University of Ljubljana
Faculty of arts

Department of archaeology

Documenta Praehistorica XXXV

Neolithic studies

Univerza *v Ljubljani*
Filozofska fakulteta
Oddelek za arheologijo

Documenta Praehistorica XXXV

EDITOR
Mihael Budja

15[TH] NEOLITHIC STUDIES

ISSN 1408-967X
ISSN 1854-2492

LJUBLJANA 2008

DOCUMENTA PRAEHISTORICA XXXV

15. NEOLITSKE ŠTUDIJE / 15th NEOLITHIC STUDIES

Uredniki/Editors:
Dr. Mihael Budja, urednik/editor, miha.budja@ff.uni-lj.si
Bojan Kambič, tehnični urednik/technical editor, spikar@siol.net
Dr. Dimitrij Mlekuž, urednik spletne strani/web editor, dimitrij.mlekuz@guest.arnes.si

Jezikovni pregled/English advisor: Philip James Burt

DTP: Cambio d.o.o., Ljubljana

Tisk/Printed by: Tiskarna Hren, Ljubljana

Naklada/Number printed: 750 izvodov

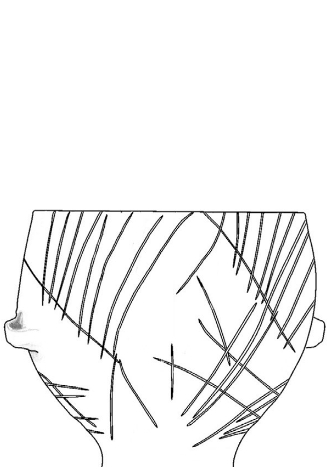
Natisnjeno s podporo Javne agencije za raziskovalno dejavnost Republike Slovenije./
Funded by the Slovenian Research Agency.

The *Documenta Praehistorica* is edited at the Department of Archaeology,
Faculty of Arts, University of Ljubljana.

The *Documenta Praehistorica* website provides a free access to all the articles published since 2001.
Find us at *http://arheologija.ff.uni-lj.si/documenta/*

Documenta Praehistorica je vključena v/The *Documenta Praehistorica* is indexed in
European Reference Index for the Humanities (ERIH),
http://www.esf.org/research-areas/humanities/research-infrastructures-including-erih.html

*The 15th Neolithic Studies anthology comprises selected papers, presented at fifteenth Neolithic Seminar '*The Neolithic Mind, Populations and Landscapes*' that took place at the Department of Archaeology, University of Ljubljana in November 2007. We present also a papers focussed on the colour, form, animals and deception in the ice age; on the catastrophic flooding of the now submerged North Sea continental shelf ('Doggerland') by the Storegga Slide tsunami at around 8200 calBP; on the climate induced (8200 calBP 'climate event') social unrest and warfare in the Late Neolithic\Early Chalcolithic in Anatolia; on the episodes in past river behaviour and settlements dynamics on the Ljubljana Marshes that correspond with climate anomalies in European palaeoclimate records in the Holocene; on the reassessment of Mesolithic/Neolithic 'gap' in Southeast European cave sequences; on the reassessment of formation processes, stratigraphy and dating at Vlasac, Padina and Hajdučka Vodenica in Danube Gorge; on the early herding practices and milk consumption revealed through organic residue analysis of early and middle Neolithic pottery in Dinaric region.*



Mala Triglavca. Neolithic bowl
*with evidence of milk lipids (*Šoberl et al. this volume*).*

Contents

UDK 550.344.4(261.26)"633"
Documenta Praehistorica XXXV (2008)

The catastrophic final flooding of Doggerland by the Storegga Slide tsunami

Bernhard Weninger[1], Rick Schulting[2], Marcel Bradtmöller[3], Lee Clare[1], Mark Collard[4], Kevan Edinborough[4], Johanna Hilpert[1], Olaf Jöris[5], Marcel Niekus[6], Eelco J. Rohling[7], Bernd Wagner[8]

1 *Universität zu Köln, Institut für Ur- und Frühgeschichte, Radiocarbon Laboratory, Köln, D,* b.weninger@uni-koeln.de; 2 *School of Archaeology, University of Oxford, Oxford, UK;* 3 *Neanderthal Museum, Mettmann, D;* 4 *Laboratory of Human Evolutionary Studies, Dpt. of Archaeology, Simon Fraser University, Burnaby, CDN;* 5 *Römisch Germanisches Zentralmuseum Mainz, D;* 6 *Groningen Institute of Archaeology, Groningen, NL;* 7 *School of Ocean and Earth Science, National Oceanography Centre, Southampton, UK;* 8 *Universität zu Köln, Institut für Geologie und Mineralogie, Köln, D*

ABSTRACT – *Around 8200 calBP, large parts of the now submerged North Sea continental shelf ('Doggerland') were catastrophically flooded by the Storegga Slide tsunami, one of the largest tsunamis known for the Holocene, which was generated on the Norwegian coastal margin by a submarine landslide. In the present paper, we derive a precise calendric date for the Storegga Slide tsunami, use this date for reconstruction of contemporary coastlines in the North Sea in relation to rapidly rising sea-levels, and discuss the potential effects of the tsunami on the contemporaneous Mesolithic population. One main result of this study is an unexpectedly high tsunami impact assigned to the western regions of Jutland.*

IZVLEČEK – *Okoli 8200 calBP je velik del danes potopljenega severnomorskega kontinentalnega pasu (Doggerland) v katastrofalni poplavi prekril cunami. To je eden največjih holocenskih cunamijev, ki ga je povzročil podmorski plaz na norveški obali (Storegga Slide). V članku predstavljamo natančne datume za cunami Storegga Slide in jih uporabimo pri rekonstrukciji takratnih obal Severnega morja, v času naglega dviganja morske gladine. Dotaknemo se tudi možnih posledic cunamija za mezolitske populacije. Glavni rezultat študije je nepričakovano močan vpliv cunamija na zahodni del Jutlanda.*

KEY WORDS – *Mesolithic; Doggerland; Storegga Slide tsunami*

Introduction

The hypothesis that a major tsunami was generated by an underwater slide off the west coast of Norway was first proposed by Svendsen (*1985*) and further elaborated in a large number of studies (*e.g. Bondevik 2003; Bondevik et al. 1997; 2003; 2005; 2006; Dawson et al. 1988; 1990; 1993; Grauert et al. 2001; Haflidason et al. 2005; Long et al. 1989; Smith et al. 1985; 2004*). As a result of detailed fieldwork (*e.g. Bondevik et al. 1997; 2003; 2005; Smith et al. 2004*), followed by comprehensive modelling studies (*Harbitz 1992; Bondevik et al. 2005*), a comparatively large number of deposits on the coasts of Norway and eastern Scotland can now be safely attributed to the Second Storegga Slide tsunami. The generation of the tsunami apparently involved some 2400–3200km³ of material that spread across the North Atlantic sea floor, altogether covering an area of around 95 000km² (*Haflidason et al. 2005*) – that is about the size of Scotland. Bryn et al. (*2005*) suggest the cause of the Storegga slide was a strong earthquake in the North Atlantic, but further investigations are necessary to substantiate this hypothesis. Due to the large slide/slump volume and extensive reworking, the direct dating of the slide sediments is no easy matter. Comprehensive analysis of a long (more than 50 ^{14}C-ages) series of AMS-radiocarbon ages for stratified basal post-slide sediments, processed on purposely chosen monospecific planctonic foraminifera (*Neogloboquadrina pachyderma* and *Globigerina bulloides*) to reduce the risk of reworking, give an (averaged) direct date for the main slide of 7250 ± 250 ^{14}C yrs BP (*Haflidason et al. 2005*).

Traces of the corresponding Second Storegga Slide tsunami have been identified in many regions of the North Atlantic, with the best-studied locations on the coast of Norway and eastern Scotland. On the Norwegian coast, at locations directly opposite to the sub-marine landslide region, the tsunami had a maximum runup of 10–12m. Further north, a runup of 6–7m is reconstructed. On the eastern coast of Scotland typical runup heights exceed 3–5m (*Smith et al. 2004*). Storegga deposits are also known from the Faroes (*Grauert et al. 2001*) and the Shetland Islands, where runup exceeds 20m (*Bondevik et al. 2005*). Recent studies show that the tsunami probably even reached the east coast of Greenland (*Wagner et al. 2007*). This would agree with modelling studies (*Bondevik et al. 2005*), according to which the wave front would have crossed the North Atlantic within 3 hours, with maximal elevation on the open ocean of 3m. The size of these waves, and their spread over such a large area, indicate that most of the volume of the slide was involved in the generation of the tsunami (*Bondevik et al. 2005*). On the Norwegian coast, the arrival of the first wave would have been associated with a major water withdrawal, corresponding to a predicted initial sea-level drop of 20m. The model also predicts that multiple waves should occur. This is confirmed for deposits probably laid down by the Storegga slide tsunami on the east coast of Greenland, where the grain-size composition, biogeochemical and macrofossil data indicate that the Loon Lake basin was inundated by at least four waves (*Wagner et al. 2007*). The effects of the tsunami on other North Sea coasts – and notably on Mesolithic Doggerland (*Coles 1998*) – have not yet been modelled. As a starting point for our studies towards the potential effects of the Storegga Slide tsunami in the southern North Sea, we assume that runup in this region is likely to have been around 3m (*pers. comm. Bondevik 2007*).

Tsunami deposits

The accurate dating of the Storegga Slide Tsunami represents a major challenge to established radiocarbon methodology. As already recognised by Bondevik et al. (*2006*), the accurate radiocarbon dating of palaeotsunamis is problematic for three reasons: (1) erosion of the underlying strata, (2) redeposition of organic material within the tsunami deposit, and (3) redeposition of organic matter following the tsunami event. Due to the importance of these issues for radiocarbon dating, we begin with a brief description of the tsunami deposits under study on the coasts of Norway and Great Britain.

Norway

In Norway, the Storegga Slide tsunami deposits are typically recognised as a distinct layer of sand in peat outcrops, with an underlying and often sharply eroded surface (*Bondevik et al. 1997; 2003*). Similar observations have been made all along the eastern coast of Scotland, where the inferred tsunami deposits are readily recognised by a recurring sand layer within raised estuarine sediments that pass into peat in a landward direction (*Dawson et al. 1993*). This sand layer, both in Norway and Scotland (see below), contains a variety of chaotically redeposited organic materials, including twigs and bark. These are the samples, typically described as deriving from 'within the tsunami layer', that were carefully selected during field-work. When short-lived (annual growth) dating material (*e.g.* twigs, bark) is available, this is the preferred material submitted for radiocarbon dating, in contrast to peat samples, which are expected to have an in-built 'older' age due to peat growth processes.

Along the Norwegian coast, as observed at higher levels, the tsunami inundated a number of fresh-water bodies, again leaving behind a characteristic sand layer. These deposits contain redeposited lake mud, rip-up clasts, and churned up marine fossils. This sand layer has many of the characteristic properties known from modern tsunami deposits. In particular, the observations made for the Storegga Slide tsunami are consistent with the modern observation that tsunamis are commonly associated with at least two waves, with the second wave arriving within minutes, but even up to a few hours after the first, depending on distance to the source (*Bondevik et al. 2005*). Regarding the geological situation in Norway, the first wave typically appears to have eroded the peat surface, producing huge amounts of rip-up peat clasts, which were then chaotically redeposited along with other organic remains, during the backwash. The second wave then appears to have buried these materials in a layer of sand (*Bondevik et al. 1997*).

In order to accurately measure the runup heights for the Storegga tsunami, Bondevik et al. (*2005*) developed a novel method for runup reconstruction, which is applicable to the large number of tsunami deposits known from the Norwegian coast. The method is to map the precise heights of the tsunami deposits in a series of increasingly higher lake basins, until the maximum height is reached. By this method, it appears that the waves inundated the coastal lakes up to 10–12m above contemporary sea-level, but failed to reach lakes at a height of 13m (*Bondevik et al. 2005*). Similar to the Shetland islands, as described below, the reconstructed maximal runup depends strongly on the established local contemporary sea-level, but in this case that level is well constrained (to within 1m), due to previous studies of Glacial uplift for the Fennoscandian ice-shield.

According to Bondevik et al. (*2003*), the tsunami deposits in Norway were sampled for radiocarbon dating by the careful selection of short-lived plant macrofossils. Such samples are available both from peat outcrops, as well as lakes. From the peat deposits, the ages judged most reliable were obtained on seeds found immediately below the sand layer. Further sampling emphasis is on leaves and seeds from lake mud just above the tsunami deposit. In one case, a radiocarbon age was obtained on a stick immediately above the sand layer. Following critical sample selection, Bondevik et al. (*1997*) propose that the tsunami most likely dates to *c.* 7300 ^{14}C-BP. This age is supported by Bondevik et al. (*2003*), who give a calibrated age value of *c.* 8150 calBP.

Scotland

Geological observations probably relating to the Storegga tsunami are also available for the east coast of Scotland, where a conspicuous sand layer is recognised at numerous localities (*Dawson et al. 1988; 1993; Smith et al. 2004*). According to Dawson et al. (*1990*), this sand layer was deposited by a major tsunami believed to have overwhelmed a Mesolithic occupation at Inverness, and it may also have flooded other Scottish archaeological sites, *e.g.* at Morton. Ballantyne (*2004*) urges interpretational caution, however, since localised storm events would have had equally catastrophic effects, particularly during a period of rapidly rising sea-levels. The sand layer is not found on the west coast of Scotland. This would be indicative of a tsunami coming from the east.

Britain

A useful review of all the currently known sites in the United Kingdom with evidence of the Storegga Slide tsunami is given by Smith et al. (*2004*). These authors demonstrate that the tsunami affected a much larger coastal area than previously described, with the total length of the inundated coastline reaching more than 600km along eastern Scotland. In addition to giving information on the altitude, distribution, stratigraphical context, and microfossil characteristics of the deposits, it is shown by detailed particle size analysis that the majority of tsunami sand deposits have a marked fining-upwards characteristic. This is important, because it gives information pertaining to the dynamics of the wave at different heights. Since sedimentation is only possible when the suspended sand particles are released, the implication is that the tsunami runup is likely to have exceeded the measured maximal height of the sand layer by several metres (*Smith et al. 2004, with references*). This study is of further interest, since the authors invest some effort in discussing the taphonomic properties of the dated samples, in search of a useful dating strategy.

According to Smith et al. (*2004*), based on a total of 47 radiocarbon dates from the United Kingdom, the tsunami event took place sometime around 7100 ^{14}C-BP (7900 calBP). This estimate seems about 200 years later than that from Norway (*Bondevik et al. 1997; 2003*), but this 'offset' likely results from the different dating approaches in the Norwegian and British studies.

In their ^{14}C-analysis, which is of special interest to us for the purposes of comparison, Smith et al. (*2004*) describe and classify the UK ^{14}C-dates according to whether the samples have a 'transgressive' or 'regressive' overlap with the tsunami sand layer. The idea is that it might be possible to produce a statistical 'sandwich' date for the tsunami, when large numbers of such paired dates are analysed. As mentioned by Smith et al. (*2004*), this approach could be problematic, since the derived dates from the contact zone might turn out too young, if there is a delay in peat growth on the sand layer, following the tsunami. To further analyse the UK dates, and notably to compare the results of applying different descriptive approaches to the tsunami deposits, we have adopted the database of Smith et al. (*2004*) essentially unchanged (Appendix, Tab. 8).

England (Howick case study)

Further south, deposits that have been attributed to the Storegga tsunami have been identified in the vicinity of the Mesolithic site at Howick, situated in Northumberland on the east coast of England (*Boomer et al. 2007*). For these deposits a set of ^{14}C-ages is available (Tab. 1). It is important to note that these ^{14}C-ages are not from the Mesolithic coastal cliff-top site at Howick (*Waddington 2007*), but from a core, approximately 800cm long core (HEX02 11007) taken from riverine sediment in the immediate vicinity of the site (*Boomer et al. 2007*). The stratigraphic situation in core HEX02 11007 is highly complex. According to the detailed description by Boomer et al. (*2007*), core HEX02 11007 contains a 30cm layer of coarse sands and sandstone pebbles, which is distinctly defined at a depth of around 750–705cm. Due to a lack of samples, no ^{14}C-dates are available from this layer. Terrestrial samples from immediately below this layer have ages ranging between 8.2 and 10 ka ^{14}C-BP. They do not contribute to the present discussion. Hazelnut shells from the immediately overlying deposits have supplied a date of 7269 ± 39 ^{14}C-BP (Oxa–11833) at a depth of 685–684cm, and a statistically identical date of 7308 ± 40 ^{14}C-BP (OxA–11858) at 683cm depth. In the stratigraphy 53cm higher, there follows a slightly younger date from a hazel twig (OxA–11860: 7160 ± 40 BP), and further dates around 7 ka ^{14}C-BP are obtained at depths up to 580cm. According to Boomer et al. (*2007*), the sand layer at 750–705cm may be related to the Storegga tsunami. It appears as a distinct and 'chaotic' clastic unit, within an otherwise uniform and fine-grained riverine sediment. Although quite different from the tsunami deposits along the Scottish coast, the geological context of this layer is indicative of an extremely high-energy event.

Although we can follow the authors in relating this layer to the Storegga tsunami, we are not convinced of the proposed age of 8350 calBP for the event, which was derived by Bayesian linear regression analysis of the sample stratigraphy at heights above the sand layer. As an alternative approach, further described below in the context of a model we have developed for radiocarbon dating of chaotic tsunami deposits, we propose simply to take the two (statistically identical) dates closest to the clastic unit (Oxa–11833 and OxA–11858), calculate their weighted average, and use the age value as a close terminus ante quem for the tsunami event.

Lab Code	^{14}C-Age [BP]	$\delta^{13}C$ [‰ PDB]	Material	Core Depth [cm]	Calendric Age [calBP] (68%)
Oxa–12952	6988 ± 37	–26,5	hazelnut shell	580	7840 ± 60
Oxa–12953	7117 ± 39	–26,1	hazelnut shell	580	7940 ± 40
OxA–12954	7075 ± 37	–30,7	sliver of wood bark	583	7910 ± 40
OxA–11859	7174 ± 35	–26,4	carbonised wood	627	7990 ± 30
OxA–11860	7160 ± 40	–27,3	hazel twig	630	7980 ± 30
OxA–11858	7308 ± 40	–25,6	hazelnut shell	683	8110 ± 50
OxA–11833	7269 ± 39	–24,9	hazelnut shell	684–685	8090 ± 60
Tsunami	–	–	poorly sorted, coarse clastic unit	705–750	–

Tab. 1. Selected Radiocarbon Ages from Howick, Core HEX02 11007 (**Boomer et al. 2007*****).***

This weighted average (7308 ± 28 ^{14}C-BP: 8110 ± 50 calBP) corresponds closely to the date of 7300 ^{14}C-BP (8150 calBP) proposed by Bondevik et al. (*1997*) and Bondevik et al. (*2003*), but disagrees significantly with the result of 8350 calBP obtained by Boomer et al. (*2007*). If the Boomer et al. (*2007*) estimate is correct, then the dating discrepancy poses the question of whether both studies are addressing the same event, and notably whether the event observed at Howick indeed represents the Storegga Slide tsunami. Boomer et al. (*2007*) mention that the clear identification of tsunami deposits at Howick requires further fieldwork, but do not comment on the issue of why there should be a large (200 yr) discrepancy between the ages of the Storegga Slide tsunami at Howick and on the Norwegian coast. In contrast, our simpler and more straightforward approach to dating the event in Howick would suggest that the deposits at Howick are of exactly the same age (within confidence limits) as the Storegga event deposits in Norway.

Radiocarbon dating model for tsunami deposits

The difficulties encountered when radiocarbon dating palaeotsunamis, when based on peat stratigraphies with intercalated tsunami deposits, can be seen as a chain of interrelated problems: (i) the tsunami wave(s) will have cut away an undefined amount of peat, such that (ii) the deposits remaining in-situ ('***below the tsunami***') after the waves have passed may be of any age, ranging from decades to hundreds of years older than the event of interest. Next, (iii) reworking the highly mobile deposits will cause the majority of samples found '***within the tsunami la-***

yer*'** to have dates totally unrelated to the tsunami event, and (iv) due to the good conservation of organic substances in peat deposits, the 'short-lived' samples (*e.g.* leaves, seed) found 'within the tsunami layer***' may originate from older layers, Finally, (v) due to the differential sedimentation of the reworked materials (peat, sand, rocks, twigs, leaves, seeds) many of the plant materials taken from layers '***above the tsunami***' may not be younger, as perhaps expected, but rather again represent older samples, since these (twigs, leaves, seeds) would have the longest floatation times. That these expected effects may indeed be effective for the deposits under study in Norway, England and Greenland is shown in Figure 1.

We omit discussion of the four irrelevant samples that are catalogued as deriving from '***below the tsunami***' (Fig. 1). The following group of samples designated as taken from '***directly below***' the tsunami show the expected wide spread of ages, with an overall range of 9300–8180 calBP. Interestingly, the samples from '***within the tsunami sand***' show the same overall spread in age, but this group ends with an enhanced cluster of dates, centred on the time-window 8200–8000 calBP, which give the appearance of a sharply defined age cut-off. We have shaded the corresponding region range (8000–8200 calBP) in Figure 1, and have also extracted the corresponding time-windows for all groups, for further analysis. As it turns out, all samples belonging to this time-window and selected from the group '***within the tsunami sand***' were processed on short-lived samples (moss, twigs, bark cf. Tab. 2).

The next 'younger' group (Fig. 1) taken from '***directly above the tsunami***' contains only two samples, one of which is a churned up and redeposited shell from Loon Lake (East Greenland), dating to 8800 ± 120 calBP (KIA-27661: 7925 ± 45 ^{14}C-BP). The second date in this group is also older than expected. The multi-group sequence continues with an exceptionally large ('default') group of widely spreading dates on samples taken from '***above the tsunami***'. We note that this group contains just as many dates 'younger' than the tsunami, as dates that are clearly 'older'. The following set of dates from Howick Core HEX02 11007 (Fig. 1) contains the two short-lived dates on hazelnut, already discussed above (OxA-11833: 7269 ± 39; OxA-11858: 7308 ± 40 ^{14}C-BP). Both dates, and especially their weighted average of 7308 ± 28 ^{14}C-BP (8110 ± 50 calBP), have a central position within the shaded time-window of the Storegga Slide tsunami. As discussed above, these samples were taken from immediately above the possible tsunami sands. The position of these two samples within the overall tsunami group sequence now simultaneously confirms the identification of these sands as laid down by the Storegga tsunami, and refutes the date of 8350 calBP derived from Bayesian stratigraphic analysis (*Boomer et al. 2007*). Finally, as shown in Figure 1, the classification of ^{14}C- dates from eastern Scotland (*Smith et al. 2004*) according to the descriptive stratigraphic terms 'Regressive Contact' and 'Transgressive Contact' with the tsunami sand layer does not allow the required clear distinction between samples contemporaneous with the tsunami, and other (older or younger) samples, as was already recognised by the authors (*Smith et al. 2004*).

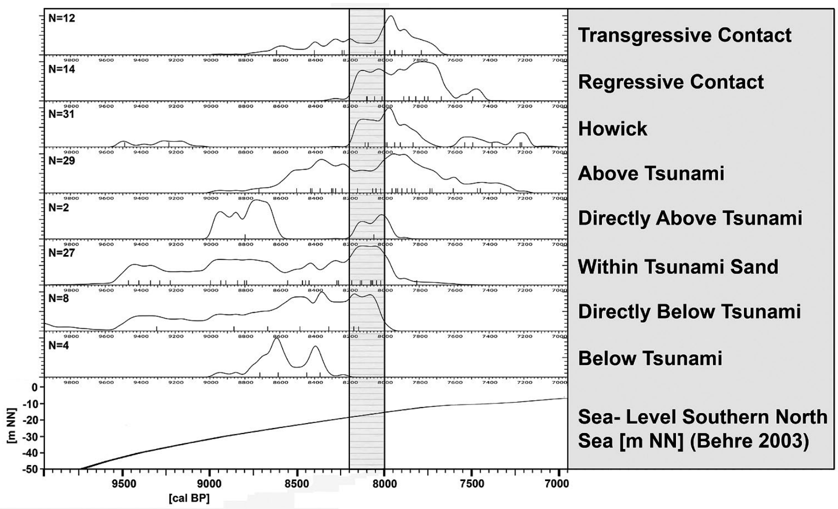


Fig. 1. Calibrated radiocarbon ages for tsunami deposits from Norway, East Greenland, and Britain, arranged according to descriptive taphonomic terms (Below Tsunami, Directly Below Tsunami, Within Tsunami Sand, Directly Above Tsunami, Above Tsunami, Transgressive Contact, Regressive Contact). Due to chaotic reworking of tsunami deposits temporal relations such as 'older' or 'younger' do not correctly describe the sample sequence (*cf. *text). The applied descriptive terms allow for this situation and support visual identification of meaningful tsunami samples (*cf. *text). We conclude the Storegga Slide tsunami dates between 8200 and 8000 calBP (vertical shading, *cf. *Fig. 2).

At this point of the discussion, we have two weighted ^{14}C-age averages at our disposal, both directly dating the tsunami event, that is (i) 7298 ± 26 ^{14}C-BP for N = 10 selected short-lived samples from N = 5 different sites in Norway (Tab. 2), and (ii) 7308 ± 28 ^{14}C-BP for two selected samples from Howick in England (Tab. 3).

There is a strong agreement between these two values and calculation of the weighted average for the two combined ages (7298 ± 26 ^{14}C-BP and 7308 ± 28 ^{14}C-BP) finally gives 7308 ± 19 ^{14}C-BP. A statistical Chi-Square test gives 95% probability that the observed spread in the overall underlying data (total N = 12 ages on short-lived samples from N = 6 different sites in 2 countries; *cf* Tab. 3) can be explained by random effects in the ^{14}C-measurement procedures.

To allow for possible differences in interlaboratory calibration, as well as for advisable caution in subsequent interpretation we raise the calculated error from ±19 ^{14}C-BP to ±30 ^{14}C-BP. This measure is neither necessary nor indicated by the given data; we simply wish to remain on the safe side of the radiocarbon-based chronological world of chance.

As a final measure, again only taken for convenience, in all following discussions we base our argumentation on the rounded value 7300 ± 30 ^{14}C-BP (8110 ± 100 calBP, p = 95%).

In conclusion, although we have not been able to demonstrate the existence of a reliable (single sample) dating method for Storegga Slide deposits, the 'best' sampling (and classification) method appears to be the careful selection of short-lived macro-samples from within the tsunami sands. By comparing the spread of calibrated median values for sample groups classified by different field criteria (Fig. 1), we can show that a well-defined 'cut-off' age exists, for short-lived samples taken from the tsunami sands. These results corroborate and highlight the sampling strategy of Bondevik et al. (*2006*), which advocates the AMS radiocarbon dating of green (chlorophyll-rich) moss stems.

Palaeogeographic boundary conditions

Due to rising sea-levels in the 9th millennium calBP, the exact timing of the Storegga Slide tsunami relative to contemporaneous sea-levels in the North Sea is of major importance for the reconstruction of the tsunami-'s environmental impact. At this time the North Sea region was experiencing a phase of most rapid early Holocene sea-level change (*Lambeck 1995; Shennan et al. 2000; Behre 2003*), in combination with equally significant glacio- and hydro-isostatic land-level changes, *e.g.* tilting of Scotland and Norway (*Lambeck 1995; Dawson and Smith 1997; Gyllencreutz 2005b*). To further complicate matters, due to rapidly rising sea-levels during the 9th millennium, more and more sections of Doggerland – a now submerged land-area situated between Britain and the continent (*Coles 1998*) – were becoming submerged. Allowance also has to be made for the tidal regime at the time.

To facilitate study of the environmental impact of the Storegga Slide tsunami in the southern parts of Doggerland (where we expect the highest density of Mesolithic occupation, see below), we can now rely on a highly accurate date for the tsunami event at our disposal: 7300 ± 30 ^{14}C-BP (95%-confidence), or 8100 ± 100 calBP (95%-confidence). The importance of using an appropriate regional sea-level value in any investigation of the impact of the Storegga slide tsunami is exemplified by data from the Shetland Islands. There, the tsunami appears to have invaded

Lab Code	^{14}C-Age	^{13}C-PDB	Material	Country	Site	Position	Latitude	Long.	Reference
Tua–1350	7315 ± 70	–22,9	Moss	Norway	Audalsvatnet	within Tsunami	63,8314	9,8289	*Bondevik et al. 1997*
Tua–834	6970 ± 175	–26	Twig	Norway	Gorrtjonna I	within Tsunami	63,8264	9,8308	*Bondevik et al. 1997*
Tua–1269	7445 ± 65	–29,5	Twig	Norway	Gorrtjonna I	within Tsunami	63,8264	9,8308	*Bondevik et al. 1997*
Tua–1122	7175 ± 75	–30,7	Twig	Norway	Klingrevatnet	within Tsunami	62,4424	6,2324	*Bondevik et al. 1997*
Tua–831	7240 ± 70	–27,7	Twig	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	*Bondevik et al. 1997*
Tua–984	7200 ± 80	–26,1	Twig	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	*Bondevik et al. 1997*
T–10597	7230 ± 105	–26,1	Twig	Norway	Ratvikvatnet	within Tsunami	62,4619	6,2242	*Bondevik et al. 1997*
Tua–861	7250 ± 75	–26,1	Bark	Norway	Skolemyra	within Tsunami	62,3331	5,6486	*Bondevik et al. 1997*
Tua–524	7365 ± 90	–26,1	Twig	Norway	Skolemyra	within Tsunami	62,3331	5,6486	*Bondevik et al. 1997*
Tua–860	7435 ± 75	–26,1	Bark	Norway	Skolemyra	within Tsunami	62,3331	5,6486	*Bondevik et al. 1997*

Tab. 2. Subgroup of ^{14}C-Ages for Samples taken from 'Within the Tsunami Deposit', with ages 8000–8200 calBP (*cf*. Fig. 1). Weighted Average: 7298 ± 26 ^{14}C-BP (8110 ± 50 calBP).

Lab Code	^{14}C-Age	^{13}C-PDB	Material	Country	Site	Position	Latitude	Longitude	Reference
Oxa–11833	7269 ± 39	–24,9	hazelnut	England	Howick	directly above	55,4403	–1,5917	*Boomer et al. 2007*
Oxa–11858	7308 ± 40	–25,6	hazelnut	England	Howick	directly above	55,4403	–1,5917	*Boomer et al. 2007*

Tab. 3. Subgroup of ^{14}C-Ages on Samples taken from 'Directly Above the Tsunami Deposit', from Howick (Great Britain) (*cf. *Fig. 1). Weighted Average: 7308 ± 28 ^{14}C-BP (8110 ± 50 calBP).

coastal lakes and have run up peaty hillsides to a maximum height of 9.2m above the present high tide level (*Bondevik et al. 2005*). However, around 7300 ^{14}C-BP, sea levels around the Shetland Islands and the Faroes stood at 10–15m below the present level (*Lambeck 1995*), so that the reconstructed run-up height in reality must have been within a range around 19–25m above the sea level of that time. Within confidence limits, this would be the largest runup reconstructed anywhere for the Storrega Slide tsunami (*Bondevik et al. 2005*).

Regarding sea-level and tsunami impacts on our study region – Doggerland (*Coles 1998*) – a number of geological and geomorphological boundary conditions must be taken into consideration. Foremost is the rapid rise of sea-levels in the early Holocene. For example, in the southern North Sea (a region with minimal isostasy), sea-level rise between 9000 calBP and 7000 calBP amounts to an average value of 1.25m/100 yrs (*Behre 2003*). In addition, several superimposed geomorphological and climatic processes (with their own time-scales) have contributed and complicated the sea-level changes during the interval of interest (Tab. 4).

The timing of the Storegga Slide

On the basis of comprehensive submarine geomorphological studies off the coast of Norway, a series of more than 50 ^{14}C-AMS-ages on monospecific planctonic foraminifera from stratified basal post-slide sediments give a direct date (weighted average) for the expected timing of the Storegga Slide emplacement of 7250 ± 250 ^{14}C yrs BP (*Haflidason et al. 2005*), in close agreement with our summary estimate for the Storegga tsunami of about 7300 ^{14}C yrs BP (*this paper*). In Figure 2 this ^{14}C-date is shown along with the early Holocene sea-level curve for the southern North Sea (*Behre 2003*), and the stable oxygen isotope record from the Greenland GISP2 ice core (*Grootes et al. 1993*). Two key observations can be made from Figure 2.

Firstly, the broad picture of sea-level rise, as shown in Figure 2 (lower box), is one of a comparatively rapid rise between 10 ka calBP and 6 ka calBP, followed by a significant slowing in the following millennia. The slow rise in recent millennia (since 5000 calBP) is accompanied by minor oscillations (for discussion, see *Bungenstock 2006*). According to Behre (*2003; 2007*), the sea-level curve for the southern North Sea is to some extent representative of global sea-level rises. In the southern North Sea, isostatic effects are not observed, and tectonic movements are so weak as to be irrelevant (the situation becomes more complex when Scotland and north Jutland are considered, as these areas were subject to isostatic uplift). The correlation of the ^{14}C-age for the Storegga Slide and Tsunami with this sea-level curve (Fig. 2) shows that the Storegga Slide occurred at a time when the sea level in the southern North Sea stood at about 17m higher than the present level.

Secondly, Figure 2 suggests that the Storegga Slide occurred during the period of the well-known '8200 calBP' climate event. The implications of this observation will be studied further below.

Key Event or Process	Duration	Affected Region	Date	Reference
Abrupt Drainage of Lake Agassiz	Months	North Atlantic	8470 ± 300 calBP	*Barber et al. 1998*
Rapid rise in global sea-level by 0.2–0.5 m	Months	Global	~ 8200 calBP	*Bauer et al. 2004*
Reduced North Atlantic Deep Water Formation	Two Centuries	Global	8247–8086 calBP	*Thomas et al. 2007*
Storegga Slide Tsunami	Hours	North Sea	~ 8150 calBP	*Bondevik 1997*
Eustatic/isostatic Sea Level Rise	Millenia	Northwest Europe	Continuous	*Lambeck 1995*
Slow Flooding of Doggerland	Centuries	North Sea	~ 8000 calBP	*Behre 2003*
Slow Final Flooding of Doggerland	Centuries	North Sea	~ 7000 ^{14}C-BP	*Shennan et al. 2000*
Rapid Final Flooding of Doggerland	Hours	North Sea	8100 ± 100 calBP	*this paper*

Tab. 4. Key events, processes, time scales, dates, and geographic regions.

The timing of the Storegga Slide tsunami

In the following, we present further refinements to the temporal correlation of the Storegga Slide tsunami with contemporary sea-levels, and consider in detail the potential correlation of the tsunami with the 8200 calBP climate event. These arguments make use of CalPal-software (*Weninger et al. 2003; Weninger and Jöris 2004*), and the main results are displayed in Figure 3.

Figure 3 shows in high resolution the tree-ring calibrated radiocarbon date for the tsunami (7300 ± 30 ^{14}C-BP, 95%) in comparison with the Greenland $\delta^{18}O_{ice}$ ice-core data obtained from the GISP2-drilling (*Grootes et al. 1993*). The $\delta^{18}O_{ice}$-GISP2 data, as shown in Figure 3, are shifted 40 years younger, in comparison to the age values published by Grootes et al. (*1993*). This shift is obtained by visual comparisons between different climate proxies undertaken to achieve a precise and absolute (tree-ring synchronised) reference time interval for the North Atlantic 8200 climate event *sensu strictu* (*i.e.* the Hudson Bay outflow) (*Weninger et al. 2006*). The 40-year shift of the GISP2 age model is supported by the recent recount of Greenland Ice Core ages in the Holocene (GICC05 age model) (*Vinther et al. 2006*), as well as by dedicated high-resolution studies of the 8200 calBP climate event by Thomas et al. (*2007*).

Following Barber et al. (*1997*), the sequence of events associated with the '8200 calBP' event is as follows: during deglaciation, a remnant ice mass blocked the northward drainage of the large glacial lakes Agassiz and Ojibway, which previously discharged southeastward over sills into the St Lawrence river. Around 8500 calBP (8470±300 calBP according to *Barber et al. 1997*), the ice dam collapsed, allowing the lakes to drain swiftly northwards into the Labrador Sea. The release of an estimated 1.6 x 10^{14} m^3 of freshwater (*Teller et al. 2002*) from the proglacial lakes through the Hudson Strait would have substantially weakened deep water formation in the North Atlantic (*e.g., LeGrande 2006*). Temperatures in the North Atlantic region decreased abruptly, with subsequent recovery over the following 200 years or so (*e.g. LeGrande et al. 2006; Thomas et al. 2007*). In central Greenland the surface air temperature dropped by 3–6°C (*e.g. Johnsen et al. 2001*), and perhaps up to 7.4°C (*Leuenberger et al. 1999*). A reduction in air temperature of this magnitude is likely to be linked with drier conditions and stronger winds over the North Atlantic and the surrounding land (*Alley et al. 1997; Bauer et al. 2004; LeGrande 2006*).

The freshwater release estimates are of importance for the present studies, since this water would lead to an abrupt rise of global-mean sea level. The estimates range from about 0.25 to 0.5m, with timescales of the release thought to be in the order of several months to a year (*e.g. Bauer et al. 2004; LeGrande 2006*).

Clearly, the exact timing of these events is of crucial importance to socio-environmental studies on the Mesolithic in north-western Europe, just as it is on

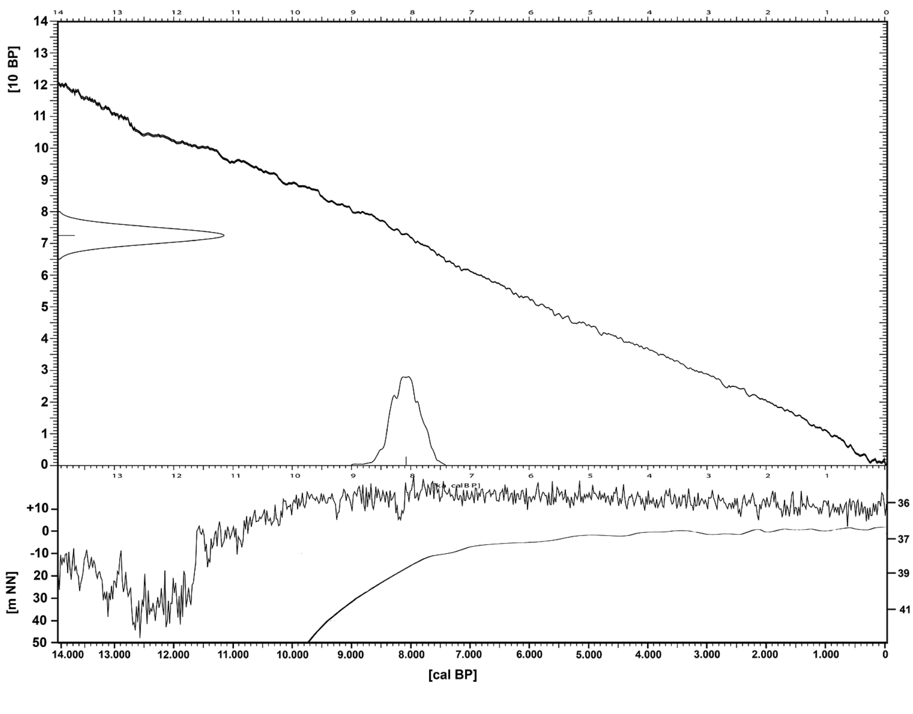


Fig. 2. Overview. Tree-Ring Age Calibration of ^{14}C-Age for Storegga Slide 7250 ± 250 BP (*Haflidason et al. 2005*) shown in context of Early Holocene Sea-Level Rise in the Southern North Sea (*Behre 2003*) and Stable Oxygen Isotope Signature in Greenland Ice-Core GISP2 (*Grootes et al. 1993*). Calibration Data: Reimer et al. (*2004*). Calibration Methods: Weninger and Jöris (*2004*).

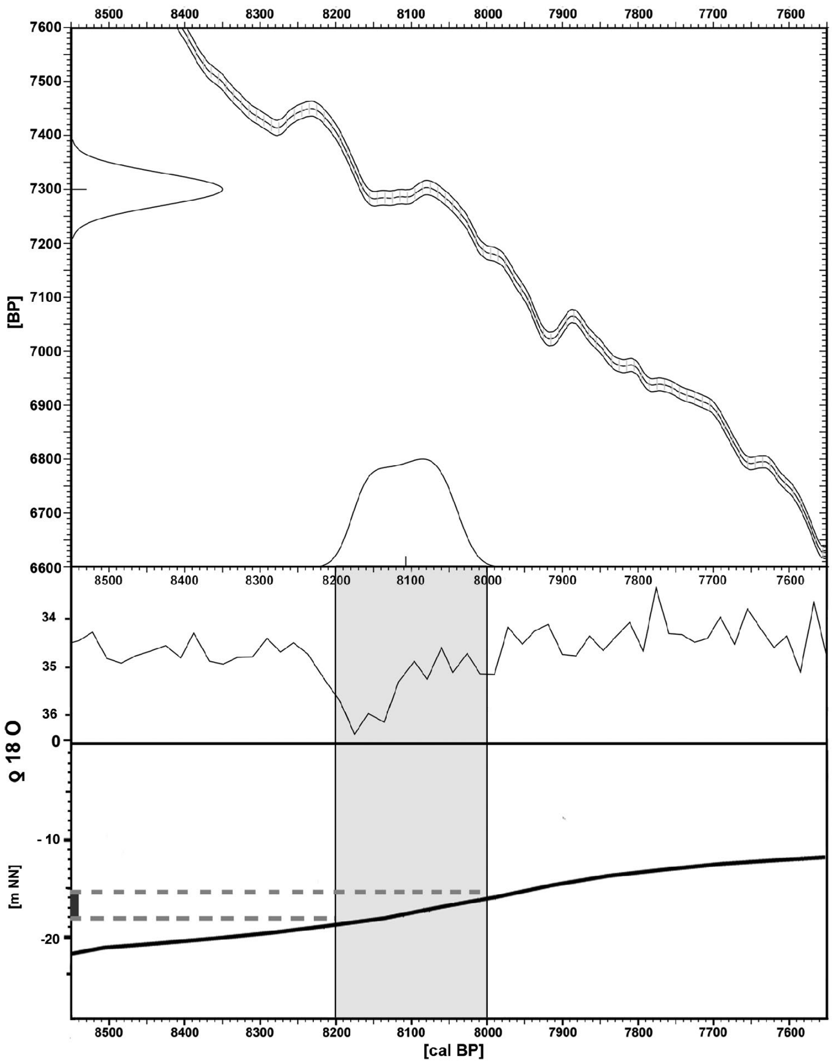


Fig. 3. Tree-ring calibration of the derived ¹⁴C-age (7300 ± 30 ¹⁴C-BP, 95%) for the Storegga Slide tsunami (upper box) in comparison with GISP-δ¹⁸O-data showing the '8200 calBP' cooling event and contemporary sea levels in the southern North sea (lower box). The GISP-δ¹⁸O-data have been shifted 40 yr younger, in comparison to age values published by Grootes et al. (1993), according to results by Weninger et al. (2006), which agree with recent age revisions of the Greenland Ice-Core Age Model (Vinther et al. 2006) and with dedicated high-resolution studies of the event by Thomas et al. (2007). The shaded age interval 8000-8200 calBP shows that the Storegga Slide occurred during the Middle/Late phase of the North Atlantic 8200 calBP cooling. The derived tree-ring calibrated ¹⁴C-age of 8100 ± 100 calBP (95%) for the tsunami corresponds to a reading of –17 ± 2 m on the sea-level curve for the southern North Sea of Behre (2003). Tree-ring ¹⁴C-age calibration data (± 1 σ error bars) by Reimer et al. (2004).

wider archaeological scales (*cf. Weninger et al. 2006; Clare et al. this volume*). However, the situation is complicated, since we now recognise that the '8200 calBP event' (*sensu strictu*: Hudson Bay outflow) is superimposed on a wider period of cooling, dating to *c.* 8600–8000 calBP (*Rohling and Pälike 2005*). Given the lack of sufficient temporal resolution, the signatures of actually quite different climatic and environmental processes are unfortunately quite often compounded into one 'default' signal called the '8200 calBP' event. However, the complexity of rapid climate change during this period is becoming clearer now, on the basis of dedicated high-resolution studies. Of special interest to our study, the temporal structure of the '8200 calBP' cooling event has been studied in great detail by Thomas et al. (*2007*), who conclude that the event had an overall duration of 220 ± 2 years and a central, 4-year-long spike at 8222 calBP, during which Greenland ice surface temperatures dropped by up to 13 ± 2 °C (for comparison: cooling during the Younger Dryas amounts to approx. 15 °C). We make use of these results in evaluating the temporal relation between the 8200 calBP climate event and the Storegga Slide tsunami, as follows.

