenta Praehistorica XXVII

A New Painted Pottery Assemblage at Ismailabad; a Late Neolithic Site in the Central Plateau of Iran

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ABSTRACT – *Recent discoveries of Middle and Late Neolithic pottery assemblage at Ismailabad have been presented. Ismailabad painted pottery was the hallmark of a distinctive culture. Ornamental patterns are representationally sophisticated and conceptional, showing inspiration from an Iranian tradition.*

IZVLEČEK – *Predstavljamo zadnja odkritja srednje- in poznoneolitske keramike iz Ismailabada. Ismailabadska slikana keramika nosi jasen pečat kulture, katere vzorci okraševanja so značilno prefinjeni in vsebinsko izdelani, in ki se navdihujejo v iranski tradiciji.*

KEY WORDS – *Iran; Neolithic; painted pottery*

INTRODUCTION

For many reasons the single-culture unit of the northern-central part of Iran presents one of the most provocative challenges for archaeologists working on Neolithic studies because (1) there are only a few sites in the area that have been excavated (Fig. 1), (2) most of the sites were excavated years ago, when stratigraphy was considered much less significant (*Talai 1983a*), (3) archaeological reports have mostly emphasised pottery sequences and therefore the problem of cultural sequence and its relation with other cultural zones in Iran, such as northwest, central west, southwest and northeast, are based on ceramic parallels (*Dyson 1991*), (4) it is still unclear when and how the Neolithic period in the area began in comparison to the Zagros region – the central north part of the Iranian plateau does not seem to have gone through a pre-pottery and early Neolithic phases. It is worth noting that there are still some problems in identifying the Iranian pre-pottery Neolithic if we do not take into account the very few sites indicating pre-pottery debris. Given all the available evidence, we can divide the Neolithic period in the central plateau into a middle and late Neolithic (6200–4300 BC). Yet the foundation for the determination of the two phases is only based on a change in pottery tradition, the appearance of the black-on-red painted pottery which is most characteristic for the late Neolithic and appears first in Zagheh level 8 (*Malek Shahmirzadi 1990*) and Sialk 1-5 (*Ghirshman 1938*). Obviously this foundation is very insecure, and the writer is quite ready to discard his in-

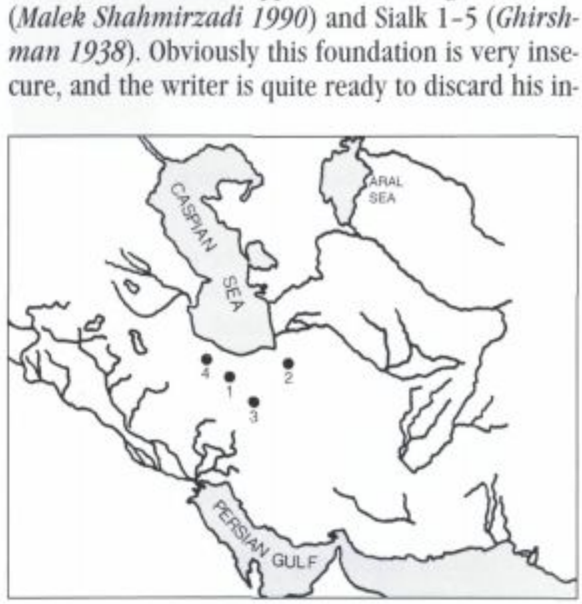

Fig. 1. Site distribution: 1. Ismailabadis, 2. Tepe Hissar, 3. Sialk, 4. Zagheh.

terpretation as soon as contradictory evidence is available. The Middle Neolithic period is represented in the lower levels of Zagheh I in the western part of the region and in Tepe Sialk level I in the eastern part, while the information from Cheshmeh Ali is scanty and inconclusive. The Late Neolithic period is represented in upper levels of Zagheh, in Sialk level II, in lower levels of Cheshmeh Ali and in a more recently excavated site at Ismailabad. However, on the bases of stratigraphy and chronology of Zaheh and Ismailabad, there seems to be a discontinuity in pottery sequence from the Middle to the late Neolithic.

THE MIDDLE NEOLITHIC (MN) POTTERY ASSEMBLAGE

An interesting feature of the MN is painted buff pottery (Fig. 2), which from a technical point of view is obviously more developed than the Early Neolithic pottery in Iran. The place of origin of MN pottery is a matter of considerable dispute. The original period of this assemblage is difficult to determine. It may have received some stimulus from the north-west of

Fig. 2. Zagheh, MN painted pottery.

Iran, but we hesitate to adopt the popular explanation of descent from a common source. The MN pottery is almost always thick-walled, made of coarsely levigated gritty clay and badly fired. The fabric of the pottery is buff in colour, of medium coarseness and contains chopped straw. The surface was smoothed before the application of paint, which is usually brown, with the design always monochrome. The style of painting and fabric of the pottery differ from the LN pottery assemblage (Fig. 3); MN pottery is technically inferior, coarse in texture and rough surfaced, with a slip used infrequently. The motifs are predominantly geometric and show that the painters had a marked preference for straight lines over curves. Simple patterns, such as hatching, crosshatching and zigzags are used very effectively, those made with multiple parallel lines and vertically painted zones being especially noticeable. Almost invariably the drawing is arranged in an orderly decorative scheme, and a feeling for the shape of the vessel is clearly absent. Another interesting characteristic of MN culture are containers for grain storage, indicating a well-developed storage system. The walls of these vessels are approximately 6 cm thick, made of baked straw-tempered clay, with diameters averaging around 60 cm. These vessels were lowered into underground pits and the spaces around them filled with loose debris. Many bins still held decayed chaff and carbonised grain when excavated.

Biconical spindle whorls, usually of baked clay, and bone tools such as needles are common, but flints and obsidian blades are very rare. Tiny, drilled beads and stone pendants appear, sometimes made of agate, turquoise, limestone, hematite and unidentified stone. The presence of some objects within MN assemblages suggests the existence of long-distance trade (*Talai 1999*). Crude human and animal clay figurines (*Negahban 1984*) and plain tokens in the shape of cone disks are present in MN deposits, as are clay tokens used for counting and accounting units of goods (*Schmandt-Besserat 1997*). MN deposits in the region show a well- developed society of people who built permanent dewellings. Tepe Zagheh is the largest site to yield architectural remains. As a result of several seasons of excavations a considerable part of the open and defenceless MN village has been revealed in the upper levels with the best-preserved houses with open courtyards. The settle-

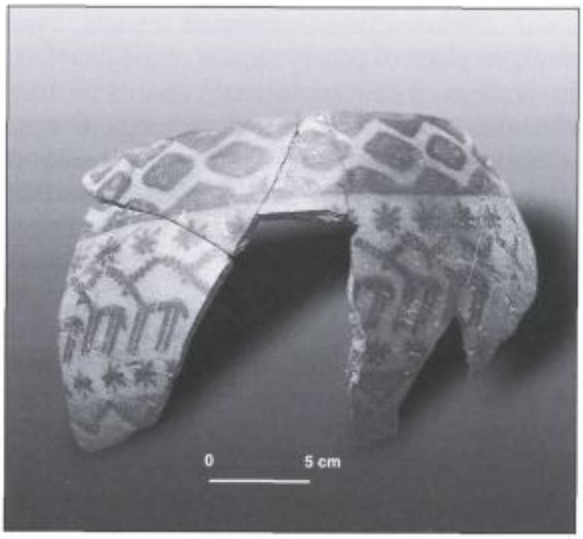

Fig. 3. Ismailabad, LN painted pottery.