Figure 3 illustrates that the Storegga Slide tsunami occurred, with 95% confidence, at some time during the interval 8200–8000 calBP. We can state this is surely *within* the period of reduced North Atlantic Deep Water (NADW) formation and attendant circum-Atlantic cooling (8247–8086 calBP, according to *Thomas et al. 2007*). Dating constraints are also sufficient to state that it is *unlikely* that the tsunami occurred near the onset of the 8200 calBP climate event, or, in other words, the Storegga Slide was *not* synchronous with the Hudson Bay flood, but post-dated it. Consequently, the tsunami appears to have impacted the southern North Sea at some time during the course of the 8200 calBP climate event. Further precision is impeded by the fact that the tsunami's ¹⁴C-age of 7300 ± 30 ¹⁴C-BP (95%) falls into a flat region of the tree-ring calibration curve (Fig. 3). Given that reduced North Atlantic Deep Water

(NADW) formation may cause changes in the carbon cycle that may lead to such so-called radiocarbon plateaux in the calibration curve (as modelled for the Younger Dryas, *Hughen et al. 2006*), this provides extra corroboration for the suggestion that the Storegga Slide occurred at some time within the 8200 calBP climate event. To conclude, the Storegga tsunami event occurred within one to two centuries *after* the global sea-level jump of 0.25–0.5m that was associated with the Hudson Bay flood. This juxtaposition would have helped to increase the flooding impact of the tsunami in low-lying coastal regions.

Palaeogeographical reconstructions: key stages and events

The large continental shelf between Britain, Norway, and the NW-European coast which is commonly known as 'Doggerland' (*Coles 1998*) is now completely submerged under the North Sea, but was subaerially exposed at the beginning of the Holocene. In addition, a considerable area of land was exposed off the west coast of Jutland. Due to eustatic sea-level changes, combined with glacio- and hydro-isostatic land-level changes, the former land areas were increasingly submerged during the course of the Early Holocene. Key stages in the development of Doggerland, according to reconstructions by Lambeck (*1995*), Shennan et al. (*2000*) and Behre (*2003*), include (i) the gradual evolution of a large tidal embayment between eastern England and Dogger Bank before 9 ka calBP (9–8 ka ^{14}C-BP); (ii) the development of Dogger Bank as an island at high tide 8–7 ka ^{14}C-BP; and (iii) the final disconnection of England from the continent by *c.* 8.0 ka calBP (7–6 ka ^{14}C-BP). Prior to its complete flooding around 8000 calBP, Doggerland formed a wide, undulating plain containing a complex meandering river system, with associated channels and lakes (*Gaffney et al. 2007*).

Although there is general consensus that Doggerland was completely submerged by *c.* 8000 calBP, different authors give alternative palaeogeographic reconstructions for the history of Doggerland (*Dix et al. 2008*). Corresponding to the quite general lack of archaeological and palaeo-environmental data from the submerged areas, contemporary research puts the focus on the timing of selected major (key) events. An example is shown in Table 5, where Gyllencreutz (*2005a*) has collated published ages for the opening of the English Channel.

Note that, according to the ages given in Table 5, the English Channel was most likely open at the time of the Storegga Slide Tsunami – although this may have been a fairly recent development which had taken place just a few hundred years previously.

Summaries such as Table 5 would imply that the existence of the key event '*Opening of the English Channel*' is not open to question, but that its age is. However, there is a higher level of complexity. It is important to recognise not only that intensive research may result in different apparent dates for the same (or similar) events, but also that the illustrated approach relies on an underlying assumption that an event (*e.g.* the flooding of Doggerland) is actually well-described by the dates. There is a strong emphasis in contemporary studies on dating key events as a widespread *method* to describe the history of Doggerland. Lambeck (*1995*) argues that the English Channel was established as an open marine waterway by about 7500 ^{14}C-yrs BP (8600 calBP). According to Shennan et al. (*2000*), at this time Dogger Bank was still an island at high tide, while the channel separating northern Norfolk from mainland Europe was 5–10m deep. At the same time, wide intertidal areas and saltmarsh lowlands are predicted for areas to the east of Norfolk (*Shennan et al. 2000*). During these centuries, according to Behre (*2003; 2005*), the sea level in the southern North Sea rose at the enormous rate of more than 1m per century. The southern North Sea had become fully marine by 7000 ^{14}C-yrs BP (7840 calBP) (*Lambeck 1995*). Very similar results, with the focus on the timing of the 'fully marine' North Sea, were reported by Shennan et al. (*2000*).

^{14}C–Age [ka ^{14}C–BP]	Calendric Age [ka calBP]	Reference
8	9.0 – 8.7	*Nordberg 1991*
7.6	8.5	*Conradsen and Heier-Nielsen 1995*
7.7	8.6	*Jiang et al. 1997*
8 – 7	9.0 – 7.7	*Björklund et al. 1985*
8 – 7	9.0 – 7.7	*Lambeck 1995*
8.7 – 8.3	9.7 – 9.3	*Jelgersma 1979*

Tab. 5. A Key Event in the History of Doggerland: The English Channel Opening (compilation by* Gyllencreutz 2005a*).

Recent work has taken an entirely different approach to reconstructing the history of Doggerland, building on the unique opportunities offered by 3D seismic analysis of submerged North Sea sediments, as made available by petroleum-exploration companies (*Fitch et al. 2005; Gaffney et al. 2007*). The available data demonstrate the existence in the submerged North Sea of complex meandering river systems, with major and secondary channel belts, tunnel valleys, possible estuarine or intertidal settings, sand banks, and lakes, as revealed at high vertical and horizontal resolution at different depths, times, and stratigraphic settings, for the Early Holocene deposits (*Fitch et al. 2005; Gaffney et al. 2007*). However, before integrating the bathymetric and 3D seismic data, we must await additional information, especially concerning the precise timing of the different stratigraphic settings. As was stated by Coles (*1998*), there remains the '*intriguing*' question of whether the sediments in the southern North Sea show signs of impact by the Storegga Slide tsunami.

An explorative bathymetric 3D digital elevation model for Doggerland

With this question in mind, and wishing to evaluate the potential environmental and social impact of the tsunami, we have undertaken further explorative studies to assess the impacted coastlines, with the results shown in Figure 4. These results are based on (i) the derived date for the tsunami event of 7300 ± 30 ^{14}C-BP (8100 ± 100 calBP; 95%) (*cf.* Fig. 1), (ii) the hypothetical sea-level height of –17 ± 2m (95%) NN for the southern North Sea at this time (*cf.* Fig. 3), but extended to cover bathymetric depths of –17 ± 5m (see below), and (iii) the palaeo-coastlines at this time, as interpolated from the reconstructions of Shennan et al. (*2000*) and Behre (*2003*).

In detail, our reconstruction of the impacted areas as shown in Figure 4 is based on the following data and methods. From the different coastlines, defined by these authors for different stages in the development of Doggerland, we first selected coastlines dating as closely as possible to the tsunami event. As shown above, these coastlines are typically defined for 'key events', between which we must now interpolate. For the tsunami age of 7300 ± 30 ^{14}C-BP (8100 ± 100 calBP) there are two such (closest) coastlines, which give us an event-sandwich: firstly, the coast-line defined *c.* 200 ^{14}C-yrs *before* the tsunami event (*Shennan et al. 2000.Fig.5d*: 7500 ^{14}C-BP) and, secondly, the coastline *c.* 200 ^{14}C-yrs *after* the tsunami (*Shennan et al. 2000.Fig.5d*: 7000 ^{14}C-BP). Although very similar coastlines can be read from the palaeo-geographic reconstructions of Doggerland given by Behre (*2003*), we decided to base our reconstructions on Shennan et al. (*2000*), if only for the simple reason that the coastlines in this publication are defined using uncalibrated ^{14}C-ages of 7500 and 7000 ^{14}C-BP, which simplifies our visual interpolation for the nearly exactly intermediate value of 7300 ^{14}C-BP.

The first step in map construction, then, was to digitize the coastlines from the colour graphs of Shennan et al. (*2000*) for 7500 ^{14}C-BP and 7000 ^{14}C-BP. They are shown as thin lines in Figure 4. They are used as a basic reference for the coasts of Doggerland '*before*' and '*after*' the tsunami event. Note that we do not imply that the tsunami was responsible for reshaping the Doggerland coasts. The adopted coastlines were then projected as shapefiles onto a map of the North Sea based on a 3D digital elevation model using unedited SRTM (Shuttle Radar Topography Mission) data. Since this data is unedited, it contains occasional voids, gaps, or streaks, where the terrain lay in the radar beam's shadow or in areas of extremely low radar backscatter where an elevation solution could not be found. Such streaks are evident in Figure 4 for the SRTM30 tile we use, which is named w020n90 by the USGS (*United States Geological Survey 2008*). This tile has a horizontal grid spacing of 30 arc seconds (approximately 1 kilometre). The data is expressed in geographic coordinates (latitude/longitude) and is referenced to the World Geodetic Survey (WGS) system of 1984 (WGS84). We used Globalmapper (www.globalmapper.com) to construct the map.

The next step was to find an interpolation between these two coastlines that would be representative of the coastline at 7300 ^{14}C-BP, the time of the Storegga Slide tsunami. Rather than applying a direct interpolation between the two given coastlines, we applied an explorative method, based on the calculation of a set of bathymetric contours using the SRTM-data, at intervals of 1m between –30m and –10m. These contours were projected onto the same map as previously used for the two coastline shapefiles derived from Shennan et al. (*2000*) for ages 'before' and 'after' the tsunami. As shown in Figure 4 using an appropriate colour ramp to show areas potentially 'above' and 'below' the contemporary sea-level, it was possible to approximate the coastlines of Shennan et al. (*2000*) for Dogger Bank solely based on SRTM 1m bathymetric contours. The final step was to colour shade the interpolated areas according to their bathymetric depth, in relation to the two reference coastlines derived from the studies of Shennan et al. (*2000*). It is encouraging that quite similar reconstructions are obtained from the maps of Doggerland, as published by Behre (*2003*), for the time-window under study. We emphasise that the precision and accuracy of the maps obtained by this pro-

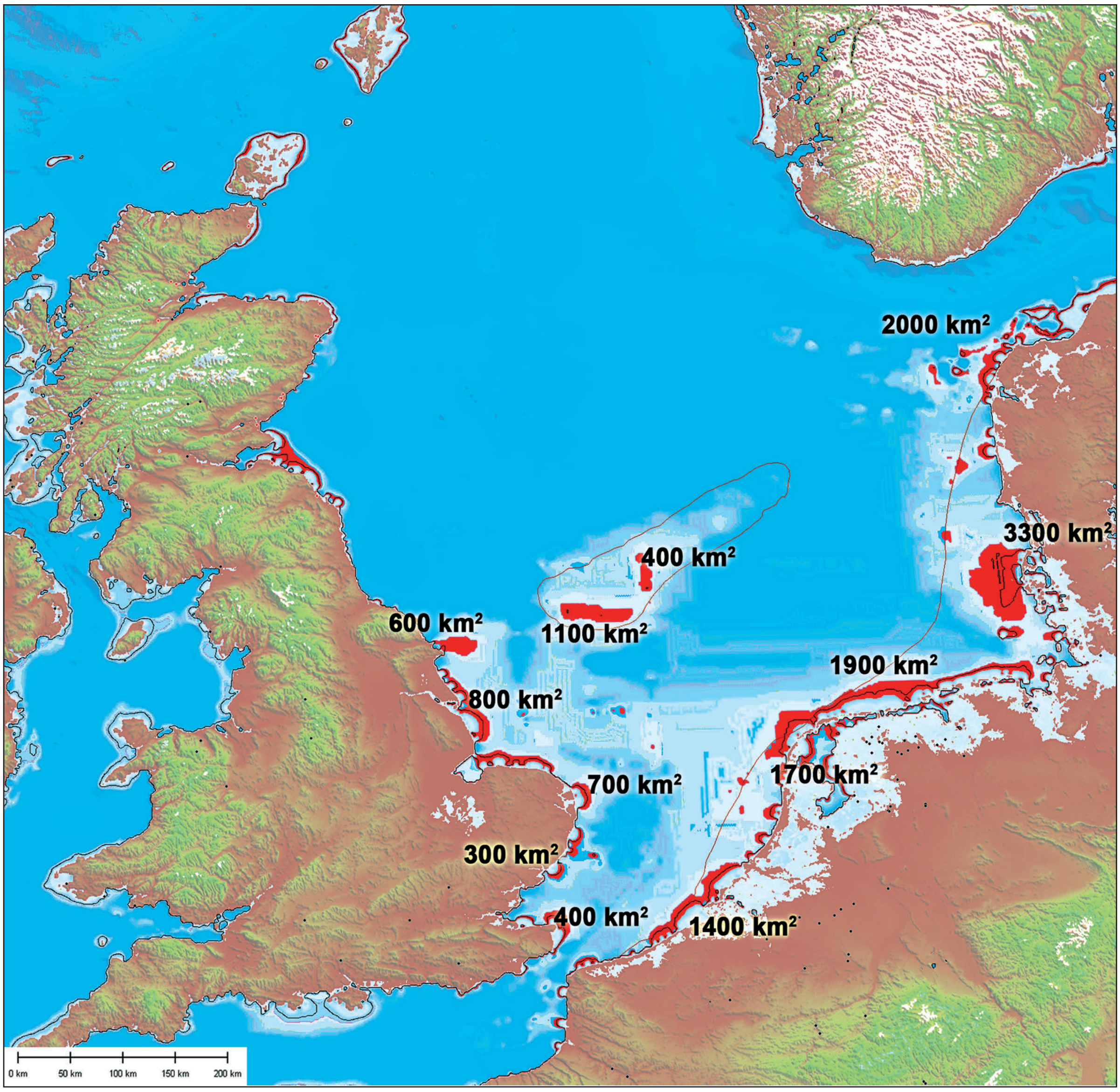


Fig. 4. Hypothetical regions with major impact by the Storegga Slide tsunami. Ocean colour shading is based on SRTM bathymetric data (United States Geological Survey 2008; cf. ***text). Major individual hypothetical tsunami impact areas, represented by the SRTM-bathymetric depth interval –17 ± 5 m, are shaded red. Due to applied reconstruction and specific colour shading approach, red shaded areas represent lowlying 'run-in' areas. These are not identical to potentially even more dangerous 'run-up' areas (*** cf. ***text). Thin brown lines represent digitized palaeogeographic coastlines according to Shennan et al. (***2000***), but slightly changed to allow for minor differences vs the reconstructions given by Behre (***2003***). Together, these two coastlines approximate Doggerland some 200 ^{14}C-yrs 'before' and 'after' the tsunami event. For simplicity, the Doggerbank 'island' is only shown for the date*** c. ***7500 ^{14}C-BP. Whether this 'island' was really subaerial, or not, at the time of the tsunami, cannot be decided with given data.***

cedure is not limited to that of the palaeo-coastlines used in their calibration. Although these are extremely useful for orientation purposes, they do not enter the final reconstruction (Fig. 4). Instead, assuming the correlation between the derived date for the tsunami and the contemporaneous sea-level is accepted, we recognise as a major limiting factor our lack of knowledge concerning the post-tsunami sedimentational processes that surely occurred in the regions under study. One main result of this study is the (unexpectedly) high tsunami impact assigned to the western regions of Jutland, and in particular to the northern coasts of Jutland opposite Norway (Fig. 4). Due to the given combination of shallow flats and steep coastal channels, these coasts are especially vulnerable to the different kinds of destructive energy contained in the tsunami (see below).

Tsunami physics and palaeogeographic impact scenarios

A detailed description of tsunami impacts on coastal lowlands is beyond the scope of the present paper, and we suffice with a brief recapitulation of the general physical principles underlying a tsunami impact, following Dawson (*2008*). We interpret those processes within the context of the configuration of the palaeo-landscapes under study in the southern North Sea.

The impacts of a tsunami depend most strongly on coastal shape. For steep coastlines, such as the fjords and estuaries of East Scotland, the physical effects are best expressed in terms of *runup*, which is defined as the maximum height reached by the head of the tsunami wave. However, on the more gently inclined coastlines, mud-flats, salt-marshes and gently rolling plains of Mesolithic Doggerland, it would be more appropriate to take the maximum width of the inundated zone (or '*run-in*') as a measure of the scale of the energetic impact. For such gently inclined areas, the extent of the inundated area is limited not by the maximum height of the wave, but by frictional forces, drag and turbulence, as the wave advances and retreats over the more or less rough surface. In such settings, a tsunami initially appears more like an unusually extensive flood, rather than a giant wave. The water body first develops its huge destructive potential at the moment the wave breaks. This can already occur at some distance from the coast, as shown by eyewitness accounts on Flores Island of the 1992 Indonesian tsunami (*Shi and Smith 2003*). On Flores Island, already along a comparatively short coastline of some 100km, runup heights varied mostly between 1.5 and 4m, but runup reached as high as 26m at one location (Riangkrok), due to local underwater bathymetry and coastline configuration (*Shi and Smith 2003*).

The extent of the (catastrophically) flooded area further depends strongly on local vegetation (*e.g.* sand, grass, peat, schrubs, trees) and local topography (*e.g.* sandbanks, slopes, smaller and larger water channels). As documented for the 1992 Indonesian tsunami, this combination of major '*runin*' and locally extreme '*runup*' effects could also be expected for the Storegga Slide tsunami in the southern North Sea, and here most likely in the fjords of Jutland, or in the tunnel valleys found by 3D-seismic surveying in Late Holocene Doggerland (*Fitch et al. 2005*). In search of these areas, a closer look at Figure 4 reveals that quite a number of the red areas indeed put focus on such coastal sections (recognisable by the bending-in of the red areas), where underwater bathymetry would magnify the incoming waves. This differential vulnerability of palaeo-coastlines is clearly an important topic (*e.g. Shi and Smith 2003*), although beyond the scope of the present paper. We are confident that, allowing for such effects, the hypothetical tsunami '*run-in*' impact map (Fig. 4) supports a *conservative* assessment of potential tsunami 'danger zones'.

As a final topic to address, due their long wavelengths in deep water, tsunamis will refract around large obstacles, such as islands. Hence, depending strongly on the sea level of the time, the Storegga Slide tsunami may either have dissipated its energy on the northern side of the Dogger Bank, if this region was indeed an island with a height above around 5–10m, or – if the Dogger Bank was submerged already – the tsunami may have reached the coasts of Belgium, the Netherlands and North Germany. Based on the reconstruction shown in Figure 4, and in view of all the data entered, interpolations, literature, and methods, this latter scenario seems the most probable. As shown below, this conclusion is further corroborated by available ^{14}C-ages measured on finds dredged up from the southern North Sea.

Radiocarbon data from the southern North Sea

Numerous Pleistocene and Holocene faunal remains have been dredged up from the southern North Sea, particularly in recent years (*Mol et al. 2006; 2008*), including worked bone and antler implements, some of which have been directly dated to the Early Mesolithic (Tab. 6), while other finds can be assigned to this period typologically. Even more dramatic evidence has emerged in the form of human skeletal remains dredged from many kilometres offshore and directly dated to the Early Mesolithic (*Glimmerveen et al. 2004; Mol et al. 2008*) (Tab. 6).

Abundant faunal remains and artefacts have also been found close to shore in the Netherlands (*Louwe Kooijmans 1971; Verhart 2005*) and both inshore and offshore along the west coast of Jutland (*Fischer 2004.Fig. 3.3*).

Although surely not the last word, since it is impossible to generalize from the present small (but beautiful) database of finds from the North Sea (*cf. Glimmerveen et al. 2004; Mol et al. 2008*), we need but a quick look at the available ^{14}C-ages to conclude that these do not provide evidence for habitation of Doggerland, at ages younger than *c.* 8000 ^{14}C-BP.

For completeness, we must comment on the reference to 'Andersen (*pers comm*)' given by Coles (*1999.57*) and repeated by Behre (*2003.41*), as well as by Behre (*2005.210*), concerning a worked bone dredged from Dogger Bank dating to '6050 calBC' (*Coles 1999.57*) resp. '6050 v.Chr.' (*Behre 2003.41; 2005.210*). This date was long suspect to the present authors, since it seemed to indicate a very late final flooding of Dogger Bank, perhaps even synchronous with the Storegga Slide tsunami. If validated, this date would have directly falsified our reconstruction (Fig. 4), at least give reason to assume a much larger Doggerland at this time. However, the date itself does not survive critical scrutiny. According to Søren Andersen (*pers comm* to B.W., 15th April 2008), it is simply misquoted.

Mesolithic palaeodemography

Since the pioneering studies of Coles (*1998*), it is beyond credence that Doggerland was an inhabited landscape during the Late Palaeolithic and earlier Mesolithic periods. In terms of estimating the impact of the Storegga slide event on contemporary human populations, results will depend strongly on the extent of the area impacted, the severity of the tsunami over this area, and the density and distribution of human settlement (Fig. 5). Average population densities for Mesolithic northwest Europe, based largely on ethnographic analogy, have been estimated on the order of 0.05 to 0.10 person/km^2 (*Binford 2001; Constandse-Westermann and Newell 1989; Rozoy 1978*). However, the population would not have been evenly distributed over Doggerland, and we can propose with some confidence that coastal, lacustrine and riverine areas would have experienced substantially higher population densities (*Fischer 1997; Paludan-Müller 1978*), perhaps to the order of 0.50 to 1.0 person/km^2 (*cf. Schulting in press*), while areas further inland (away from resources) would have been relatively sparsely populated. There exists some stable isotope and archaeological evidence in support of these notions (*Schulting in press; Schulting and Richards 2001*).

Since it is precisely the coastal and near-shore riverine areas (the latter because of a funnelling effect up coastal river valleys) that would have been most affected by the Storegga tsunami, there may have been considerable impact on the contemporary population. For example, one of the most notable geo-

Location	Species	Element	Lab no.	^{14}C-BP	Calendric Age [calBP] (68%)	References
Leman & Owen	*C elaphus*	antler harpoon	OxA–1950	11740±150	13640±200	(4)
S Bight, North Sea	*Bos primigenius?*	decorated metapodial	GrA–28364	11560±50	13460±80	(3)
S Bight, North Sea	*A alces*	worked antler	GrA–27206	9910±50	11350±90	(3)
S Bight, North Sea	*H sapiens*	mandibula	GrA–23205	9870±70	11330±100	(2)
52°10' N, 02°49' E	*H sapiens*	cranium	UtC–3750	9640±400	11110±620	(1)
S Bight, North Sea	*A alces*	worked antler	GrA–37004	9520±50	10880±150	(3)
S Bight, North Sea	*Sus scrofa*	humerus	UtC–7886	9450±70	10790±180	(2)
S Bight, North Sea	*H sapiens*	humerus	GrA–27188	9140±50	10320±70	(3)
S Bight, North Sea	*H sapiens*	humerus	GrA–30733	9080±50	10250±40	(3)
S Bight, North Sea	*H sapiens*	humerus	GrA–31287	9035±40	10210±30	(3)
S Bight, North Sea	*H sapiens*	humerus	GrA–35949	9005±45	10140±90	(3)
52°22' N, 03°06' E	*C elaphus*	1st phalanx	GrA–20256	8820±60	9920±160	(2)
Eurogeul	C capreolus	worked antler?	GrA–33949	8405±45	9420±60	(3)
53°00' N, 02°54' E	*H sapiens*	mandible	GrA–11642	8370±50	9390±70	(2)
52°27' N, 02°55' E	*C elaphus*	2nd phalanx	GrA–20353	8350±50	9370±70	(2)
S Bight, North Sea	*H sapiens*	cranium	UtC–624	8340±130	9300±150	(2)
S Bight, North Sea	*A alces*	worked antler?	GrA–30731	8240±45	9220±80	(3)
S Bight, North Sea	*H sapiens*	humerus	GrA–27205	8180±45	9140±90	(3)
Eurogeul	*C elaphus*	modified antler	GrA–22999	8070±50	8950±110	(2)
Eurogeul	*A alces*	antler	GrA–23201	7970±60	8830±120	(2)

Tab. 6. Final Upper Palaeolithic and Mesolithic dates on human and faunal remains dredged from the North Sea. Sources: 1 **– Erdbrink and Tacoma 1997*****; 2*** **– Glimmerveen et al. 2004*****; 3*** **– Mol et al. 2008*****; 4*** **– Gillespie et al. 1984.** ***According to Glimmerveen (*****pers. comm*****) most of the finds from the Southern Bight originate southwest of the Brown Bank and have the following approximate coordinates: 52°34' N, 02°35'5" E. Calibrated using CalPal (http://www.calpal.de).***

morphological features in a recent 3D-seismic mapping exercise of the southern North Sea is the presence of a central lake known as the 'Outer Silver Pit' (*Gaffney et al. 2007*). Briggs et al. (*2007*) interpret two elongate ridges within the Pit as sand banks that formed in an estuarine environment during the Early Holocene transgression, inferring from this the presence of strong tidal currents in the north-facing estuary. Following Donovan (*1975*), these tidal currents may have been in part responsible for the formation of the Outer Silver Pit depression itself. Similar estuarine features are well-known from the sea floor in the Danish archipelago, where they support numerous Mesolithic settlements (*Fischer 2004*). They would have, (i) attracted a concentration of Mesolithic settlements (*Fischer 1997; 2004*) and (ii), been heavily impacted by a channelling of energy during the impact of the Storegga tsunami.

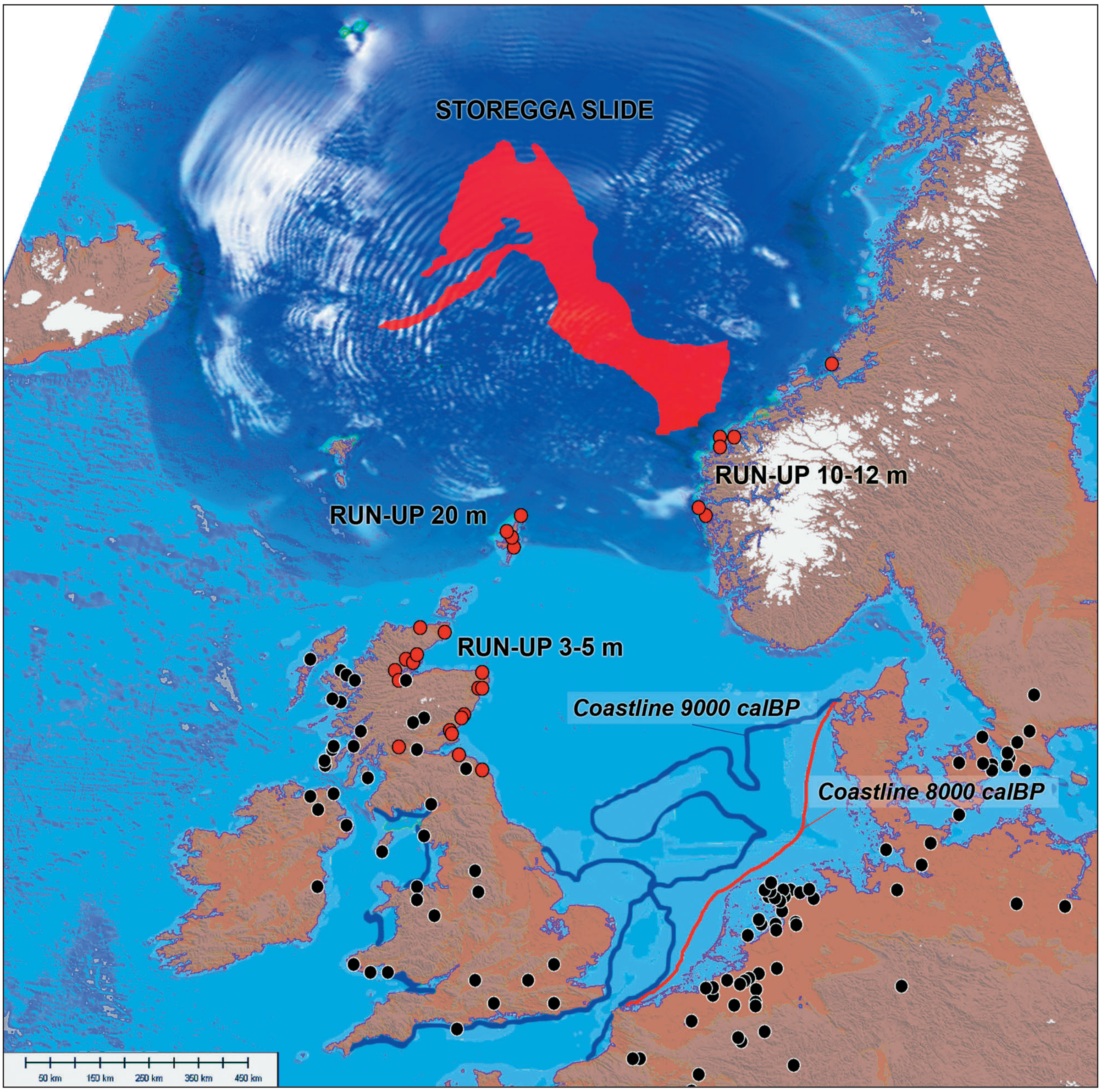


Fig. 5. Early Holocene palaeogeography of the Northwest European continental shelf ('Doggerland') and geographic distribution of ¹⁴C-dated Mesolithic sites in Northwest Europe for the time-window 7600–7000 ¹⁴C-BP. Palaeogeographic coastlines according to Shennan et al. (*2000*) and Behre (*2003*), with colour shading on the base of SRTM bathymetric data (*cf. *text). Radiocarbon-dated Mesolithic sites according to* Weninger et al. in press*) shown as black dots. Red dots indicate sites with radiocarbon-dated tsunami deposits (*cf. *Appendix, Tab.8). Area of the submarine Storegga Slide digitized and georeferenced according to Bondevik et al. (*2003*) shown red. Modelled wave for the Storegga tsunami taken from Bondevik et al. (*2005*), adapted and projected onto the map graphically, with no vertical scaling. The modelled tsunami wave has a height of 3 m on the open ocean (*Bondevik et al. 2005*) and is likely to have reached the southern North Sea with this height (*Bondevik, pers. comm. 2007*)

	area (km²)	Population density (person/km²)			
		0.05	0.10	0.50	1.00
Total area under threat	13 600	680	1360	6800	13 600
1/2 area	6800	340	680	3400	6800
1/4 area	3400	170	340	1700	3400

Tab. 7. Estimated population sizes in the study area affected by the Storegga tsunami at various population densities. The most likely scenario may be a population density of 0.10 to 0.50 person/km² over an impacted area of some 6800km², affecting some 700 to 3000 people, both directly and indirectly (see text).

Table 7 presents various possible scenarios for the number of individuals affected by the Storegga tsunami, based on the 'danger areas' shown in red in Figure 4. As a first approximation, and assuming that half of the area under threat was severely impacted, it can be suggested that some 700 to 3000 individuals were affected. This number is sufficiently large to have potentially resulted in the extinction of a number of local bands, or possibly even a regional dialectical tribe (*cf. Newell et al. 1990.table 13*). This does not necessarily imply that all were killed immediately, although given the likely rapidity and scale of the event, a significant number of people would almost certainly have been caught and drowned by the inexorably rising waters, while many others would have been displaced. Nor would the consequences be limited to the wave's immediate impact, as productive coastal areas could have been devastated, shellfish beds destroyed and covered by sands, together with any fixed fishing facilities, well-attested for the Late Mesolithic Ertebølle period (*Pedersen 1997*), but also known from the early Kongemose (*c.* 8300 calBP) in Denmark (*Fischer 2004*). Moreover, depending on the time of year that the wave hit, any stored foods meant to last over the winter may also have been lost (*cf. Spikins 2008*), with subsequent starvation among survivors. Indeed, macrofossil analysis of fish bone and twigs from deposits in Norway has shown that the tsunami probably occurred during late autumn (*Bondevik et al. 1997*). It is conceivable, particularly in the context of continuing rising sea-levels at this time, that the final abandonment of the remaining remnants of Doggerland as a place of permanent habitation by Mesolithic populations was brought about by the Storegga tsunami.

Thus, both the immediate and longer-term affects of this event, in terms of population redistribution and social memory would have been considerable, although it remains difficult to provide more specific details at this stage (*cf. Coles 1998; Waddington 2007; Ward et al. 2006*). One clear effect of the final separation of Britain and the continent is a strong impression of insularity in the former, seen most clearly in the absence in Britain of the trapeze armatures that dominate later Mesolithic microlith industries on the adjacent continent from *c.* 8500 calBP (*Jacobi 1976*). Incidentally, this date is consistent with some of the more recent estimates given by palaeo-environmental researchers for the formation of the English Channel (see Tab. 5), and could even be interpreted as providing independent corroboration. While the process thus appears to have already been well underway, the Storegga tsunami may have finally severed any remaining (*e.g.* tidal) link between England and the continent.

Discussion and conclusions

We have assembled a large amount of ^{14}C-radiometric evidence for the Storegga Slide and its attendant tsunami, ranging from Norway to the British Isles. We find that the Storegga Slide tsunami event is reliably and accurately dated to 7300 ± 30 ^{14}C-BP (p = 95%) [8100 ± 100 calBP]. We then combined this with published palaeogeographic reconstructions for the now submerged Northwest European continental shelf known as 'Doggerland' (*Coles 1998; Behre 2003*) and regional sea-level records for the southern North Sea (*Behre 2003*) to evaluate the potential environmental and social impact of the tsunami in the Doggerland region. During the time-interval 8200–8000 calBP, the coastal lowlands of North Germany and the Netherlands were being steadily inundated by rising sea-levels due to a combination of eustatic and isostatic processes (amounting to a rise of 1.25m per century, *Behre 2003*). In addition, there would have been an abrupt 0.25–0.5m sea-level jump at around 8300 calBP, marking the sea-level effects of the catastrophic meltwater release from Lake Agassiz that triggered the so-called '8200 calBP' cold event around the Atlantic (*e.g. LeGrande 2006; Clare et al., this issue*). Simply stated, due to this coincidence, it may have been unusually cold and windy on the remaining coasts of Doggerland.

In the Netherlands (especially the northern part of the country, *i.e.* north of the Rhine), at the time of the Storegga Slide tsunami, and again essentially simultaneous with the 8200 calBP climate event, the number of available ^{14}C-dates is very low when compared to the earlier and final part of the Mesolithic. This temporal patterning seems to correspond with a shift in emphasis of settlement location towards the central and western part of the area (*Niekus 2006*). However, the process of a drop in the number of dates begins *c.* 300 years earlier than the tsunami, and *c.* 200 years earlier than the North Atlantic 8200 calBP cold event, and at present we see no causal relation between these natural processes and the drop in the number of dates. Furthermore, according to Raemaekers and Niekus (*in press*), it would be better to interpret the observed patterns as a demise in ^{14}C dates in the higher areas, instead of a true shift in occupation, especially since there are several major biasing factors that should be taken into account when discussing spatio-temporal patterning in the northern Netherlands (discussed in more detail in *Niekus 2006*). It seems most likely, however, that the Mesolithic population in the area were reacting to the steadily rising ground-water levels at this time (*Niekus 2006*).

Similar population relocation – in reaction to the loss of vital hunting and fishing grounds – may also be expected for the steadily sinking Doggerland. Unfortunately, due to major syn-sedimentary processes in the southern North Sea (*Fitch et al. 2004; Gaffney et al. 2007; Dix et al. 2008*) it is not yet possible to reliably reconstruct the ancient topography of Mesolithic Doggerland itself solely on the base of modern bathymetric data, let alone reconstruct the exact coastlines for the time-window of 8200–8000 calBP.

By comparing two alternative scenarios, based on 'highest possible' and 'lowest possible' sea levels (rated at –17 ± 5 m asl) that are contemporary with the derived date for the tsunami (8100 ± 100 calBP, 95% confidence) according to the sea-level curve of Behre (*2003*) for the southern North Sea, we conclude that the Storegga Slide tsunami would have had a catastrophic impact on the contemporary coastal Mesolithic population. One main result of this study is the high tsunami impact assigned to the western regions of Jutland, and in particular to the northern coasts, where Storegga Slide deposits may be expected, depending on locality, with strong postglacial isostatic working against rapid sea-level rise (*Fischer 2004*). Following the Storegga Slide tsunami, it appears, Britain finally became separated from the continent and, in cultural terms, the Mesolithic there goes its own way.

ACKNOWLEDGEMENTS

This study makes use of high-resolution 3D-digital satellite data from the SRTM (Shuttle Radar Topography) mission, flown in February 2000. This data is freely available for scientific research. We would like to express our sincere thanks to everyone involved in data accumulation, processing, and distribution. Jan Glimmerveen (The Hague, Netherlands) is personally thanked for providing ^{14}C-dates on finds from the North-Sea. We extend our personal thanks to Bryony Coles (Exeter, Great Britain), Søren Andersen (Højbjerg, Denmark), Stein Bondevik (Bergen, Norway), and Martin Street (Neuwied, Germany) for helpful information.

∴

REFERENCES

ALLEY R. B., MAYEWSKI P. A., SOWERS M., STUIVER M., TAYLOR K. C., CLARK P. U. 1997. Holocene climate instability: A prominent, widespread event 8200 yr ago. *Geology 25(6): 483– 486.*

BALLANTYNE C. K. 2004. After the Ice: Paraglacial and Postglacial Evolution of the Physical Environment of Scotland, 20,000 to 5000 BP. In A. Saville (ed.), *Mesolithic Scotland and its Neighbours. The Early Holocene Prehistory of Scotland, its British and Irish Context, and some Northern European Perspectives*. Society of Antiquaries of Scotland. Edinburgh: 27–53.

BAUER E., GANOPOLSK A., MONTOYA M. 2004. *Simulation of the cold climate event 8200 years ago by meltwater outburst from Lake Agassiz*. Paleoceanography 19.

BARBER D. C., DYKE A., HILLAIRE-MARCEL C., JENNINGS A. E., ANDREWS J. T., KERWIN M. W., BILODEAU G., McNEELY R., SOUTHON J., MOREHEAD M. D., GAGNON J.-M. 1997. Forcing of the cold event of 8,200 years ago by catastrophic drainage of Laurentide lakes. *Nature 400: 344–348.*

BEHRE K.-E. 2003. Eine neue Meeresspiegelkurve für die südliche Nordsee. Transgressionen und Regressionen in den letzten 10.000 Jahren. In E. Strahl, F. Bungenstock, J. Ey, S. Wolters, R. Kiepe, L. Spath (eds.), *Probleme der Küstenforschung im südlichen Nordseegebiet.* (Niedersächsisches Institut für historische Küstenforschung), Iseensee Verlag. Oldenburg: 9–63.

2005. Die Einengung des neolithischen Lebensraumes in Nordwestdeutschland durch klimabedingte Faktoren: Meeresspiegelanstieg und grossflächige Ausbreitung von Mooren. In D. Gronenborn (ed.), *Climate Variability and Culture Change in Neolithic Societies of Central Europe, 6700–2200 cal BC*. RGZM-Tagungen Band 1. Verlag des Römisch-Germanischen Zentralmuseums Mainz. Mainz: 209–220.

2007. A new Holocene sea-level curve for the southern North Sea. *Boreas 36: 82–102*.

BINFORD L. R. 2001. *Constructing Frames of Reference*. University of California Press. Berkeley.

BJÖRKLUND K. R., BJØRNSTAD H., ERLENKEUSER H., HENNINGSMOEN K. E., HØEG H. I., JOHNSEN K., MANUM S. B., MIKKELSEN N., NAGY J., PEDERSTAD K., QVALE G., ROSENQVIST I. T., SALBU B., SCHOENHARTING G., STABELL B., THIEDE J., THRONDSEN I., WASSMAN P., WERNER F. 1985. Evolution of the upper Quaternary depositional environment in the Skagerrak: A synthesis. *Norsk Geologisk Tidsskrift 65: 139–149*.

BONDEVIK S. 2003. Storegga tsunami sand in peat below the Tapes beach ridge at Harøy, western Norway, and its possible relation to an early Stone Age settlement. *Boreas 32: 476–483*.

BONDEVIK S., SVENDSEN J. I., JOHNSEN G., MANGERUD J., KALAND P. E. 1997. The Storegga tsunami along the Norwegian coast, its age and runup. *Boreas 26: 29–53*.

BONDEVIK S., MANGERUD J., DAWSON S., DAWSON A., LOHNE Ø. 2003. Record-breaking Height for 8000-Year-Old Tsunami in the North Atlantic. *EOS Trans. AGU 84 (31): 289–300*.

BONDEVIK S., LØVHOLT F., HARBITZ C., MANGERUD J., DAWSON A., SVENDSEN J. I. 2005. The Storegga Slide tsunami – comparing field observations with numerical observations. *Marine and Petroleum Geology 22: 195–208*.

BONDEVIK S., LOYHOLT F., HARBITZ C., STORMO S., SKJERDAL G. 2006. The Storegga Slide Tsunami – Deposits, Run-up Heights and Radiocarbon Dating of the 8000-Year-Old Tsunami in the North Atlantic. *Eos Trans. AGU 87(52), Fall Meet. Suppl., Abstract 0S34C-01*.

BOOMER I., WADDINGTON C., STEVENSON T., HAMILTON D. 2007. Holocene coastal change and geoarchaeology at Howick, Northumberland, UK. *The Holocene 17 (1): 89–104*.

BRIGGS K., THOMSON K., GAFFNEY V. 2007. A geomorphological investigation of submerged depositional features within the Outer Silver Pit, southern North Sea. In V. Gaffney, K. Thomson, S. Fitch (eds.), *Mapping Doggerland: the Mesolithic Landscapes of the Southern North Sea*. Archaeopress. Oxford: 43–59.

BRYN P., BERG K., FORSBERG C. F., SOLHEIM A., KVALSTAD T. J. 2005. Explaining the Storegga Slide. Marine and Petroleum. *Geology 22: 11–19*.

BUNGENSTOCK F. 2006. Der holozäne Meeresspiegelanstieg südlich der ostfriesischen Insel Langeoog, südliche Nordsee – hochfrequente Meeresspiegelbewegungen während der letzten 6000 Jahre. PhD-Thesis. Mathematisch-Naturwissenschaftliche Fakultät der Rheinischen Friedrich-Wilhelms-Universität Bonn. Available online: http://hss.ulb.uni-bonn.de/diss_online

COLES B. J. 1998. 'Doggerland': a speculative survey. *Proc. Prehist. Society 64: 45–81*.

COLES B. 1999. Doggerland's loss and the Neolithic. In B. Coles, J. Coles, M. Schou Jorgensen (eds.), *Bog Bodies, Sacred Sites and Wetland Archaeology*. WARP (Wetland Archaeology Research Project) Occasional Paper 12. Department of Archaeology, University of Exeter. Exeter: 51–57.

CONRADSEN K., HEIER-NIELSEN S. 1995. Holocene paleoceanography and paleoenvironments of the Skagerrak-Kattegatt, Scandinavia. *Paleoceanography 10: 810–813*.

CONSTANDSE-WESTERMANN T. S., NEWELL R. R. 1989. Social and biological aspects of the Western European Mesolithic population structure: a comparison with the demography of North American Indians. In C. Bonsall (ed.), *The Mesolithic in Europe*. Edinburgh University Press. Edinburgh: 106–115.