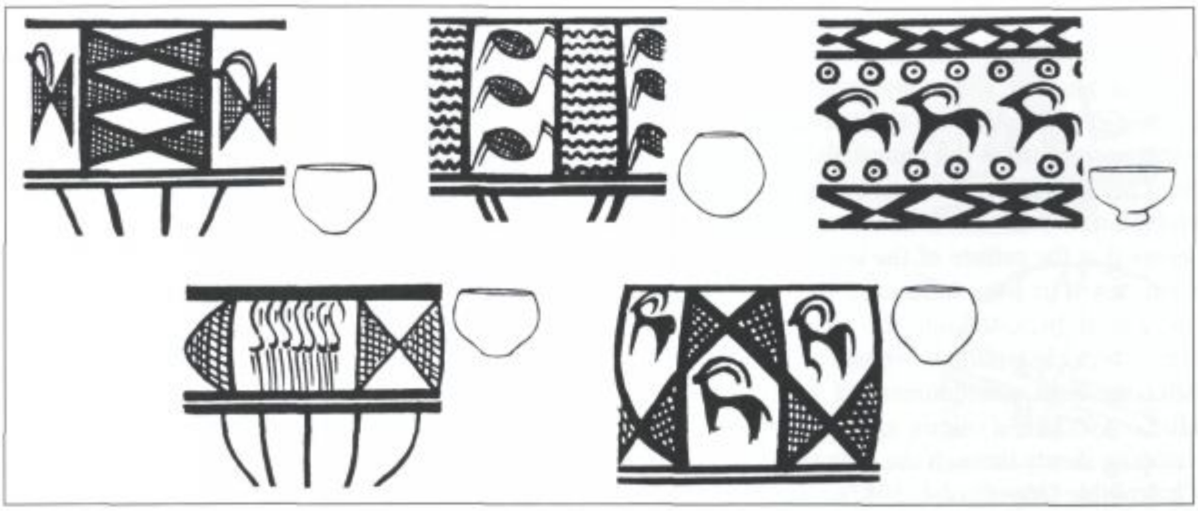

Fig. 4. Ismailabad, zoomorphic motives (after **Maleki 1968***).*

ment was probably at all times about the same size as modern villages in the neighbourhood. The total height of the mound from virgin soil is 6.7 meters. In the early stage *pise* is used a building material. But soon technical proficiency increased and they began to use long mud brick. Structural details indicate that there must have been a long tradition in MN architecture. The point is the appearance of Zagheh painted temple, a large (117 m^2) and complex structure with nine benches and a fireplace built inside. Walls were painted with simple designs. Large numbers of clay figurines were found inside the temple, which further indicates the building was a religious centre or was used for social gatherings (*Negahban 1979*). Domesticated plants and unidentified animal species are documented. The people of MN buried their dead with grave goods under the floors of the roofed areas of houses. In most cases the skeletal remains showed intensive use of red ochre, even in the mouth, which, if we may judge by burial practices, suggests an idea of an afterlife (*Negahban 1979*). As a whole, the assemblage depicts well the lifestyle and economy of MN people in this region, who reached a considerable level of technical development and created a flourishing culture.

THE LATE NEOLITHIC (LN) POTTERY ASSEMBLAGE AND ARCHITECTURE

Due to its distinguished architecture and pottery, Ismailabad remains the most important site of the Late Neolithic period. The stratigraphy of almost 7 meters of deposit and ten architectural levels of LN occupation is incomparable with any other site in the region because it shows a continuous development of black-on-red painted pottery, which is the common denominator of the Late Neolithic period, from light red to dark red. This fact makes it very likely that Ismailabad began its history as a result of migration very early in the sixth millennium BC. During the sixth millennium BC Late Neolithic villages

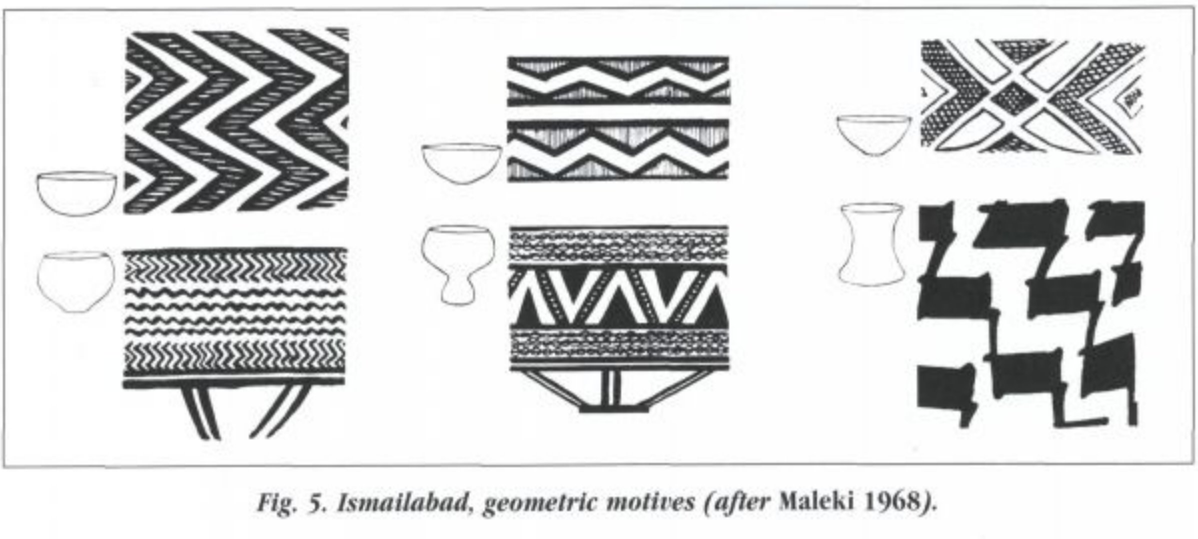

Fig. 5. Ismailabad, geometric motives (after **Maleki 1968***).*

appear widely on the central plateau and beyond, from Qazvin plain to Kashan (Sialk), and eastwards to Turkestan. It would be premature to assert on the present evidence that the wide expansion of the LN culture originated in the central plateau. The connections between LN settlements on the central plateau and eastern Iran seem, however, indisputable. It seems that the culture of the central plateau had a character of its own, influenced by local traditions. The culture persisted into the fifth millennium BC, with a break in continuity recognized in the region. After the final abandonment of Ismailabad, soon after c. 4300 BC, a culture appeared at Sialk III, developing slowly through the long succession of late Chalcolithic (*Majidzadeh 1981*).

As stated earlier, red painted ware is the most characteristic of Late Neolithic pottery. The motifs are predominantly geometric representing stylised animals and plants (Fig. 4). Complex linear designs such as hatching, crosshatching, chevrons and zigzag are common and used effectively, those made of multiple parallel lines being especially noticeable (Fig. 5). The considerable use of various horned and unhorned animals and birds is most noteworthy. Fish, wild horse and various unidentified animals also appear, the animals being represented almost in horizontal rows. The horned animals and birds are orientated in different directions, which might indicate two different conceptions of those animals in the painter's mind (Figs. 6, 7).

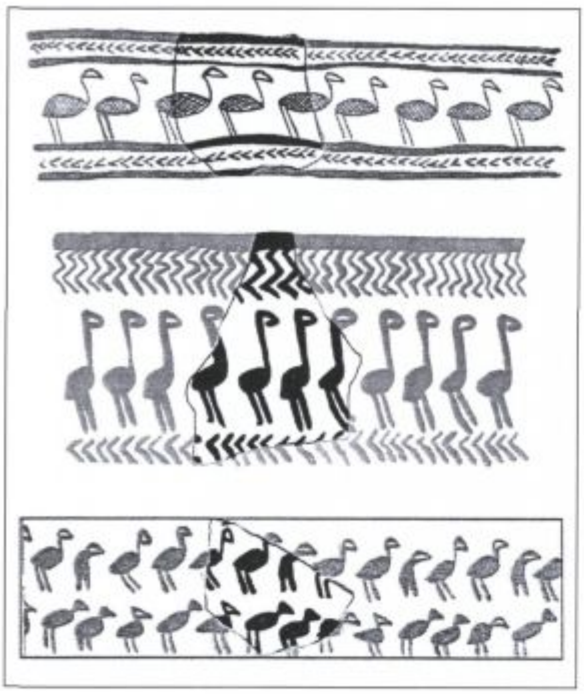

Fig. 7. Ismailabad, birds being represented in horizontal rows.