DAWSON S., SMITH D. E. 1997. Holocene relative sea-level changes on the margin of a glacio-isostatically uplifted area: an example from northern Caithness, Scotland. *The Holocene 7 (1): 59–77*.

DAWSON A. G., LONG D., SMITH D. E. 1988: The Storegga Slides: evidence from eastern Scotland for a possible tsunami. *Marine Geology 82: 271–276*.

DAWSON A. G., SMITH D. E., LONG D. 1990. Evidence for a tsunami from a Mesolithic site in Inverness, Scotland. *Journal of Archaeological Science 17 (6): 509–512*.

DAWSON A. G., LONG D., SMITH D. E., SHI S., FOSTER I. D. L. 1993. Tsunamis in the Norwegian Sea and North Sea caused by the Storegga submarine landslides. In S. Tinti (ed.), *Tsunamis in the World*. Kluwer Academic Publishers. The Netherlands: 228.

DAWSON A. 2008. The Tsunami Risk Project, on-line: www.nerc-bas.ac.uk/tsunami-risks/html/Phy3Impact.htm.

DIX J., QUINN R., WESTLEY K. 2008. A Re-assessment of the Archaeological Potential of Continental Shelves. Final Report. Department of Archaeology, University of Southampton, available on-line: http://www.arch.soton.ac.uk/Research/Aggregates/shelve-report.htm.

DONOVAN D. T. 1975. The geology and origin of the Silver Pit and other closed basins in the North Sea. *Proceedings of the Yorkshire Geological Society 39: 267–293*.

EDINBOROUGH K. 2004. *Evolution of Bow Arrow Technology*. Unpubl. PhD thesis: University College London.

ERDBRINK D. P. B., TACOMA J. 1997. Une calotte humaine datée au ^{14}C du basin sud de la mer du Nord. *L'Anthropolgie 100: 541–545*.

FISCHER A. 1997. People and the sea – settlement and fishing along the Mesolithic coast. In L. Pedersen, A. Fischer, B. Aaby (eds.), *The Danish Storebælt Since the Ice Age*. A/S Storebælt Fixed Link, Kalundborg Museum, National Forest and Nature Agency and the National Museum of Denmark. Copenhagen: 63–77.

2004. Submerged Stone Age – Danish examples and North Sea potential. In N. C. Flemming (ed.), *Submarine prehistoric archaeology of the North Sea*. Council for British Archaeology. York: 23–36.

FITCH S., THOMSON K., GAFFNEY V. 2005. Late Pleistocene and Holocene depositional systems and the palaeogeography of the Dogger Bank, North Sea. *Quaternary Research 64: 185–196*.

GAFFNEY V., THOMSON K., FITCH S. (eds.) 2007. *Mapping Doggerland: the Mesolithic Landscapes of the Southern North Sea*. Archaeopress. Oxford.

GILLESPIE R., GOWLETT J. A. J., HALL E. T., HEDGES R. E. M. 1984. Radiocarbon measurements by accelerator mass spectrometry: an early selection of dates. *Archaeometry 26: 15–20*.

GLIMMERVEEN J., MOL D., POST K., REUMER J. W. F., van der PLICHT H., van GEEL B., van REENEN G., PALS J. P. 2004. The North Sea project. The first palaeontological, palynological and archaeological results. In N. C. Flemming (ed.), *Submarine Prehistoric Archaeology of the North Sea*. Council for British Archaeology Research Report 141: 21–36.

GRAUERT M. S., BJÖRCK S., BONDEVIK S. 2001. Storegga tsunami deposits in a coastal lake on Suduroy, the Faroe Islands. *Boreas 30: 263–271*.

GROOTES P. M., STUIVER M., WHITE J. W. C., JOHNSEN S., JOUZEL J. 1993. Comparison of Oxygen Isotope Records from the GISP2 and GRIP Greenland Ice Core. *Nature 366: 552–554*.

GYLLENCREUTZ R. 2005a. Holocene and Latest Glacial Paleoceanography in the North-Eastern Skagerrak. Meddelanden från Stockholms Universitets Institution för Geologgi Och Geokemi No. 322. Available on-line: http://www.gyllencreutz.se/references.html

2005b. Late Glacial and Holocene paleoceanography in the Skagerrak from high-resolution grain size records. *Palaegeography, Palaeoclimatology, Palaeoecology 222: 344–369*.

HAFLIDASON H., LIEN R., SEJRUP H. P., FORSBERG C. F., BRYN P. 2005. The dating and morphometry of the Storegga Slide. *Marine and Petroleum Geology: 123–136*.

HARBITZ C. B. 1992. Model simulation of tsunamis generated by the Storegga Slides. *Marine Geology 105: 1–21*.

HUGHEN K., SOUTHON J., LEHMAN S., BERTRAND C., TURNBULL J. 2006. Marine-derived ^{14}C calibration and activity record for the past 50,000 years updated from the Cariaco Basin. *Quaternary Science Reviews 25: 3216–3227. doi:10.1016/j.quascirev.2006.03.014*.

JACOBI R. M. 1976. Britain inside and outside Mesolithic Europe. *Proceedings of the Prehistoric Society 42: 67–84*.

JELGERSMA S. 1979. Sea-level changes in the North Sea basin. In E. Oerle, R. T. E. Shüttenhelm, A. J. Wiggers (eds.), *The Quaternary history of the North Sea*. Symposia Universitatis Upsaliensis Annum Quingentesimum Celebrantis 2: 233–248.

JIANG H., BJÖRCK S., KNUDSEN K. L. 1997. *A palaeoclimatic and palaeoceanographic record of the last 11000 ^{14}C years from the Skagerrak-Kattega*.

JOHNSEN S. J., DAHL-JENSEN D., GUNDESTRUP N., STEFFENSEN J. P., CLAUSEN H. B., MILLER H., MASSON-DULMEOTTE V., SVEINBJØRNDOTTIR A. E., WHITE J. 2001. Oxygen isotope and palaeotemperature records from six Greenland ice-core stations: Camp Century, Dye-3, GRIP, GISP2, Renland and NorthGRIP. *Journal Quaternary Science 16 (4): 299–307*.

KLITGAARD-KRISTENSEN D., SEJRUP H. P., HAFLIDASON H., JOHNSEN S., SPURK M. 1998. A regional 8200 cal. yr BP cooling event in northwest Europe, induced by final stages of the Laurentide ice-sheet deglaciation? *Journal of Quaternary Science 13 (2): 165–169*.

LAMBECK K. 1995. Late Devensian and Holocene shorelines of the British Isles and North Sea from models of glacio-hydro-isostatic rebound. *Journal of the Geological Society 152: 437–448*.

LeGRANDE A. N. 2006. *The Climate Imprint on the Oxygen Isotopic Composition of Water: Observations, Proxies, and Coupled Isotopic Model Simulations*. Ph.D. thesis. Columbia University.

LEUENBERGER M., LANG C., SCHWANDER J. 1999. Delta ^{15}N measurements as a calibration tool for the paleothermometer and gas-ice age differences: A case study for the 8200 B.P event on GRIP ice. *Journal of Geophysical Research 104 (22): 163–170*.

LONG D., SMITH D. E., DAWSON A. G. 1989. A Holocene tsunami deposit in eastern Scotland. *Journal of Quaternary Science 4: 61–66*.

LOUWE KOOIJMANS L. P. 1971. Mesolithic bone and antler implements from the North Sea and from the Netherlands. *Berichten Rijksdienst voor het Oudheidkundig Bodemonderzoek 20–21:27–73*.

MOL D., POST K., REUMER J. W. F., van der PLICHT J., de VOS J. 2006. The Eurogeul—first report of the palaeontological, palynological and archaeological investigations of this part of the North Sea. *Quaternary International 142–143: 178–85*.

MOL D., GLIMMERVEEN J., POST K., van der PLICHT H., van GEEL B. 2008. Kleine encyclopedie van het leven in het Pleistoceen. Mammoeten, neushoorns en andere dieren van de Noordzeebodem. Veen Magazines. Diemen.

NEWELL R. R., CONSTANDSE-WESTERMANN T. S., van der SANDEN W. A. B., van GIJN A. 1990. An inquiry into the ethnic resolution of Mesolithic regional groups. The study of their decorative ornaments in time and space. Brill. Leyden.

NIEKUS M. J. L. Th. 2006. A geographically referenced ^{14}C database for the Mesolithic and the early phase of the Swifterbant culture in the Northern Netherlands. *Palaeohistoria 47/48: 41–99*.

NORDBERG K. 1991. Oceanography in the Kattegat and Skagerrak over the past 8000 years. *Paleoceanography 4: 461–484*.

PALUDAN-MÜLLER C. 1978. High Atlantic food gathering in north-western Zealand: ecological conditions and spatial representation. *Studies in Scandinavian Prehistory and Early History 1: 120–57*.

PEDERSEN L. 1997. They put fences in the sea. In L. Pedersen, A. Fischer, B. Aaby (eds.), *The Danish Storebælt Since the Ice Age*. Copenhagen: 124–143.

RAEMAEKERS D. C. M., NIEKUS M. J. L. Th. in press. Developments in Dutch Late Mesolithic: landscape, site location, subsistence and the introduction of pottery. In Ph. Crombé, M. van Strydonck, J. Sergant, M. Bats, M. Boudin (eds.), *Proceedings of the international congress "Chronology and Evolution in the Mesolithic of NW Europe"*, Brussels, May 30 till June 1 2007, Cambridge Scholar Publishing.

REIMER P. J., BAILLIE M. G. L., BARD E., BAYLISS A., BECK J. W., BERTRAND C. J. H., BLACKWELL P. G., BUCK C. E., BURR G. S., CUTLER K. B., DAMON R. L., EDWARDS R. L., FAIRBANKS R. G., FRIEDRICH M., GUILDERSON T. P., HOGG A. G., HUGHEN K. A., KROMER B., McCORMAC F. G., MANNING S. W., RAMSEY C. B., REIMER R. W. REMMELE S., SOUTHON J. R., STUIVER M., TALAMO S., TAYLOR F. W., van der PLICHT J., WEYHENMEYER C. E. 2004. IntCal04 Terrestrial radiocarbon age calibration, 26 – 0 ka BP. *Radiocarbon 46: 1029–1058*.

ROHLING E. J., PÄLICKE H. 2006. Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature 434: 975–979*.

ROZOY J.-G. 1978. Les Derniers Chasseurs. L'Épipaléolithique en France et en Belgique. Essai de Synthèse. Bulletin de la Société Archéologique Champenoise. Charleville.

SCHULTING R. J., RICHARDS M. P. 2001. Dating women and becoming farmers: new palaeodietary and AMS data from the Breton Mesolithic cemeteries of Téviec and Hoëdic. *Journal of Anthropological Archaeology 20: 314–344*.

SCHULTING R. J. in press. Worm's Head, Caldey Island (south Wales, UK) and the question of Mesolithic territories. In S. B. McCartan, R. J. Schulting, G. Warren, P. C. Woodman (eds.), *The Proceedings of the 7th Mesolithic in Europe Conference*. Oxbow. Oxford.

SHENNAN I., LAMBECK K., FLATHER R., HORTON B., McARTHUR J., INNES J., LLOYD J., RUTHERFORD M., WINGFIELD R. 2000. Modelling western North Sea palaeogeographies and tidal changes during the Holocene. In I. Shennan, J. Andrews (eds), *Holocene Land-Ocean Interaction and Environmental Change around the North Sea*. Geological Society, London, Special Publications 166: 299–319.

SHI S., SMITH D. E. 2003. Coastal Tsunami geomorphological impacts and sedimentation processes: Case studies of modern and prehistorical events. Lecture held at the International Conference on Estuaries and Coasts November 9–11, 2003, Hangzhou, China. Available online: http://www.irtces.org/pdf-hekou/021.pdf

SMITH D. E., CULLINGFORD R. A., HAGGART B. A. 1985. A major coastal flood during the Holocene in eastern Scotland. *Eiszeitalter und Gegenwart 35: 109–118*.

SMITH D. E., SHI S., CULLINGFORD R., DAWSON A., DAWSON S., FIRTH C., FOSTER I., FRETWELL P., HAGGART B., HOLLOWAY L., LONG D. 2004. The Holocene Storegga Slidse tsunami in the United Kingdom. *Quaternary Science Reviews 23: 2291–2311*.

SPIKINS P. A. 2007. Mesolithic Europe: glimpses of another world. In G. Bailey, P. A. Spikins (eds.), *Mesolithic Europe*. Cambridge University Press. Cambridge: 1–17.

SVENDSEN J. L. l985. Standforskyvning pá Sunnmøre. Bio- og litostratigrafske undersokelser pá Gurskøy, Leinøy og Bergsøy. Thesis, University of Bergen, 142 pp. [Cited in Bondevik et al. 1997].

TELLER J. T., LEVINGTON D. W., MANN J. D. 2002. Freshwater outbursts to the oceans from glacial Lake Agassiz and their role in climate change during the last deglaciation. *Quaternary Science Reviews 21: 879–887*.

TELLER J. T., MURTY T., NIRUPAMA N., CHITTIBABU P., BAIRD W. F. 2005. Possible Tsunami in the Labrador Sea related to the Drainage of Glacial Lake Agassiz ~8400 years B.P. *Science of Tsunami Hazards 23 (3): 3–16*.

THOMAS E. R., WOLFF E. W., MULVANEY R., STEFFENSEN J. P., JOHNSEN S. J., ARROWSMITH C., WHITE J. W. C., VAUGHN B., POPP T. 2007. The 8.2 kyr event from Greenland ice cores. *Quaternary Science Reviews 26(1–2): 70–81*.

UNITED STATES GEOLOGICAL SURVEY 2008. Data from http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html

VERHART L. 2005. A drowned land. Mesolithic from the North Sea floor. In L. P. Louwe Kooijmans, P. W. van den Broeke, H. Fokkens, A. L. van Gijn (eds.), *The Prehistory of the Netherlands*. Amsterdam University Press. Amsterdam: 157–160.

VINTHER B. M., CLAUSEN H. B., JOHNSEN S. J., RASMUSSEN S. O., ANDERSEN K. K., BUCHARDT S. L., DAHL-JENSEN D., SEIERSTAD I. K., SIGGAARD-ANDERSEN M.-L., STEFFENSEN J. P., SVENSSON A. M., OLSEN J., HEINEMEIER J. 2006. A synchronized dating of three Greenland ice cores throughout the Holocene. *Journal of Geophysical Research. doi:10.1029/2005JD006921*.

WADDINGTON C. (ed.) 2007. *Mesolithic Settlement in the North Sea Basin: A Case Study from Howick, North-East England*. Oxbow and English Heritage. Oxford.

WAGNER B., BENNIKE O., KLUG M., CREMER H. 2007. First indication of Storegga tsunami deposits from East Greenland. *Journal of Quaternary Science 22 (4): 321–325*.

WARD I., PIERS L., LILLIE M. 2006. The dating of Doggerland – post-glacial geochronology of the southern North Sea. *Environmental Archaeology 11 (2): 207–218*.

WENINGER B. 1986. High-precision calibration of archaeological radiocarbon dates. *Acta Interdisciplinaria Archaeol IV: 11–53*.

1995. Stratified ^{14}C Dates and Ceramic Chronologies. Case Studies for the Early Bronze Age at Troy (Turkey) and Ezero (Bulgaria). *Radiocarbon 37 (2): 443–456*.

WENINGER B., JÖRIS O., DANZEGLOCKE U. 2003. Climate Archaeology with Fortran. Fortran Source Volume 19,1. Spring 2003. Lahey Computer Systems Inc.

WENINGER B., JÖRIS O. 2004. Glacial Radiocarbon Calibration. The CalPal Program. In T. Higham, C. Bronk Ramsey, C. Owen (eds.), *Radiocarbon and Archaeology*. Fourth International Symposium. Oxford, 2002. Oxford University School of Archaeology Monograph 62: 9–15.

WENINGER B., ALRAM-STERN E., BAUER E., CLARE L., DANZEGLOCKE U., JÖRIS O., KUBATZKI C., ROLLEFSON G., TODOROVA H., van ANDEL T. 2006. Climate forcing due to the 8200 cal yr BP event observed at Early Neolithic sites in the eastern Mediterranean. *Quaternary International 66: 401–420*.

WENINGER B., EDINBOROUGH K., BRADTMÖLLER M., COLLARD M., CROMBÉ P., DANZEGLOCKE U., HOLST D., JÖRIS O., NIEKUS M., SHENNON S., SCHULTING R. in press. A Radiocarbon Database for the Mesolithic and Early Neolithic in Northwest Europe. In Ph. Crombé, M. Van Strydonck, J. Sergant, M. Bats, M. Boudin (eds.), *Proceedings of the international congress "Chronology and Evolution in the Mesolithic of NW Europe"*, Brussels, May 30 till June 1 2007. Cambridge Scholar Publishing.

Appendix

Tab. 8. Radiocarbon dates for the Storegga Slide tsunami

Age conventions

In the present paper all ages are given in tree-ring calibrated calendric years [calBP] before present (0 calBP = AD 1950). Calibrated ^{14}C-ages are obtained using the software CalPal (www.calpal.de), with methods described in Weninger (*1986*) and procedures described in Weninger and Jöris (*2004*), using the tree-ring data set INTCAL04 (*Reimer et al. 2004*). Conventional ^{14}C-ages are given on the ^{14}C-scale with units [^{14}C-BP]. To avoid misunderstanding, in the text we provide ages on both time scales. An example is: T–11707A: 7020 ± 90 ^{14}C-BP (7840 ± 90 calBP) with laboratory code T–11707A. In this case the conventional ^{14}C-age is 7020 ± 90 ^{14}C-BP. The corresponding tree-ring calibrated calendric age is 7840 ± 90 calBP. A database containing the ^{14}C-ages for the Storegga Slide tsunami, as collated from published studies and used here (Tab. 8). Note that this database does not show the tree-ring calibrated ages for individual dates. For the purposes of the present paper, these values are superfluous. The age-calibrated results based on these dates are shown in the graphs and tables.

References: Abbreviations

(1) *Bondevik et al. 1997*; (2) *Boomer et al. 2007*; (3) *Wagner et al. 2007*; (4) *Smith et al. 2004*

Position: Abbreviations

Position *e.g.* 'Above Tsunami': in relation to Storegga sand deposit, as defined in reference.
(R) = Regressive Contact (defined by *Smith et al. 2004*).
(T) = Transgressive Contact (defined by *Smith et al. 2004*).

Lab Code	^{14}C-Age	^{13}C-PDB	Material	Country	Site	Position	Latitude	Long.	Reference
Tua–522	7080 ± 80	–26,1	Twig	Norway	Almesstadmyra	above Tsunami	62,2175	5,6675	(1)
T–11707A	7020 ± 90	–29,6	Gyttja	Norway	Auretjorn	above Tsunami	60,9564	4,8147	(1)
T–11606A	7320 ± 140	–29,8	Gyttja	Norway	Auretjorn	above Tsunami	60,9564	4,8147	(1)
T–10599A	6865 ± 105	–30,7	Gyttja	Norway	Endrevatnet	above Tsunami	62,4331	6,2708	(1)
T–10598A	7105 ± 135	–30,6	Gyttja	Norway	Endrevatnet	above Tsunami	62,4331	6,2708	(1)
T–4162	7490 ± 90	–32,1	Gyttja	Norway	Endrevatnet	above Tsunami	62,4331	6,2708	(1)
T–10592A	7500 ± 80	–25,2	Gyttja	Norway	Froystadmyra	above Tsunami	62,3253	5,6764	(1)
T–10593A	7615 ± 150	–26	Gyttja	Norway	Froystadmyra	above Tsunami	62,3253	5,6764	(1)
T–11708A	7475 ± 110	–29,9	Gyttja	Norway	Forlandsvatnet	above Tsunami	60,8906	4,8442	(1)
T–11249A	7605 ± 105	–29,8	Gyttja	Norway	Gorrtjonna I	above Tsunami	63,8264	9,8308	(1)
T–11244A	7100 ± 125	–29,8	Gyttja	Norway	Kvennavatnet	above Tsunami	63,8347	9,8225	(1)
T–12013A	7570 ± 90	–30	Gyttja	Norway	Kvennavatnet	above Tsunami	63,8347	9,8225	(1)
T–10595A	6550 ± 100	–29,9	Gyttja	Norway	Ratvikvatnet	above Tsunami	62,4619	6,2242	(1)
T–10594A	7430 ± 95	–29,5	Gyttja	Norway	Ratvikvatnet	above Tsunami	62,4619	6,2242	(1)
T–10590A	7130 ± 95	–30,6	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–10591A	7205 ± 90	–30,2	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–11278A	6575 ± 110	–30,4	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–11277A	6890 ± 65	–30,7	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–11276A	7045 ± 70	–30,1	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–11245A	7610 ± 100	–29,4	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
Tua–862A	7850 ± 85	–27,7	Gyttja	Norway	Skolemyra	above Tsunami	62,3331	5,6486	(1)
T–11282A	5695 ± 100	–30,6	Gyttja	Norway	Asetjorn	above Tsunami	60,9056	4,8797	(1)
T–11281A	6406 ± 85	–30,2	Gyttja	Norway	Asetjorn	above Tsunami	60,9056	4,8797	(1)
T–11280A	6995 ± 110	–30,7	Gyttja	Norway	Asetjorn	above Tsunami	60,9056	4,8797	(1)

Lab Code	^{14}C-Age	^{13}C-PDB	Material	Country	Site	Position	Latitude	Long.	Reference
T–12260A	7180 ± 95	–30,8	Gyttja	Norway	Asetjorn	above Tsunami	60,9056	4,8797	(1)
T–11202A	7230 ± 105	–31,1	Gyttja	Norway	Asetjorn	above Tsunami	60,9056	4,8797	(1)
Tua–1350	7315 ± 70	–22,9	Moss	Norway	Audalsvatnet	within Tsunami	63,8314	9,8289	(1)
T–11705A	8090 ± 120	–28,5	Detritus	Norway	Auretjorn	within Tsunami	60,9564	4,8147	(1)
Tua–523	7655 ± 85	–26,1	Twig	Norway	Froystadmyra	within Tsunami	62,3253	5,6764	(1)
T–11246A	7985 ± 115	–24,8	Detritus	Norway	Froystadmyra	within Tsunami	62,3253	5,6764	(1)
T–4967A	8480 ± 160	–27,8	Detritus	Norway	Froystadmyra	within Tsunami	62,3253	5,6764	(1)
T–11710A	8040 ± 160	–30,5	Detritus	Norway	Forlandsvatnet	within Tsunami	60,8906	4,8442	(1)
Tua–834	6970 ± 175	–26	Twig	Norway	Gorrtjonna I	within Tsunami	63,8264	9,8308	(1)
Tua–835	7930 ± 65	–26,1	Twig	Norway	Gorrtjonna I	within Tsunami	63,8264	9,8308	(1)
Tua–1269	7445 ± 65	–29,5	Twig	Norway	Gorrtjonna I	within Tsunami	63,8264	9,8308	(1)
Tua–1122	7175 ± 75	–30,7	Twig	Norway	Klingrevatnet	within Tsunami	62,4424	6,2324	(1)
Tua–833	8285 ± 185	–27,7	Calluna	Norway	Kulturmyra	within Tsunami	62,3319	5,6553	(1)
TUa–831	7240 ± 70	–27,7	Twig	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	(1)
TUA–984	7200 ± 80	–26,1	twig	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	(1)
TUa–832	8405 ± 70	1	Shell	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	(1)
TUa–859	10780 ± 95	1	Shell	Norway	Kvennavatnet	within Tsunami	63,8347	9,8225	(1)
T–10597	7230 ± 105	–26,1	Twig	Norway	Ratvikvatnet	within Tsunami	62,4619	6,2242	(1)
T–10596	7610 ± 70	–26,1	Wood	Norway	Ratvikvatnet	within Tsunami	62,4619	6,2242	(1)
TUa–861	7250 ± 75	–26,1	Bark	Norway	Skolemyra	within Tsunami	62,3331	5,6486	(1)
TUa–524	7365 ± 90	–26,1	Twig	Norway	Skolemyra	within Tsunami	62,3331	5,6486	(1)
TUa–860	7435 ± 75	–26,1	Bark	Norway	Skolemyra	within Tsunami	62,3331	5,6486	(1)
T–11275A	8315 ± 110	–24,9	Detritus	Norway	Skolemyra	within Tsunami	62,3331	5,6486	(1)
TUa–858	7765 ± 80	–26,1	Twig	Norway	Skolemyra	within Tsunami	62,3331	5,6486	(1)
T–11279A	7915 ± 70	–30,4	Detritus	Norway	Asetjorn	within Tsunami	60,9056	4,8797	(1)
TUa–864	8045 ± 75	–26,1	Twig	Norway	Asetjorn	within Tsunami	60,9056	4,8797	(1)
TUa–863	8350 ± 80	–26,1	Twig	Norway	Asetjorn	within Tsunami	60,9056	4,8797	(1)
T–11704A	7320 ± 80	–29,9	Gyttja	Norway	Auretjorn	directly below	60,9564	4,8147	(1)
T–11247A	9020 ± 155	–26,1	Gyttja	Norway	Froystadmyra	directly below	62,3253	5,6764	(1)
T–11709A	7985 ± 150	–29,5	Gyttja	Norway	Forlandsvatnet	directly below	60,8906	4,8442	(1)
T–11250A	7680 ± 70	–32,5	Gyttja	Norway	Gorrtjonna I	directly below	63,8264	9,8308	(1)
T–11837A	8340 ± 115	–29,7	Gyttja	Norway	Kulturmyra	directly below	62,3319	5,6553	(1)
TUa–1270	7350 ± 80	–22,3	Moss	Norway	Kvennavatnet	directly below	63,8347	9,8225	(1)
T–11201A	7805 ± 115	–29,6	Gyttja	Norway	Asetjorn	directly below	60,9056	4,8797	(1)
Oxa–11833	7269 ± 39	–24,9	Hazelnut	England	Howick	directly above	55,4403	–1,5917	(2)
Oxa–11858	7308 ± 40	–25,6	Hazelnut	England	Howick	directly above	55,4403	–1,5917	(2)
OxA–11860	7160 ± 40	–27,3	Twig	England	Howick	above Tsunami	55,4403	–1,5917	(2)
OxA–11859	7174 ± 35	–26,4	Wood	England	Howick	above Tsunami	55,4403	–1,5917	(2)
OxA–12954	7075 ± 37	–30,7	Bark	England	Howick	above Tsunami	55,4403	–1,5917	(2)
OxA–12953	7117 ± 39	–26,1	Hazelnut	England	Howick	above Tsunami	55,4403	–1,5917	(2)
OxA–12952	6988 ± 37	–26,5	Hazelnut	England	Howick	above Tsunami	55,4403	–1,5917	(2)
KIA–24754	6735 ± 40	0,41	Shell	Greenland	Loon Lake	above Tsunami	72,8839	–22,1342	(3)
KIA–27660	7720 ±45	–0,77	Shell	Greenland	Loon Lake	above Tsunami	72,8839	–22,1342	(3)
KIA–27661	7925 ± 45	0,85	Shell	Greenland	Loon Lake	directly above	72,8839	–22,1342	(3)
KIA–27662	7640 ± 45	1,68	Shell	Greenland	Loon Lake	within Tsunami	72,8839	–22,1342	(3)
KIA–27663	7515 ± 45	1,54	Shell	Greenland	Loon Lake	directly below	72,8839	–22,1342	(3)
KIA–27664	7820 ± 45	0,37	Shell	Greenland	Loon Lake	under Tsunami	72,8839	–22,1342	(3)
KIA–27665	7555 ± 45	0,56	Shell	Greenland	Loon Lake	under Tsunami	72,8839	–22,1342	(3)
KIA–24755	7625 ± 60	–5,95	Shell	Greenland	Loon Lake	under Tsunami	72,8839	–22,1342	(3)
SRR 4902	7215 ± 60	–27.4	Peat	Shetland	Burragarth	R	60,7134	–0,949	(4)

Lab Code	^{14}C-Age	^{13}C-PDB	Material	Country	Site	Position	Latitude	Long.	Reference
Beta169274	6840 ± 40	−25.0	Peat	Shetland	Norwick	R	60,807	−0,8196	(4)
SRR 1793	5130 ± 50	n.d	Wood	Shetland	Garth's Voe	above Tsunami	60,4371	−1,2746	(4)
SRR 1794	7870 ± 50	n.d	Wood	Shetland	Garth's Voe	below Tsunami	60,4371	−1,2746	(4)
SRR 3839	5315 ± 45	−28.8	Peat	Shetland	Garth's Voe	R	60,4371	−1,2746	(4)
SRR 3838	5765 ± 45	−27.8	Peat	Shetland	Garth's Voe	T	60,4371	−1,2746	(4)
SRR 3841	3815 ± 45	−28.5	Peat	Shetland	Scatsta Voe	R	60,4367	−1,275	(4)
SRR 3840	5700 ± 45	−28.5	Peat	Shetland	Scatsta Voe	T	60,4367	−1,275	(4)
n.d	7025 ± 60	n.d.	Wood	Shetland	Sullom Voe	R	60,5132	−1,3641	(4)
n.d.	7120 ± 60	n.d.	Seeds	Shetland	Sullom Voe	T	60,5132	−1,3641	(4)
n.d.	7320 ± 70	n.d,	Twig	Shetland	Garth Loch	within Tsunami	60,2647	−1,1536	(4)
n.d.	7220 ± 70	n.d.	Seeds,Leaves	Shetland	Garth Loch	directly above	60,2647	−1,1536	(4)
Beta105030	7290 ± 50	−31.4	Peat	Scotland	Strath Halladale	R	58,5375	−3,9062	(4)
Beta105031	7590 ± 50	−30.5	Peat	Scotland	Strath Halladale	T	58,5375	−3,9062	(4)
Beta 89710	7070 ± 80	−27.9	Peat	Scotland	Wick River	R	58,4533	−3,1283	(4)
Beta 89709	7210 ± 80	−27.6	Peat	Scotland	Wick River	T	58,4533	−3,1283	(4)
Beta89706	7170 ± 80	−28.4	Peat	Scotland	Wick River	R	58,4533	−3,1283	(4)
Beta89707	7140 ± 90	−29.4	Peat	Scotland	Wick River	T	58,4533	−3,1283	(4)
Beta89712	7810 ± 70	−28.4	Peat	Scotland	Wick River	T	58,4533	−3,1283	(4)
SRR 3791	6580 ± 55	−29.0	Peat	Scotland	Smithy House	R	57,9654	−4,0095	(4)
SRR 3792	6980 ± 65	−29.0	Peat	Scotland	Smithy House	R	57,9654	−4,0095	(4)
SRR 3694	6930 ± 55	−27.6	Peat	Scotland	Creich	R	57,8682	−4,2781	(4)
SRR 3693	6950 ± 55	−28.9	Peat	Scotland	Creich	T	57,8682	−4,2781	(4)
SRR 3787	5190 ± 65	−27.5	Peat	Scotland	Dounie	R	57,8456	−4,1971	(4)
SRR 3790	7120 ± 45	−27.7	Peat	Scotland	Dounie	T	57,8456	−4,1971	(4)
BIRM 1126	7270 ± 90	−21.6	Peat	Scotland	Moniack	R	57,463	−4,4312	(4)
BIRM 1127	7430 ± 170	−21.1	Peat	Scotland	Moniack	T	57,463	−4,4312	(4)
GU 1377	7080 ± 85	−25.5	Charcoal	Scotland	Castle St.Inverness	T	57,6754	−4,5994	(4)
SRR 5478	6905 ± 55	−27.3	Peat	Scotland	Water of Philorth	R	57,6672	−1,976	(4)
SRR 5479	7395 ± 45	−29.2	Peat	Scotland	Water of Philorth	T	57,6672	−1,976	(4)
SRR 5473	6995 ± 45	−28.1	Peat	Scotland	Water of Philorth	R	57,6672	−1,976	(4)
SRR 5474	7215 ± 45	−28.9	Peat	Scotland	Water of Philorth	T	57,6672	−1,976	(4)
SRR 1565	6850 ± 140	−26.0	Peat	Scotland	Waterside	RžT	57,3284	−1,9904	(4)
SRR 4717	7135 ± 45	−28.1	Peat	Scotland	Tarty Burn	R	57,3342	−2,0292	(4)
SRR 4718	7400 ± 45	−28.4	Peat	Scotland	Tarty Burn	T	57,3342	−2,0292	(4)
SRR 2119	6850 ± 75	−28.8	Peat	Scotland	Puggieston	R	56,7315	−2,493	(4)
SRR 2120	7120 ± 75	−27.4	Peat	Scotland	Puggieston	T	56,7315	−2,493	(4)
BIRM 867	6880 ± 110	−26.8	Peat	Scotland	Fullerton	R	56,694	−2,5319	(4)
BIRM 823	7140 ± 120	−26.8	Peat	Scotland	Fullerton	T	56,694	−2,5319	(4)
Beta92235	7070 ± 130	−28.9	Peat	Scotland	Maryton	R	56,6993	−2,5166	(4)
Beta92236	7420 ± 120	−28.8	Peat	Scotland	Maryton	T	56,6993	−2,5166	(4)
n.d.	7605 ± 130	n.d.	Peat	Scotland	Silver Moss	T	56,4905	−2,8852	(4)
SRR 1333	7050 ± 100	−28.1	Peat	Scotland	Silver Moss	R	56,4905	−2,8852	(4)
SRR 1334	7555 ± 110	−23.6	Peat	Scotland	Silver Moss	T	56,4905	−2,8852	(4)
SRR 1603	6870 ± 50	−26.6	Peat	Scotland	Over Easter Offerance	T	56,1375	−4,2909	(4)
SRR 1431	7490 ± 70	−28.1	Gyttja	Scotland	Lochhouses	R	56,0305	−2,6167	(4)
SRR 1430	7450 ± 60	−29.1	Gyttja	Scotland	Lochhouses	T	56,0305	−2,6167	(4)
SRR 3912	7315 ± 70	−30.0	Gyttja	Scotland	Lochhouses	R	56,0305	−2,6167	(4)
SRR 3913	7590 ± 60	−30.0	Gyttja	Scotland	Lochhouses	T	56,0305	−2,6167	(4)
AA 25596	6700 ± 60	−28.2	Peat	Scotland	Broomhouse Farm	R	55,6992	−1,9395	(4)
AA 25601	7165 ± 60	−29.0	Peat	Scotland	Broomhouse Farm	T	55,6992	−1,9395	(4)

back to contents

UDK 551.583.7:911.52(434)"63":902.67
Documenta Praehistorica XXXV (2008)

Holocene paleoclimatic and paleohydrological changes in the Sárrét basin, NW Hungary

Pál Sümegi [1], Sándor Gulyás [1], Gergő Persaits [1]
1 *University of Szeged, Department of Geology and Paleontology, Hungary*
sumegi@geo.u-szeged.hu

ABSTRACT – *According to detailed sedimentological and paleontological analyses carried out on samples taken from the Sárrét–Nádasdladány core-profile, a complete environmental history of a neotectonic depression was drawn. The sequence is composed of fluvial-lacustrine and marshland deposits which started to accumulate during the Late Glacial and culminated at the beginning of the Holocene. The highly characteristic changes in the biofacies were linked to changes in the lithofacies within this sequence. A transition in the dominance of moving water species, observable initially in lacustrine species preferring well-lit, well-oxygenated conditions was observed. Eventually, the littoral and eutrophic lacustrine species, as well as marsh-dwellers, became dominant in the profile, marking the emergence of uniform peat land in the Sárrét Basin.*

IZVLEČEK – *S pomočjo sedimentoloških in paleontoloških analiz vzorcev iz vrtine Sárrét-Nádasdladány lahko sestavimo popolno okoljsko zgodovino te neotektonske depresije. Zaporedje sestavljajo rečni, jezerski in močvirski depoziti, ki se začnejo v poznem glacialu in se nadaljujejo v začetek holocena. Zelo značilne spremembe v fosilnih zbirih lahko povežemo s spremembami v sedimentaciji. Na začetku prevladujejo vrste, ki živijo v tekoči vodi, te pa kasneje zamenjajo vrste, ki živijo v jezeru, v dobro osvetljenih vodah z dovolj kisika. Kasneje postanejo pogostejše obalne in evtrofične kot tudi močvirske vrste, ki zaznamujejo nastanek šote v kotlini Sárrét.*

KEY WORDS – *paleohydrology; paleoecology; mollusks; Holocene; Sárrét*

Introduction

Quaternary geological and malacological investigations in the neotectonic basin of the Sárrét started as early as the beginning of the 20th century (*Kormos 1909*). The region, with an area of approximately 120km^2 located at the interface of the Mezőföld and the Transdanubian Mid-Mountains, occupies a neotectonic basin (*Lóczy 1913; Cserny 2000*) with a NE-SW trend which developed at the end of the Quarternary (*Dömsödi 1977*) and infilled with Quaternary deposits of great thickness. Although a large portion of the peat was destroyed, compacted and suffered pedogenesis as a result of drainage (from 1825 onwards), according to the quarter-malacological investigations initiated by Tivadar Kormos (*1909*), Holocene deposits of great thickness are still preserved in the area under investigation.

The region of the Sárrét came into the focus of Hungarian paleo-environmental and stratigraphic research via the detailed quarter-malacological investigations carried out by Endre Krolopp and Levente Fűköh from the 1970s onwards (*Fűköh-Krolopp 1986; Fűköh 1977; Krolopp 1972*). Furthermore, corings with continuous undisturbed samples in the area near Nádasladány and Sárkeszi in the Sárrét region (Fig. 1), and the sedimentological, isotope-geochemical, geochemical, pollen analytical and quarter-malacological investigations carried out as part of a Hungarian-British Joint Scientific Cooperation in 1995, meant a major breakthrough in the stratigraphic and paleo-environmental study of the area (*Willis et al. 1996; Cserny 2000*). The findings of the detailed chronological, lithostratigraphical and biostratigraphical analyses of these core samples are presented in this paper.

Material and methods

Sampling was carried out with the help of a Livingstone piston corer, following the so- called 'overlapping' method. Cores were halved lengthwise after having been transported to the lab, to suit the needs of different analytical approaches. The terminology and symbols of Troels-Smith (*Troels-Smith 1955*), internationally accepted for unconsolidated sediments, were used to describe the lithology.

Radiocarbon measurements were carried out on 7 samples derived from the peat layers, the inwashed charcoals and flue-ash horizons in the Light Isotope Laboratory of the Nuclear Research Center at the Hungarian Academy of Sciences in Debrecen. The methodology and techniques presented in Hertelendi et al. (*1989*) were followed for the digestion and measurements. In addition, these 3 samples were analyzed with AMS in the Isotope Laboratory of Oxford University (*Willis 1997*). Radiocarbon dates were utilized to determine the lithostratigraphy and chronological units with the help of the results of geochemical, pollen analytical and malacological analyses. They were also utilized to determine the rate of deposition in the sedimentary basin (Fig. 2).

The results of pollen analysis were used as input in comparative biostratigraphy. In order to gain an expansive picture of the paleo-environment, pollen data published earlier by Katherine Jane Willis (*Willis 1997*) have been utilized.

Samples collected from layers between 8–12cm were washed through a mesh screen for mollusks. The work of Sümegi and Krolopp (*2002*), Meijer (*1985*), Ložek (*1964*) was utilized to determine and put the species into paleo-ecological groups according to their temperature tolerance, recent biogeographic affinity and distribution, as well as their humidity and vegetation cover preferences. Both the dominance values of the species found and the ratio of paleo-ecological and recent biogeographical groups, along with the results of the radiocarbon measurements and the lithostratigraphy, were depicted on graphs with Psimpoll software (*Bennett 1992*).

Lithological and lithostratigraphical findings

Three major lithostratigraphic units were identified in the undisturbed, continuous core of the 398cm deep borehole (Fig. 2). The first unit, located between depths of 398 and 268cm, is made up of alternating layers of fine laminated silt, gravelly sand and sandy gravel. According to the radiocarbon data, the development of these silty intercalations must have taken place between 13 000–11 000 BP, at the end of the Pleistocene.

The next sedimentary unit is located between depths of 268 and 164cm. This horizon is composed of white, grayish-white, calcareous muds, with a carbonate content ranging between 80–90%. The majority of the carbonates are derived from biomicritic pellets secreted by the Chara vegetation and calcareous oogonia. This sequence must have been deposited in a relatively shallow, well-lit lacustrine system, with eutrophic conditions prevailing at the bottom. This lacustrine phase, characterized by the deposition of calcareous marls, must have existed between 11 000 and 9000 BP in the area.

From a depth of 164cm, there is a sudden decrease in the carbonate content, accompanied by a prominent increase in the organic content. The distribution of organic matter is not homogenous and by no means dispersed, but resembles a downward flame-like structure made up of the remnants of peat fern (*Thelypteris palustris*). All this points to the emergence of individual floating mats, which must have

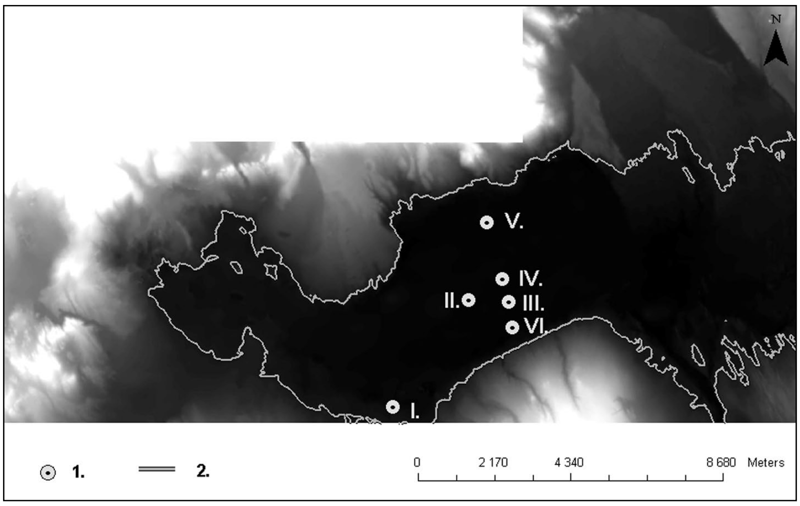


Fig. 1. The area of the Sárrét catchment basin, with the Sárrét-Nádasdladány borehole (I.) marked.

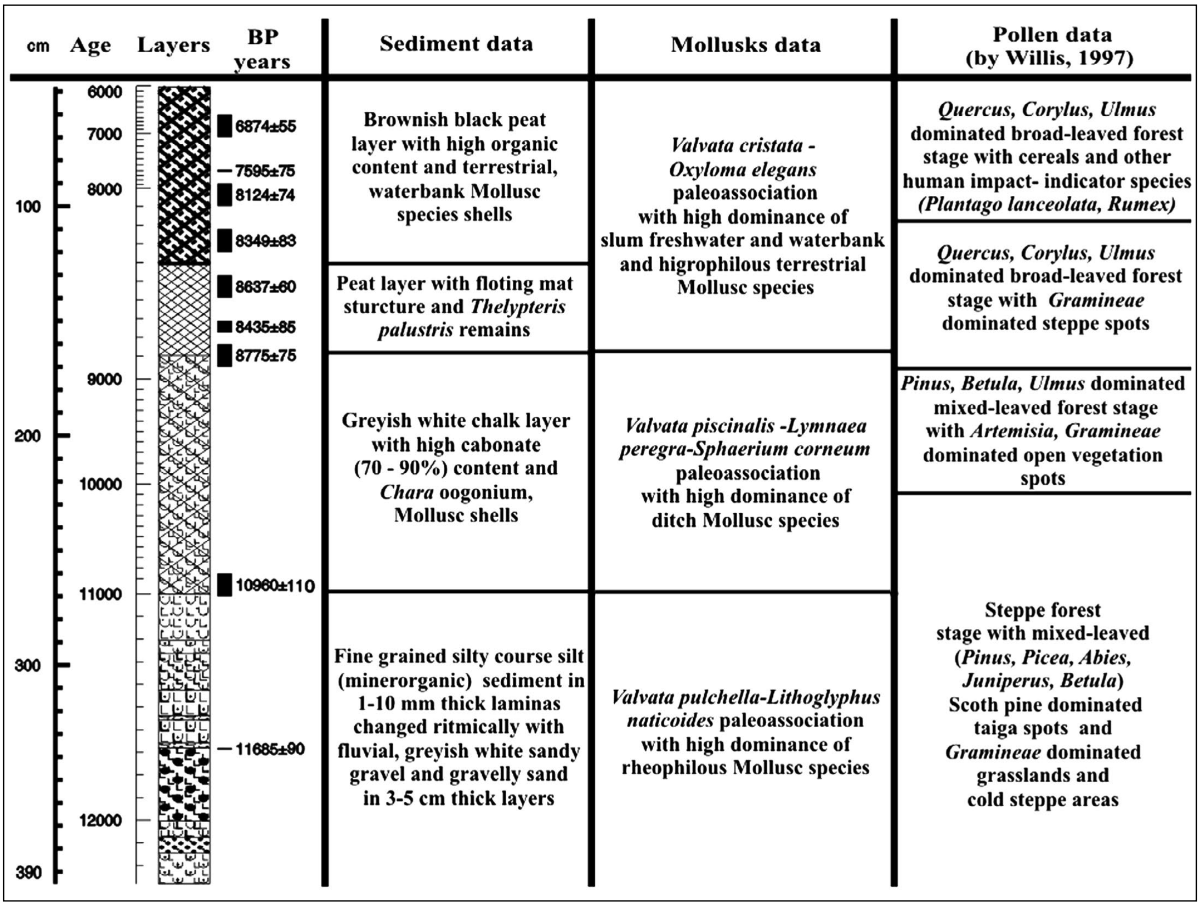


Fig. 2. Palaeo-ecological results of the Sárrét–Nádasdladány I core sequence.

united and closed within a period of 100–200 years. A recent analogy for the development of such floating mats is known from Lake Velencei, situated NE of the area of the Sárrét (*Balogh 2000*).

No samples were taken from the surface down to a depth of 48cm and no radiocarbon measurements were taken for this part of the profile. The emergence of floating mats can be placed between 8500–8700 BP, while the development of a unified closed peat horizon must be younger than 8500 BP. Peat formation must have been quite significant even at 6500 BP as well, according to the radiocarbon data.

The results of malacological analysis

Some 4785 specimens belonging to 41 species have come to light from the core. Three major malacological zones have been identified with the help of statistical analyses on the data (Fig. 2.).

The first zone is located between depths of 398 and 270cm. According to sedimentation rates, this horizon must have developed between 13 000–11 000 BP. The ratio of species with a preference for moving water habitats is above 50% in this horizon (*e.g.: Valvata psicinalis, Lithoglyphus naticoides, Pisidium amnicum, Unio cf. crassus*). Specimens of the Boreal *Gyraulus riparius* and *Valvata pulchella* have come to light from this part of the profile alone. One of the major characteristics of this horizon is the collective appearance of aquatic species expanding during the colder phases of the Pleistocene, becoming restricted at the beginning of the Holocene (*Valvata pulchella, Bithynia leachi, Gyraulus riparius*), and the aquatic species starting their expansion during the Holocene (*Lithoglyphus naticoides, Bithynia tentaculata*). This collective appearance of mollusks preferring milder climatic and colder climatic periods at the end of the Pleistocene and the beginning of the Holocene can be regarded as one of the most characteristic features of the Quaternary malacofauna of the Carpathian basin. (*Willis et al. 1995; Sümegi 2004*). Fauna of the same age and composition have been identified from the areas of the Tapolca basin, the Jászság, the bedrock horizon of the Vörös marshland of Császártöltés, and the sandpit of Tószeg (*Hertelendi et al. 1993*). On the basis of these fauna horizons, we may assign the collective appearance of the species *Valvata pulchella* and *Lithoglyphus naticoides* between 12 000–9000 BP in the Carpathian Basin.

The results of the pollen analysis from the malacological samples (*Willis 1997*) also seem to corroborate the findings of the radiocarbon measurements (Fig. 2).

The neotectonic depression of the Sárrét was surrounded by gallery, forest-like, forest-steppe taiga, characterized by a dominance of birch (*Betula*) mixing with conifers of common pine (*Pinus silvestris*), spruce (*Picea*), fir (*Abies*), juniper (*Juniperus*) and grasses (*Graminea*), carices (*Cyperaceae*) at the time. Although regarding the extension of the sedimentary basin of the Sárrét (80–120 km^2) (*Jacobson-Bradshaw 1981*), we may assume that the pollen composition of the profile reflects the composition of the vegetation on a wider, regional scale (Mezőföld, Bakonyalja, Bakony) and not only the adjacent marginal vegetation of the depression.

The second malacological horizon is located between depths of 270–167cm. The majority of species with a moving-water habitat preference, like *Valvata pulchella, Gyraulus riparius, Lithoglyphus naticoides, Lymnaea stagnalis, Pisidium amnicum, Unio cf. crassus*, became restricted. On the other hand, the rheophilous species *Valvata piscinalis* managed to survive. Moreover, there was a significant increase in the proportion of this latter species, which has become a prevailing element of this local malacological zone. However, it must be noted that there was a definite decrease in the size of the specimens collected from the calcareous muds compared to those from the preceding zone. According to data and observations on the recent malacofauna, as well as the Quaternary malacofauna deriving from several profiles in the Nyírség and Lake Balaton, the gastropod species *Valvata piscinalis* successfully copes with environmental transformations like that from a fluvial to a lacustrine habitat, surviving in the littoral surf zone, where moving water supplies a sufficient amount of dissolved oxygen. It is in this malacological zone that the species *Lymnaea peregra* (*f. ovata*), *Physa fontinalis, Gyraulus albus, Sphaerium corneum,* and *Bithynia tentaculata* appear and gradually become dominant. Besides these strong changes in the aqueous fauna, the amphibic species *Carychium minimum* and *Succineas* also show up in this horizon. All these changes seem to imply the development of a relatively shallow, 1–3m deep, well-lit, but eutrophication at the bottom lacustrine environment, characterized by mild water temperatures and alkaline pH during the growth season in the area under investigation. The higher ratio of littoral elements implies the proximity of our sampled profile to a singular littoral surf zone.

The analyzed biological zone must have emerged between 11 000 and 9000 BP. That is, the End-Pleistocene, Early Holocene mesotrophic lake phase must have emerged as early as 11 000 BP in the Sárrét depression, and this correlates well with the developmental history of the sub-basins of the neotectonic depression of Lake Balaton (Tapolca Basin, Kis-Balaton) and the ponds located at the Danube-Tisza Interfluve (*Cserny-Nagy-Bodor 2000*). This calcareous mud horizon of Sárrét yielded some harpoons assumed to be of Mesolithic Age, according to archeological data (*Marosi 1935; 1936a; 1936b; Nemeskéri 1948; Makkay 1970*). Thus the calcareous muds identified in the Nádasladány borehole may be correlated with a period of the Mesolithic.

According to palynological data, there was also significant change in the composition of the vegetation parallel with the emergence of this malacological horizon (*Willis 1997*). There was a shift in the advance of deciduous trees, in contrast to the formerly dominant conifers, namely birch (*Betula*), oak (*Quercus*), elm (*Ulmus*), and hornbeam (*Carpinus*). Nevertheless, the ratio of common pine (*Pinus silvestris*) remained significant. This latter factor might be strongly related to the ability of the Sárrét sedimentary basins to act as a regional pollen trap in the area. Thus pollen from the common pine woodlands, being extensive in the Bakony Mts. at the beginning of the Holocene, might also have been transported into and accumulated in the sedimentary basin of the Sárrét from greater distances. To put it another way: the basin must have preserved pollens originating from several regions characterized by different natural endowments and highly varying plant paleoassociations (coniferous remnant woodlands, the cooler basins and valleys of the Bakony Mts., deciduous woodlands, the Bakony Mts. including the foothill area, open loess and dolomite steppe areas, the dolomite cliffs of the foothill area of the Bakony, with high relief, the area of the Mezőföld).

There was a complete turnover in the malacofauna at the final stage of calcareous mud deposition and the initiation of peat formation in the area of Sárrét-Nádasladány. Species with a moving water habitat preference completely disappeared, giving way to the extensive, Holarctic still water species. The gastropod *Valvata cristata* is the dominant form in this part of the profile. However, species preferring a well-lit, well-oxygenated lacustrine habitat (*Physa fontinalis, Lymnaea peregra f. ovata, Sphaerium corneum*) also completely disappeared when peat formation began. The increase in the proportions of marsh-dwellers (*Acroloxus lacustris, Planorbis planorbis, Anisus leucostoma*), and the littoral, amphibic *Succinea*s (*Succinea oblonga, Oxyloma elegans*) indicate a change in the environment and lithology. The malacological data are in close correlation with changes in the sedimentary layers, the emergence of floating mats and the appearance of a wet, terrestrial-like habitat wedged into the lacustrine environment. Such island-like patches of floating mats was observed on the Nagy-Mohos floating mat of Kállósemjén at the end of the 1980s. According to the findings of investigations on the recent malacofauna, the underwater areas of the floating mats are inhabited by the gastropod species of *Valvata cristata, Planorbis planorbis* and *Anisus*es. While the surfaces located above the water such as wet reed, ferny and bulrush areas are populated by *Succinea*s and *Carychium minimum* in large quantities, the composition of the malacofauna of the recent floating mats of Kállósemjén is highly similar to that of the floating mat phase observed in the borehole of Sárrét–Nádasdladány.

According to radiocarbon data, peat formation, resulting in a transformation of the lacustrine environment, began around 9000 BP in the area under investigation, being active even at 6000 BP. Peat formation must have continued even after that. However, because of the presence of mixed, disturbed layers, no samples were taken from the surface to a depth of 48cm.

The composition of pollens also underwent a sharp and strong change at the beginning of peat formation, with a sudden increase in the proportions of fern (*Pteridophyta*), and grass (*Gramineae*) pollens, including water plants (*e.g.* float-grass – *Glyceria*). All these changes are closely linked to the development and evolution of floating mats in the area. The inwash and transportation of pollens of local flowering plants into the basin was dominant during this time, as reflected in the composition of pollens and spores. The question is, however, what might have caused the transformation of the basin from a regional pollen trap into a local one? It seems that the conditions favoring pollen entrapment must have changed in the basin as a result of the development of floating mats also changing the entrapment capacity. According to investigations carried out, this horizon can be characterized by the quickest rate of deposition. The underlying factor must have been the rapid horizontal and vertical growth and expansion of floating mats. According to the analyses of plant remains, the majority of the spores within this horizon come from peat fern (*Thelypteris palustris*), one of the most important floral elements in floating mats. As a result of the relatively rapid growth in the local vegetation, and the rapid accumulation and deposition of their spores, along with rapid sedimentation, prevented the large-scale accumulation of regional, distant pollens transported into the basin. These pollens appear only subsequently in the profile in this horizon.

Following the development of floating mats, the rate of deposition decreased, accompanied by a stall in peat formation increasing the pollen entrapment ability of the Sárrét sedimentary basin and enabling the entrapment of regional pollens as well. As a result of this, larger amounts of pollen from oak (*Quercus*), elm (*Ulmus*) hazel (*Corylus*), and grasses (*Gramineae*) could have accumulated. According to the pollen composition, a mixing of pollens deriving from a forest steppe or closed woodland existing in the neighborhood in a milder phase (with a transportation direction from the Bakony and Vértes Mts.) and an open steppe area (Mezőföld, loess steppes) was identified. The early appearance of cereal pollens in the Sárrét-Nádasdladány section (6000 calBC) seems to be in good agreement with the appearance of the Early Neolithic communities and the emergence of productive societies in the Carpathian basin (*Hertelendi et al. 1998*).

Summary

According to the detailed sedimentological and palaeoontological analyses carried out on samples taken from the Sárrét–Nádasdladány core-profile, a complete environmental history of a neotectonic depression have been drawn. The sequence is composed of fluvial-lacustrine and marshland deposits which started to accumulate during the Late Glacial. Paleo-associations determined with the help of malacological data form a line of successions, with the first fluvial phase appearing as early as 13 000–11 000 BP. The infant neotectonic depression characterized by fluvial conditions must have been surrounded by open, gallery-like mixed taiga vegetation. At a greater distance, a more open, cold, continental forested steppe covering the loess and dolomite surfaces can be reconstructed.

Around 11 000 BP the depression was inundated, resulting in the emergence of a well-lit, but eutrophication at the bottom lacustrine environment, characterized by a water depth of 3m in the deepest parts of the depression. There was a change in the vegetation around the depression at about 10 000 uncalBP, characterized by the emergence of deciduous woodland in the area. A substantial amount of pollen grains from the pinewoods surviving in the cold relict spots in more distant, mountainous regions, accumulated during the Early Holocene. The lake was surrounded by extensive cattail and reedbeds, as well as sedge tussocks, at the time fringed by hardwood and softwood gallery forests and deciduous woodland. These conditions survived for some one thousand years, suggesting that the rate of infilling (0.31 mm/year) roughly equalled that of the rate of subsidence (11 000–9000 uncalBP).

The infilling of the basin intensified between 9000–6500 uncal BP, with the sedimentation rate exceeding 0.8 mm/year. There is a marked change in the pollen composition here, characterized by the appearance of taxa indicating arable farming and stockbreeding. The close correlation between the appearance of taxa reflecting a production economy, and the acceleration of the sedimentation rate, most certainly indicate the presence of human settlements around Lake Sárrét during the Early Neolithic, resulting in increased erosion rates. As a result of human activities, paludification of the lake was accelerated, and from 6500 uncalBP onwards led to the emergence of stable marshland with floating mats.

∴

REFERENCES

BALOGH M. 2000. A lápok rendszerezése. (Systematization of swamps). In E. Szurdoki (ed.), *Tőzegmohás élőhelyek Magyarországon: kutatás, kezelés, védelem*. (Sphagnum biotops in Hungary: research, handling, protect) CEWEEB Munkacsoport, Miskolc: 57–65.

BENNETT K. D. 1992. PSIMPOLL – A quickBasic program that generates PostScript page description of pollen diagrams. INQUA Commission for the study of the Holocene: working group on data handling methods. *Newsletter 8: 11–12*.

CSERNY T. 2000. Komplex földtani kutatások hazai tavakon, lápokon és mocsarakon. (Komplex geological researches on Hungarian lakes, swamps and marshes). In E. Szurdoki (ed.), *Tőzegmohás élőhelyek Magyaroszágon: kutatás, kezelés, védelem*. (Sphagnum biotops in Hungary: research, handling, protect) CEWEEB Munkacsoport, Miskolc: 27–41.

CSERNY T., NAGY-BODOR E. 2000. Limnogeological investigations on Lake Balaton, In E. Gierlowski-Kordesch, K. Kelts (eds.), *Lake Basins Through Space and Time*. AAPG Studies in Geology 46: 605–618.

DÖMSÖDI J. 1977. A Fejér-megyei Sárrét talajjavító anyagai (tőzeg, lápföld, lápi mész). (Materials for soil amelioration from the Sárrét of Fejér country (peat, lime-mud)). *Agrokémia és Talajtan, 26: 331–350*.

FŰKÖH L. 1977. A Fejér-megyei Sárrét Mollusca faunájának biosztratigráfiai vizsgálata. (Biostratigraphical investigation on Mollusc fauna of Sárrét in Fejér-country). *Soosiana 5: 17–26*.

HERTELENDI E., CSONGOR É., ZÁBORSZKY L., MOLNÁR I., GÁL I., GYŐRFFY M., NAGY S. 1989. Counting system for high precision C-14 dating. *Radiocarbon 31: 399–408*.

HERTELENDI E., LÓKI J., SÜMEGI P. 1993. A Háy-tanya melletti feltárás rétegsorának szedimentológiai és sztratigráfiai elemzése. (Sedimentological and stratigraphical examination of the profile at the Háy-tanya). *Acta Geographica, Geologica et Meteorologica Debrecina 30–31: 65–75*.

HERTELENDI E., KALICZ N., RACZKY P., HORVÁTH F., VERES M., SVINGOR É., FUTÓ I., BARTOSIEWICZ L. 1996. Reevolution of the Neolithic in eastern Hungary based on calibrated radiocarbon dates. *Radiocarbon 37: 239–244*.

JACOBSON G. L., BRADSHAW R. H. W. 1981. The selection of sites for palaeovegetational studies. *Quaternary Research 16: 80–96*.

KERNEY M. P., CAMERON R. A. D., JUNGBLUTH J. H. 1983. *Die Landschnecken Nord- und Mitteleuropas*. P. Parey, Hamburg-Berlin.

KORMOS T. 1909. A Fejér-megyei Sárrét geológiai múltja és jelene. (Geological past and present of the Sárrét in Fejér-country) In L. Lóczy (ed.), *A Balaton tudományos tanulmányozásának eredményei I.1. (Results of the study of Balaton lake)*. Paleontológiai Függelék 1: 66.

KROLOPP E. 1972. Negyedidőszak. (Quarter) In A. Rónai, F. Szentes (eds.), *Magyarázó Magyarország 200.000-es földtani térképsorozatához. 34. Székesfehérvár*. (Memoir to the 1:200.000 scale geological map series of Hungary 34. Székesfehérvár).

LOŽEK V. 1964. *Quartermollusken der Tschechoslowakei*. Rozpravy Ústavu ústedniku geologichkého 31. Praga.

LÓCZY L. 1913. *A Balaton tó tudományos vizsgálatának eredményei. (Results of the study of Balaton lake)*. Magyar Földrajzi Társaság Balaton Bizottságának kiadványa. Budapest: 617.

MAKKAY J. 1970. A kőkor és rézkor Fejér megyében. In Fitz J. (ed.), *Fejér megye története az őskortól a honfoglalásig. Fejér megye története I*. Székesfehérvár: 9–52.

MAROSI A. 1935. Őskőkori szigony Merítőpusztáról. *Székesfehérvári Szemle: 75–76*.

1936a. Kormeghatározó adatok a csór-merítőpusztai őskori csontszigonyhoz. *Székesfehérvári Szemle: 40–42*.

1936b. A székesfehérvári múzeum őskori csontszigonya. *Archaeológiai Értesítő 49: 83–85*.

MEIJER T. 1985. The pre-Weichselian nonmarine molluscan fauna from Maastricht-Belvedere (Southern Limburg, the Netherlands). *Mededelingen Rijks Geologische Dienst 39: 75–103*.

NEMESKÉRI J. 1948. A mezolithikus kultúra új nyomai Magyarországon. *Természettudomány 3: 221–222*.

SÜMEGI P. 2004. The results of paleo-environmental reconstruction and comparative geoarcheological analysis for the examined area. In P. Sümegi, S. Gulyás (eds.), *The geohistory of Bátorliget Marshland*. Archaeolingua Press. Budapest: 301–348.

SÜMEGI P., KROLOPP E. 2002. Quartermalacological analyses for modeling of the Upper Weichselian palaeoenvironmental changes in the Carpathian Basin. *Quaternary International 91: 53–63*.

TROELS-SMITH J. 1955. *Karakterisering af lose jordater*. Danmarks Geologiske Undersogelse, ser. IV.

WILLIS K. J. 1997. The Impact of Early Agriculture upon the Hungarian Landscape. In J. Chapman, P. Dolukhanov (eds.), *Landscapes in Flux Central and Eastern Europe in Antiquity*. Oxbow Books. Oxford: 93–207.

WILLIS K. J., SÜMEGI P., BRAUN M., TÓTH A. 1995. The Late Quaternary Environmental History of Bátorliget, N.E. Hungary. *Palaeoclimatology, Palaeoecology, Palaeogeography 118: 25–47*.

1996. *Flora, fauna and human impact changes in the Western part of Hungary at Lateglacial/Postglacial transition*. Manuscript, Cambridge University, Subdepartment of Quaternary Sciences.

back to contents

UDK 551.583.7:911.52(439)"63":902.67
Documenta Praehistorica XXXV (2008)

Holocene paleoclimatic and paleohydrological changes in Lake Balaton as inferred from a complex quantitative environmental historical study of a lacustrine sequence of the Szigliget embayment

Pál Sümegi [1], Sándor Gulyás [1], Gusztáv Jakab [2]
1 *University of Szeged, Department of Geology and Paleontology, Szeged*, sumegi@geo.u-szeged.hu
2 *Sámuel Tessedik College of Agriculture, Szarvas, Hungary*

ABSTRACT – *The present paper discusses the findings of a complex quantitative paleoecological investigation implemented for capturing the Upper Weichselian, Late Glacial and Postglacial development of Lake Balaton in western Hungary, in the heart of Transdanubia. The studied Late Pleistocene and Holocene lacustrine marl and peat sequence preserved the complete evolutionary history of the catchment basin of the Szigliget Embayment from the time of its birth. The inferred palaeohydrological changes, along with that of the hydroseries, were compared to those observable coevally in the terrestrial vegetation. According to the available data, the birth of the studied embayment can be put to the Late Glacial/Upper Weichselian transition. A wide array of hydrophyte vegetation and habitat types emerged in the embayment depending on the actual water supply and geomorphologic position. Based on a collective quantitative evaluation of the observed sedimentary features and fossil assemblages retrieved from the sequence, a record of paleohydrological transformations in the littoral part of the lake was drawn.*

IZVLEČEK – *Članek predstavlja rezultate kompleksne kvantitativne pelookoljske raziskave, katere cilj je ugotavljanje pleniglacialnega, poznoglacialnega in postglacialnega razvoja Blatnega jezera v zahodni Madžarski. V zaporedju poznopleistocenskih in holocenskih jezerskih sedimentov in šote je ohranjena celotna zgodovina porečja zaliva Szigliget od njegovega nastanka naprej. Ugotovljene paleohidrološke spremembe skupaj s premenami jezera smo primerjali s spremembami v kopenski vegetaciji. Na podlagi raziskav lahko nastanek zaliva umestimo v prehod med pleniglacialom in začetkom kasnega glaciala. Količina vode in geomorfološki položaj je pogojeval nastanku velikega spektra vodne vegetacije in habitatnih tipov. Skupna kvantitativna analiza sedimentacijskih značilnosti in fosilnih zbirov nam omogoča, da lahko opišemo zaporedje paleohidroloških premen v obalnem delu zaliva.*

KEY WORDS – *paleohydrological changes; complex quantitative environmental historical approach; Lake Balaton; Holocene*

Introduction

The primary aim of our investigations, funded by a grant from the National Research and Development Programme (NKFP), was to find and retrieve sedimentary sequences which capture as much of the geohistory of Lake Balaton as possible. Thus in addition to sampling the sediments accumulated in meridional valleys, an additional sampling location was chosen for detailed analysis along Lake Balaton's northern shoreline, in the Balatonederics Embayment in the Tapolca Basin (Fig. 1). According to our preliminary findings, one of the subsidence centres in the Tapolca Basin, covering an area with a diameter of 1–2km, must have been located in the centre of the roughly 3 km-long basin at the transect of the Balatonederics railway line and the castle hill at Szigliget. Sediment accumulation must have started in this basin at the terminal part of the Upper Weichselian.

Our investigation results pointed to the evolution of a brown moss peat in this area at the terminal part of the Pleistocene. The fringes of this peatland must have been covered by pebbly, gravelly deposits of mass wasting during the Late Glacial, with a complete lacustrine sediment sequence overlying the peat layers. Earlier cores were only taken to a depth of the gravel mat redeposited from the piedmonts, and it was therefore believed that this formation was the bedrock of the lacustrine sediment sequence. However, according to our findings, the Holocene lacustrine sediments and Pleistocene peat sequence are found under these redeposited gravel mats, meaning that the most promising sequences for palaeo-environmental reconstructions could be extracted from this area, which is why this area was selected for further analysis.

Fig. 1. The location of the studied borehole in the Balatonederics Embayment depicted on a map of the First Austrian Military Survey (1782), recording conditions preceding the hydrological regulations of the 19th century.

Preliminaries

Lake Balaton is the largest freshwater lake not only in Hungary, but the entire Central European region. As proven by archeology, it has been continuously populated since prehistoric times and as such represents not only a treasure of the modern Hungarian landscape, but a witness of human history. Despite its economic, tourism and historical importance, relatively little was known of its detailed evolutionary history until the 1980s–1990s.

The first reliable portrayals of Lake Balaton can be seen on maps by Lazarus and Martellus from the 16th century. It's interesting to note that Lazarus marks it as a lake while Martellus uses the term Palus, indicating a marshland for Balaton. However, only indirect information is available for the preceding periods regarding its shape, and extent of the shoreline, mainly derived from written records, archaeological and geological observations.

The French geologist Francois Sulpice Beudant was the first to prepare a detailed geological map of the area. Beadant was assigned the task of travelling around Central Europe and mapping mineral and geological resources of economic importance (*Beudant 1822*). He was the first to map out and describe the peat layers of Little Balaton and those near Siófok. Furthermore, he successfully separated the diluvial from the alluvial layers which were deposited before and after the Biblical flood. These are known today as Pleistocene and Holocene sequences.

The first reliable evolutionary history of the Lake, based on a comprehensive analysis of geological and paleo-ecological data was given by Lajos Lóczy and colleagues during the first half of the 20th century (*Lóczy 1913*). They realized that the lake itself developed as a result of neotectonic faulting and subsidence, creating a system of 4 successive sub-basins, characterized by unique sedimentary histories. By mapping out the distribution of peat sequences along the Lake, they pointed out that the extension of the shoreline was a lot larger than that of the modern Lake in prehistoric times. The highest estimated water level was between elevations of 105–110m ASL.

The modern Balaton, with its presently known shape, extent and shoreline, is the outcome of numerous regulation efforts lasting as long as the second half of the 19th century. Regulation works implemented at the end of the 18th and the first half of the 19th century were primarily aimed at increasing area suitable for agriculture via drainage, which fundamentally resulted in a drop in the water level as well. The presently artificially maintained maximum water level in the basin lies at an elevation of 104.5m ASL, which is considered still very low. A mere half-meter increase in the water level would ultimately result in the inundation of the adjacent meridional valleys along the southern shoreline. This would also increase the original extent of the Lake by about 150 percent, yielding a total water coverage of 900km^2.

And this half-meter increase in the water level is not even a big issue, as the allowed fluctuation limit given by the modern strict regulations is around 0.4m. However, in order that the modern extent be doubled, another 5m increase in the water level is required. For the shoreline to reach an elevation of 110 m ASL, an enormous increase in the Lake's volume is required. This can happen only during an extremely long cool and humid period enjoying much precipitation. The present study is engaged with elucidating past shoreline fluctuations via the comprehensive environmental historical analysis of a core sequence taken from the littoral part of the Lake, where shoreline displacements are best preserved.

Material and methods

In accordance with the standards and general practice of Quaternary palaeo-environmental studies (*Aaby-Digerfeldt 1986*), overlapping cores were taken using a Russian type corer. After transportation to the laboratory, the cores were dissected lengthwise for various analyses; the sections for palaeobotanical and geochemical analyses were stored at 4 °C, in accordance with international standards. The samples submitted to lithological analyses were identical with the ones used for the palaeobotanical, macrobotanical, malacological and radiocarbon analyses.

Samples from the extracted cores were submitted for radiocarbon analysis to determine their absolute ages. The recent modernisation of the Light Isotope Laboratory of the Nuclear Research Centre of the Hungarian Academy of Sciences at Debrecen made this laboratory suitable for implementing these measurements (*Hertelendi et al. 1989*). Charcoal remains, and peat retrieved from the sections were used, in proportions of 6–10g of peat and charcoal respectively. Each sample was original; bulk peat was cleaned of roots (6–10g). The results of the measurements are depicted in Fig 2.

The internationally accepted Troels-Smith soft sediment classification system and symbols were adopted for the lithological description of the sediment sequence (*Troels-Smith 1955*). The carbonate and organic content was determined by the loss-on-ignition procedure as described by Dean (*1974*). The entire core sequence of Balatonederics was sub-sampled at 4cm intervals for palaeobotanical and malacological analyses using a plastic sampler.

For the classification of the plant macrofossil remains a modified version of the QLCMA technique (semi-quantitative quadrat and leaf-count macrofossil analysis technique) was adopted (*Jakab et al. 2004*). Organic remains from peat and lacustrine sediments rich in organic matter can be divided into two major groups. Some remains can be identified with lower ranking taxa (specific peat components), while others cannot be identified using this approach (non-specific peat components).

The exterior of the cores was removed and sub-samples were taken from the core interior to avoid errors arising from recent pollen contamination. Pollen grains are counted until a sum of at least three hundred pollen grains from terrestrial plants are counted (aquatic species are discounted) – statistical studies have shown that higher counts do not yield substantially more information. *Lycopodium* spore tablets were added for the determination of pollen concentrations. The pollen diagrams in this volume show relative frequencies calculated from the pollen sums of the various arboreal (AP) and non-arboreal (NAP) taxa, excluding the values of aquatic species, spores, ferns, mosses and sedges (AP + NAP = 100%).

Sediment samples were washed through a fine mesh screen (0.5mm). The retrieved mollusc remains were taxonomically identified using standard reference works (*Kerney et al. 1983; Ložek 1964*). The core was sampled for mollusc remains at 4cm intervals and evaluated at 8cm intervals. The identified taxa were assigned to palaeo-ecological groups for evaluation (*Sümegi-Krolopp 2002*).

Paleo-ecological results

The base of the sequence at 520cm was given by sandy silts mixed with gravel, grading into homogenous peat containing brown moss fragments. This refers to considerable fluctuations in the water level in the infant neotectonic basin, which must have been reached by streams flowing from the Bakony Mountains, because the sediment contained typical

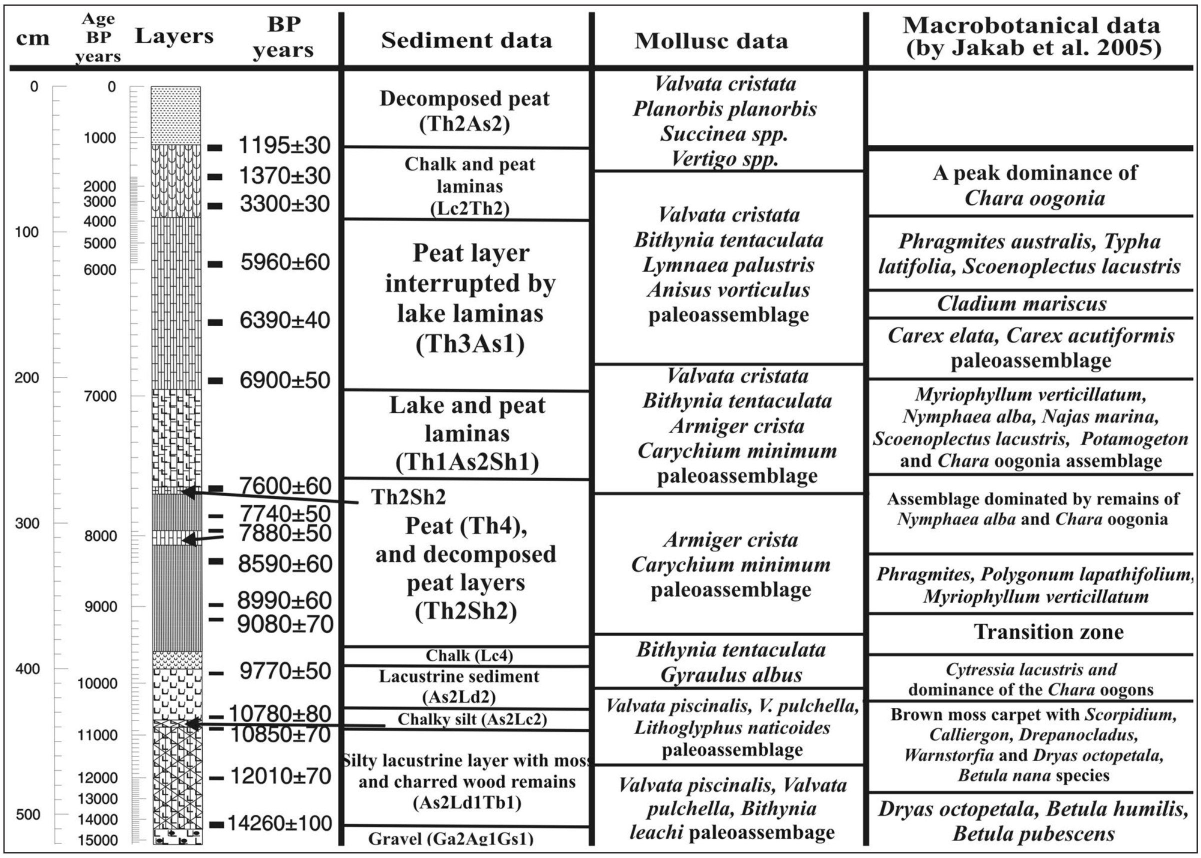


Fig. 2. The palaeoecological results from the core sequence of the Balatonederics.

stream inwashed particles (small pebbles). The inwashed sediment horizon was overlain by a dark brown, homogenous peat layer containing brown moss fragments, which gradually decreased upwards. Above the peat layer containing brown moss, we have come across a typical lacustrine sequence with peat intercalations containing reed, reed-mace and sedge. The Holocene sediment sequence is made up of alternating lacustrine marls containing organic matter and alternating peat layers, reflecting the fluctuating, cyclic changes in the water cover during the past ten thousand years. The sediment sequence and the radiocarbon dates suggest that the water level in the Balatonederics Embayment must have changed cyclically, reflecting the influences of alternating wetter and drier climatic periods.

As is observable on the geological profile of the borehole, the sequence starts with coarse-grained, pebbly, sandy deposits corresponding to the infant lacustrine basin. This is overlain by periodically alternating horizons of grayish lacustrine marls and intercalated peat layers, marking the individual stages in the evolutionary history of the Lake, when either a highstand developed, representing open-water lacustrine conditions resulting in a transgression to the shoreline; or a lowstand, creating marshland conditions. This fluctuating pattern is also discernible in the individual parameters of inorganic/organic and carbonate content of the studied deposits. The horizons with a higher carbonate and lower organic content, and an estimated slow deposition of 0.3 mm/year correspond to the Lake's phases, while those of a higher organic content represent marshland conditions.

Above the bottom of the core, 8 peaks could have been identified in the parameters of inorganic and carbonate content, representing a highstand due to probably less evaporation and greater rainfall. Similarly, 8 peaks in the organic content could have been identified, representing drier periods and an accompanying lowstand. Here, it is worth noticing the peak marking an all-time lowstand at 7000 calBP years.

The results of the macrofossil analyses on Fig. 2. are presented from a depth of 515cm, marking the transition zone of the Weichselian/Late-Glacial (*Jakab et al. 2004; Jakab 2007; Jakab-Sümegi 2007*). On the basis of the observed features of plant macrofossil remains, 11 zones could have been identified in the core sequence.

BEM–1 zone (515–485cm)
The extension of *Phragmites* and *Typha* cover was maximal in the catchment basin in this phase. Seeds of *Cyperus fusus* indicate seasonal dessication of the catchment basin. A mat of *Chara* green algae developed at the bottom of the catchment basin during this phase. The concentration of the ostracoda was vey high, and the charcoal concentration increased permanently in this layer. The seeds of *Dryas occtopetala, Betula humilis, Betula pubescens* and the remains of *Pinus* indicate the development of cold and wet microclimatic conditions. This was the first time that remains of white dryas and elements of the *Dryas flora* were identified from the central part of the Carpathian Basin in this part of the section.

BEM–2 zone (485–420cm)
This zone yielded the richest Late Glacial macrofossil community from the entire Carpathian Basin. This macrofossil community consists of tundra- and peat-habitant moss species such as *Scorpidium scorpioides, Calliergon richardsonii, C. giganteum, Warnstorfia sarmentosa, Hamatocaulis vernicosus, Drepanocladus lycopodioides, D. sendtnerii, D. aduncus, Tomenthypnum nitens*. According to the macrofossil data, these moss species must have lived together with small tundra vegetation willows like *Betula nana* and *Betula humilis* in the Balatonederics embayment during the referred period. On the other hand, the presence of the remains of *Pinus sylvestris*, with a maximum of charred wood fragments of the species, indicate that this basin was a brown moss peatland covered by coniferous stands of Scots pine during the transition phase of the Upper Weichselian and Late Glacial, rather than a tundra-like environment. Brown moss carpets are one of the most typical vegetation communities of the Subarctic region today. It was also one of the most pervading vegetation types in the Carpathian Basin during the Upper Weichselian and Late Glacial periods.

BEM–3 zone (420–390cm)
There is an abrupt change in the composition of the macrobotanical remains at a depth of 430cm, characterized by a uniform decline in peat and the deposition of lacustrine silts on top of the brown moss peat horizon. There is a major decline in the amount of charcoal here, accompanied by an upward increase in the proportion of *Chara* oogonia, ostracod and mollusk remains. These transformations indicate a gradual increase in the water level, which ultimately led to the decline of the littoral reedy vegetation. Plus, with the expansion of open water surfaces in the Balatonederics Embayment during this zone, a relatively deep, oligo-mesotrophic lake must have emerged during the last phase of the Late Glacial period. According to the available radiocarbon data, this high water level horizon and palaeoecological stage can be dated to the first half of the Mesolithic or Epipalaeolithic (*Bánffy 2004; 2007*).

BEM–4 zone (390–360cm)
A new peat formation and accumulation started at 390cm at the time of the Pleistocene/Holocene transition due to the gradually declining water level. An increase in the macro-charcoal concentration refers to the development of drier climatic conditions. This macrofossil zone can be dated to the Pleistocene/Holocene transition and must represent the second half of the Mesolithic (*Bánffy 2004; 2007*).

BEM–5 zone (360–320cm)
The elevated macro-charcoal concentrations and the expansion of *Phragmites* and *Typha* in this zone refer to drier conditions resulting in a lowstand. There is a decline of *Chara* oogonia along with the expansion of eutrophic, warmth-loving pondweeds (*Polygonum lapathifolium, Myriophyllum verticillatum*) in this zone, indicating the development of shallow, eutrophic lacustrine conditions. The BEM–5 macrofossil zone can be assigned to the Pre-Boreal/Boreal transition phase based on the available radiocarbon data. As a result of the mentioned environmental changes, the neotectonic basin of Lake Balaton was dissected into smaller subbasins harboring paludifying smaller water bodies. The emergence and transformations of these smaller lacustrine basins must have fundamentally influenced the movement and settlement strategies of Mesolithic communities inhabiting the area, similarly to what has been observed in connection with the subsidence of the Sárrét (*Marosi 1935; 1936; Makkay 1972; Sümegi 2003*), where the presence of Mesolithic fishers was confirmed by the archaeological record.

Former studies assumed a complete desiccation of the basin of Lake Balaton for the Early Holocene. However, according to our findings, the accumulation of lacustrine sediments must have been continuous in the area of the Balatonederics Embayment during the referred period. As shown by the macrofossil data available from our studied sequence, the lowstand recorded for the Early Holocene was a relatively short event culminating around 10 300 calBP. This peak lowstand must have been preceded by a gradually decreasing water level in the basin, followed by an increase in average water levels. Conversely, no such signal indicating a major drop followed by a rise in the water level was found in the macrobotanical remains for the referred period. Rather, they refer to uninterrupted lacustrine conditions in the study area (*Jakab 2007*).

BEM-6 zone (320–270cm)

The accumulation of peat continued in this zone, although there are signs of peat alteration and decomposition between the depths of 315 and 305cm. This cannot be attributed to a drop in the water level, because the macrofossil record shows a continuous increase in pondweeds (*Chara, Nymphaea alba*) within the referred section. We may assume the development of special conditions here, where the inferred increase in precipitation could not compensate for the increasing continentality of the climate ultimately changing the proportion of wetter and drier days during the year. The presumably higher precipitation during the winter period must have created a general highstand, with minor fluctuations on the one hand; on the other hand, the possibility that the near-shore areas dried out at regular intervals can not be excluded either during the year. This assumption is clearly supported by the observable increase in concentrations of macro-charcoal and the appearance of *Nanocyperion* species (*Chenopodium rubrum, Cyperus fuscus, Polygonum persicaria*) in this zone. This zone can be dated to the last phase of the Mesolithic (*Bánffy 2004; 2007*).

BEM-7 zone (270–200cm)

There is a major alteration in the sediment composition at a depth of 270cm (8450–8330 calBP). The presence of blackish-grey, lacustrine deposits with mollusc remains, reflect an initial highstand. This period can be correlated with the beginning of the Atlantic phase. From this point there is a continuous decline in the water level, reaching a minimum at 7600 calBP, replaced by a later increase (*Jakab et al. 2005*).

The open water habitat was gradually replaced by reed-beds. Pondweeds occur in substantial amounts here (*Chara, Nymphaea alba, Potamogeton* sp., *Najas marina, Myriophyllum verticillatum*). Moreover, *Schoenoplectus lacustris* has also a marked presence. There is a gradual increase in the proportion of Phragmites rhizomes in the sediment, together with the amount of *Eupatorium cannabinum* and *Utricularia vulgaris*, both of which are associated with reed-beds. All this indicates that the previously observable fluctuations in the water level must have diminished. Furthermore, there was a considerable decrease in the dissolved carbonate content of the water body.

BEM-8 zone (200–165cm)

The abrupt changes observable in this zone must be attributed to changes in the hydrogeological conditions, rather than to that of the climate. A significant rise in the water level was inferred for the initial part of the zone, followed by a sudden drop, which reached its absolute Holocene minimum at 7000 calBP. This zone can be correlated with the second half of the Atlantic.

According to the macrobotanical data, reed-beds reached their maximum expansion during this period. The carbonate content decreased (*Cladium* is not attested, *Chara* oogoniums and *Ostracoda* shells decrease), and the bay paludified, as shown by the peaks of *Carex elata* and *Carex acutiformis*. Another increase in the water level can be assumed. There was a temporary increase in the dissolved carbonate content of the water, shown by a peak concentration of *Chara* oogonia.

These transformations must be the outcome of geological processes acting on a larger scale than the studied embayment. This zone coincides with the period when the central and eastern subbasins of Lake Balaton were reunited, resulting in an abrasion of the shoreline and a continuous increase in the water level. This unification process, resulting in general abrasion along the shoreline, followed by a highstand, seems to have been recorded in our studied embayment in the form of a brief initial drop in the water level, which was exchanged for a gradual rise, as shown by the substantial increase in *Chara* oogonia at 180cm, with no apparent antecedents. Based on the macrofossil record, this transformation must be dated to the second half of the Atlantic (at *c.* 7000 calBP).

BEM-9 zone (165–140cm)

A gradual rise in the water level can be noted from 165cm to the top of the sequence. Open water species (*Chara, Mollusca, Ostracoda*) expand, although with smaller fluctuations, at the expense of reed-beds. The composition of zone BEM-7 resembles zone BEM-9. *Cladium mariscus* occurred in significant amounts here.

BEM-10 zone (140–90cm)

Reed-beds still play a significant role in this zone. Peat formation continues. In addition to reeds, *Schoenoplectus lacustris* and *Typha latifolia* have a significant presence. The rising water level is reflected by the disappearance of *Nymphaea alba*, a species less tolerant of wave action, which prefers bays protected by reed-beds.

BEM–11 zone (90–50cm)
There is another abrupt change in the composition of sediments here, marked by the deposition of blackish-grey, lacustrine layers with mollusk remains, indicating a rise in the water level. The number of open water species (*Chara, Mollusca, Ostracoda*) also increases. Conversely, there is a dramatic decline in reed-beds here. This must be attributed to the fact that reeds can form communities at a maximum water level of only 2m (*Haslam 1972; Rodwell 1995*). In case of the modern Balaton, reeds tend to form communities to a depth of 80cm (*Jakab 2007*), suggesting that the water level must have been higher than at present, and reached its Holocene maximum in this zone. The currently terrestrial areas of the Balatonederics Embayment must have formed a side bay during the referred period. Above 50cm, the sediment was unsuitable for macrobotanical analyses.