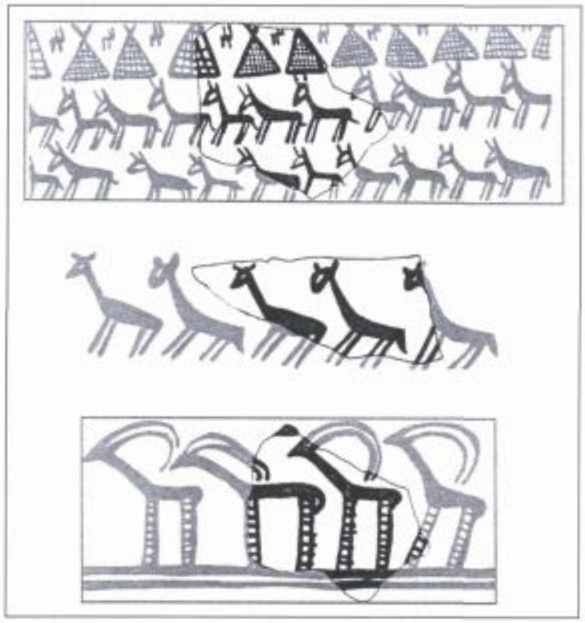

Fig. 6. Ismailabad, the horned animals being represented in horizontal row.

Negative design, which means the background is filled in with paint while the design areas are left in the colour of the pot surface, is frequently used (Fig. 8). It seems that painters were quite skilled at this technique, and they embellished it by adding painted motifs within negative areas or by placing painted motifs so as to produce the effect of a negative design. The fact that this technique appears earlier in the MN painted pottery assemblage is one of the reasons for considering LN pottery as local in character.

Horizontal zones of continuous design, undoubtedly the most effective decoration for the round surface of a pot, predominate; elements in these design zones tend to be contiguous. Rarely, mostly on simple bowls and some pots, only one zone of design appears. Even on these vessels the broad zone is frequently accompanied by very narrow subsidiary zones on simple bands. The characteristic LN style of

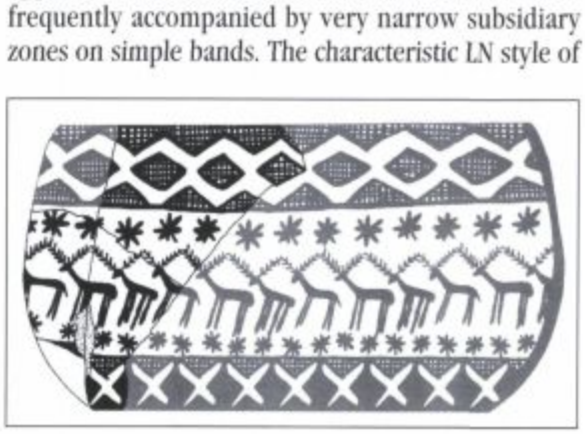

Fig. 8. Ismailabad, negative design and horned animals.

Fig. 9. Ismailabad, circular surface decoration.

decoration consists of multiple zones of design, usually rather narrow, extending from the exterior rim to, or just below, the point of the largest diameter. Generally, these are separated by plain narrow bands. The spacing, filling and balancing of these design zones is excellent, as well as the feeling for dark and light areas. The drawing tends to be in thin lines, but heavy ones are not avoided, and a notable balance of the bold and the fine is achieved.

In all taller and more closed forms the main design is on the outside. Shallow bowls and plates bear their main design in the interior; it is in the composition of these interior designs that the painter achieved his best works. The decoration of a circular surface presents a difficult aesthetic problem. The success of the painters is demonstrable by a glance at their work: they have created a wonderful effect of life and movement and a harmonic balance by dividing the circular surface into four equal parts (Fig. 9). Drawing is arranged in and orderly decorative scheme. Feeling for the shape of the vessel is present and can clearly be seen in many examples. The lower part of vessel is differentiated from the upper part in many cases, often by a heavy festoon design, while the foot usually only bears plain vertical bands of paint (Fig. 4). Finally, there was a continuous use of designs such as swastikas and the rays of the sun throughout the whole sequence of the LN period (Figs. 10, 11).

The painted ware takes many main forms (Figs. 4, 5, 9). The fabric is red in colour, of mostly fine clay, with the inclusion of chopped straw or fine sand. The surface was usually slipped before the application of paint, which is mostly black, while the design is always monochrome.

There seems to have been a dual system of pottery production in the LN period. Everyday vessels were probably produced in small quantities in every village. The second mode of production, in which high quality ware was produced apparently by specialists for export to neighbouring settlements, is best known from Ismailabad. Studies have shown that pottery from this workshop was traded over a radius of about 200 km. If this was the case, then it is suggested that the high quality Ismailabad painted ware, which shows a uniformity of design and execution, was probably mass-produced, while other less sophisticated ware was produced locally (*Maleki 1968; Vanden Berghe 1968*).