Only a few pollen sequences spanning the entire Late Glacial and the Holocene are known from Hungary (*Sümegi-Törőcsik 2008*). The Balatonederics sequence will undoubtedly be one of the most important pollen profiles after the completion of the pollen analyses, with sub-sampling at 16 intervals in the old analysis (*Juhász 2007*) and 4cm intervals in the new analysis (*Sümegi-Törőcsik 2008*), and once the radiocarbon dates for another six samples from this sequence are available. On the basis of the observed features of pollen remains, 10 zones could have been identified in the core sequence marked as BEP, an abbreviation of Balatonederics (BE) and Pollen (P).

This part of the study presents the Pleistocene and the Holocene sections of the pollen sequence and its interpretation, with a focus on? the vegetation changes caused by the activity of human communities settling in the broader area of the sampling location.

BEP–1 (515–480cm)
The lowermost local pollen zone reflects vegetation dominated by *Pinus, Betula* and *Poaceae*. The pollen assemblage reflects a dense pine-birch forest, with *Pinus cembra, Pinus sylvestris/Pinus mugo*, and high values of *Picea, Quercus, Ulmus, Fagus, Alnus* and *Corylus*. The herbaceous vegetation is dominated by *Poaceae*, with *Artemisia* and *Chenopodiaceae*, reflecting dry grassland around the pine forests. The mean values of *Pinus* suggest a milder climate and open, Scots pine forest cover. According to the radiocarbon data, this pollen horizon and palaeoecological phase developed in the last phase of the Upper Palaeolithic (*Tolnai-Dobosi 2000*).

BEP–2 (480–420cm)
The second local pollen zone reflects vegetation dominated by *Pinus, Betula* and *Larix*. The pollen assemblage reflects dense pine/birch forest with *Pinus cembra, Pinus sylvestris/Pinus mugo, Larix* and low values of *Picea, Quercus, Ulmus, Fagus* and *Corylus*. The dominance of the herbaceous vegetation declined. The high values of *Pinus* (60–80%) suggest a milder climate and local, dense Scots pine cover. Based on the radiocarbon data, this pollen horizon and palaeoecological phase developed in the first half of the Mesolithic or Epipalaeolithic (*Bánffy 2004; 2007*).

BEP–3 (420–372cm)
A local origin can be assumed for some of the pollen material, since the values of *Pinus sylvestris/P. cembra* range between 70–90% (*Peterson 1983*). These data were congruent with pollen profiles from other locations in the Balaton region (*Bodor 1987; Nagy-Bodor-Cserny 1998a, 1998b; Nagy-Bodor-Járainé 2000*), which show a similar dominance maximum of over 80% of *Pinus sylvestris* between 9000–11 000 uncalBP. This zone can be dated to the second phase of the Mesolithic (*Bánffy 2004; 2007*).

BEP–4 (372–296cm)
The ratio of coniferous trees, including *Pinus* species, declined dramatically, parallel to a dominance maximum of deciduous species thriving in a milder climate, such as *Quercus, Ulmus, Tilia* and *Corylus*, in the Early Holocene phase. The high values of *Poaceae* can in part be attributed to the high number of *Phragmites* pollens. The changes in the values of arboreal and herbaceous species allow the separation of three phases, which can probably be associated with fluctuations in the water level. The water level rises, although with fluctuations probably caused by a more continental climate during the Early Holocene phase. This zone can be dated to the last phase of the Mesolithic Age (*Bánffy 2004; 2007*).

BEP–5 (296–200cm)
The continuous curve of *Fagus*, whose regional presence was attested in the previous zone, and the appearance of the first *Carpinus* pollens and the start of its continuous curve, characterise the Boreal/At-

lantic transition, dated to 7600 ± 70 uncalBP (6500–6380 calBC) at 278–280cm. *Poaceae/Phragmites* have higher values, and the transitional maximum of *Fraxinus* and *Alnus* at the beginning of this zone suggest a higher water level and the presence of a gallery forest. *Corylus* thrives on the margins of the oak forest, of which *Tilia* and *Ulmus* are the important members. Wetter areas are dominated by *Cyperaceae* together with *Alnus*. *Typha angustifolia* and *Typha latifolia/Sparganium* are present with low values at first, slightly increasing later. The water level was probably lower during the Boreal/Atlantic transition, probably owing to a more continental climate. Later, during the Atlantic, the water level increased again. Ferns with monolete spores show a substantial decline at the beginning of the zone and are present with relatively low, but continuous values during its second part. The difference between the beginning and the second part of the zone was possibly caused by fluctuations in water levels. This zone can be dated to the transition phase of the Mesolithic and Neolithic and the first phase of the Neolithic (*Bánffy 2004; 2007*).

BEP-6 (200–160cm)

Pollens indicating human activity and trampling appear in this zone. *Fagus*, light-loving *Betula* and *Corylus* have fluctuating values, with repeated declines and expansions during this zone. The cyclically changing values of Poaceae can probably be associated with human activity, although the changes may also have been caused by the paludification of the bay and peat formation, reflected by the expansion of *Cyperaceae* and *Typha* in this zone. This phase is characterised by the decline of all thermophilous arboreal species and the expansion of herbaceous vegetation. Poaceae, Asteraceae, and cereals have higher values. The opening up of the forest canopy resulted in the spread of *Betula* and *Carpinus* and an increase in *Typha/Sparganium* and Poaceae/*Phragmites*. This change suggests that the infilling process speeded up during this time and a wide marshy zone developed on the lake-side region of this bay. Cyperaceae, Filicales, *Myriophyllum spicatum* and *M. verticillatum* thrive in the wetter areas, where *Alnus* has a relatively low, but continuous presence. This zone can be dated to the second phase of the Neolithic Age (*Bánffy 2004; 2007*).

BEP-7 (160–120cm)

This pollen zone is characterised by the maximum of deciduous species (*Fagus, Fraxinus, Quercus, Ulmus, Tilia*), reflecting the maximum expansion of forests in Transdanubia and the Carpathian Basin and the Holocene climatic optimum. According to the radiocarbon data, this period can be dated to between 6000 and 5000 uncalBP within the Atlantic. *Fagus* and *Fraxinus* dominate the oak forest, in which *Tilia* and *Ulmus*, as well as *Corylus* are also attested. The herbaceous vegetation is relatively poor in species. *Typha angustifolia* and *T. latifolia* and *Myriophyllum spicatum* and *M. verticillatum* as well as Filicales make an appearance towards the end of the zone. The declining values of Cyperaceae suggest a rise in the water level. This zone can be dated to the transition zone of the Neolithic and Copper Ages (*Bánffy 2004; 2007*).

BEP-8 (120–100cm)

This zone is characterised by the decline of *Tilia, Ulmus* and *Fagus*, while *Quercus* and *Alnus* have continuous, significant values. *Betula* and *Carpinus* appear in open areas of oak forest, and there was also a species-rich gallery wood nearby. Poaceae/*Phragmites* expand, and steppe ruderals make their appearance (*Artemisia*, Asteraceae and Chenopodiaceae). The spread of herbaceous species (Chenopodiaceae, Poaceae, *Artemisia*) and the changes in the composition of deciduous trees can be attributed to human activity, to the improvement in subsistence techniques, and population growth. The relatively high values of cereals, *Plantago lanceolata* and *Rumex* suggest the presence of a human population near the sampling location. It would appear that the activity of the Early Copper Age population had a major impact on the forest. Pastoral activity indicated by *Rumex, Plantago* and *Urtica* can be noted from the Middle Copper Age.

BEP-9 (100–72cm)

The ratio of species preferring an open habitat declines compared to the previous zone, while arboreal species expand. A rise in the values of most forest species (*Betula, Corylus* and *Tilia*, as well as *Fagus* and *Carpinus*) reflects the closing of the forest canopy. The gallery forest made up of *Fraxinus, Salix* and *Alnus* retreats. Nitrophilous taxa, such as *Urtica* and *Plantago lanceolata*, are still attested. It seems likely that the Lake's water level rose to such an extent that reeds could hardly survive it: Cyperaceae have a transitional maximum, while *Phragmites* almost disappears. The high water level probably forced the human population to relocate their settlements farther from the lake, and the previously open territories were colonised by light-loving arboreal species. The earlier fields were used for grazing livestock during the Late Copper Age.

BEP–10 (72–40cm)

The water level probably dropped around 4000 uncalBP, and the human communities living in the broader area of the sampling location apparently used the area for arable farming, as shown by the presence of cereals (*Secale* and *Triticum*) and of *Centaurea*. This zone is characterised by a decline in deciduous species and expansion of herbaceous vegetation. In addition to the substantial amount of cereal pollens, the weed flora of tilled fields and species tolerant of trampling are also attested.

The expansion of herbaceous species and changes in the mix of deciduous trees can be attributed to intensifying human activity, to improvements in subsistence techniques, and population growth. Although no radiocarbon dates are available for this horizon, the changes in the vegetation are typical of the Middle Bronze Age, characterised by a dense settlement network in the Carpathian Basin (including Transdanubia) and a high level of arable farming (*Poroszlai 2004; Kiss 2004*).

Compositional changes in the mollusk fauna add a further piece to the history of the Lake's level and shoreline changes. The lowermost part of the section is dominated by cold-loving, cold-resistant boreal elements and an add-on of typical loess fauna. These findings, plus those of plant macrofossil studies refer to the emergence of a local tundra-like cold spot at the terminal Würmian in the infant lacustrine basin.

The appearance of *Lithoglyphus naticoides* in the next zone clearly highlights the stage of the Pleistocene/Holocene transition (Fig. 2). Its co-presence with *Valvata piscinalis* indicate temporary moving water conditions attributable either to the emergence of a higher energy, wave dominated shoreline, or a greater freshwater discharge from a nearby creek.

In the next zone, recording events from the opening of the Holocene, the formerly dominating cold-resistant, cold-loving and moving water elements disappear, giving way to elements preferring milder conditions. A dominance of the lacustrine elements of *Bythinia tentaculata* and *Gyraulus albus* refer here to a lacustrine stage characterized by carbonate mud precipitation and lush aquatic vegetation preceding the emergence of an incipient marshland.

The next zone marks the appearance of various marshland dweller forms and those preferring dense aquatic vegetation, reflecting a temporary lowstand. Then in the next zone, a slight increase in the lacustrine elements besides the marshland dweller forms indicates the emergence of a eutrophic lake with a somewhat elevated water level. This process is observable from around 8200 calBP onwards, marking a rise in the water-level somewhat balanced by the vegetation. From about 2m upwards in the section, the intensity of lake level fluctuations is somewhat reduced and the eutrophic lacustrine fauna are gradually replaced by littoral and marshland dweller forms, indicating the emergence of a shoreline with dense, closed aquatic vegetation cover.

If we compare the data expressing lake level fluctuations inferred from three independent data sources of sedimentology, malacology and plant macrofossils, there seems to be a similar general trend with slight differences in the intensity of water level fluctuations. This must be attributed to the fact that, while sediment compositional changes record fluctuations over a larger scale of the open water body, the compositional changes of the mollusk fauna and plant macrofossils of the aquatic vegetation reflect changes attributable to the evolution of the littoral aquatic vegetation. However, the highstand at 8200 calBP and the all-time lowstand at 7000 calBP are clearly visible in all three records.

Conclusion

Based on complex sedimentological, paleoecological investigations of a continuous uninterrupted sequence dating from the Late Glacial to the Early Holocene, the following evolutionary history could be drawn: following the birth of the neotectonic basin around 16 000 calBP, vegetation characteristic of the taiga tundra interface appeared in the area due to the emergence of a cold-spot, thanks to the local microclimate of the basin. A rich fen, with conifers, dwarf shrubs and mixed deciduous taiga species evolved during the second half of the Late Glacial. This mosaic of tundra vegetation, a rich fen and taiga evolving side by side as a result of the micro-climate was inhabited by a characteristic cryophilous mollusk fauna. The water level was at its lowest at around 14 000 calBP (Bølling interstadial) and highest around 10 000 calBP (Preboreal phase).

Several high and lowstands were recorded for the captured period of the Holocene. The water level probably reached its all-time low with the onset of the period (7000 calBP). The morphological conditions of the discharge area, reflected in such components as the span of the permafrost, plus the vegetation cover, and the rate of evaporation, must have been the most important components influencing water level fluctuations in the basin besides the annual rainfall.

As shown by our findings, the water level seems to have been quite high during the Mesolithic and the basin must have consisted of a number of adjacent carbonate-rich lakes. The shallow ponds and sub-basins, such as the studied Szigliget Embayment, were surrounded by an extensive marshy zone and a closed gallery forest, with more open woodlands in the foothills, where hazel thrived on the forest margins.

Between 8100–8200 calBP a characteristic, but short climatic change can be reconstructed in this sequence, associated with a highstand in a cool and rainy phase. After this climatic event during the Neolithic Age, some major environmental changes are discernible. Soil erosion and the infilling of the basin accelerated, and simultaneously, the extensive woodland became more open, with clearings and more open patches of vegetation at the beginning of the Holocene.

The interpreted fluctuation of the water level and the evolution of Lake Balaton were congruent with that characteristic of the lakes of the Balkans in the Late Glacial and Early Holocene part of the record. Conversely, it followed a pathway somewhat similar to the lakes of Northern Europe from the Middle Holocene onwards, with one important exception. The Holocene history of Lake Balaton is characterized by several lowstands , which must be attributed to the emergence of a Continental (Boreal) and later on a sub-Mediterranean (Atlantic) climatic influence in the area. The findings are comparable with those observed in Slovenian and Western European profiles of similar ages.

∴

REFERENCES

AABY B., DIGERFELDT G. 1986. Sampling techniques for lakes and bogs. In B. E. Berglund (ed.), *Handbook of Holocene Palaeoecology and Palaeohydrology*. New York: 181–194

BÁNFFY E. 2004. The 6th Millennium BC boundary in Western Transdanubia and its role in the Central European transition (The Szentgyörgyvölgy-Pityerdomb settlement). *Varia Archaeologica Hungarica 15: 451*.

BÁNFFY E. 2007. Settlement patterns in the little Balaton Uplands. Neolithic and Copper age settlement patterns in the Little Balaton region and in the Balaton Uplands. In Cs. Zatykó, I. Juhász, P. Sümegi (eds.), *Environmental archaeology in Transdanubia. Varia Archaeologica Hungarica 20: 97–105*.

BARBER. K. E., CHAMBERS. F. M., MADDY D., BREW J. 1994. A sensitive high resolution record of the Holocene climatic change from a raised bog in northern England. *The Holocene 4: 198–205*.

BEUDANT F. S. 1822. *Voyage minéralogique et géologique en Hongrie pendant l'année 1818*. Verdière. Paris.

BODOR E 1987. Formation of Lake Balaton palynological aspects. In M. Pécsi (ed.), *Holocene environment in Hungary*. Budapest: 77–80.

CAMERON R. A. D., REDFERN M. 1976. *British Land Snails (Mollusca: Gastropoda): Keys and Notes for Identification of the Species*. London. Academic Press

DEAN W. E. 1974. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignition: comparison with other methods. *Journal of Sedimentary Petrology 44: 242–248*.

HASLAM S. M. 1972. Biological flora of the British Isles. Phragmites communis Trin. *Journal of Ecology 60: 585–610*.

HERTELENDI E., CSONGOR É., ZÁBORSZKY L., MOLNÁR I., GÁL I., GYŐRFFY M., NAGY S. 1989. A counter system for high precision ^{14}C dating. *Radiocarbon 31: 399–408*.

JAKAB G. 2007. Macrobotanical remains from Balatonederics. In Cs. Zatykó, I. Juhász, P. Sümegi (eds.), *Environmental Archaeology in Transdanubia (Hungary)*. Varia Archaeologica Hungarica sorozat XX. kötet, MTA Régészeti Intézet, Budapest: 63–66.

JAKAB G., SÜMEGI P. 2007. Vegetation history of Szigliget Bay. In Cs. Zatykó, I. Juhász, P. Sümegi (eds.), *Environmental Archaeology in Transdanubia (Hungary)*. Varia Archaeologica Hungarica sorozat XX. kötet, MTA Régészeti Intézet, Budapest: 135–137.

JAKAB G., SÜMEGI P., MAGYARI E. 2004. New Quantative Method for the Paleobotanical Description of Late Quaternary Organic Sediments (Mire-Development Pathway and Paleoclimatic Records from Southern Hungary). *Antaeus 27: 181–212*.

JUHÁSZ I 2007. The pollen sequence from Szigliget. In Cs. Zatykó, I. Juhász, P. Sümegi (eds.), *Environmental Archaeology in Transdanubia (Hungary)*. Varia Archaeologica Hungarica sorozat XX. kötet, MTA Régészeti Intézet, Budapest: 69–75.

KISS V. 2004. Central European economies: agriculturalists in Transdanubia. In Zs. Visy (ed.), *Hungarian archaeology at the turn of the millennium*. Budapest: 148–149.

LÓCZY L. (1913). A Balaton környékének geológiai képződményei és ezeknek vidékek szerinti telepedése [Geological formations of the Balaton region and their spatial distribution]. In L. Lóczy (ed.), *A Balaton tudományos tanulmányozásának eredményei. Vol. 1, Part 1*. Budapest 1913: 287–305, 461–476, 507–579.

LOŽEK V. 1964. *Quartermollusken der Tschechoslowakei*. Rozpravy Ústavu ústedniku Geologichkého 31. Praha.

MAROSI A. 1935. Őskőkori szigony Merítőpusztáról [A prehistoric harpoon from Merítőpuszta]. *Székesfehérvári Szemle (1935): 75–76*.

1936 Kormeghatározó adatok a csór-merítőpusztai őskori csontszigonyhoz [Notes on the chronology of the harpoon from Csór-Merítőpuszta]. *Székesfehérvári Szemle (1936): 40–42*.

MAKKAY J. 1970. *A kőkor és a rézkor Fejér megyében. (The stone age and the copper age in County Fejér.) Fejér megye története I./1*. Székesfehérvár.

NAGY-BODOR E., CSERNY T. 1998a. A balatoni öblök vízborítottságának összehasonlító fejlődéstörténete a palinológiai vizsgálatok eredményei alapján [Paleoecological evolution of Lake Balaton based on palynological results]. *Hidrológiai Közlöny 78/5–6: 360–363*.

1998b. A Szigligeti-öböl vízborítottságának összehasonlító fejlődéstörténete a palinológiai vizsgálatok eredményei alapján [Inundation history of Szigliget bay based on palynological results]. *Hidrológiai Közlöny 78/5–6: 364–366*.

NAGY-BODOR E., JÁRAI-KOMLÓDI M. 2000. Palinológiai vizsgálatok a Tapolcai medencében. I. Vízi és mocsári növények a holocén és késő-glaciális időkben [Palynological studies in the Tapolca Basin I. Aquatic and bog plants during the Holocene and the Late Glacial]. *Hidrológiai Közlöny 79: 332–333*.

PETERSON G. M. 1983 Recent pollen spectra and zonal vegetation in the western USSR. *Quaternary Science Reviews 2: 281-321*.

POROSZLAI I. 2004. Fortified centres along the Danube. In Zs. Visy (ed.), *Hungarian archaeology at the turn of the millennium*. Budapest: 151–155.

RODWELL J. S. (ed.) 1995. *British plant communities, vol. 4. Aquatic communities, swamps and tall-herb fens*. Cambridge University Press. Cambridge.

STOCKMARR J. 1971. Tablets with spores used in absolute pollen analysis. *Pollen et Spores 13: 615–621*.

SÜMEGI P. 2003. New chronological and malacological data from the Quaternary of the Sárrét area, Transdanubia, Hungary. *Acta Geologica Hungarica 46: 371–390*.

SÜMEGI P., KROLOPP E. 2002. Quartermalacological analyses for modeling of the Upper Weichselian palaeoenvironmental changes in the Carpathian Basin. *Quaternary International 91: 53–63*.

SÜMEGI P., TÖRŐCSIK T. 2008. *Jelentés a Balatonederics-1 fúrás 4 cm-kénti pollen vizsgálatáról*. Unpublished report to the Department of Geology, University of Szeged.

TOLNAI-DOBOSI V. 2000. Archaeological investigations at Bodrogkeresztúr-Henye. In T. Dobosi V. (ed.), *Bodrogkeresztúr-Henye (NE Hungary) Upper Palaeolithic site*. Magyar Nemzeti Múzeum Kiadványa, Budapest: 5–111.

TROELS-SMITH J. 1955. Karakterisering af løse jordater [Characterisation of unconsolidated sediments]. *Danmarks Geologiske Undersøgelse Series. IV. 3 (10): 1–73*.

back to contents

UDK 902.65:911.52(497.4):903.4"634/636":551.581.2
Documenta Praehistorica XXXV (2008)

Settlements, landscape and palaeoclimate dynamics on the Ižica floodplain of the Ljubljana Marshes

Mihael Budja[1], Dimitrij Mlekuž[1]
1 *Department of archaeology, Faculty of Arts Ljubljana University, SI*
miha.budja@ff.uni-lj.si

ABSTRACT – *In this paper we present the results of the radiocarbon dating of organic sediments from palaeochannels we have mapped by LiDAR (Light Detection and Ranging) imagery on the Ižica floodplain. We point out that the palaeochannels and the settlement structures at Maharski prekop site are contemporaneous. We hypothesise that the episodes in past river behaviour on the Ljubljana Marshes correspond with climate anomalies in European palaeoclimate records in the Holocene.*

IZVLEČEK – *V članku predstavljamo rezultate radiokarbonskega (^{14}C) datiranja organskih depozitov v paleostrugah, ki smo jih kartirali z LiDAR posnetkom površja v poplavni ravnici Ižice. Dokazujemo, da so paleostruge in prazgodovinsko naselje Maharski prekop sočasni. Ugotavljamo, da se spremembe v rečni mreži in hidrološkem režimu časovno prekrivajo z nizom klimatskih anomalij v holocenu.*

KEY WORDS – *Ljubljana Marshes; Holocene; LiDAR; palaeochannels; neo-eneolithic settlements; radiocarbon dating; climate anomalies*

Introduction

Simplified interpretative postulates in the perception of the prehistoric settlement patterns and palaeolandscapes on the Ljubljana Marshes that 'lake chalk' and 'vertical piles' can be representamens of a 'prehistoric lake' and pile-dwellings built on it, and that they can mark the shift of post-Mesolithic, supposedly Neolithic settlements from the land to the lake were recently replaced by the model of an active river floodplain and settlements and catchment areas within. The interpretative reduction that a series of vertical piles relates to the function of platform holders exclusively was compensated by the complex interpretation of a series of 2432 vertical wooden piles at the Maharski prekop site that show the number of rectangular wooden structures (group of houses), and a structure running parallel with the palaeochannel that is believed to protect the settlement against river bank erosion (for details see *Budja 1994 (1995); 1997; Budja, Mlekuž 2001; Mlekuž, Budja, Ogrinc 2006*).

In this paper, we present the results of the radiocarbon dating of the organic sediments from palaeochannels we have mapped by the LiDAR (Light Detection and Ranging) imagery. These data are than compared with and discussed in relation to Holocene climate anomalies. We hypothesise that the episodes in past river behaviour on the Ljubljana Marshes correspond with climate anomalies in European palaeoclimate records.

Ižica floodplain and LiDAR

The Ižica is a river with an extensive karstic watershed in the Dinaric plateau south of the Ljubljana Marshes. It is a low energy river characterized by a very low gradient, broad floodplain and dominant fine-grained sedimentation. The Ižica was a mobile river and left earlier channels scattered across the floodplain. They can be identified on aerial photos as cropmarks, mainly as faint, broad anomalies, which do not enable the identification of individual channels. Aerial photographs reveal a very complex palimpsest of palaeochannels.

In order to create a more complete picture of the Ižica floodplain an airborne LiDAR survey of the part of the floodplain was commissioned. An area of 1300 x 600m (78 hectares) was surveyed. Eneolithic and Bronze Age sites (Resnikov prekop and Maharski prekop) are located in the surveyed area. LiDAR is frequently used as a tool for examining aspects of river floodplains, most often for geomorphological mapping or flood prediction purposes (*Lohani and Mason 2001; Charlton et al. 2003; Cobby et al. 2001; Marks and Bates 2000; Challis 2005; 2006; Jones et al. 2006*).

A LiDAR digital terrain model exposes extensive geomorphological detail of the study area and allows us to resolve fine details of the floodplain and terrace (Fig. 1). Three-dimensional elevation data enable us to discern the stratigraphic relations between floodplain features and to create cross-channel profiles. LiDAR provides us with a much more complete and detailed picture of the geomorphology than aerial photography (*Jones et al. 2007*). The results of LiDAR allow us to discern two main geomorphological units in the study area – an older terrace and a younger and lower active floodplain. The difference in elevation between units is up to 40cm. The most obvious features of the study area are the palaeochannels, visible as slight depressions in the landscape; however, LiDAR reveals other features, such as levees, and ridge and swale.

Based on the relative stratigraphic positions of palaeochannels, at least four distinctive phases of fluvial activity can be discerned. The first phase is characterized by a number of thin, relatively straight channels preserved on the terrace, suggesting a past

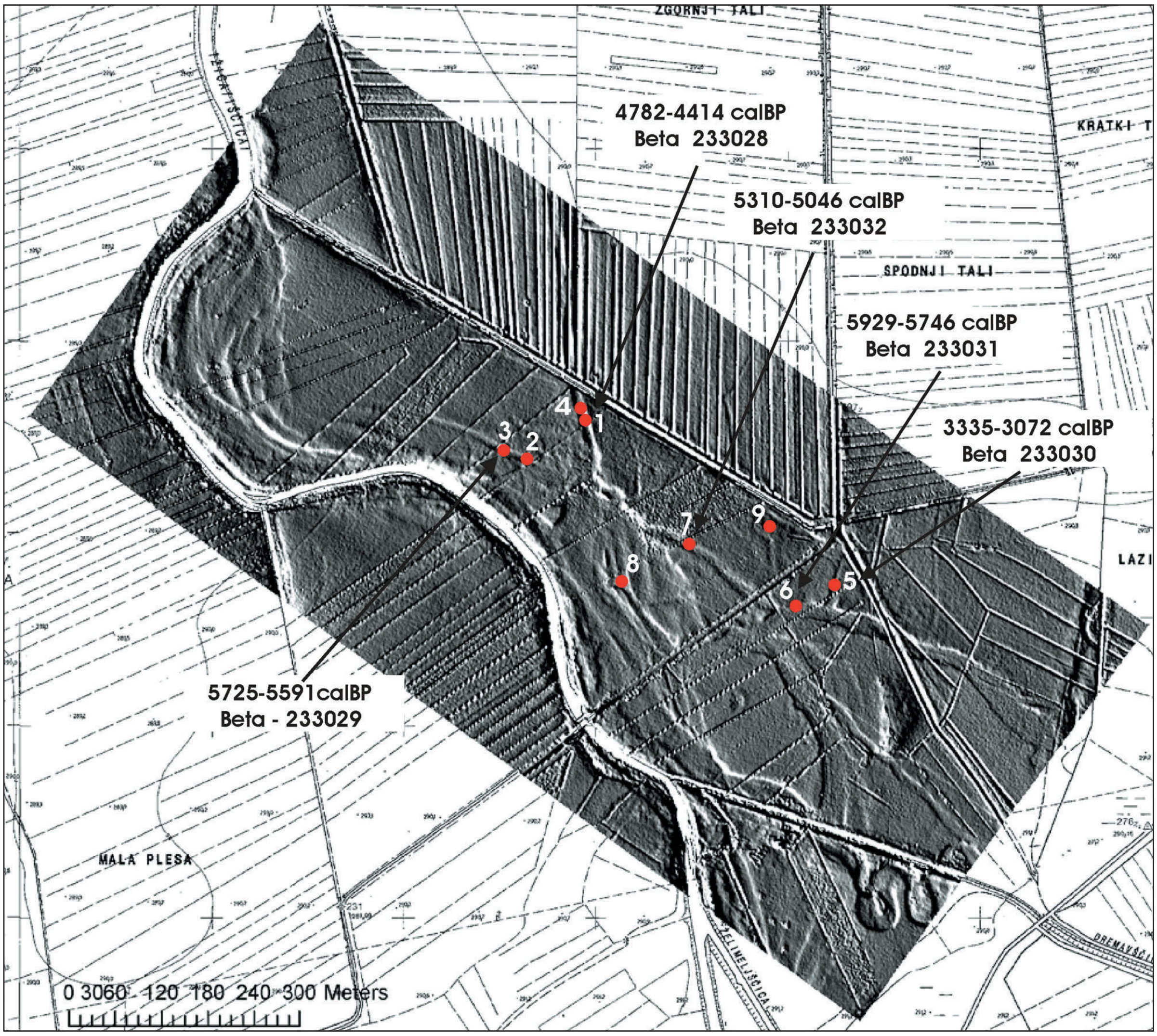


Fig. 1. LiDAR terrain model with the location of borehole records and radiocarbon dates of channels infill.

anastomosing regime. The second phase is represented by wide anastomosing channels in direct superposition with some phase one channels. Third phase is marked by the degradation of the Ižica and the creation of an active floodplain. This process created a well-developed terrace edge and preserved phase 1 and 2 channels on the terrace. Ižica became a more sinuous river. The most distinctive features of this phase are the ridge and swale features in the floodplain, with thalwegs, indicating significant lateral channel migration and meander core growth. And lastly, the fourth phase is a modern network, the result of flood-control and irrigation works in the 19th and 20th centuries (Fig. 2).

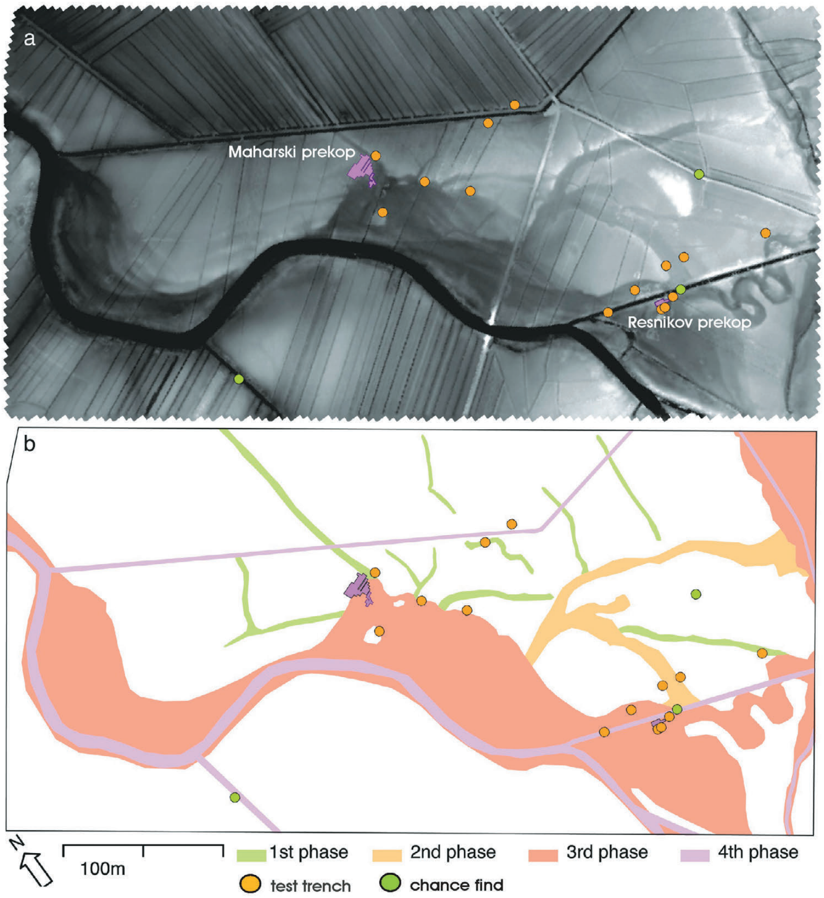


Fig. 2. LiDAR image (a) and, Maharski prekop and Resnikov prekop sites in the context of Ižica floodplain. The landscape is structured by an interlocking pattern of palaeochannels, and at least three phases of superimposed palaochanels can be observed (b) (after* Mlekuž, Budja, Ogrinc 2006.Fig.2*).

The change from straight and anastomosing to sinuous/meandering channels and degradation of the Ižica shows that there were significant changes in the hydrological regime of the streams draining the Ižica floodplain that were probably connected to Holocene climate anomalies.

Dating of palaeochannels

Systematic mapping of the study area allowed the selection of key localities for direct dating of the palaeochannels. Locations for boreholes were chosen on the base of LiDAR map and field inspections (Fig. 1). Boreholes were drilled with a motorized auger of 8cm diameter. Only substantial, spatially contiguous stratigraphic units were recorded. The model records the details of at least three sedimentary units: topsoil, organic deposits and lacustrine marls.

In total, 9 boreholes were drilled and examined; five samples from five boreholes were directly dated in the first phase of the project (Fig. 1). Samples for AMS radiocarbon dates were collected from the bottom of organic channel infill, 5 to 20cm above the lacustrine marl. This assumes that dates post-date channel cutting and provide maximum age (*terminus ante quem*) for channel infilling and abandonment.

Borehole 1 was located in a phase 1 palaeochannel near the site of Maharski prekop. On the ground, the depression is very evident. The borehole was comprised of topsoil underlain by fibrous dark organic deposit. At 120cm there is a sharp transition to chalky lacustrine marls. A sample of the organic deposit collected from 110cm yielded a radiocarbon age range 4782–4414 calBP (Beta-233028)[1].

Borehole 3 was drilled in a straight phase 1 channel, southwest of the Maharski prekop site. It shows very similar stratigraphy, with topsoil, organic rich sedi-

1 All the dates in the text are calibrated with the program CALIB version 5.10., and given in two sigma ranges (*Reimer et al. 2004*). The conventional radiocarbon dates are presented on Table 1.

ment and a sharp transition to lacustrine marls at 115cm. A sample from 110cm yielded age range 5725–5591 calBP (Beta-233029).

Borehole 7 was recovered from the phase 1 palaeochannel southeast of the Maharski prekop site. The sample was taken from a depth of 50cm, 5cm above the marl, and yielded age range 5310–5046 calBP (Beta-233032).

Borehole 5 was located at the junction of the straight channel and wider, second phase channel. A sample of organic sediment from 125cm, 20cm above the lacustrine marl, yielded age range 3335–3072 calBP (Beta-233030).

Borehole 6 was located at the edge of the wide, second phase palaeochannel, 50m west of borehole 5. A sample from a depth of 100cm, 20cm above the marls, yielded age range 5929–5746 calBP (Beta-233031). This date can be considered as too early for the infill of the second phase channel. The dated channel is in direct superposition with the first phase channel, dated with borehole 7 (see above) to age range 5310–5046 calBP. The date from borehole 5 suggest that this second phase channel could be dated to before age range 3335–3072 calBP. We assume that the date pre-dates channel cutting and actually dates the terrace surface. This is supported by a piece of prehistoric pottery found in the borehole, indicating that we dated an undisturbed surface, predating channel cutting. We therefore suggest that 5929–5746 calBP is the age range of the terrace surface.

Radiocarbon dates place the first phase of the palaeochannels before 5725 calBP. Thus, at the latest at 3776 calBC this part of Ljubljana Marshes was an active floodplain and not a shallow lake, as the traditional view suggests.

Maharski prekop settlement on the Ižica floodplain

The radiocarbon data indicate that the south-eastern part of Ljubljana Marshes was already settled in the tenth millennium BP. The earliest series of conventional radiocarbon dates from the Breg and Babna Gorica sites are followed by radiocarbon dates from Resnikov prekop and Maharski prekop (Tab. 1).

Palynological data indicate that the floodplain supported mixed-deciduous woodland, composed predominantly of *Quercus*, *Corylus, Fagus* and *Alnus*, but with some coniferous elements and open ground herbaceous taxa. In addition, the presence of cereal type pollen is attested at least from 6000 calBP (*Šercelj 1975.121–122; Gardner 1999.130, 189*). Extensive burning in the period 5550–5330 calBP that may have related to human activity in the area is hypothesised from high values in the charcoal curve. Increased burning (clearance) correlates with a sharp decline in arboreal pollen and an expansion of herbaceous taxa, particularly cereal type pollen and Poaceae, and thus supports the notion of fields surrounded by woodland (*Gardner 1999.130, 165, 168*; see also *Andrič 2007*).

In the composite plan of 2432 vertical wooden piles at Maharski prekop site, two patterns are recognized (Fig. 3). The first consists of rectangular wooden structures that were recognized as a group of houses with sizes of around 8–10 x 3.5–4.5m arranged in parallel. Each house is built of three rows of structural timbers, with a central row of centre-posts supporting a roof ridge pole; the lateral rows are wall posts. The floors were plastered with clay, and the stone features are probably the remains of thermal structures in the front/back of the house, or might be paved surfaces. Pottery, stone and bone tools are often deposited directly upon burned clay surfaces. The superpositions of clay floors separated by a thin layer of occupational debris may indicate the periodic rebuilding of surfaces. Houses were oriented with the longer side parallel to the channel. However, there is at least one house which is oriented perpendicularly to the others. Three woods, oak (*Quercus*), ash (*Fraxinus*) and rowan (*Sorbus*), comprise more than 90% of identified taxa (*Bregant 1974; 1975; Šercelj 1973; 1975; Budja 1994 (1995); 1997; Mlekuž, Budja, Ogrinc 2006*).

The second relates to two or three dense linear concentrations of piles running on the eastern side of the excavated area. The piles, of much smaller diameters than those mentioned above, were hammered into the palaeochannel slope, recognized at the hypothesised settling outskirts (*Bregant 1975.18–20; Šercelj 1973; 1975*). The structure is believed to have protected the site from floods and river bank erosion.

Abrupt climate changes in the Holocene

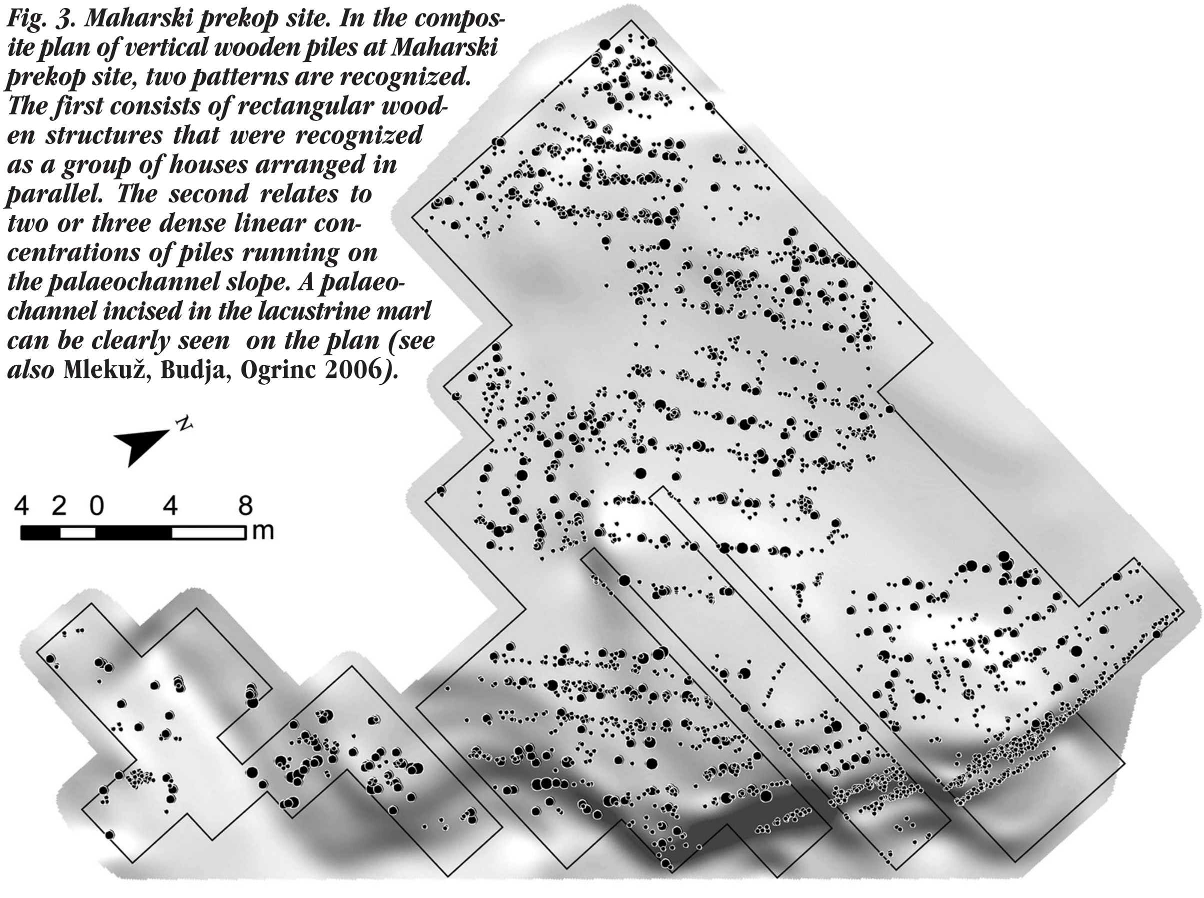
The 8200 calBP 'climate event' which abruptly and drastically changed global environments during the transition to farming in southeastern Europe is recently an intensively discussed topic. Less attention is being devoted to later climate oscillations and associated contrasting patterns of hydrological changes in Europe in response to abrupt climate changes and cooling phases. There were several cooling oscillations, hydrological reversals and major atmospheric circulation changes, recorded globally at *c.* 8200, 5200, 4200, 3500, 1200, and 600 calBP (*Rohling et al. 2002a; 2002b; Alley et al. 2003; Mayewski et al. 2004*) (Fig. 4).

From the central European Neo-Eneolithic perspective the most important are the climate oscillations in the period 5600–5000 calBP. The records from various regions in both hemispheres show global cooling and contrasting patterns of hydrological changes. The changes in vegetation cover, glacier advance and decline in tree lines in the mountains, increasing permafrost and retreating timberlines at high latitudes, cooler sea surface temperatures and ice-sheet isotope records at the poles have been recorded. In the European Alps the cooling has been assessed at 1–1.5° C for mean summer temperatures. While in central Asia, in the northern part of Africa and in the southern Mediterranean region where drier conditions were predominant, there were wetter conditions over intermediate latitudes between approx. Latitudes 40° and 60° in west-central Europe, where large fluctuations in river and lake levels and regional humidity have been recorded (*Mayewski et al. 2004; Magny 2004; Magny and Hass 2004*). These climate oscillations were being more recently recognized in western central European palaeoenvironmental and archaeological data as an abrupt tripartite climate change associated with drastic lake level fluctuations at 5550–5320 calBP (*Magny et al. 2006*). It is defined as 'Episode 9' in the long sequence of Alpine lake level fluctuations (*Magny 2004.74*).

The sequence consists of 15 successive episodes of higher lake levels in the Holocene. 'Episode 1' is dated just prior to 1394 AD, and 'Episode15' to a age range between 11 250 and 11 050 calBP (*Magny 2004; Magny et al. 2006*). The reconstruction of the episodes is based on regional patterns of palaeohydrological changes and lake level transgressions and regressions that have been recognized recently in palaeoenvironmental data and in a set of 180 radiocarbon, tree-ring and archaeological dates obtained from 26 lakes in the Jura Mountains, the northern French Pre-Alps and the Swiss Plateau.

'Episode 9' shows three successive peaks of higher water levels in Lake Constance (Bodensee), Lake Ge-

Fig. 3. Maharski prekop site. In the composite plan of vertical wooden piles at Maharski prekop site, two patterns are recognized. The first consists of rectangular wooden structures that were recognized as a group of houses arranged in parallel. The second relates to two or three dense linear concentrations of piles running on the palaeochannel slope. A palaeochannel incised in the lacustrine marl can be clearly seen on the plan (see also* Mlekuž, Budja, Ogrinc 2006*).



Labcode	Conventional radiocarbon age (BP)	CalBP age range (2σ)	CalBC age range (2σ)	Material	Context	Reference
Babna Gorica						
GrA–9855	5900±50	6881–6569	4932–4620	Charcoal	Excavations 1995; SU 09	
GrA–9856	6290±50	7321–7025	5372–5076	Charcoal	Excavations 1995; SU 19	
GrA–9857	6200±50	7249–6976	5300–5027	Charcoal	Excavations 1995; SU 17	
GrA–9440	6700±50	7660–7483	5711–5534	Other/Chalky lacustrine marls	Excavations 1995; SU 20	
Resnikov prekop						
Z–345	5850 ± 150	7142–6312	5193–4363	Wood	Excavations 1962, pile 5	*Srdoć et al. 1987.354*
Hd–24038	5718 ± 23	6627–6437	4678–4619	Wood (*Alnus glutinosa*)	Excavations 2005, trench 3, pile 33	*Čufar and Korenčič 2006.124*
Beta–182667	2120 ± 40	2301–1991	352–42	Sediment	Profile depth 120 cm	*Andrič 2006.Tab. 2*
Beta–184792	2220 ± 40	2331–2123	382–174	Sediment	Profile depth 115 cm	*Andrič 2006.Tab. 2*
Maharski prekop						
Z–278	4633 ± 117	5594–4974	3645–3025	Wood (*Quercus?*)	Excavations 1972, grid 12?, pile 40	*Srdoć et al. 1975.152*
Z–305	4345 ± 113	5305–4617	3356–2668	Wood (*Fraxinus*)	Excavations 1973, grid 15, pile 1	*Srdoć et al. 1975.152*
Z–314	4964 ± 99	5919–5482	3970–3533	Wood		*Srdoć et al. 1975.152*
Z–315	4701 ± 104	5644–5055	3695–3106	Wood (*Sorbus*)	Excavations 1972, grid 15, pile 4	*Srdoć et al. 1975.152*
Z–351	5080 ± 110	6174–5594	4225–3645	Wood (*Sorbus*)	Excavations 1974, test trench 4 grid 42, pile 156	*Srdoć et al. 1977.465–475*
Z–353	4330 ± 120	5300–4580	3351–2631	Wood	Excavations 1974, test trench 4	*Srdoć et al. 1977.465–475*
AA–27182	4680 ± 55	5581–5311	3632–3362	Charcoal	MP1 sediment exposure, charchoal layer 61–63 cm	*Gardner 1999.Table 5.1*
AA–27183	4980 ± 60	5892–5601	3943–3652	Charcoal	MP1 sediment exposure, charchoal layer 138cm	*Gardner 1999.Table 5.1*
Beta–219606	4740 ± 40	5586–5326	3637–3377	Bone (*Ovis*)	Grid square 42	*Mlekuž et al. 2006*
Beta–219607	4720 ± 40	5583–5323	3634–3374	Bone (*Ovis*)	Grid square 42	*Mlekuž et al. 2006*
Beta–219608	4710 ± 40	5582–5321	3633–3372	Bone	Grid square 42	*Mlekuž et al. 2006*
Beta–219609	6570 ± 40	7563–7424	5614–5475	Bone	Grid square 34	*Mlekuž et al. 2006*
Beta–219610	4750 ± 50	5589–5325	3640–3376	Bone	Grid square 34	*Mlekuž et al. 2006*
Beta–219611	4740 ± 40	5586–5326	3637–3377	Bone	Grid square 32	*Mlekuž et al. 2006*
Palaeochannels						
Beta–233028	4020 ± 40	4782–4414	2833–2465	Organic sediment	Borehole 1, 110 cm	
Beta–233029	4920 ± 40	5725–5591	3776–3642	Organic sediment	Borehole 2, 110 cm	
Beta–233030	3000 ± 40	3335–3072	1386–1123	Organic sediment	Borehole 3, 50 cm	
Beta–233031	5110 ± 40	5929–5746	3980–3797	Organic sediment	Borehole 4, 105 cm	
Beta–233032	4520 ± 40	5310–5046	3361–3097	Organic sediment	Borehole 5, 100 cm	

Tab. 1. Radiocarbon dates for Maharski prekop and Resnikov prekop sites, and Ižica floodplain palaeochannels. Calibration performed with CALIB version 5.10., and given in two sigma ranges (**Reimer et al. 2004*****).***

neva and Jurassic lakes that correlate to abrupt tripartite climate changes between 5550 and 5320 calBP, supposedly caused by varying solar activity, as it corresponds with climatic cooling and/or changes in moisture conditions in various regions in both hemispheres. Moreover, the mid-Holocene climate oscillations appear to have been characterised by intermediate warm spells within a distinct succession of strong cooling episodes.

The tripartite sequence of abrupt increases in lake water levels was reconstructed from sediment and pollen analyses of a sediment sequence at Lake Constance. The first abrupt high level event was dated to age range 5647–5478 calBP. The second abrupt rise in lake level appears to have occurred in three distinct episodes of rising lake levels at *c.* 5500 calBP. The third sudden rise in lake level was dated before a range of 5583–5317 calBP. This event is marked by rapid depositions of sediment shortly after building destruction at Arbon-Bleiche 3, the 'Neolithic pile-dwellings site' located at the lake shore (*Magny 2004; Magny et al. 2006*). It has been suggested that this was associated with settlement abandonment at 5320 calBP, according to dendrochronological dating (*Leuzinger 2000*).

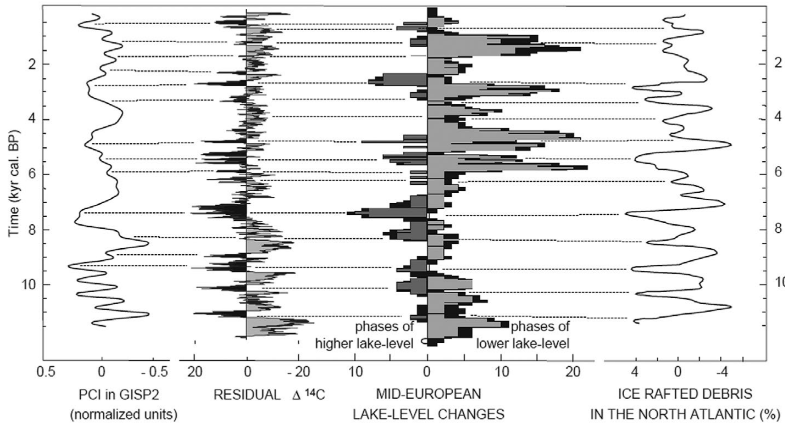


Fig. 4. The correlation of mid-European lake level fluctuations and the Holocene climate anomalies, recorded in Polar Circulation Index at GISP2, the atmospheric residual ¹⁴C variations, and the ice-rafting debris (IRD) events in the North Atlantic Ocean (after **Magny 2004.Fig 3*)*.**

Although available data does not allow us to correlate episodes of Alpine lake level fluctuations with the development and change of fluvial network on the Ižica floodplain directly, we may hypothesise that this mid-Holocene abrupt climate change and associated reversion to wetter conditions affected regional hydrological regimes and river behaviour on the Ljubljana Marshes and their catchments in the karstic Dinaric Mountains and Julian Pre-Alps. The dynamics of channel bed movements (in different directions) and their abundance in the first phase of fluvial activity on the Ižica floodplain in the age ranges 5725–5591 calBP and 5310–5046 calBP are broadly contemporary with the tripartite climate reversal and the sequence of abrupt increases and decreases in water levels in Lake Constance, Lake Geneva and Jurassic lakes (Fig. 5). Similar age ranges of 5644–5055 (Z-315) and 5305–4617 (Z-305) were obtained for the wooden structure believed to protect the Maharski prekop settlement against floods and river bank erosion.

The third phase of fluvial activity on the Ižica floodplain is marked by larger streams, lateral channel movement, and bank erosion. The LiDAR image clearly shows that the Resnikov prekop site is situated in the area, damaged by the third phase channels. Recently performed stratigraphical, sedimenological and palynological analyses at the Resnikov prekop site showed that the settlement deposit was washed out by intensive river erosion (*Andrič 2006; Velušček 2007.426*). Two radicarbon dates of the channel infill, in the age ranges 2336–2146 calBP (Beta – 184792) and 2148–2040 calBP (Beta – 182667), both post-date the event, may indicate that it corres-

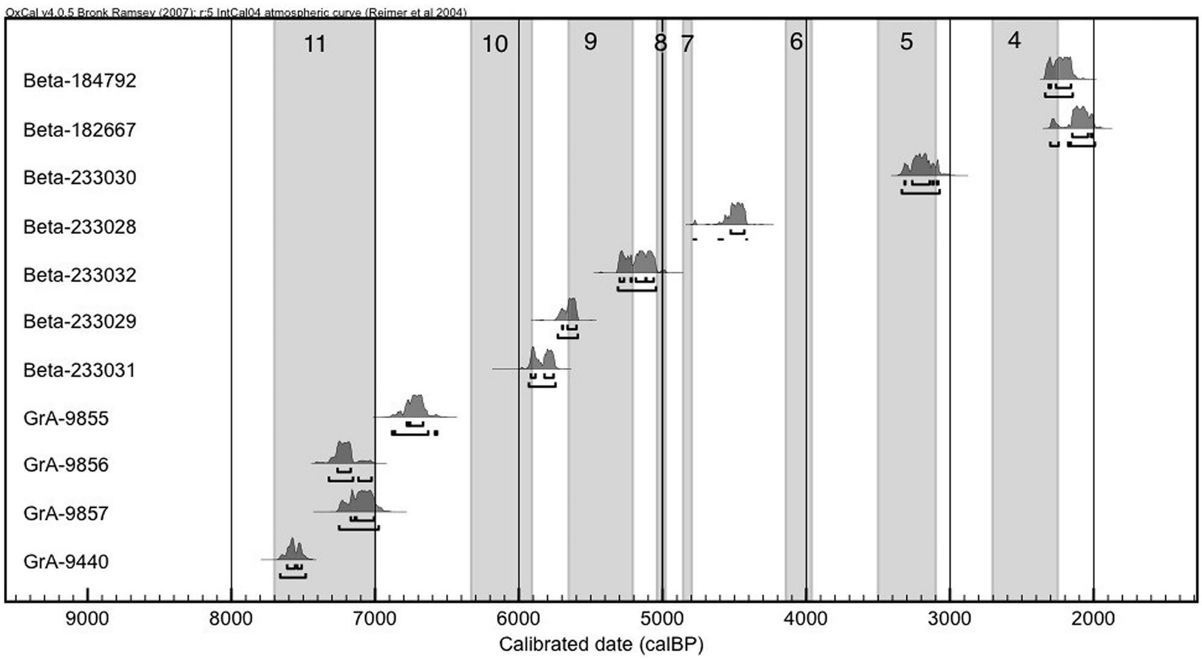


Fig. 5. The chronological sequence of 'episodes' (4–11) of abrupt increases in lake water levels in the Jura Mountains, the northern French Pre-Alps and the Swiss Plateau (**Magny 2004; Magny et al. 2006*), and calibration ranges at 1 and 2 standard deviations (calBP) of radiocarbon dates from Babna gorica and palaeochannels in Ižica floodplain.***

ponds to an abrupt cooling phase, and to the major flood event in west-central Europe 'after *c.* 2700 calBP and before *c.* 2265 calBP' as Michel Magny (*2006. 13*) suggests.

It is worth pointing out the complex floodplain lake level fluctuations and fluvial dynamics on the north-eastern edge of the Ljubljana Marshes that predate those on the Ižica floodplain. Microclimate proxy data from the bottom part of the stratigraphic sequence of the Babna Gorica test trench indicate dynamic events in the age range of 7660 to 6976 calBP. In the bottom part of the stratigraphic sequence transgression/regression dynamics of a probable floodplain lake are recorded. A layer of lacustrine marls is dated to age range 7660–7483 calBP (GrA-9440). It is covered by an organogenic layer dated to age range 7249–6976 calBP (GrA-9857) associated with a buried soil horizon. The area was inundated again, as demonstrated by a thin layer of lake marl. Above it, another buried soil horizon was identified. Wood stumps and charcoal deposition in age range of 7321–7025 calBP (GrA-9856) were contextualised within it. Thereafter, a series of loam, sand and gravels deposits was recorded after the age range 6881–6569 calBP (GrA9855) that indicates the dynamic alluvial episodes (*Vidic 1997; Mlekuž, Budja, Ogrinc 2006.257*). The floodplain lake transgression and regression sequence runs parallel with the 'Episode 11 (7550–7250 calBP)' of abrupt central European lake-level fluctuations (*Magny 2004.72*) (Fig. 6).

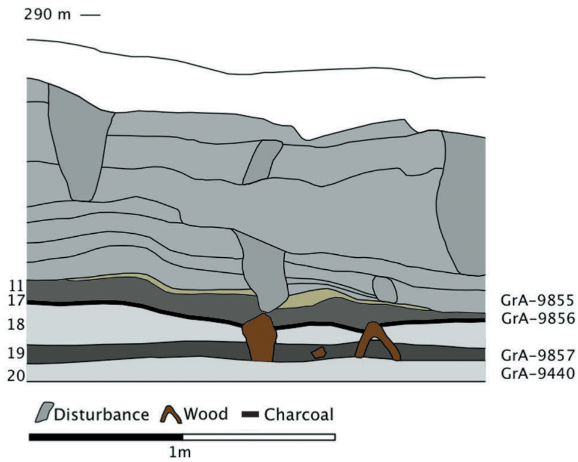


Fig. 6. Babna gorica test section 2. A layer of lacustrine marls (20) is covered by an organogenic layer associated with a buried soil horizon (19). The area was inundated again, as demonstrated by a layer of lake marl (18). Above it, another buried soil horizon was identified (11) with well preserved wood stumps and charcoal deposition contextualised within (17). Thereafter, a series of loam, sand and gravels deposits was recorded that indicates the dynamic alluvial episodes (for stable isotope $\delta^{13}C$ and $\delta^{15}N$ analysis see* Mlekuž, Budja, Ogrinc 2006.257–258*).

Conclusions

The absolute dates of the first phase palaeochannels identified on LiDAR imagery are contemporary with the dates from the Maharski prekop site. The wooden structures, either rectangular buildings or structure that run parallel with the channel, demonstrate the overlapping age range. It is worth noting, however, that the abandoned channel was already identified and excavated in the 1970s (*Bregant 1975.18–20*). The palaeochannels and the settlement reveal a microtopography suitable for settlement which, although prone to seasonal flooding, offered an attractive resource for floodplain agriculture. Therefore, we can imagine Maharski prekop as a dispersed settlement with several settlement foci located on the channel levees and surrounded by fields.

We suggest that the complexity of fluvial and alluvial process on the Ljubljana Marshes, dependent on palaeoclimate oscillations, must be incorporated in an adequate understanding of landscape dynamics and settlement patterns in the microregion. Furthermore, the age ranges of changes in the Ižica floodplain palaeochannel system and Babna Gorica floodplain lake transgression and regression correspond with Alpine lake level fluctuations and mid-Holocene global cooling and contrasting patterns of hydrological changes.

We present here fragmentary data that can have heuristic value only at the southeastern part of Ljubljana Marshes to show that at least at the time of occupation (and probably even earlier) of the Resnikov prekop and Maharski prekop sites, this part of the Ljubljana marshes was not covered by a shallow lake, as the traditional view suggests, and that changes in hydrology correspond to abrupt climate changes. However, intensive multidisciplinary palaeoenvironmental research and adequate radiometric dating of particular contexts can be the way forward in interpreting the complex archaeological and palaeoenvironmental records of the Ljubljana Marshes.

ACKNOWLEDGEMENTS

We would like to acknowledge the research was supported by the Slovenian Research Agency: Project J6–6013–0581–04' and, Research Programme Arheologija P6–247.

REFERENCES

ALLEY R. B., MAROTZKE J., NORDHAUS W. D., T. OWERPECK J., PETEET D. M., PIELKE Jr. R. A., PIERREHUMBERT R. T., RHINES P. B., STOCKER T. F., TALLEY L. D., WALLACE J. M. 2003. Abrupt Climate Change. *Science 299(5615): 2005–2009*.

ANDRIČ M. 2006. Ali lahko analiza pelodnega zapisa v kulturni plasti arheološkega najdišča pove, kakšna vegetacija je rasla v okolici? Primer: Resnikov prekop. In A. Velušček (ed.), *Resnikov prekop, najstarejša koliščarska naselbina na Ljubljanskem barju*. Opera Instituti Archaeologici Sloveniae 10: 103–113.

2007. Why were the Neolithic landscapes of Bela krajina and Ljubljana Marshes regions of Slovenia so dissimilar? In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 177–89*.

BREGANT T. 1974a. Kolišče ob Maharskem prekopu pri Igu – raziskovanja leta 1972. *Poročilo o raziskovanju neolita in eneolita v Sloveniji 3: 39–67*.

1974b. Kolišče ob Maharskem prekopu pri Igu – raziskovanja leta 1970. *Poročilo o raziskovanju neolita in eneolita v Sloveniji 3: 7–35*.

1975. Kolišče ob Maharskem prekopu pri Igu – raziskovanja 1973. in 1974. leta. *Poročilo o raziskovanju neolita in eneolita v Sloveniji 4: 7–114*.

BUDJA M. 1994(1995). Spreminjanje naravne in kulturne krajine v neolitiku in eneolitiku na Ljubljanskem barju I. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 22: 163–81*.

1997. Landscape changes in the neolithic and copper ages in Slovenia: case study: the Ljubljansko Barje region. In Chapman J. and Dolukhanov P. (eds.), *Landscapes in Flux (Central and Eastern Europe in antiquity)*. Colloquia Pontica 3, Oxbow books, 77–88.

BUDJA M. and MLEKUŽ D. 2001. GIS support in reconstructing Neolithic flood-plain dynamics: The Ljubljana Moor case. In B. Slapšak (ed.), *On the good use of geographic information systems in archaeological landscape studies* (Proceedings of the COST G2 WG2 Round Table, Ljubljana, 18 to 20 December 1998, EUR, COST Action G2, 19708), European Communities Luxembourg: 117–26.

CHARLTON M. E., LARGE A. R. G. and FULLER I. C. 2003. Application of airborne LiDAR in river environments: the River Coquet, Northumberland, UK. Earth Surface *Processes and Landforms 28: 299–306*.

CHALLIS K. 2005. Airborne Lidar: A Tool for Geoarchaeological Prospection in Riverine Landscapes. In Stoepker H. (ed.), *Archaeological Heritage Management in Riverine Landscapes*. Rapporten Archeologische Monumentenzorg 126: 11–24.

2006. Airborne laser altimetry in alluviatedlandscapes. *Archaeological Prospection 13: 103–127*.

COBBY D. M., MASON D. C. and DAVENPORT I. J. 2001. Image processing of airborne scanning laser altimetry data for improved river flood modelling. *ISPRS Journal of Photogrammetry & Remote Sensing 56: 121–138*.

GARDNER A. 1999. *The impact of Neolithic agriculture on the environment of South-East Europe*. PhD Thesis, University of Cambridge.

JONES A. F., BREWER P. A., JOHNSTONE E. and MACKLIN M. G. 2007. High-resolution interpretative geomorphological mapping of river environments using airborne LiDAR data. *Earth Surface Processes and Landforms 31: 1574–1592*.

LEUZINGER U. 2000. *Die jungsteinzeitliche Seeufersiedlung Arbon-Bleiche 3. Befunde*. Archäologie im Thurgau, vol. 9. Verlag Huber, Frauenfeld.

LOHANI B. and MASON D. C. 2001. Application of airborne scanning laser altimetry to the study of tidal channel geomorphology. *ISPRS Journal of Photogrammetry & Remote Sensing 56: 100–20*.

MAGNY M. 2004. Holocene climate variability as reflectedby mid-European lake-level fluctuations andits probable impact on prehistoric human settlements. *Quaternary International 113: 65–79*.

MAGNY M. and HAAS J. N. 2004. A major widespread climatic change around 5300 cal. yr BP at the time of the Alpine Iceman. *Journal of Quaternary Science 19(5): 423–430*.

MAGNY M., LEUZINGER U., BORTENSCHLAGER S., NICOLAS HAAS J. N. 2006. Tripartite climate reversal in Central Europe 5600–5300 years ago. *Quaternary Research 65: 3–19*.

MLEKUŽ D., BUDJA M., OGRINC N. 2006. Complex settlement and the landscape dynamic of the Iščica floodplain (Ljubljana Marshes, Slovenia). In M. Budja (ed.), *13th Neolithic Studies. Documenta Praehistorica 33: 253–71*.

MARKS K. and BATES P. 2000. Integration of high-resolution topographic data with floodplain flow models. *Hydrological Processes 14: 2109–2122*.

MAYEWSKI P. A., ROHLING E. E., STAGER J. C., KARLÉN W., MAASCH K. A., MEEKER L. D., MEYERSON E. A., GASSE

F., VAN KREVELD S., HOLMGREN K., LEE-THORP J., ROSQVIST G., RACK F., STAUBWASSER M., SCHNEIDER R. R., STEIG E. J. 2004. Holocene climate variability. *Quaternary Research 62(3): 243–255*.

REIMER P. J. and 28 authors. 2004. IntCal04 Terrestrial Radiocarbon Age Calibration, 0–26 cal kyr BP. *Radiocarbon 46 (3): 1029–1059*.

ROHLING E. J., MAYEWSKI P. A., HAYES A., ABU-ZIED R. H., CASFORD J. S. L. 2002a. Holocene atmosphere-ocean interactions: records from Greenland and the Aegean Sea. *Climate Dynamics 18: 587–593*.

ROHLING E. J., CASFORD J., ABU-ZIED R., COOKE S., MERCONE D., THOMSON J., CROUDACE I., JORISSEN F. J., BRINKHUIS H., KALLMEYER J., WEFER G. 2002b. Rapid Holocene climate changes in the eastern Mediterranean. In F. Hassan (ed.), *Droughts, Food and Culture: Ecological Change and Food Security in Africa's Later Prehistory*. Kluwer Academic/Plenum Publishers. London: 35– 46.

ŠERCELJ A. 1973. Poročilo o ksilotonskih raziskavah kolišča ob Maharskem prekopu – raziskovanja leta 1972. *Poročilo o raziskovanju neolita in eneolita v Sloveniji 3: 69–70*.

1975. Analize makroskopskih in mikroskopskih rastlinskih ostankov s kolišča ob Maharskemu prekopu, izkopavanja 1973. in 1974. leta. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 4: 115–22*.

VELUŠČEK A. 2007. Prispevek k diskusiji o procesu neolitizacije. *Arheološki vestnik 58: 425–434*.

VIDIC N. 1997. *Poročilo o pedoloških raziskavah ob arheoloških izkopavanjih pri Babni Gorici (1995) in Bregu (1996)*. Center za pedologijo in varstvo rastlin. UL BTF Ljubljana.

back to contents

UDK UDK 902(4/5)"633/634":577.2
Documenta Praehistorica XXXV (2008)

Phylogeography of Y chromosomal haplogroups as reporters of Neolithic and post-Neolithic population processes in the Mediterranean area

Fiorenza Pompei[1], Fulvio Cruciani[2], Rosaria Scozzari[2], Andrea Novelletto[1]
1 *Department of Biology, Università "Tor Vergata", Rome, Italy*
novelletto@bio.uniroma2.it
2 *Department of Genetics and Molecular Biology, Sapienza Università di Roma, Rome, Italy*

ABSTRACT – *The phylogeny of the human Y chromosome as defined by unique event polymorphisms is being worked out in fine detail. The emerging picture of the geographic distribution of different branches of the evolutionary tree (haplogroups), and the possibility of genetically dating their antiquity, are important tools in the reconstruction of major peopling, population resettlement and demographic expansion events. In the last 10 000 years many such events took place, but they are so close together in time that the populations that experienced them carry Y chromosomal types which can hardly be distinguished genetically. Nevertheless, under some circumstances, one can detect departures from the model of a major dispersal of people over much of the territory, as classically claimed for the European Neolithic. The results of three studies of haplogroups relevant for Southern European populations are discussed. These analyses seem to resolve the signal of recent post-Neolithic events from the noise of the main East-to-West Palaeolithic/early Neolithic migrations. They also confirm that, provided an appropriate level of resolution is used, patterns of diversity among chromosomes which originated outside Europe may often be recognized as the result of discontinuous processes which occurred within Europe.*

IZVLEČEK – *Filogenija človeškega kromosoma Y, kot jo lahko preberemo skozi zaporedje polimorfizmov, je dobro poznana. Čedalje jasnejša slika geografskih distribucij posameznih vej evolucijskega drevesa (haploskupin) in možnosti njihovega genetskega datiranja so pomembna orodja pri preučevanju širjenja človeštva, premikov in širitev populacij. V zadnjih 10 000 letih se je zgodilo kar nekaj takih dogodkov, ki pa so si časovno tako blizu, da populacije, ki so bile vanje vpletene, nosijo tako zelo podobne Y kromosome, da jih genetsko le težko razločimo med seboj. Kljub temu je moč pod nekaterimi pogoji opaziti razlike, ki se ločijo od klasičnega modela širjenja populacij, ki velja za evropski neolitik. Predstavljamo rezultate treh študij haploskupin južnoevropskih populacij. Analize so pokazale, da je moč iz šuma glavnih paleolitskih in neolitskih migracij iz vzhoda proti zahodu razločiti nekatere po-neolitske demografske dogodke. Študija tudi potrjuje, da je mogoče – ob dovolj visoki ločljivosti – nekatere vzorce kromosomov, ki izvirajo izven Evrope, pripisati seriji prekinjenih procesov znotraj Evrope.*

KEY WORDS – *Y chromosome; Neolithic; peopling of Europe; population genetics; demographic expansions*

Introduction

The genetic characterization of human populations has long been recognized as an important and often indispensable complement to historical research for the understanding of population stratification, the reconstruction of migrations and the evaluation of gene flow. A major leap forward in this field was represented by the possibility of assembling and analysing genetic data into a phylogenetic perspective. Here we are concerned with the application of this approach to population processes that occurred in the Neolithic and post-Neolithic, as inferred from the current population distribution of genetic diversity of the male-specific portion of the human Y chromosome (MSY).

The phylogenetic approach takes into account the sequential accumulation of mutations in a given stretch of DNA (in this case the MSY) over time. A mutation in a given DNA position produces a so-called derived allele at that position. Whenever this event can be considered unique, and subjects carrying the derived allele coexist in the population with subjects carrying the non-mutated (ancestral) allele, a so-called Unique Event Polymorphism (UEP) can be observed (also called biallelic polymorphisms, as typically only two alleles are observed at a given position). In this situation, each derived allele becomes a genetic marker whose origin can be located in a time when the 'parental' type already existed and can, in turn, be considered 'parental' for other mutations that appeared later. Graphs that summarize the overall process are called phylogenetic trees, and they display branches that diverge progressively, each new branch being defined by a new derived allele in any position along the MSY.

A direct extension of these concepts is that all MSY copies (each carried by a different subject) bearing the same derived allelic variant at a given position can be considered, as a first approximation, descendants of the first one in which that particular mutational event occurred (*i.e.* have a monophyletic origin). When considering more than one position on the same DNA molecule, the particular combination of allelic variants (the haplotype) thus represents a record of all the mutational events that occurred on the lineage leading to that haplotype. Alleles shared by two haplotypes testify to their common ancestry, whereas alleles which differentiate two haplotypes show that they belong to lineages that diverged some time in the past and, since then, have accumulated a different series of mutations.

The principles and methods of phylogenetic reconstruction from experimental data can be found in basic books. A general consensus has been reached on the nomenclature of lineages of the human MSY, with alternating letters and numbers from the deepest to the terminal branches (*Y Chromosome Consortium 2002*) (Fig. 1). Each lineage defined by biallelic markers is referred to as a haplogroup, whereas the term haplotype has been restricted to a combination of alleles at Short Tandem Repeats (STRs, see below).

After a pioneering era, the search for biallelic markers exploited high-throughput methods that were first applied to samples representative of the entire world population and, later, oriented to resolve in finer detail some specific lineages.

Another important class of markers is represented by STRs. These include loci with different lengths of the basic repeat, and extensive searches for developing them as markers have been performed (*Kayser et al. 2004*). Mutation at these loci occurs by the addition/subtraction of a number of repeats that is one in the majority of cases. This latter feature fits the theoretical 'Stepwise Mutational Model', which allows us to create expectations for the rate of accumulation of diversity and the distribution of allele sizes. What matters here is that the overall amount of STR diversity observed among the carriers of a specific lineage defined by biallelic markers is a function of the time elapsed since the origin of that lineage, and this property is exploited to arrive at an evaluation of the antiquity of that lineage purely on genetics grounds.

The genetic concepts and tools described above have been used to search for the genetic signatures that

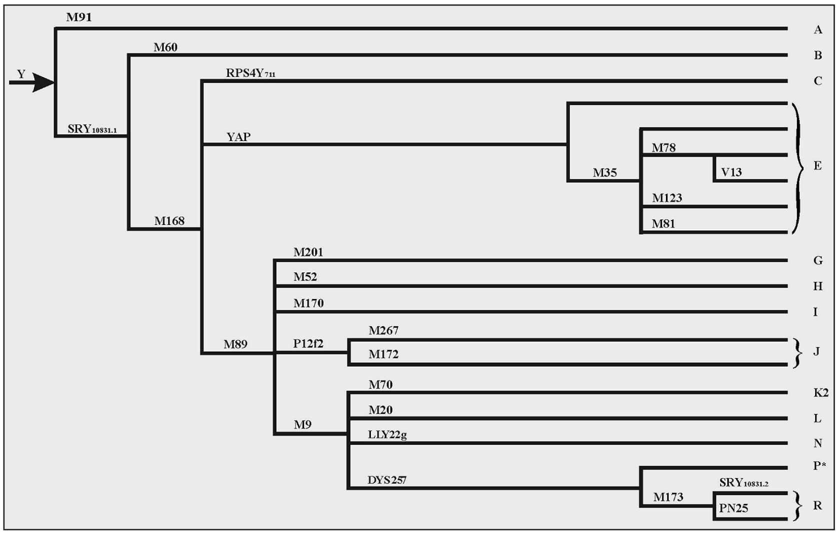


Fig. 1. Schematic representation of the human MSY phylogenetic tree. Only the main branches found in Europe are shown. Mutations that identify each branch are reported above the corresponding line. Letters used in the unified nomenclature for the main haplogroups are shown on the right. The positions of the nodes are not proportional to age estimates.

the Neolithic revolution has left in the male gene pool of populations of the Mediterranean region and other areas nearby. However, it has to be emphasized that events that occurred in the last tenth of millennia or later may have left traces that could only modify the pre-existing repertoire of genetic markers and their particular geographic distributions. These were the result of processes occurring over a much longer time preceding the Neolithic. In fact, even in the current description of the MSY phylogenetic tree, most of the markers are older than 10–15 ky BP, *i.e.* they were already present in the populations that experienced the demographic changes associated with the Neolithic revolution. In conclusion, the question for the geneticist is whether a DNA polymorphism which is able to mark a specific episode indeed exists and is known. In the phylogenetic framework, only under some circumstances one can safely assume that a particular pattern of genetic variation within a single or a group of populations can be the result of a Neolithic or post-Neolithic event. These are:

❶ a biallelic marker near to the tip of a branch of the MSY tree is dated at a time compatible or younger than the Neolithic or,

❷ no such marker is known but, within an older lineage, a subset of populations display a limited amount of STR variation, as if they had been founded at a more recent time and by a reduced number of founders.

We review and discuss here three studies (*Di Giacomo et al. 2004; Cruciani et al. 2007; Luca et al. 2007*) that found genetic evidence of demographic events which occurred after the spread of the Neolithic culture from the Levant and involved Central and South-Eastern Europe.

Post-Neolithic expansion from the Aegean detected by haplogroup J2f1–M92

Haplogroup J has been considered to represent a signature of Neolithic demic diffusion associated with the spread of agriculture (*Semino et al. 1996*). Di Giacomo et al. (*2004*) provided population data which give insights into the ways in which this haplogroup spread.

Phylogenesis. Haplogroup J can be subdivided into two major clades J1 and J2 – characterized by the markers M267 and M172, respectively – plus the rare paragroup J*(xJ1,J2). Within J2, the analysis of a multi-repeat deletion in the dinucleotide STR locus DYS413 (*Malaspina et al. 1998*) resolves a major multifurcation of six independent lineages, recently increased to 11 (*Sengupta et al. 2006*). This additional mutational step within J2 enhances the possibility of performing phylogeographic studies of the entire J2 sub-haplogroup in the Mediterranean area (Fig. 2).

Population Data. Data on the overall occurrence of the entire J haplogroup display an area of high frequencies (>20%) stretching from the Middle East to the central Mediterranean. A review of the frequency data on Europe, the Caucasus, Iran, Iraq and North Africa reveals that, in the Mediterranean, this haplogroup is mainly confined to coastal areas. The high frequencies in Turkey, Jewish and non-Jewish Middle Eastern populations and in the Caucasus, identify the fertile crescent and the east Mediterranean as the focal area for the westward dispersal of the haplogroup. However, the data agree in showing that this haplogroup did not leave a strong signature in the peoples of the northern Balkans and central Europe, this being the most likely route under the demic diffusion model for the entry of agriculturalists into the European continent north to the Alps. Instead, the raw frequency data from within the Iberian, Italian and Balkan peninsulas are more in line with alternative routes of westward spread, possibly maritime.

Internal J diversity. The highest UEP diversity is observed in Turkey, Egypt and three locations in southern Europe. The two most derived sub-haplogroups typed (J2f1–M92 and J2e–M12) were only found in Turkey and locations west to it, boosting the UEP internal diversity. The sub-haplogroup distribution found in Turkey is similar to that reported by Cinnioglu et al. (*2004*).

The UEP diversity within J2 is lower in the Middle East compared to both Turkey and the European locations. In conclusion, the UEP diversity of J in Turkey and southern Europe does not seem to be a simple subset of that present in the area where this haplogroup first originated. This finding, also confirmed in the data by Semino et al. (*2004*), points to Turkey and the Aegean as a relevant source for the J diversity observed throughout Europe.

The contribution of STRs for dating. When combined with the results of 5 STRs, the age returned for the entire J clade and its confidence interval fell within the range reported in previous works (39.6

–10.5 ky BP). Conversely, two of the terminal branches (J2f–M67 and J2f–M92) turned out to be much younger, with estimated ages of 4 and 2.6 ky BP, respectively (C.I. 2.4–7.7 and 1.6–4.2, respectively).

Conclusion 1

The dating estimates obtained by Di Giacomo et al. (*2004*) are in agreement with the appearance of J1 and J2 in the Levant at the time of the Neolithic agriculture revolution. Implicitly, these figures make these haplogroups of little aid in identifying splits in population that may have accompanied the westward dispersal of the entire haplogroup.

The data by Di Giacomo et al. (*2004*) and Semino et al. (*2004*) show that J2f1–M92 is predominantly found in the northern Mediterranean, from Turkey westward. In particular, the estimates for this latter sub-haplogroup are barely compatible with its presence among the early Levantine agriculturalists. Thus the most likely explanation is the emergence of J2f1 in the Aegean area, possibly during the population expansion phase also detected by Malaspina et al. (*2001*), and coincident with the expansion of the Greek world up to the European coast of the Black sea. This scenario would agree with the clustering of J2f1–M92 chromosomes in the north-west of Turkey (*Cinnioglu et al. 2004*).

In summary, this set of data is in agreement with a major discontinuity for the peopling of southern Europe. Here, haplogroup J constitutes not only the signature of a single wave-of-advance from the Levant but, to a greater extent, also of the expansion of the Greek world, with an accompanying novel quota of genetic variation produced during its demographic growth. Recently Cadenas et al. (*2007*) described similar evidence concerning haplogroup J1–M267 as a marker of the Neolithic spread from the fertile crescent to the South Arabian peninsula.

Post-Neolithic expansion from within the Balkans detected by haplogroup E–V13

Cruciani et al. (*2007*) provided detailed population data on the distribution of E–M78 binary sub-haplogroups defined by ten UEPs in 81 populations mainly from Europe, western Asia and Africa. In order to obtain estimates of the internal diversity and coalescence age of E–M78 sub-haplogroups and their associated human migrations and demographic expansions, a set of eleven microsatellites was also analyzed. The same set of microsatellites was also analyzed in a sample of Y chromosomes belonging to the haplogroup J–M12. These results not only provide a refinement of previous evolutionary hypotheses based on microsatellites alone, but also well defined time frames for different migratory events that led to the disper-

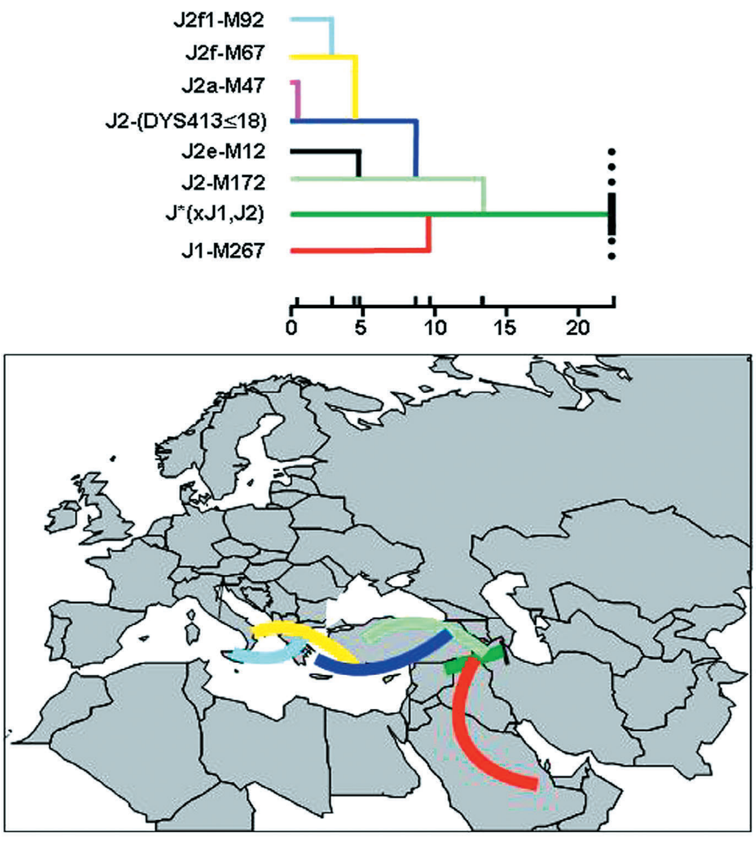


Fig. 2. Top. Phylogenetic arrangement of lineages within haplogroup J, as analysed by Di Giacomo et al. (*2004*). Other internal lineages (*Y Chromosome Consortium 2002; Sengupta et al. 2006*) are not shown. The positions of the nodes of the tree are according to age estimates (*Di Giacomo et al. 2004*) and are marked on the lower bar (0 = present). Bottom. Same phylogenetic tree as above superimposed onto geography, to show the main routes of dispersal of the different lineages. The origin of the entire J haplogroup was arbitrarily placed in the fertile crescent and only south and westward dispersals are outlined. For simplicity, J2–M12 and J2–M47 are not shown. The endpoints of each line are schematic and do not represent exclusive directions of migration (*e.g. *J1–M267 is found not only in the Arabian Peninsula, but also in other areas where J is present).

sal of these haplogroups and sub-haplogroups in the Old World.

Phylogenesis. By analyzing a worldwide sample of 6501 male subjects, 517 chromosomes belonging to haplogroup E-M78 were identified, more than twice the number found in a previous study (*Cruciani et al. 2004*). These chromosomes have been further analyzed for 10 biallelic markers. Four sub-haplogroups were either rare or absent in the global sample, while the other haplogroups/paragroups were relatively common.

Population data and dating. The subdivision of E-M78 in the six common major clades revealed a pronounced geographic structuring: haplogroup E-V65 and the paragroups E-M78* and E-V12* were observed mainly in northern Africa, haplogroup E-V13 was found at high frequencies in Europe, and haplogroup E-V32 was observed at high frequencies only in eastern Africa. The only haplogroup showing a wide geographic distribution was E-V22, relatively common in north-eastern and eastern Africa, but also found in Europe, western Asia, up to southern Asia.

The peripheral geographic distribution of the most derived sub-haplogroups with respect to north-eastern Africa, as well as the results of quantitative analysis of UEP and microsatellite diversity, are strongly suggestive of a north-eastern African origin of E-M78. The evolutionary processes that determined the wide dispersal of the E-M78 lineages from north-eastern Africa to other regions can then be addressed.

Previous studies on the Y chromosome phylogeography have revealed that central and western Asia were the main sources of Palaeolithic and Neolithic migrations contributing to the peopling of Europe (*Underhill et al. 2000; Wells et al. 2001*). The molecular dissection of E-M78 contributes to the understanding of the genetic relationships between northern Africa and Europe. Several lines of evidence suggest that E-M78 sub-haplogroups E-V12, E-V22 and E-V65 were involved in trans-Mediterranean migrations directly from Africa. These haplogroups are common in northern Africa, where they probably originated, and are observed almost exclusively in Mediterranean Europe, as opposed to central and eastern Europe. Also, among the Mediterranean populations, they are more common in Iberia and south-central Europe than in the Balkans, the natural entry-point for chromosomes coming from the Levant. Such findings are hardly compatible with the south-eastern entry of E-V12, E-V22 and E-V65 haplogroups into Europe. Upper limits for the introduction of each of these haplogroups in Europe are given by their estimated ages (18.0, 13.0 and 6.2 ky BP, respectively), while lower bounds should be close to the present time, given the lack of internal geographic structuring.

Haplogroup E-V13 is the only E-M78 lineage that reaches the highest frequencies outside Africa. In fact, it represents about 85% of European E-M78 chromosomes, with a clinal pattern of frequency distribution from the southern Balkan peninsula (19.6%) to western Europe (2.5%) (Fig. 3). The same haplogroup is also present at lower frequencies in Anatolia (3.8%), the Near East (2.0%) and the Caucasus (1.8%). In Africa, haplogroup E-V13 is rare, being observed only in northern Africa at a low frequency (0.9%). The European E-V13 microsatellite haplotypes are related to each other to form a nearly perfect, star-like network, a likely consequence of rapid demographic expansion (*Jobling et al. 2004*). The age of the European E-V13 chromosomes turns out to be 4.0–4.7 ky BP. On the other hand, when only E- V13 chromosomes from western Asia are considered, the resulting network does not show such a star-like shape, and a much earlier age of 11.5 ky BP (95% C.I. 6.8–17.0) is obtained. These results present the possibility of recognizing time windows for i) population movements from the E-M78 homeland in north-eastern Africa to Eurasia, and ii) population movements from western Asia into Europe and, later, within Europe.

The most parsimonious and plausible scenario is that E-V13 originated in western Asia about 11 ky BP, and its presence in northern Africa is the result of a more recent introgression. Under this hypothesis, E-V13 chromosomes sampled in western Asia and their coalescence estimate detect a likely Palaeolithic exit from Africa of E-M78 chromosomes devoid of the V13 mutation, which later occurred somewhere in the Near East/Anatolia. The refinement of location for the source area of such movements and associated chronologies attained by Cruciani et al. (*2007*) may be relevant to controversies on the spread of cultures (and languages) between Africa and Asia in the corresponding timeframes (*Bellwood 2004; Ehret et al. 2004*).

Two haplogroups support the same scenario. As to a western Asia-Europe connection, the data suggest that western Asians carrying E-V13 may have reached the Balkans anytime after 17.0 ky ago, but expanded into Europe not earlier than 5.3 ky ago. Accordingly, the allele frequency peak is located in Europe, whereas the distribution of microsatellite allele variance shows a maximum in western Asia. Based on previously published data discussed above, Cruciani et al. (*2007*) observed that another haplogroup, J-M12, shows a frequency distribution within Europe similar to that observed for E-V13. In order to evaluate whether the present distribution of these two haplogroups can be the consequence of the same expansion/dispersal microevolutionary event, the two frequency distributions in Europe were compared. A high and statistically significant correspondence between the frequencies of the two haplogroups (r = 0.84, 95% C.I. 0.70–0.92) was observed. A similar result (r = 0.85, 95% C.I. 0.70–0.93) was obtained when the series was enlarged with the J-M12 data from Bosnia, Croatia and Serbia (*Marjanović et al. 2005*) matched with the frequencies of E-M78 cluster α (*Peričić et al. 2005*) as a proxy for haplogroup E-V13.