The characteristic site formation of the MN and LN periods in the region is a by-product of the main building material used. Unbaked mud brick is cheap, convenient and easy to make, but unless a mud brick building is kept in good condition with a proper roof and plastered interior and exterior

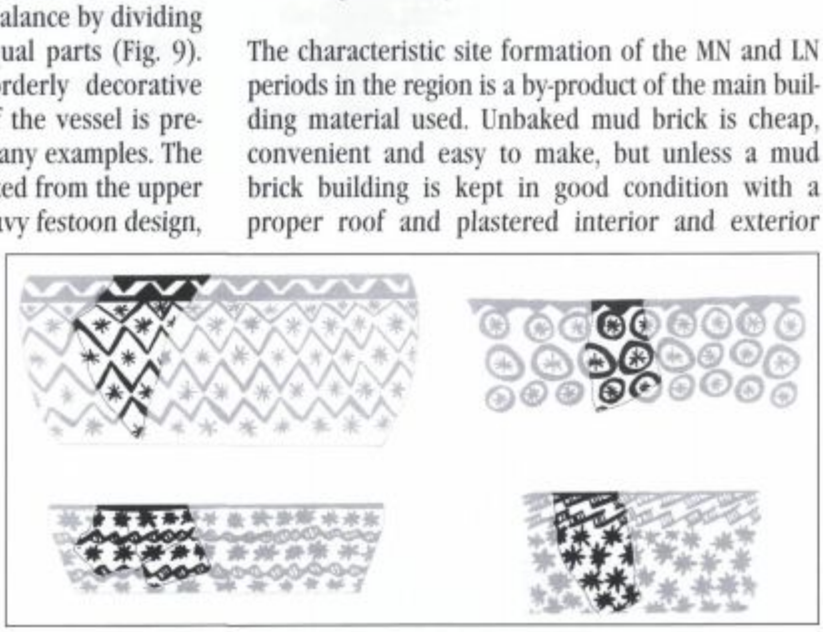

Fig. 10. Ismailabad, "Sun rye" motive.

walls, it deteriorates very quickly and the bricks crumble back into a low heap of earth. This heap will often form the basis of later buildings and so, over a period of years, a small site is formed. This process, repeated on the ground scale, augmented by domestic debris, leads eventually to the formation of the sites which comprise the ancient settlements in much of the Iranian plateau.

Mud brick and *pise* are the main building materials. Chopped straw and sand are usually added to improve the consistency, and the mixture is manually shaped. The size and shape of bricks changes through time and can sometimes be used as age indicators. For example, the MN period is characterised by the use of long rectangular handmade mud brick. The LN period is characterised by the use of so-called "plano-convex" brick, rectangular in plan, with a rough flat surface, dried in the sun. This odd shape seems to have been achieved by rounding off each brick by hand. Bricks were often laid in a conventional bonding fashion. They are distinctive and are found only in the LN period. The mortar used with the brick is usually of mud. The importance of protecting exterior walls from the weather has already been mentioned, and mud or lime plaster is usually used to achieve this. Chopped straw is

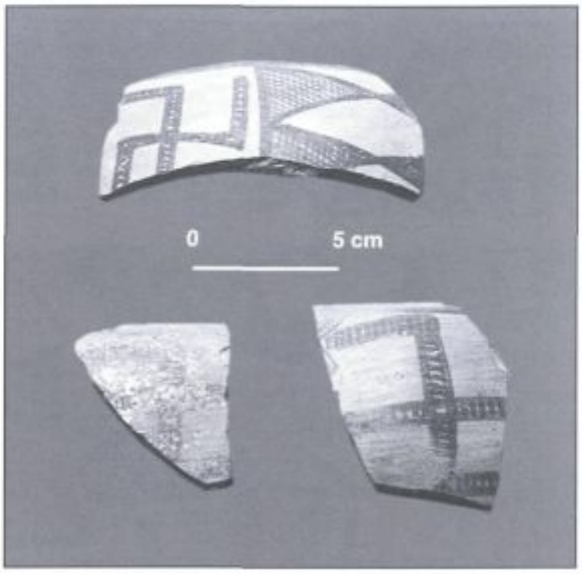

Fig. 11. Ismailabad, swastika presentation on pottery.