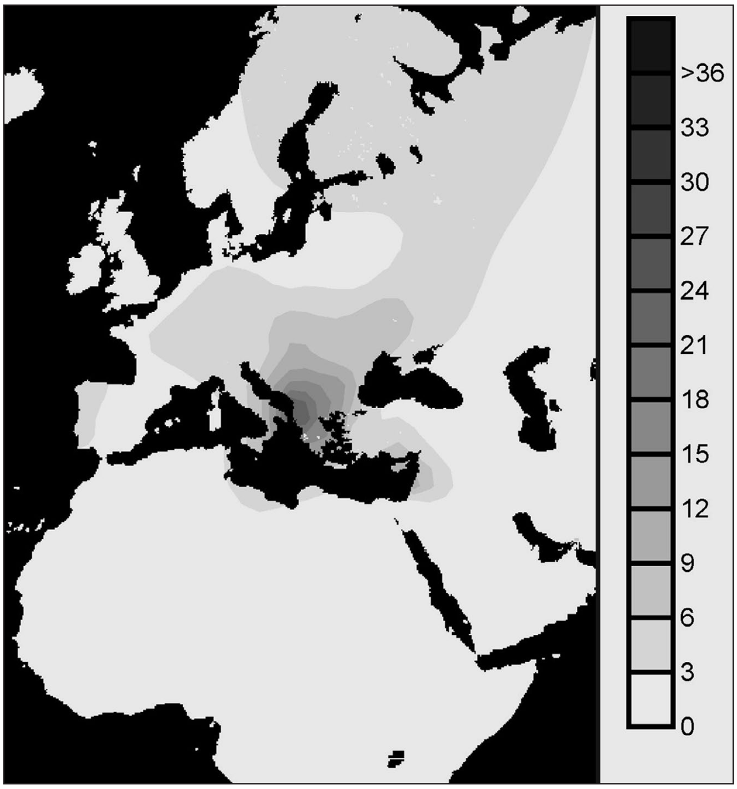


Fig. 3. Map of the observed haplogroup E-V13 frequencies (*Cruciani et al. 2007*).

Finally, tetranucleotide microsatellite data were used in order to obtain a coalescence estimate for the J-M12 haplogroup in Europe. By taking into consideration two different demographic expansion models, age estimates very close to those of E-V13 were obtained, *i.e.* 4.1 ky BP (95% C.I. 2.8–5.4 ky BP) and 4.7 ky BP (95% C.I. 3.3–6.4 ky), respectively.

The overall view was confirmed by subsequent works aimed at clarifying the peopling of Crete. According to Martinez et al. (*2007*) E-M78 cluster α chromosomes (which largely overlap E-V13) may have reached Crete as a result of gene flow from mainland Greece during and/or after the Neolithic. King et al. (*2008*) dated the expansion of E-V13 chromosomes in Crete at 3.1 ky BP, "*arguably reflecting the presence of a mainland Mycenaean population in Crete*". Also, the V13 marker is able to rule out recent genetic affinities between Crete and Egypt, where E chromosomes are mainly devoid of V13.

Conclusion 2

The congruence between frequency distributions, shape of the networks, pair-wise haplotypic differences and coalescent estimates point to a single evolutionary event at the basis of the distribution of haplogroups E-V13 and J-M12 within Europe, a finding never appreciated before. These two haplogroups account for more than one fourth of the chromosomes currently found in the southern Balkans, underlining the strong demographic impact of the expansion in the area.

At least four major demographic events have been envisioned for this geographic area, *i.e.* the post-Last Glacial Maximum expansion (about 20 ky BP) (*Taberlet et al. 1988; Hewitt 2000*), the Younger Dryas-Holocene re-expansion (about 12 ky BP), the population growth associated with the introduction of agricultural practices (about 8 ky BP) and the development of Bronze technology (about 5 ky BP). Though large, the confidence intervals for the coalescence of both haplogroups E-V13 and J-M12 in Europe exclude the expansions following the Last Glacial Maximum, or the Younger Dryas. The estimated coalescence age of about 4.5 ky BP for haplogroups E-V13 and J-M12 in Europe (and their C.I.s) would also exclude a demographic expansion associated with the introduction of agriculture from Anatolia and would place this event at the beginning of the Balkan Bronze Age, a period that saw strong demographic changes as clearly seen in the archaeological record. The arrangement of E-V13 and J-M12 frequency surfaces appears to fit the expectations for a range expansion in an already populated territory. Moreover, similarly to what Peričić et al. (*2005*) found for the E-M78 network, the dispersion of E-V13 and J-M12 haplogroups seems to have mainly followed the rivers connecting the southern Balkans to north-central Europe, a route that had already hastened by a factor of 4–6 the spread of the Neolithic to the rest of the continent (*Davison et al. 2006*).

Post-Neolithic expansion within Central Europe detected by three haplogroups

Luca et al. (*2007*) explored the MSY diversity in five, closely spaced Czech population samples. The haplogroups P-DYS257*(xR1a) and R1a-SRY_{10831} establish a major divide across central Europe, initially identified with a line roughly extending from the Adriatic to the Baltic (*Malaspina et al. 2000*). This line separates high frequencies of R1a-SRY_{10831} to the East from low frequencies to the West, with an opposite trend for P-DYS257*(xR1a). Kayser et al. (*2005*) found this sharp genetic boundary to coincide with the German-Polish border, and interpreted it as the result of massive population movements associated with World War II, superimposed on pre-existing continent-wide clines. The Czech Republic appears to be affected by a much smoother frequency shift, if any, supporting the interpretation of a very recent origin of the German-Polish discrepancy.

Overall, the haplogroup frequencies identify the Czech population as one influenced to a very moderate extent by genetic inputs from outside Europe in the post-Neolithic and historical times. It thus may represent an ideal population to draw inferences on geographically confined processes that might also have occurred in other parts of central Europe.

Inferences based on STR variation in the three most common haplogroups obtained with coalescent methods deserve careful evaluation. First, even though sampling was carried out in a limited geographic area, it returned age estimates for I-M170, P-DYS257*(xR1a) and R1a-SRY_{10831} similar to those obtained in reports with a wider geographical coverage (approximately 500, 400 and 350 generations ago, respectively). Conservatively, one can simply conclude that the Czech population harbours a large part of the STR variation generated in each haplogroup. The ages of the three most common haplogroups turned out to be largely overlapping, and compatible with their presence during or soon after the Last Glacial Maximum.

However, a local signal emerged from the distribution of this diversity, *i.e.* that of a fast and recent population growth, which persists even after relaxing the prior assumptions of the dating method and is similar for the three haplogroups. This is summarized by the parameters alpha (rate of population growth, 0.023, 0.031 and 0.032 for I-M170, P-DYS257*(xR1a) and R1a-SRY_{10831}, respectively) and beta (beginning of population growth, 97, 150 and 125 generations ago, respectively) and their relatively narrow confidence intervals (up to 1.5 fold the average). Estimation of the beta parameter most likely locates the beginning of this process in the 1st millennium BC, with confidence intervals that are barely compatible with the archaeologically documented introduction of Neolithic technology in this area (*Haak et al. 2005*). At least for the female lineage, these authors found a little genetic contribution to the present European gene pool from the first farmers settled in the area. Independently of the relevance of these data for reconstructing the genetics of Europe in the early Neolithic (*Barbujani and Chikhi 2006*), the central value for population growth coincides with a later period of repeated changes in the material cultures in this geographic region, driven by the development of metal technologies and the associated social and trade organization.

Conclusion 3

The combined use of UEP and STR markers allowed the exploration of different time horizons for the age of molecules and for the process of population growth (*Torroni et al. 2006*). In fact, the data for the Czech population favour a model in which the age of the most common MSY molecules could be separated from consistent population growth. Similar results have been obtained for Lithuania (*Kasperaviciute et al. 2004*). Both regions lie at the north-western and northern edge, respectively, of the putative homeland (central and south-eastern Europe) of an aboriginal quota of the molecular MSY diversity. This offers an unprecedented opportunity to test alternative models for a continental pattern of diversity which is arranged along the southeast-to-northwest axis. The question of whether this could be the result not only of a single demic diffusion, but also of the demographic increases affecting pre-existing local gene pools is still open. Examples of the recent growth of pre-existing gene pools that add complexity to the simple demic diffusion models, are provided by mtDNA haplogroup HV and H1 (*Achilli et al. 2004*), as well as Y chromosomal haplogroup R-SRY_{2627} (*Hurles et al. 1999*).

Concluding remarks

The build-up of present day male-specific Y chromosome (MSY) diversity can be viewed as an increase in complexity, due to the repeated addition of new variation to the pre-existing background by two main mechanisms: the immigration of differentiated MSY copies from outer regions, and the accumulation of novel MSY variants generated by new mutations *in loco*. Recently, Sengupta et al. (*2006*) pointed out that combining highly resolved phylogenetic hierarchy, haplogroup internal diversification, geography and expansion time estimates can lead to the appropriate diachronic partition of the MSY pool. The DNA content of the MSY ensures that abundant diversity exists to proceed a long way in this process of phylogeographic refinement, eventually leading to a level of resolution for human history comparable with, or even greater than, that achieved by mitochondrial DNA (*Torroni et al. 2006*).

In addition, environmental or cultural transitions are usually considered to be the basis of dramatic changes in the size of human populations. These changes, too, are expected to leave a distinct signature in the genetic pools of the populations that experienced them. Even in the absence of known markers that are able to qualitatively mark these episodes, quantitative analysis is feasible and can sometimes lead to robust inferences.

Here we show that a growing body of work converges in disclosing a further level of complexity in the genetic landscape of central and south-eastern Europe. This appears to be, to a large extent, the consequence of a recent population increase *in situ*, rather than the result of a mere flow of western Asian migrants during the early Neolithic.

ACKNOWLEDGEMENTS

This work was supported by grants Grandi Progetti Ateneo, Sapienza Università di Roma (to R.S.), and the Italian Ministry of the University – Progetti di Ricerca di Interesse Nazionale 2007 (to R.S. and A.N. grant numbers 20073RH73W_002 and 20073RH73W_003).

REFERENCES

ACHILLI A., RENGO C., MAGRI C., BATTAGLIA V., OLIVIERI A., SCOZZARI R., CRUCIANI F., ZEVIANI M., BRIEM E., CARELLI V. et al. 2004. The molecular dissection of mtDNA haplogroup H confirms that the Franco-Cantabrian glacial refuge was a major source for the European gene pool. *American Journal of Human Genetics 75:910–8*.

BARBUJANI G., CHIKHI L. 2006. Population genetics: DNAs from the European Neolithic. *Heredity 97: 84–5*.

BELLWOOD P. 2004. The origins of Afroasiatic. *Science 306: 1681*.

CADENAS A. M., ZHIVOTOVSKY L. A., CAVALLI-SFORZA L. L., UNDERHILL P. A., HERRERA R. J. 2007. Y-chromosome diversity characterizes the Gulf of Oman. *European Journal of Human Genetics 13: 374–86*.

CINNIOGLU C., KING R., KIVISILD T., KALFOGLU E., ATASOY S., CAVALLERI G. L., LILLIE A. S., ROSEMAN C. C., LIN A. A., PRINCE K. et al. 2004. Excavating Y-chromosome haplotype strata in Anatolia. *Human Genetics 114: 127–48*.

CRUCIANI F., LA FRATTA R., SANTOLAMAZZA P., SELLITTO D., PASCONE R., MORAL P., WATSON E., GUIDA V., COLOMB E. B., ZAHAROVA B. et al. 2004. Phylogeographic analysis of haplogroup E3b (E-M215) y chromosomes reveals multiple migratory events within and out of Africa. *American Journal of Human Genetics 74: 1014–22*.

CRUCIANI F., LA FRATTA R., TROMBETTA B., SANTOLAMAZZA P., SELLITTO D., COLOMB E. B., DUGOUJON J. M., CRIVELLARO F., BENINCASA T., PASCONE R. et al. 2007. Tracing past human male movements in northern/eastern Africa and western Eurasia: new clues from Y-chromosomal haplogroups E-M78 and J-M12. *Molecular Biology and Evolution 24: 1300–11*.

DAVISON K., DOLUKHANOV P., SARSON G. R., SHUKUROV A. 2006. The role of waterways in the spread of the Neolithic. *Journal of Archaeological Science 33: 641–52*.

DI GIACOMO F., LUCA F., POPA L. O., AKAR N., ANAGNOU N., BANYKO J., BRDICKA R., BARBUJANI G., PAPOLA F., CIAVARELLA G. et al. 2004. Y chromosomal haplogroup J as a signature of the post-neolithic colonization of Europe. *Human Genetics 115: 357–71*.

EHRET C., KEITA S. O. Y., NEWMAN P. 2004. The origins of Afroasiatic. *Science 306: 1680–81*.

HAAK W., FORSTER P., BRAMANTI B., MATSUMURA S., BRANDT G., TANZER M., VILLEMS R., RENFREW C., GRONENBORN D., ALT K. W. et al. 2005. Ancient DNA from the first European farmers in 7500-year-old Neolithic sites. *Science 310: 1016–8*.

HEWITT G. 2000. The genetic legacy of the Quaternary ice ages. *Nature 405: 907–13*.

HURLES M. E., VEITIA R., ARROYO E., ARMENTEROS M., BERTRANPETIT J., PEREZ-LEZAUN A., BOSCH E., SHLUMUKOVA M., CAMBON-THOMSEN A., MCELREAVEY K. et al. 1999. Recent male-mediated gene flow over a linguistic barrier in Iberia, suggested by analysis of a Y-chromosomal DNA polymorphism. *American Journal of Human Genetics 65: 1437–48*.

JOBLING M. A., HURLES M. E., TYLER-SMITH C. 2004. *Human evolutionary genetics*. New York: Garland Science.

KASPERAVICIUTE D., KUCINSKAS V., STONEKING M. 2004. Y chromosome and mitochondrial DNA variation in Lithuanians. *Annals of Human Genetics 68: 438–52*.

KAYSER M., KITTLER R., ERLER A., HEDMAN M., LEE A. C., MOHYUDDIN A., MEHDI S. Q., ROSSER Z., STONEKING M., JOBLING M. A. et al. 2004. A comprehensive survey of human Y-chromosomal microsatellites. *American Journal of Human Genetics 74: 1183–97*.

KAYSER M., LAO O., ANSLINGER K., AUGUSTIN C., BARGEL G., EDELMANN J., ELIAS S., HEINRICH M., HENKE J., HENKE L. et al. 2005. Significant genetic differentiation between Poland and Germany follows present-day political borders, as revealed by Y-chromosome analysis. *Human Genetics 117: 428–43*.

KING R. J., OZCAN S. S., CARTER T., KALFOGLU E., ATASOY S., TRIANTAPHYLLIDIS C., KOUVATSI A., LIN A. A., CHOW C.-E. T., ZHIVOTOVSKY L. A. et al. 2008. Differential Y-chromosome Anatolian influences on the Greek and Cretan Neolithic. *Annals of Human Genetics 72: 205–14*.

LUCA F., DI GIACOMO F., BENINCASA T., POPA L. O., BANYKO J., KRACMAROVA A., MALASPINA P., NOVELLETTO A., BRDICKA R. 2007. Y-chromosomal variation in the Czech Republic. *American Journal of Physical Anthropology 132: 132–39*.

MALASPINA P., CRUCIANI F., CIMINELLI B. M., TERRENATO L., SANTOLAMAZZA P., ALONSO A., BANYKO J., BRDICKA R., GARCIA O., GAUDIANO C. et al. 1998. Network analyses of Y-chromosomal types in Europe, northern Africa, and western Asia reveal specific patterns of geographic distribution. *American Journal of Human Genetics 63: 847–60*.

MALASPINA P., CRUCIANI F., SANTOLAMAZZA P., TORRONI A., PANGRAZIO A., AKAR N., BAKALLI V., BRDICKA R., JARUZELSKA J., KOZLOV A. et al. 2000. Patterns of male-specific inter-population divergence in Europe, West Asia and North Africa. *Annals of Human Genetics 64: 395–412*.

MALASPINA P., TSOPANOMICHALOU M., DUMAN T., STEFAN M., SILVESTRI A., RINALDI B., GARCIA O., GIPARAKI M., PLATA E., KOZLOV A. I. et al. 2001. A multistep process for the dispersal of a Y chromosomal lineage in the Mediterranean area. *Annals of Human Genetics 65: 339–49*.

MARJANOVIĆ D., FORNARINO S., MONTAGNA S., PRIMORAC D., HADŽISELIMOVIĆ R., VIDOVIĆ S., POJSKIĆ N., BATTAGLIA V., ACHILLI A., DROBNIČ K. et al. 2005. The peopling of modern Bosnia-Herzegovina: Y-chromosome haplogroups in the three main ethnic groups. *Annals of Human Genetics 69: 757–63*.

MARTINEZ L., UNDERHILL P. A., ZHIVOTOVSKY L. A., GAYDEN T., MOSCHONAS N. K., CHOW C. E., CONTI S., MAMOLINI E., CAVALLI-SFORZA L. L., HERRERA R. J. 2007. Paleolithic Y-haplogroup heritage predominates in a Cretan highland plateau. *European Journal of Human Genetics 15: 485–93*.

PERIČIĆ M., LAUC L. B., KLARIĆ I. M., ROOTSI S., JANIČIJEVIĆ B., RUDAN I., TERZIĆ R., COLAK I., KVESIĆ A., POPOVIĆ D. et al. 2005. High-resolution phylogenetic analysis of southeastern Europe traces major episodes of paternal gene flow among Slavic populations. *Molecular Biology and Evolution 22: 1964–75*.

SEMINO O., PASSARINO G., BREGA A., FELLOUS M., SANTACHIARA-BENERECETTI A. S. 1996. A view of the neolithic demic diffusion in Europe through two Y chromosome-specific markers. *American Journal of Human Genetics 59: 964–8*.

SEMINO O., MAGRI C., BENUZZI G., LIN A. A., AL-ZAHERY N., BATTAGLIA V., MACCIONI L., TRIANTAPHYLLIDIS C., SHEN P., OEFNER P. J. et al. 2004. Origin, diffusion, and differentiation of Y-chromosome haplogroups E and J: inferences on the neolithization of Europe and later migratory events in the Mediterranean area. *American Journal of Human Genetics 74: 1023–34*.

SENGUPTA S., ZHIVOTOVSKY L. A., KING R., MEHDI S. Q., EDMONDS C. A., CHOW C. E., LIN A. A., MITRA M., SIL S. K., RAMESH A. et al. 2006. Polarity and temporality of high-resolution y-chromosome distributions in India identify both indigenous and exogenous expansions and reveal minor genetic influence of central asian pastoralists. *American Journal of Human Genetics 78: 202–21*.

TABERLET P., FUMAGALLI L., WUST-SAUCY A.-G. J.-F. C. 1988. Comparative phylogeography and postglacial colonization routes in Europe. *Molecular Ecology 7: 453–64*.

TORRONI A., ACHILLI A., MACAULAY V., RICHARDS M., BANDELT H. J. 2006. Harvesting the fruit of the human mtDNA tree. *Trends in Genetics 22: 339–45*.

UNDERHILL P. A., SHEN P., LIN A. A., JIN L., PASSARINO G., YANG W. H., KAUFFMAN E., BONNE-TAMIR B., BERTRANPETIT J., FRANCALACCI P. et al. 2000. Y chromosome sequence variation and the history of human populations. *Nature Genetics 26: 358–61*.

WELLS R. S., YULDASHEVA N., RUZIBAKIEV R., UNDERHILL P. A., EVSEEVA I., BLUE-SMITH J., JIN L., SU B., PITCHAPPAN R., SHANMUGALAKSHMI S. et al. 2001. The Eurasian heartland: a continental perspective on Y-chromosome diversity. *Proceedings of the National Academy of Sciences USA 98: 10244–9*.

Y CHROMOSOME CONSORTIUM. 2002. A nomenclature system for the tree of human Y-chromosomal binary haplogroups. *Genome Research 12: 339–48*.

back to contents

UDK 903'12/'15(560-14)"633/634":314.17:551.581.2
Documenta Praehistorica XXXV (2008)

Warfare in Late Neolithic/Early Chalcolithic Pisidia, southwestern Turkey. Climate induced social unrest in the late 7th millennium calBC

Lee Clare[1], Eelco J. Rohling[2], Bernhard Weninger[1], Johanna Hilpert[3]
1 *Universität zu Köln, Institut für Ur- und Frühgeschichte, Radiocarbon Laboratory, Köln, D*
lclare@smail.uni-koeln.de
2 *National Oceanography Centre, Southampton, UK*
3 *Universität zu Köln, Institut für Ur- und Frühgeschichte, Köln, D*

ABSTRACT – *This paper proposes an association between climate forcing connected with the 8200 calBP 'climate event' and a postulated phase of internecine warfare and population collapse at Late Neolithic/Early Chalcolithic sites in Pisidia, southwestern Turkey. A summary of this evidence is provided and a hypothetical scenario considered in the context of contemporaneous developments in neighbouring regions.*

IZVLEČEK – *V članku predlagamo povezavo med klimatskimi anomalijami – 8200 calBP 'klimatskim dogodkom' in postulirano fazo morilskih spopadov in populacijskega kolapsa v pozno neolitskih/ zgodnje halkolitskih najdiščih v Pisidiji, v jugozahodni Turčiji. Predstavljeni so dokazi ter razmislek o hipotetičnem scenariju dogajanja v kontekstu sočasnega razvoja v sosednjih regijah.*

KEY WORDS – *8200 calBP 'climate event'; Anatolia; warfare; GIS-analysis; Neolithisation*

Introduction

The past few years have seen the publication of a number of papers in which human reactions to climate forcing at the time of the 8200 calBP 'climate event' have been discussed. These have focused not only on potential implications for contemporaneous Neolithic communities in the Eastern Mediterranean, and its possible outcome on Neolithisation processes (*Weninger et al. 2005; 2006*), but have also considered temporal correlations with developments in Late Neolithic Cilicia and the Balikh valley (*Clare et al. in press*), as well as Mesolithic and/or transitional Neolithic cultures in western, north-western, central and south-eastern parts of Europe (*Weninger et al. this volume; Weninger et al. 2007; Budja 2007*).

In the following, emphasis is on the geographical region of south-western Anatolia (ancient Pisidia), which in the late seventh millennium calBC was a centre of emerging 'western' painted pottery (Hacılar) traditions[1]. Excavations at four contemporaneous sites in Pisidia (Hacılar, Kuruçay Höyük, Höyücek Höyük, Bademağacı Höyük) have produced evidence for the erection of fortifications, episodes of destruction through burning, and large scale conflagrations, all of which coincide with the 8200 calBP 'climate event'. In this paper it is argued that these may be connected with episodes of warfare triggered by the effects of altered climatic conditions in the late seventh millennium calBC.

1 At roughly the same time, the 'eastern' painted ware tradition, or Halaf culture, was developing under the influence of Hassuna and Samarra in the Middle Euphrates region (*cf. Cruells & Nieuwenhuyse 2004*).

Although a causal relationship between prehistoric warfare and climate change is certainly nothing new, and has been discussed for a number of years by researchers with a focus on the American Southwest (*e.g. Haas 1990; Haas and Creamer 1993; LeBlanc 1999*), as far as we are aware, this is the first time that such a hypothesis has been proposed for the Late Neolithic/Early Chalcolithic period in the Anatolian landscape of Pisidia.

Climate change around 8200 calBP

The period around 8200 calBP is marked by distinct climate change on large, Northern Hemispheric or even global, scales (for reviews, see *Alley et al. 1997; Mayewski et al. 2004; Rohling and Pälike 2005; Alley and Ágústsdóttir 2005*). In Greenland ice-core stable oxygen isotope data of the ice itself, there is a sharp 'event' that stands out from a largely 'stable' Holocene time-series, and it was first considered as a widespread abrupt climate change event in Alley et al. (*1997*). Based on the recently updated layer-counted timescale for Greenland ice cores, the apex of this event is dated at 8190 calBP, with a counting uncertainty of 47 yr (*Rasmussen et al. 2006*). Thomas et al. (*2007*) investigated the event in the ice cores in great detail, and concluded that it began at 8247 calBP and ended at 8086 calBP, with a central peak event between 8212 and 8141 calBP. At the Greenland summit, the observed oxygen isotope anomaly may imply about 6 ± 2 °C cooling (*Alley et al. 1997*).

The North Atlantic record

The 8200 calBP climate event has been ascribed to catastrophic flooding from glacial lakes Agassiz and Ojibway into the North Atlantic during the terminal demise of the Laurentide ice sheet, dated at 8470 ± 300 calBP (likely due to ice-dam collapse) (*Barber et al. 1999*). It was suggested that the freshwater release into the North Atlantic temporarily reduced, or even shut down, the formation of North Atlantic Deep Water (NADW), resulting in reduced oceanic northward heat transport and consequent cooling around the North Atlantic (*DeVernal et al. 1997; Alley et al. 1997*). Increasingly sophisticated modelling studies show good apparent agreement between the impacts of freshwater-related reduction of NADW formation and the changes inferred from observations on hemispheric to global scales, and also that the climate impacts would develop within a few decades after the freshwater flooding event (*Renssen et al. 2002; 2007; Bauer et al. 2004; Alley and Ágústsdóttir 2005; Wiersma and Renssen 2006; LeGrande et al. 2006*).

Studying a marine sediment core from Gardar Drift, where they can constrain the Iceland-Scotland Overflow Water (ISOW) component of NADW, Ellison et al. (*2006*) infer from stable oxygen isotope data a main freshening pulse in the North Atlantic close to the 8470 calBP timing of the Agassiz/Ojibway flood. They compare this with ISOW flow rates based on sortable silt data that are co-registered with their oxygen isotope data in the same sample archive. The sortable silt values indicate an onset of ISOW weakening around 8450 calBP, with a gradual decline leading to the weakest ISOW interval at about 8260–8050 calBP. These results are rather puzzling, since all models suggest that the NADW (including ISOW) response would have occurred within a few decades of the flood. In the models, the NADW slowdown then results in a sharp cool event around the North Atlantic. However, in the dataset of Ellison et al. (*2006*), there is a first cool spike centred on about 8490 calBP (spanning roughly 8550–8450 calBP), followed by a more distinct cool event that spans the interval 8380–8260 calBP. The latter immediately pre-dates (without overlap) a rapid reduction to lowest ISOW flow intensity, which spans the interval 8260–8050 calBP (see Figure 3 of *Ellison et al. 2006*). The data of Ellison et al. (*2006*) therefore pose some challenging questions: (1) Why did it take some two centuries after the main flooding event before ISOW flow was minimised, when models suggest there should be an almost instantaneous response? (2) Why does their main cold event appear to predate the ISOW flow minimum, instead of the expected reversed or virtually synchronous relationship? These questions cannot be brushed aside on the basis of dating uncertainties, since all the records of Ellison et al. (*2006*) are co-registered in a single sample archive, so that relative phase relationships are fixed.

Kleiven et al. (*2007*) emphasise that ISOW is just one component of NADW, and that the complete NADW signature should be considered when comparing data with models for the 8200 calBP climate event. They endeavour to do so by studying a marine sediment core from Eirik Drift, at the southern tip of Greenland, which records information from the total combined Nordic Seas overflow. Kleiven et al. (*2007*) find a single event of NADW weakening, which they date between 8380 and 8270 calBP, in close agreement with the main cooling event that Ellison et al. (*2006*) correlate to the actual 8200 calBP event. It is also within dating errors of both the 8247–8086 calBP age of the cold event in Greenland ice cores (*Thomas et al. 2007*) and the 8470 ± 300 calBP age of the Agassiz/Ojibway flood (*Barber et al. 1999*).

Kleiven et al. (*2007*) assert that their results confirm the scenario of flooding leading to NADW weakening and consequent climatic cooling (with only minor delays in between these stages), as seen in modelling experiments (*e.g. Renssen et al. 2002; 2007; Bauer et al. 2004; Alley and Ágústsdóttir 2005; Wiersma and Renssen 2006; LeGrande et al. 2006*). Note that this would imply that the onset of the gradual ISOW flow reduction at about 8500 calBP (*Ellison et al. 2006*) predated by more than a century the sharp flood-related '8200 calBP' cool event (8380–8260 calBP in *Ellison et al. 2006*). The first microfossil evidence of surface cooling in fact starts even earlier, around 8550 cal BP, in the records of Ellison et al. (*2006*) (their Figure 3). Even more intriguing, the ISOW flow minimum postdates the main 8380–8260 calBP cold event that Ellison et al. (*2006*) correlate to the actual 8200 calBP event, and hence the period of minimum total composite NADW influence over Eirik Drift noted by Kleiven et al. (*2007*). Clearly, relationships are by no means simple between the flooding, ISOW intensity at Gardar Drift, composite NADW intensity at Eirik Drift, and the (potentially complex) climate responses. While the short and sharp composite NADW reduction at Eirik Drift would seem to be related to the flooding event in a manner expected from modelling experiments (*Kleiven et al. 2007*), the Gardar Drift records of ISOW seem to be telling us about more subtle underlying changes, which span some 5 centuries from about 8500 calBP until the recovery of ISOW flow intensity at around 8000 calBP (*Ellison et al. 2006*). The state of knowledge should not be seen as 'muddled' or 'confused', but instead as a developing richness of information that will eventually lead towards a comprehensive understanding of climate change in the times around 8200 calBP.

Reviewing high-quality palaeoclimate records (drawing on the wider Holocene overview of *Mayewski et al. 2004*), and focusing on co-registered relationships between statistically significant anomalies, Rohling and Pälike (*2005*) established for the first time that the actual short, sharp 8200 calBP event occurred 'embedded' within a broader underlying climate anomaly. The broad anomaly was found to span 5 to 6 centuries, between about 8600/8500 and 8000 calBP, an interval similar to that of the entire ISOW anomaly of Ellison et al. (*2006*), as noted by those authors. The broad underlying anomaly forms part of a distinct repeating pattern of anomalies during the Holocene, marked by glacier expansions on a global scale; the well-known Little Ice Age of AD 1400–1900 forms the most recent example (*Mayewski et al. 2004*). Given that there clearly are two mechanisms at play, one causing the repeating pattern of anomalies during the Holocene, and the other a 'climatic accident' (the Agassiz/Ojibway flood), attribution of any record to the actual 8200 cal BP climate event has to be performed with the utmost caution (*Rohling and Pälike 2005*). A sound way forward is to carefully document patterns of change through an extended interval from about 9000 to 7000 calBP, to distinguish longer-term changes between about 8600/8500 and 8000 calBP from the sharp, short actual 8200 calBP event that has a Greenland ice-core age of about 8250–8080 cal BP (*Thomas et al. 2007*).

The Aegean record

The present paper is specifically concerned with the Aegean/Levantine region, and the regional expressions of climate change around 8200 calBP are here discussed within the context of a key record for identifying Holocene climate anomalies (Rapid Climate Change events, or RCCs, after *Mayewski et al. 2004*) in the eastern Mediterranean region, based on microfossil assemblages in marine sediment core LC21 (*Rohling et al. 2002a*). LC21 was recovered from the SE Aegean Sea, on the boundary between the north-south extended Aegean Sea and the west-east extended Levantine Sea, which is a sensitive location for the recording of expansions and contractions of the cooler Aegean signature relative to the warmer Levantine signature.

Changes in the assemblages of marine unicellular zooplankton microfossils (planktonic foraminifera) in sediment core LC21 were used to determine a Holocene history of relative surface-water temperature fluctuations (*Rohling et al. 2002a*). Mapping of the distribution of the same assemblages in core tops from the Aegean Sea allowed rough calibration of the relative changes into more quantitative estimates of sea surface temperature change. This work revealed a pattern of three main Holocene RCCs that were associated with temperature drops of the order of 2–3 °C in the SE Aegean region, notably in winter (*Rohling et al. 2002a*). Rohling et al. (*in press*) corroborate this initial estimate by similar values from statistically more robust calibrations of the faunal changes using an Artificial Neural Network approach (for method, see *Hayes et al. 2005*) (Fig.

1). Further to the north in the Aegean Sea, cooling may have been a little bit more intense (*Rohling et al. in press*). Contemporaneous cooling events of similar magnitude are known from the western Mediterranean, where they were quantified with organic geochemical techniques (*Cacho et al. 2001*).

Rohling et al. (*2002a*), Mayewski et al. (*2004*), and Rohling and Pälike (*2005*) have placed the Aegean record of RCCs within a wider framework of climate variability, and strong agreement was found between the Aegean RCCs and the more intense Holocene events found both throughout the North Atlantic region, and further afield. Besides global glacier advances, the Holocene RCCs are also marked by distinct increases in the concentration of K^+ ions (*i.e.* $[K^+]$) in the GISP2 ice core from Greenland (*O'Brien et al. 1995; Mayewski et al. 1997; 2004*) (Fig. 1). Potassium transport to the Greenland ice sheet is strongly related to the late winter-spring intensity of the atmospheric high-pressure conditions over Siberia (*Meeker and Mayewski 2002*), so that enhanced $[K^+]$ within the RCCs suggests an intensification of Eurasian winter conditions. The Holocene RCCs are also characterised by peaks in the sea-salt $[Na^+]$ series from the GISP2 ice core (Fig. 1). These sea-salt $[Na^+]$ variations reflect the intensity of the Icelandic Low (*Meeker and Mayewski 2002*). An intensified Icelandic Low causes intensification of onshore winds to Greenland, so that sea ice stays longer each season, and persists more from season to season. The inferred increase of North Atlantic sea-ice extent and duration during the Holocene RCCs is supported by concomitant increases in the Holocene, most likely sea-ice transported, ice-rafted debris concentrations in North Atlantic sediments during the RCCs (*Bond et al. 2001*). Mangini et al. (*2007*) presented a detailed composite speleothem record from Spannagel Cave, central Alps, which displays a temporal structure similar to that of records of North Atlantic hydrographic/sea-ice variations, as obtained from ice-rafted debris counts in marine sediment cores (*Bond et al. 2001*) and supported by the GISP2 ice-core $[Na^+]$ series (Fig. 1). The main RCCs in this speleothem record may be associated with winter cooling of roughly 3 °C, although Mangini et al. (*2007*) argue that their oxygen isotope data are better considered as a function of precipitation origin rather than temperature. The combined information demonstrates a significant correlation between terrestrial and marine palaeoclimate records at the time of Holocene RCCs, with an emphasis on winter-time perturbations.

The cooling events in the Aegean Sea have been ascribed to intensification and frequency increase of wintertime northerly outbreaks of cold polar and continental air over the basin, relative to the present (*Rohling et al. 2002a*). Such outbreaks still occur today, and for a summary and data of such an event in December 2001, we refer to Casford et al. (*2003*; and below). The northerly outbreaks are a conse-

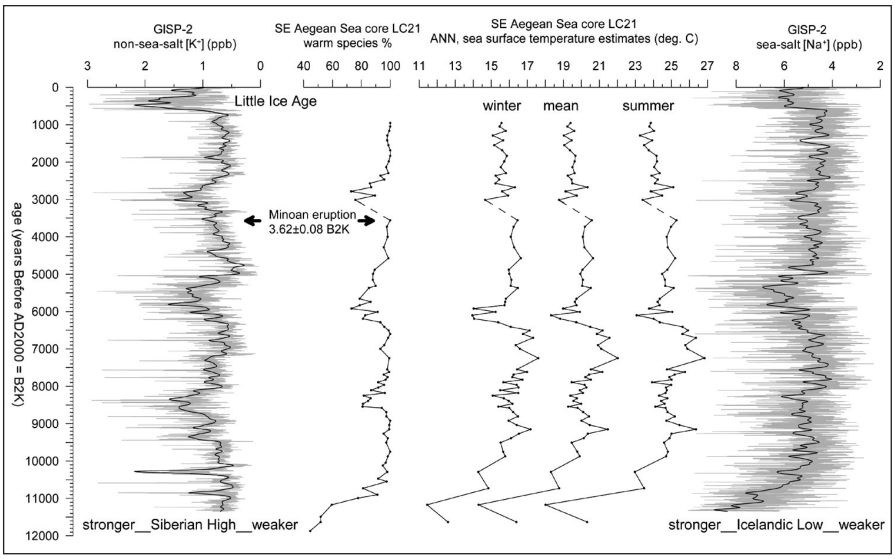


Fig. 1. After Rohling et al. (*in press*). Compilation of the Holocene non-sea-salt $[K^+]$ and sea-salt $[Na^+]$ series for the GISP2 ice core from Greenland (*O'Brien et al. 1995; Mayewski et al. 1997*), with 200-year bandpass filters, along with the sea surface reconstructions for the SE Aegean Sea from planktonic foraminiferal abundance data for sediment core LC21. The qualitative warm species percentage record is the same as that shown in Rohling et al. (*2002a*). An artificial neural network (ANN) technique is used to transform the faunal abundance data into records of winter, summer, and annual mean sea surface temperature. The technique and its core-top calibration set are fully explained in Hayes et al. (*2005*). Note that the records are presented on the left-hand side versus age in years Before 2000 CE (= yr B2K), which is the conventionally used ice-core reference datum, as well as (right-hand side) versus age in years CE/BCE (as used throughout this volume). The age of the Minoan eruption is indicated after Friedrich et al. (*2006*).

quence of the Mediterranean's latitudinal position and its mountainous northerly margin, which exert an important control on circulation and water-mass transformations in the Mediterranean Sea, and contemporaneous cooling events have been found in the Adriatic Sea and in the western Mediterranean (*Rohling et al. 1997; 2002b; Casford et al. 2001; Cacho et al. 1999; 2000; 2001; Frigola et al. 2007*). To understand the relationship between the frequency and intensity of wintertime northerly outbreaks over the Mediterranean and the climatic patterns inferred from proxy records from the wider northern hemisphere (particularly the Greenland ice sheet), we first consider the main drivers behind the general climatic conditions over the region.

During summer, climate over the eastern sector of the eastern Mediterranean is dominated by northward displacement of North African subtropical high-pressure conditions, causing widespread drought. The Aegean Sea then comes under the influence of northerly winds ('Etesians'), due to the extension of the deep monsoon Low of NW India over the Iranian highlands and Anatolia. Although this semi-permanent extension of the monsoon low causes local depression formation around Cyprus and the Middle East, dry summer conditions prevail due to descent in the upper troposphere that is related to the intense Asian summer monsoon (*Rodwell and Hoskins 1996; Trigo et al. 1999*).

During winter, the subtropical conditions are displaced southward, and polar/continental conditions expand southward from the North. Low surface-pressure conditions over the central to eastern Mediterranean develop as a consequence of the high sea-surface temperatures relative to the surrounding land masses, fuelled by the high thermal capacity of the basin's water masses (*Lolis et al. 2002*). Interactions between this Mediterranean Low and north-eastward extension of the Azores High (over Iberia, France, and southern Britain), or westward ridging of the Siberian High towards NW Europe and southern Scandinavia (*Maheras et al. 1999; Lolis et al. 2002*), drive intense northerly flows of cold and dry air masses towards the Mediterranean basin, which are channelled through valleys in the mountainous topography of the northern Mediterranean margin. Channelling of polar and continental airflows through the lower Rhone Valley towards the Gulf of Lyons gives rise to the 'Mistral', while similar flows towards the Adriatic and Aegean Seas cause the 'Bora' and 'Vardar' (Fig. 2). These wintertime outbursts of polar and continental air cause intense evaporation and associated cooling of the sea surface (*e.g. Leaman and Schott 1991; Saaroni et al. 1996; Poulos et al. 1997; Maheras et al. 1999; Casford et al. 2003; and references therein*).

The enhanced potassium accumulation in the Greenland ice sheet during Holocene RCCs (Fig. 1) suggests an intensified late winter-early spring Siberian High (*Meeker and Mayewski 2002*). Given that expansion and westward ridging of the Siberian High are important processes controlling northerly outbreaks over the Mediterranean (*Maheras et al. 1999; Lolis et al. 2002*), we infer that the enhanced Siberian High intensity during RCCs led to an increase in the frequency and intensity of northerly air outbursts over the Mediterranean (notably the Aegean). This would offer a realistic mechanism to explain the observed episodes of about 2–3 °C winter sea surface cooling. Here, it should be emphasised that mean winter sea-surface cooling by such an amount implies significant atmospheric forcing, because the well-mixed surface ocean has very high thermal inertia. Over land, therefore, the impacts should be expected to have been much sharper and

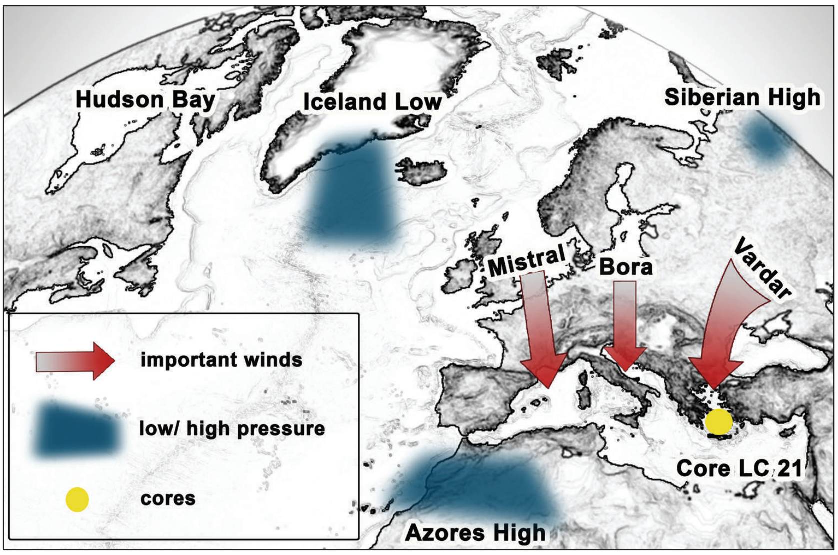


Fig. 2. Schematised map showing a) the location of Hudson Bay; b) Iceland Low, Azores High, and Siberian High pressure zones; c) the position of core LC 21; and d) intense cold northerly airflow over Western, Central and Eastern Europe in the winter months.

more pronounced, especially at altitude and further inland, away from the moderating influence of open sea (*i.e.* away from 'maritime' and into more 'continental' climate conditions). Also, the climatic effects over land may have consisted of highly variable conditions with considerable extremes, which become 'smoothed out' by long time-integration in the sea.

The main RCCs recognised in the Aegean Sea record of core LC21 are found at about 8600–8000 calBP, 6300–5500 calBP, and 3300–2600 calBP (Fig. 1). The duration of the first of these is well established at 5 to 6 centuries (*Mercone et al. 2000; Casford et al. 2007*), and it evidently forms part of a repeating RCC pattern during the Holocene. The GISP2 data (Fig. 1) clearly indicate that the Little Ice Age (LIA) is part of this repeating pattern, but the giant sediment corer used to recover core LC21 proved too crude a tool to recover this very recent (waterlogged, 'fluffy') sediment. As yet, no sharp culmination of the 8600–8000 calBP cool anomaly associated with the actual 8200 calBP event has been found in the records, which might be (unlikely) because of insufficient temporal resolution, or because further study of other indicators with different sensitivities is needed to record it. To understand the regional impact of enhanced frequency/intensity of northerly air outbreaks over the Aegean Sea, it is worth considering weather and impact reports for recent events, and historical reports for the LIA.