added to mud in order to improve the durability and consistency of the plaster. This mixture (straw and clay) is a traditional plaster in Iran, locally known as Kahgle. The lime plaster could be smoothed and polished to give a high quality finish, while the clay plaster was considerably rougher. Both clay and lime plastering is used in the LN period. Roofs were usually flat and were made much as they are today, the rafters of timbers being covered with mats layers of mud. With this limited range of material at their disposal, the LN builders mastered construction techniques (Fig. 12). We know very little about the tools and measuring equipment they used. With minimal equipment they were able to lay out relatively large buildings with accuracy and orient them to the cardinal points as tradition seemed to demand. The mathematics needed may not have been very sophisticated, but an understanding of basic engineering principles and of the properties of mud brick must have been essential.

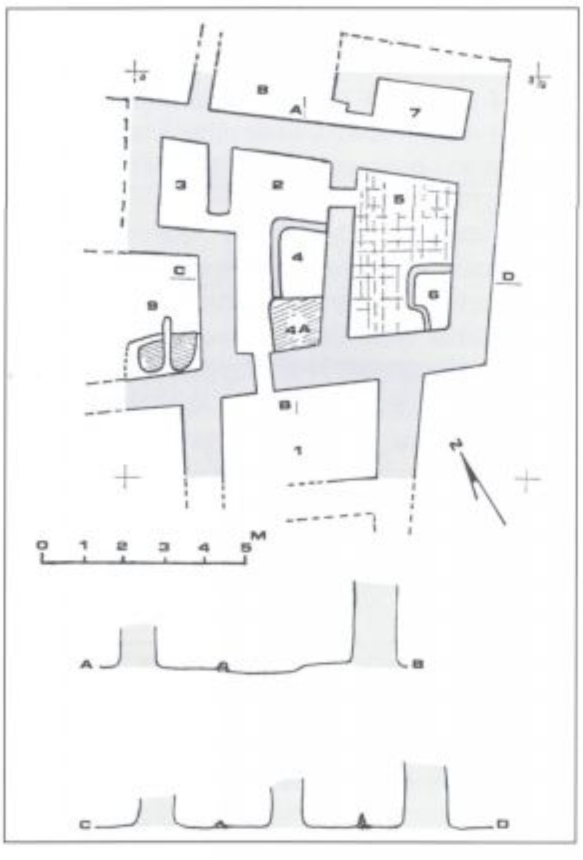

Fig: 12. Ismailabad, level 5, architectural remains.

The architectural remains at Ismailabad belong to the LN period (our evidence relates mainly to the domestic buildings which are preserved well enough to allow us to discuss them). The private houses tell us relatively little about the everyday life of the people who lived in them. They have few distinctive features and, generally speaking, are poor in small finds. The plans of the houses suggests they were for self-contained and their importance as the basic unit in society. The positions of the houses at the centre of family life is emphasised by the presence of graves under the floors. Throughout the MN and LN periods, custom seems to have dictated that the dead were buried with grave goods which were apparently intended to make life in the other world as comfortable as possible.

Whatever the relationship between the central plateau cultures finally proves to be, it appears fairly clear that at least the cultural B sequence, during the sixth and mid-fifth millennium BC has been clarified, and indeed, in some degree modified by excavations at Ismailabad. It is no longer enough to rely on the well-known discoveries at Tepe Sialk. During the sixth millennium BC the first beginnings of a new and distinctive culture can be detected - that is, the Late Neolithic culture. The radiocarbon dates may be used tentatively to suggest a maximum time-span for the culture from c. 5000 until 4300 BC. Ismailabad painted pottery was the hallmark of a distinctive culture. Another criterion of this culture, on the evidence of Ismailabad, must be the architectural pattern, which was utterly alien to the Middle Neolithic Zagheh culture. Precisely who the first inhabitants of Ismailabad were, or when, whence or how they arrived are questions which may never be answered to the satisfaction of every specialist. The pottery shows an improvement in quality of clay, firng and decoration throughout the LN period. Patterns are representationally sophisticated and conceptional, showing inspiration from an Iranian tradition. The eastward expansion of the LN culture extended as far as Turkestan (*Malek Shahmirzadi 1977*).

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