Modern meteorological analogies

In December 2001, several weeks of intermittent northerly winter outbreaks caused serious disruptions around the Black Sea-Aegean Sea region. The severe winter weather included sustained periods of sub-zero temperatures, snow-storms and blizzards, heavy rains, and strong winds (*e.g. CNN weather, 19 December 2001*). Aboard the German Research Vessel *Meteor*, air temperatures down to –1 or –2 °C were recorded in very strong (force 8, gusting 9) NE winds (*Casford et al. 2003*). Athens and Istanbul received about 30 cm of snow, and city governor Erol Cakir declared that conditions in Istanbul amounted to a 'national disaster' (Telegraph). In Larissa, Greece, night temperatures plummeted to a minimum of –20.2 °C, and more than 300 villages in northern and central Greece were snowed in, while airports and schools were closed in the North. In Bulgaria, heavy snowfall cut power lines in Bulgaria, while frosts cut off water supplies (World Weather News). The picture that emerges for the December 2001–January 2002 event portrays intermittently very heavy precipitation (both rain and snow), severe storms, and severe frosts (certainly for this region).

Our combined data suggest that such events were much more intense/frequent during the Holocene RCCs than they are today. This notion is further supported by a review of historical evidence for the periods 1675–1715 (Late Maunder Minimum) and 1780–1830 (Early Instrumental Period), key parts of the Little Ice Age during which Europe experienced significant cooling (*Xoplaki et al. 2001*). The majority of the documentary sources for these periods was found to refer to winter, which is the critical season for the eastern Mediterranean because it is normally wet and represents the early growing season. Relative to the present, these periods show significantly more cold/severe winters and springs, significant increases in precipitation during winter, and significantly more occurrences of winter drought (*Xoplaki et al. 2001*). Although the latter two may sound paradoxical, they simply reflect inter-annual variability within a context of significantly increased winter extremes. The study highlights the year 1700, when it is documented that snow cover remained present on the Cretan mountains throughout the year. Xoplaki et al. (*2001*) also report a rather common association between the extreme conditions and flooding, crop failure, famine, and deaths of animals and people. The main synoptic (= weather) situations responsible for cold and snowfall over the region were generally characterised by north-northwesterly or north-easterly airflow, with high pressure over northern Europe, and lower pressure over the central or eastern Mediterranean (*Xoplaki et al. 2001*).

The framework of the interval 8600–8000 calBP

Based on the above, we can build a speculative framework regarding the climatic impacts expected around the Aegean region in the period 8600–8000 calBP. Winter conditions would have been characterised by much more pronounced extremes than today, and the LIA examples suggest that very extensive rainfalls and snowfalls should be expected, which would have given rise to problems with crops and grazing, as well as larger issues such as flooding and the attendant potential destabilisation of hillsides and of mud-brick dwellings. These aspects would have been exacerbated by frequent, sustained, and very significant frosts. During other winters, conditions may have remained very dry, again with considerably detrimental effects on crops and grazing. Severe winds/gales are also expected more frequently than today. This spectrum of extreme conditions would have been considerably amplified at a distance from the coasts (away from the climate moderating effects of open sea), and especially at altitude. Overall, this analysis would suggest a considerable amount of pressure on resources, and general environmental stress during the RCC of 8600–8000 calBP, with a (not yet regionally documented) potential culmination between about 8250 and 8080 calBP.

The archaeology of warfare

Discussions on the origins of human warfare can be traced back to the 17th and 18th centuries, to Thomas Hobbes and Jean Jacques Rousseau, respectively. Whereas in '*Leviathan*' (1651) Hobbes proposes that the natural human condition was synonymous with a violent primitive plight, characterised by endemic war, murderous feuds, and the struggle for the preservation of personal gain, liberty, reputation, and safety, Rousseau proclaims in his '*Discourse of the Origins and Foundation of Inequality among Mankind*' (1755) a totally opposite myth. Instead, he argues that warfare only emerged following the inception of agriculture, which in turn led to demographic growth, more complex forms of social organisation, the concept of private property, and ultimately, state coercion (see *Keeley 1996.5–8; Gat 2006.5–6*). Meanwhile, it is generally accepted that archaeological evidence for warfare first becomes overtly apparent from the Neolithic (*e.g. Roper 1975; Fry 2006; Hamblin 2006*), although Rousseau's myth of the non-bellicose hunter-gatherer can certainly no longer be upheld (*cf. Keeley 1996*).

Signatures for warfare in the archaeological record are manifold, and include the construction of fortified settlements by means of walls and palisades, the erection of sites in strategic defensive locations, line-of-sight connections between contemporaneous sites, and the occurrence of settlement clusters separated by buffer zones ('*no-man's-land*'). Further, the occurrence of weapons and military paraphernalia, burial information (mass graves, warrior graves), skeletal indicators ('parry' fractures, frontal head fractures, scalping marks), burned communities, and artistic depictions are all considered characteristic attributes (*Haas 1990; LeBlanc 1999*).

Case study – Pisidia

Ancient Pisidia, also known as the Lake District, lies within the central part of the western Taurus range in modern day Turkey (*Erol 1983.92–94; Yakar 1991.139–141*). Its landscape is characterised by natural depressions and basins, many of which hold lakes, the three largest being the lakes Burdur, Eğirdir, and Beyşehir, surrounded by mountain ranges and plateaus. It is bordered to the north by the terraced plateau-landscape of central-western Anatolia, to the west by the eastern foothills of the Menderes massif, to the east by the Konya-Ereğli basin, and to the south by the western Taurus range. Although the karst nature of the Pisidian landscape (primarily in its eastern parts) has resulted in a distinct lack of larger rivers in the area compared to more central parts of Anatolia, *e.g.* the Konya Plain and Cappadocia, the region is characterised by an increased water budget, availability, alimentation and routes. Compared to both the moister lower-lying coastal areas to the south (700–1200 mm/annum) and the aforementioned arid parts of the central Anatolian plateau further east (250–370 mm/annum), Pisidia receives moderate amounts of rainfall (400–800 mm), mainly in winter and spring (*Erol 1983.93, Fig. 6; Akman and Ketenoğlu 1986; Türkeş 2003. 184, Fig. 1*). Vegetation is described as heterogenous and transitional in character, connecting the milder and moister coastal zone with the arid central Anatolian plateau, the former characterised by its sub-Mediterranean and continental sub-Mediterranean vegetation, and the latter by xerophilous grassland, shrubs and patches of temperate coniferous forest. This situation is expressed by arid, steppe-like vegetation in depressions and basins, and tropical and subtropical dry forest with Scots Pine, European Black Pine, and Downy Oak in higher lying areas (see also *Hütteroth 1982.143, Fig. 50*).

Current knowledge of the Late Neolithic and Early Chalcolithic in Pisidia comes from excavations conducted at four sites: Hacılar, Kuruçay Höyük, Höyücek Höyük, and Bademağacı Höyük (Fig. 3). Whereas Hacılar was excavated in the late 1950s by James Mellaart, investigations at the latter sites, of which those at Bademağacı are still in progress, have been realised in the framework of three decades of investigations in the Burdur region by Refik Duru and the Burdur region research team.

HACILAR (37.57°N, 30.08°W): This site is located in an intramontane valley, *c.* 940m above sea level and 26km southwest of Burdur (*Mellaart 1970*). The mound, which at the time of its excavation measured 140m in diameter and approximately 5m high, lies only a small distance from Bozçay river, one of a number of tributaries draining into nearby Burdur lake. The settlement deposits excavated at Hacılar were assigned by Mellaart to a total of ten levels. These comprise five Early Chalcolithic phases (Hacılar V–I), four Late Neolithic occupations (IX–VI), and one underlying 'aceramic Neolithic' deposit thought to comprise seven different construction levels. However, more recent sondages at the site in 1985 and 1986 (*Duru 1989*) could not confirm the presence of an 'aceramic Neolithic' settlement phase, and with the continued absence of such early deposits at other sites in the region, this is now no longer seriously considered.

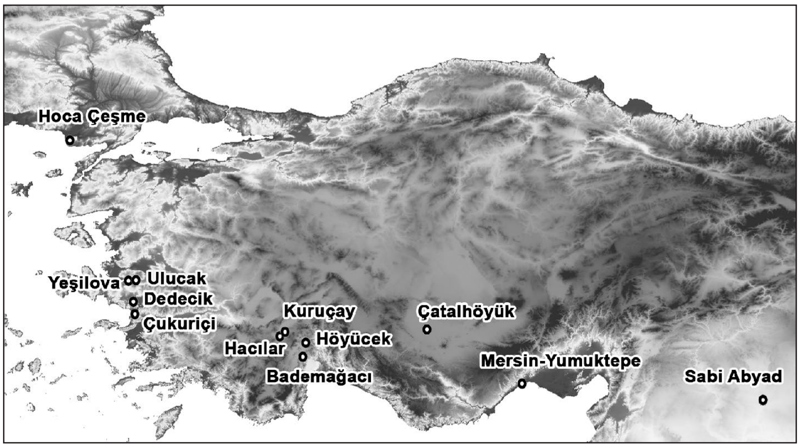


Fig. 3. Map of Anatolia and adjacent regions with archaeological sites mentioned in the text, dated to the 8600–8000 calBP RCC interval.

KURUÇAY HÖYÜK (37.63°N, 30.16°W): Kuruçay (*Duru 1983; 1994a; 2001a*) is located 15km southwest of Burdur and 10km northeast of Hacılar. The small mound, with a height of some 8m and a diameter of approximately 100m, is situated upon a natural prominence 960m above sea level, just 4km southeast of Lake Burdur. The investigation of deposits, mostly down to the underlying virgin soil, led to the identification of an archaeological sequence spanning a period from the Neolithic to the Bronze Age. Neolithic levels comprise the lowermost layers (13, 12 'lower', and 12 'upper') assigned by the excavator to the 'Early Neolithic', as well as 11 'lower' and 11 'upper' that make up the 'Late Neolithic' occupation at the site. Overlying layers 10–7 are assigned to the 'Early Chalcolithic'.

HÖYÜCEK HÖYÜK (37.45°N, 30.55°W): The small mound at Höyücek (*Duru 1994b; 1995; 2001b; Duru and Umurtak 2005*) lies in the Bucak plain, 35km south of Burdur and 30km southeast of Hacılar. The mound measures approximately 120m in diameter with a current height of some 4m. The archaeological sequence at Höyücek stretches from the Neolithic to the Chalcolithic, and features a total of four cultural layers. The earliest occupation at the site comprises the 'Early Settlements Phase' (ESP) and the 'Shrine Phase' (ShP); Late Neolithic levels are referred to as the 'Sanctuaries Phase' (SP); and finds from the Early Chalcolithic and later periods were recovered from the overlying 'Mixed Accumulations' (MA). The terminology chosen to refer to the elements of the sequence is at the same time an interpretation of the site's functions in each of its respective phases. Thus, in the Shrine Phase and the subsequent Sanctuaries Phase a dominant religious component is implied (*Duru and Umurtak 2005.230–231*).

BADEMAĞACI HÖYÜK (37.22°N, 30.49°W): This oval mound measures 200m long, some 110m wide, and 7m high (most recently *Duru 2005; Duru and Umurtak 2007; Yildirim and Gates 2007.287*). It lies on a small plain surrounded by low hills, adjacent to the northern flank of the western Taurus, approximately 50km north of Antalya. Investigations of the archaeological sequence have been underway since 1993 and have so far yielded remains from the Neolithic, Bronze Age and Christian era. Due to extreme difficulties encountered in establishing the correct stratigraphic sequence, slight revisions of previously proposed chronologies became necessary following the 2002 and 2003 seasons (*Duru 2005.541–547*). This involved the reassignment of structures previously thought to date to the Early Bronze Age, to a newly defined Late Neolithic (LN) period. Accordingly, the site of Bademağacı has yielded a Neolithic sequence (after *Duru 2005*) comprising the phases 'Early Neolithic' (ENI 9–5; ENII 4B, 4A, 4, 3A, 3, 2, 1) and 'Late Neolithic' (LN 2–1), with evidence for a Chalcolithic occupation at the site still only slight and amounting to small numbers of painted pottery sherds possibly indicative of a period of temporary settlement during this period.

From the four excavated LN/ECh sites there exists a total of 41 radiocarbon dates (Tables 1–9); 34 stem from Neolithic and Early Chalcolithic contexts, with seven Late Chalcolithic dates from the Kuruçay Höyük site. A total of 26 of these 34 dates are considered reliable, *i.e.* are neither evident outliers, nor characterised by high standard deviations in excess of ±100 ^{14}C-years. Whereas the most ancient date from the Bademağacı site (Hd-22340: 7949±31 ^{14}C-BP) may attest to the earliest reliably dated occurrence of Neolithic settlement in Pisidia so far – previously considered unlikely to predate the mid-seventh millennium calBC – others confirm contemporaneous occupation phases at all four sites with the 8600–8000 calBP RCC interval (Fig. 10, Tabs. 1–4).

On the basis of radiocarbon dates, and in due consideration of pottery assemblages from these sites, Ulf-Dietrich Schoop (*2002; 2005*) recently undertook a re-evaluation of the Neolithic and Chalcolithic sequence in the Lake District (Fig. 4). One important conclusion from this study is that the abrupt change in material culture observed in the Hacılar sequence between levels II and I, and originally interpreted by Mellaart (*1970.75*) as resulting from the immediate

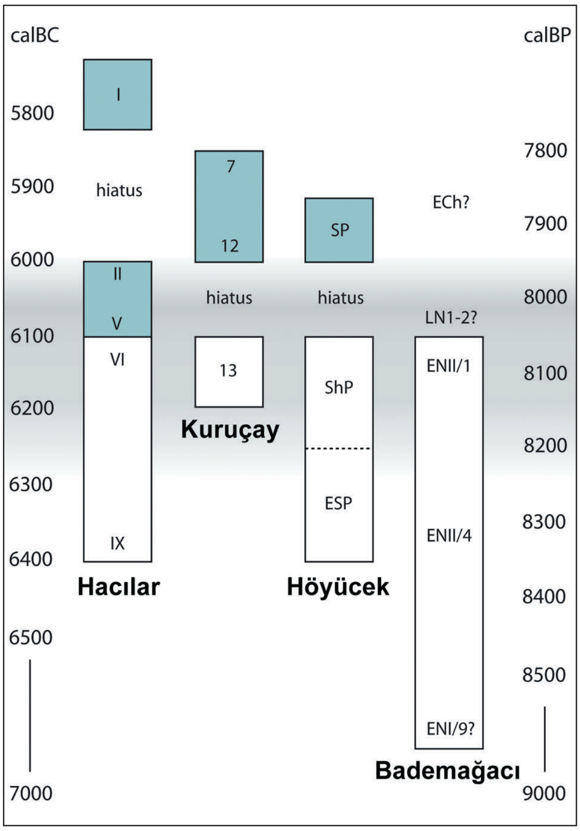


Fig. 4. Hacılar, Kuruçay Höyük, Höyücek Höyük, and Bademağacı Höyük. Synchronisation of settlement sequences after Schoop (*2005.Fig.4.9*), with most recent observations from Bademağacı after Duru (*2005*). Dark grey shading indicates Early Chalcolithic (painted pottery) levels; highlighted in light grey is the temporal extension of the 8200 calBP 'climate event'.

occupation of the site by a vanquishing 'foreign' force, was in fact due to a temporal hiatus in the occupation sequence. This gap is now filled by assemblages of a type discovered at Kuruçay 12–7. This hiatus in the Hacılar sequence is also mirrored at the nearby sites of Höyücek and Kuruçay, albeit that at these sites lacunae occurred slightly earlier. We return to the implications of such breaks (or phases of reorganisation) in settlement sequences, which can also be observed at contemporaneous sites to the east, further below.

The main line of evidence for the occurrence of LN/ECh warfare in Pisidia is twofold. On the one hand, it comprises the occurrence of major conflagrations, and on the other it involves the construction of fortificatory walls around settlements (Fig. 5).

Fires

Why were the blazes at Hacılar, Höyücek, and Bademağacı not accidental? A number of points suggest that these events are warfare-related. To this end, we must turn to an earlier study of prehistoric warfare in the American Southwest by LeBlanc (*1999*), who discusses the characteristics of accidental fires on the one hand, and warfare-related fires on the other. Here it is noted that the most telling difference between the two concerns scale. Whereas accidental burning is more likely to be characterised by small and random fires, perhaps limited to just a single room, and occurring only rarely, warfare related conflagrations will affect the entire settlement, or large sections thereof, and result from a single event. Potential motives for burning entire settlements can be, for example, the displacement of its inhabitants by the enemy (by killing them or forcing them to migrate); to strike a blow sufficient to render defenders incapable of retaliation; or alternatively, if initiated by the defenders themselves, to deny the site to the enemy. A further indicator for warfare-related fires is noted already by Roper (*1975.301*), and more recently by Fry (*2006.136–137*), who state that a good signature is when burning is followed by either abandonment or a hiatus in the occupation sequence. Unburied bodies of victims and the discovery of 'in-situ' finds in burnt houses also suggest that blazes may have resulted from conflict situations (*Roper 1975.301*). Whereas the former are considered by LeBlanc (*1999.85*) as a good signature of warfare, in-situ finds might also indicate a potential element of surprise, which of course could also suggest the occurrence of an accidental fire.

Site	Signature	Source
Hacılar	**level IB**: large scale destruction of settlement through fire; burned bodies in rooms	*Mellaart 1970.76*
	level IA-B: Hacılar I '*fortress*'	*Mellaart 1970.75–76, Figs. 33–35*
	level IIB: large scale destruction of settlement through fire	*Mellaart 1970.37, 75*
	level IIA: large scale destruction of settlement through fire; body in burnt room	*Mellaart 1970.36–37*
	level IIA-B: fortified enclosure	*Mellaart 1970.25, Figs. 19–22, 25–27*
	level IV: '*bad fire*'	*Mellaart 1970.16*
	level VI: large scale destruction of settlement through fire	*Mellaart 1970.16*
Kuruçay	**level 11**: fortified enclosure	*Duru 1994.99*
Höyücek	**ShP (end)**: large scale destruction of remaining buildings 3, 4, and 5 through fire; large number of sling projectiles found on floor of building 3 **ShP**: destruction of buildings 1 and 2 through fire; large number of sling projectiles found on floor of building 1	*Duru 1995.486–487, plate 57.1; Duru & Umurtak 2005.230*
Bademağacı	**ENII/2**: burned structures (?)	*Duru & Umurtak 2006.12*
	ENII/3: bodies in burned house	*Duru 2005.548*
	ENII/4-3: remains of fortificatory structure	*Duru 2002.582, 591, plate 11/1,2; 2004.16f.; 2005.548, plates 5, 8/1; Umurtak 2007.141; Yildirim & Gates 2007.287*

Fig. 5. Hacılar, Kuruçay Höyük, Höyücek Höyük, and Bademağacı Höyük. Archaeological signatures for warfare.

Large scale destruction through fire at Pisidian sites can be especially observed at Hacılar at the end of levels VI, IIA, IIB, and IB, whereby Mellaart himself only considers the conflagrations at the end of phases IIB and IB as resulting from attack by hostile groups (*Mellaart 1970.75, 87*). A further '*bad fire*' is also noted in level IV (*Mellaart 1970.16*). Following the destruction of level IIB, Mellaart suggests that the attacker took possession of the site, importing their own material culture and erecting the Hacılar I 'fortress'. Meanwhile, the profound change in material culture observed between these two levels is instead thought to stem from a hiatus in the occupation sequence (*Schoop 2002; 2005; see above*). Thus, this newly recognised gap, which is directly subsequent to the destruction of the IIB settlement, serves to substantiate Mellaart's original assumption that this settlement fell victim to a violent act at this time. Similarly, the '*fire and massacre*' at the end of level IB is termed by Mellaart as the "*death blow to the once flourishing settlement*", culminating in its permanent abandonment at the end of level ID (*Mellaart 1970.87*). Here, although abandonment was delayed, it would appear to have followed within a short period of the conflagration, and therefore was presumably related to this catastrophe. It should be noted, however, that the much earlier conflagration at the end of Hacılar VI, although not followed by a temporal hiatus, is characterised by a development in ceramic traditions, it marking the generally acknowledged transition from the predominantly monochrome Late Neolithic to the Early Chalcolithic, during which the ratio of painted decoration in the ceramic assemblage rapidly increased.

Whereas at Höyücek all five structures belonging to this 'religious' complex were destroyed by two separate outbreaks of fire (*Duru and Umurtak 2005.230*), at Bademağacı the evidence for destruction by fire is more limited in scale, with burned houses so far noted for levels ENII/3 and ENII/2 (*Duru 2005.548; Duru and Umurtak 2006.12*). At Höyücek, the destruction at the end of the 'Shrine Phase' is followed by a temporal hiatus in the occupation sequence of approximately 100 years until reoccupation in the so called 'Sanctuaries Phase'.

Unburied victims of fires have been reported from both Hacılar and Bademağacı. At Hacılar, unburied victims were excavated from the ruins of both the IIB and IB settlements. From the former, one victim was recovered – the crouching skeleton of a person of advanced age was found upon the floor next to the western hearth of the northeast shrine (*Mellaart 1970.36*) – and in the remains of Hacılar IB an unspecified number of bodies, especially children, has been reported (*Mellaart 1970.76*). A further occurrence of unburied victims stems from the burnt remains of house 8 in level ENII/3 at Bademağacı Höyük. Upon excavation, this structure revealed the remains of nine burnt skeletons (two adults and seven children) "*in disorderly positions in different parts of the house*" (*Duru 2005.548*). Further, the discovery of large numbers of complete pottery vessels, stone tools, a terracotta seal, bone items, and thousands of beads suggests that this building may have been destroyed by a sudden fire.

Fortifications

The erection of fortifications around settlements has often been regarded as one of the most reliable indicators for the occurrence of warfare in prehistoric societies, although more recently, alternative proposals have been considered; for example, a wall can divert flood waters away from houses, it can block winds that produce sandstorms, and it can keep animals and children in and wild animals out (*Otterbein 2004*). In the case of the first of these proposals, this calls to mind Bar-Yosef's reappraisal of the function of the walls at Jericho (*Bar-Yosef 1986*). Be this as it may, Otterbein has also compiled ethnographical data which leads him to the conclusion that there is indeed a correlation between the frequency of internal war and village 'fortifications'. Accordingly, whereas village fortifications could be shown to predict continual or frequent warfare (15 out of 18 societies), war does not predict village fortifications (15 out of 25 societies) (*Otterbein 2004.192*). Thus, whereas this evidence confirms that walls are a reliable marker for the occurrence of war, it also demonstrates that they are not a compulsory feature. Additionally, following Keeley (*1996.55*), "*the variant sufficient condition for the construction of defences is the relative intensity of the perceived threat*", *i.e.* only if the danger of attack is sufficiently acute and constant, and the community meets the necessary preconditions for construction (social systems, adequate labour input etc.), will fortifications be erected.

Fortifications at Hacılar are known from the settlements Hacılar IIA, IIB, and I. However, it remains unknown whether the earlier Hacılar VI settlement, which was destroyed in a major conflagration (see above), was also fortified, as the edge of the settlement was never reached during excavations. Nevertheless, according to Mellaart, if not enclosed by a wall, it is extremely likely that it would have been provided with "*some sort of defence, probably as at Çatalhöyük, in the form of blank doorless outer walls in the houses on the periphery of the site*" (*Mellaart 1970.10*). For all remaining periods at Hacılar, fortifications are unknown; in the case of Hacılar V, this corresponds to a general loss of evidence associated with large-scale levelling and reshaping of the mound prior to the erection of the Hacılar I 'fortress' (*Mellaart 1970.23*).

Essentially, Hacılar IIA is a rectangular, fortified enclosure, measuring 36 x 57m and comprising a mud brick wall 1.5m to 3m thick (Fig. 6). Although lacking stone foundations itself, the wall was equipped with small and irregularly placed towers which did feature such substructures (*Mellaart 1970.25, plates XXVIIIa, XXVIIIb*). The exact number of gateways to the settlement remains ambiguous – either three or four (to the northwest, southwest, northeast, and possibly southeast). The main entrance to the settlement, a narrow doorway flanked by two towers, was located on the (north)western side of the settlement and led into the 'West Court'. The shape of the enclosure was changed slightly following the fire at the end of phase IIA. In Hacılar IIB the walls were extended several metres eastwards, whereby the eastern quarter of the settlement that had been destroyed at the end of level IIA was not rebuilt, but left void of structures; this part of the settlement is now referred to as the 'Eastern Court' (*Mellaart 1970.31, Fig. 25*). Following the destruction of Hacılar IIB and the ensuing hiatus in the Ha-

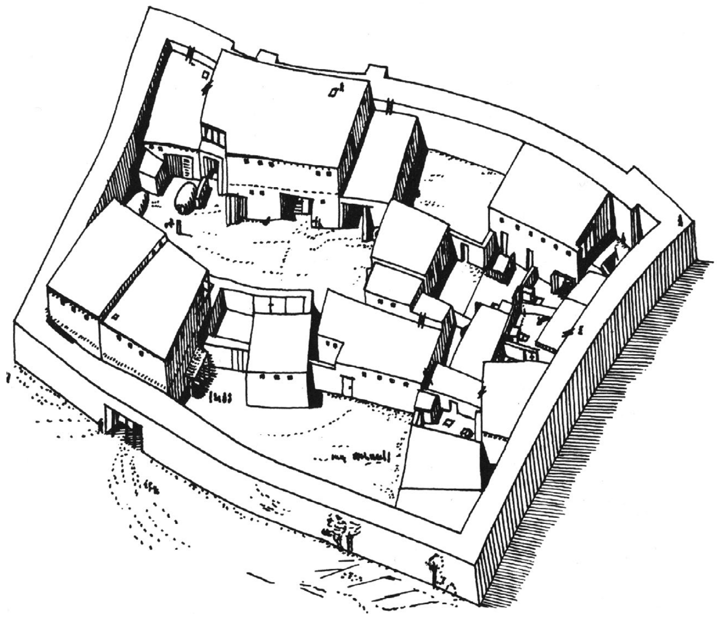


Fig. 6. Hacılar IIA. Reconstruction of the fortified settlement (from* Mellaart 1970.Fig. 22*).

cılar sequence, a new 'fortress' (Hacılar I) was erected. This comprised an extremely massive, on average 2m (and up to 4m) thick, solid mud brick wall that had been erected upon a single course of limestone rubble on the prepared level ground (*Mellaart 1970.75, 77*). The fortifications of the Hacılar I 'fortress' surrounded the entire *höyük* (approximately 100m in diameter) and encompassed a central court void of further structures; rooms were located against the inner side of the wall, groups of which were separated by small courtyards.

Of particular note is the continued presence of a deep, stone-lined well in the Hacılar settlement, in levels VI, IIA and IIB (*Mellaart 1970.19, 35, Figs. 7, 20, 25*). In each case, the numerous postholes discovered in its proximity might have belonged to some water-drawing appliance (*Mellaart 1970.35*). Here, a remark made by LeBlanc (*1999.69*) is of some relevance: "*Ethnographic accounts of warfare point to the very significant danger of ambush. Having a source where domestic water could be procured without fear of ambush would have been very valuable – and considerable effort was made to provide this security in some cases*".

Turning now to Kuruçay Höyük, the fortificatory wall discovered at this site is reported to have enclosed the level 11 settlement (*Duru 1994.99*) (Fig. 7). In spite of its poor state of preservation (only the stone foundations of the southern wall are well preserved), the fortification is thought to have been of rectangular plan, with a series of externally situated circular towers, three of which (one complete and two partially preserved) were discovered during excavations (*Duru 1999.plate 15*). The entrance to the enclosure was located at its south-eastern corner. Within the enclosure, excavations revealed very little architectural evidence. It is proposed that this is due to the northern part of the settlement having been swept away following a heavy downpour (flooding) which may have occurred during a late stage of the level 11 settlement phase (*Duru 1994a.99*).

At Bademağacı Höyük, levels ENII/4 and ENII/3 have also provided some potential evidence of fortificatory architecture (*Duru 2002.582, 591, plate 11/1,2; 2004.16–17; 2005.548, plates 5 and 8/1; Umurtak 2007.141; Yildirim & Gates 2007.287*). This feature, which is located at the edge of the tell and "*in keeping with the outer boundary of the höyük*" (*Duru 2005.548*), comprises five northwest-southeast oriented, parallel rows of foundations constructed of medium sized stones (20–35cm in diameter) placed approximately 40–50cm apart. Beneath this structure was discovered an older and more substantial (1m thick), L-shaped wall foundation. Both the younger 'grid plan foundations' as well as the earlier L-shaped wall section are thought to date to levels ENII/3 and ENII/4, respectively. Indeed, if the proposed function of this feature is confirmed, this would mean that Bademağacı presides over the earliest fortification so far discovered at a Neolithic settlement in Anatolia (*c.* 64th–63rd century calBC). On the other hand, the excavations at both Hacilar (level I) and Kuruçay (level 11) suggest that fortifications were still a common feature of Early Chalcolithic settlement into the sixth millennium calBC.

Slings and sling missiles

Although there is no direct evidence that slings were used as weapons during the Late Neolithic and Early Chalcolithic periods in Anatolia, it is interesting to note the widespread use of the sling at this time (as testified by the frequent occurrence of biconical clay sling missiles) and the contemporaneous decline in the use of the bow (as evidenced by the absence of arrowheads among these same communities) (*Korfmann 1972; Özdoğan 2002*). This is a phenomenon which can be observed over a large region, from the eastern fringes of the Near East to the Aegean in the west. Indeed, by the close of the seventh millennium calBC, the sling would have been the most readily available long-distance weapon of communities living in these geographical regions, and therefore in Pisidia also.

Nevertheless, to interpret all clay sling missiles as weapons, without considering other functions, would be wrong, and similarly, it would be false to assume that all locations where clay sling missiles occur were

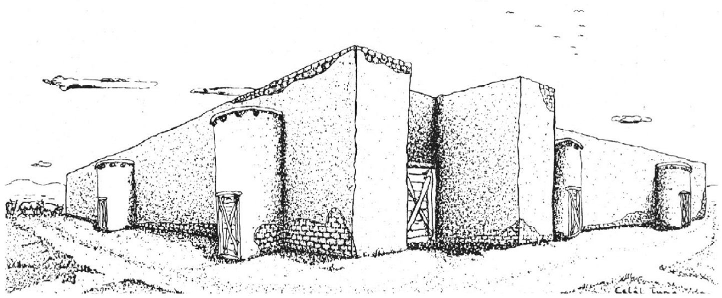


Fig. 7. Kuruçay Höyük, level 11. Reconstruction of fortifications (from* Duru 1994.Fig I–11*), with kind permission of the author.

war zones. Indeed, Perlès (*2001.229–231*) has criticised the over-emphasis on the sling's status as a weapon, which in her opinion is more likely a '*shepherd's implement*' used to bring back stray animals to a herd in the absence of sheep dogs. Although such an interpretation is acceptable, the potential destructive power of the sling should not be played down in any way. Indeed, its capabilities as a hunting weapon are related from the Halaf culture in northern Syria (*Akkermans and Wittmann 1993. 159*), and it is but a small step from its usage in the hunt to its being brandished as a weapon (*cf. Otterbein 2004.85–86*); Chapman (*2004.108*) refers to the sling as a so-called '*Tool-Weapon*', whereby the hoarding of such items, in this case sling projectiles, has been noted as a significant marker for the preparation of a community for war, particularly in the case of fortified settlements (*Redmond 1994; Chapman 2004.102–103*).

For the Neolithic, the use of slings and sling missiles in a conflict situation has been proposed by Vutriropulos (*1991.129, plate V*) for a discovery made at the Bulgarian site of Stara Zagora. Here, the excavation of a burnt (Karanovo II period) settlement – followed incidentally by a gap in the occupation sequence – revealed the remains of two adjacent structures, both of which yielded a large number of clay missiles dispersed throughout. This scene is commented on by Vutriropulos as a prime example of prehistoric warfare in the archaeological record. However, although a tempting interpretation, it is essential that we proceed with a little more caution, it being equally conceivable that these objects fell from an upper storey in the course of the (accidental) fire (*pers. comm. H. Todorova*). Be this as it may, the factor of warfare should not simply be passed by, as recent discoveries at the fourth millennium calBC settlement of Hamoukar in northern Syria have demonstrated. At this site, an excavation team "*found extensive destruction with collapsed walls, which had undergone heavy bombardment by sling bullets and eventually collapsed in an ensuing fire*" (*University of Chicago News Office*).

At the Late Neolithic/Early Chalcolithic sites in Pisidia, (clay) sling missiles are a very common occurrence. At Hacılar VI, a depot was discovered in a recess behind the oven in house Q.5 (*Mellaart 1970. 18, plate XIVb*), and in Hacılar V, IV, and III further deposits of '*slingstones*' were revealed (*Mellaart 1970.24, plate XXVIa, Fig.16*). At Höyücek (Shrine Phase), sling projectiles were also discovered in large numbers. Duru refers to "*hundreds of clay sling pellets found on the floors of the* [burnt] *Structures 3 and 1*" (*Duru 1995.486–487, plate 57.1*); in the first of these buildings they were found together with a collection of large stone hand axes (*Duru and Umurtak 2005.165*). At Kuruçay Höyük, sling projectiles are not mentioned in the comprehensive English summary of the final publication (*Duru 1994a*), although their occurrence at this fortified site must be assumed; and at Bademağacı they occur from level ENII/3 onwards, following absence from earlier levels (*Çilingiroğlu 2005.7*). On the basis of this evidence, it may be assumed that slings and clay sling missiles were introduced to the Lake District from around 6300 calBC. Only further east are earlier finds of clay projectiles known, *e.g.* at Çatalhöyük East in Central Anatolia, where they appear from level VI (*c.* 6500/6400 calBC), and at Tell Sabi Abyad in the Balikh valley, northern Syria, where – although particularly common in phases Balikh IIC and IIIA (*c.* 6200–5900 calBC) – they have also been found in relatively large numbers in recent excavations of older deposits that date back to the mid-seventh millennium calBC (*Akkermans et al. 2006.141, 144, 149*). Ultimately, this spatial and temporal pattern might be suggestive of a rapid dispersal of sling and clay projectiles from the east towards the west, arriving in Pisidia and western Anatolia in the late seventh millennium calBC. Indeed, in more westerly parts, for example in the Aegean region and the south-eastern periphery of Europe, they may even have arrived as part of the larger 'Neolithic Package', as may have been the case at Hoca Çeşme and Ulucak Höyük (*Çilingiroğlu 2005. Tab. 2*).

Who was the enemy?

Naturally, the Late Neolithic and Early Chalcolithic settlement of Pisidia comprised more than just the four excavated settlements at Hacılar, Kuruçay, Höyücek, and Bademağacı. On the basis of past and recent survey work, it must be assumed that both in the Lake District and in adjacent regions there was a dense network of contemporaneous and semi-contemporaneous sites during these periods, and therefore also in the centuries 6200–6000 calBC. So who was the enemy?

Here we must return to an aforementioned archaeological study from the American Southwest (see above) in which similar lines of enquiry have previously featured. In his investigation, LeBlanc (*1999*) reports of typical situations in which clusters of three or more sites are separated from each other by about 20 miles, with the spaces between clusters – '*no* *man's land*' – increasing over time. Whereas such a settlement pattern is presumed characteristic for group internal conflict, more densely packed conglomerations of site clusters, or the appearance of long linear arrangements of settlements, are thought likely to denote an 'outside' threat (*LeBlanc 1999. 53–54*). In order to gain a picture of these aspects in the Late Neolithic and Early Chalcolithic settlement pattern, a GIS-analysis of available settlement distribution data for south-western Anatolia and adjacent parts was undertaken.

Using GIS-applications, the spatial distribution of prehistoric sites can form the basis for a 'reconstruction' of past settlement areas and, in some cases, permits calculations of population densities (*e.g. Zimmermann 2003; Zimmermann et al. 2004; Vogelsang & Wendt 2007; Hilpert et al. 2007*). LN/ECh settlement groups have been identified using spatial data from south-western and central Anatolia using a method known as KDE ('*Kernel Density Estimates*'), first applied to an archaeological dataset by Beardah and Baxter (*1996*). It has been noted more recently (*Herzog 2007a; 2007b, Hilpert et al. in press*) as a promising alternative to the counterpart method based on the LEC ('*Largest Empty Circle*'). Common to both methods is their ability to transform point data into area data. While LEC calculations involve the application of Thiessen polygons (voronoi tessellation) for territory allocation, and the geostatistical kriging interpolation to produce isolines, the KDE method instead uses the find spots themselves. This latter method has the advantage of being less dependent on interpolation, and hence more robust in large areas with relatively low density sites, as given here.

Data was accessed from the online TAY Project Database. It includes both excavated sites with deposits radiocarbon dated to the 8200 calBP 'climate event' (N = 6; Hacılar, Kuruçay Höyük, Höyücek Höyük, Bademağacı Höyük, Erbaba, Çatalhöyük), as well as unexcavated sites (N = 81) from the Lake District and adjacent regions with surface collections assigned to either the Late Neolithic and/or Early Chalcolithic (*c.* 6500–5300 calBC) and therefore 'straddling' this same time period. Naturally, in the case of the latter sites, which by far outnumber the former, temporal resolution is far from sufficient to identify those settlements occupied during the 8200 calBP 'climate event'. Nevertheless, this database provides the best evidence for potential settlement groups in south-western Anatolia and adjacent parts at the end of the seventh millennium calBC.

The GIS-analysis of the Anatolian data confirms the existence of four distinguishable settlement groups situated within clearly defined physical borders (Fig. 8). Each group is characterised by clusters of settlements located on small plains or within natural depressions and basins, and each separated from its neighbour(s) either by bodies of water or by extensions of the western Taurus range. At the same time, the two larger groups (Burdur and Beyşehir groups) are characterised by an internal structure comprising smaller agglomerations of sites. Here it is striking that the arrangements of settlements within these same two groups show analogies with the spatial criteria stipulated by LeBlanc (*1999*) as characteristic of an 'outside' threat; particularly notable is the high frequency of sites arranged in a linear, ribbon-like manner, especially in the Beyşehir group, but also to a very visible extent in the Burdur group. Further, the GIS-analysis is particularly effective in highlighting clusters of settlements. Whereas in the Burdur group one might differentiate between three, possibly four, different concentrations, in the Beyşehir group a total five clusters are clearly distinguishable. The distance between these clusters exceeds in some cases – especially in the Beyşehir group of settlements – some tens of kilometres. Therefore, if all the analysed sites were contemporaneous, on the one hand, one might interpret their distribution as spatial evidence of an external threat, particularly the long linear arrangement of sites providing inhabitants with mutual support from neighbouring communities in times of danger; while on the other hand, visible clusters of settlements separated by considerable distances might also suggest internal conflicts. A more satisfactory conclusion from GIS-analyses would require a higher temporal resolution of the featured data, which is only possible through sondages or excavations at the featured Late Neolithic/ Early Chalcolithic sites.

Contemporaneous developments in adjacent regions

As is evident from the chronology table (Fig. 9) and the available radiocarbon dates (Figs. 10 and 11, Tabs. 1–10), there appears to be a temporal association of the 8200 calBP 'climate event' with gaps and/ or phases of reorganisation at Pisidian sites, as well as similar events at settlements in other parts of Anatolia and beyond. In the following, reference is made to Çatalhöyük in the Konya plain, Mersin-Yumuktepe in Cilicia, and Tell Sabi Abyad in the Balikh valley, northern Syria. At all three sites there is evidence that there occurred a change in settlement

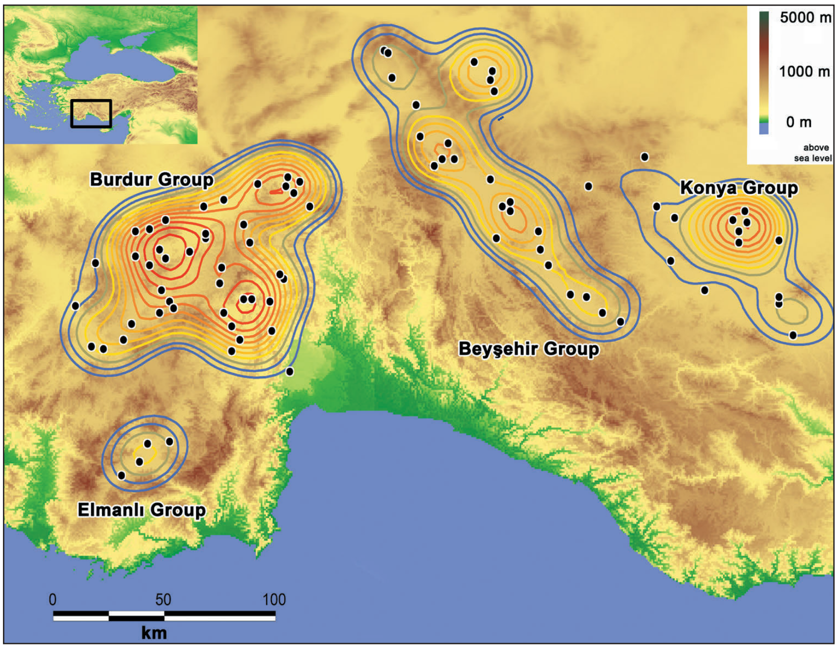


Fig. 8. Southwest Anatolia. Distribution of Late Neolithic/Early Chalcolithic sites with discernible settlement groups based on GIS-analysis (data accessed from TAY Project Database).

structures which correlate temporally with the 8200 calBP 'climate event'.

The temporal correlation of climate forcing and the abandonment of the eastern mound at Çatalhöyük has already featured in earlier papers (*Weninger et al. 2005.98; 2006.410*). There it was proposed that, following the abandonment of Çatalhöyük East, there ensued a hiatus of some 200 years prior to the founding of Çatalhöyük West in the Early Chalcolithic. Remarkably, a new series of radiocarbon dates from the western mound (Fig. 11, Tab. 5) has recently been put forward as "*strong evidence supporting the hypothesis that the sequence at Çatalhöyük West overlaps with that of its Neolithic predecessor Çatalhöyük East*" (*comment C. Cessford in Higham et al. 2007*). Notwithstanding, even in light of this new evidence, we feel obliged to hold fast to our earlier claim, *i.e.* that the available radiocarbon dates are still suggestive of a temporal break in the Çatalhöyük sequence at the end of the seventh millennium calBC, as shown in Figure 11. However, caution should be exercised, at least until it is clear that the basal deposits of the Çatalhöyük West mound are covered by the available dates. The results from continuing investigations should bring clarity in this matter. Ultimately, irrelevant to whether the abandonment of Çatalhöyük East predated, coincided with, or even post-dated, the establishment of the nearby western '*höyük*', this same period is still marked by a major reorganisation of the settlement structure in the Çatalhöyük area. This involved not only the abandonment of the eastern mound after some 1000 years of uninterrupted settlement activity, but also the founding of a new settlement on the opposite side of the Çarşamba river, *c.* 200m to the west. Further, this development is also concurrent with a major change in material culture that is characterised by the abrupt increase of painted decoration in the 'Early Chalcolithic' ceramic assemblage found at Çatalhöyük West.

A very similar development can be observed not only at the Cilician settlement of Mersin-Yumuktepe, but also at the northern Syrian site of Tell Sabi Abyad (*Akkermans et al. 2006; Clare et al. in press*). At the former, the final two centuries of the seventh millennium calBC coincide with those occupation levels (Yumuktepe XXVII–XXVI) recently assigned to an independent 'Middle Neolithic' settlement phase (*Caneva 2004a*). Whereas this period is noted for the earliest evidence at this site of rectilinear stone foundations of structures interpreted as a combination of living quarters and storage facilities (*Garstang 1953.27, Fig. 12; Caneva 2004a.37, Figs. 8 and 9; Balossi Restelli 2006.14, Pl. 2.1*), it is also a period during which its ceramic repertoire began to diverge from the contemporaneous (DFBW) assemblages found in adjacent regions to the east, *i.e.* in the Amuq plain, at Ras Shamra, and in the Rouj basin (*Balossi 2004. Tab. 1*). This 'Middle Neolithic' occupation, with its characteristic 'cell-buildings', appears to have climaxed, at least in the excavated area of the mound, with a major conflagration and the likelihood of a subsequent hiatus, albeit of short duration (*Caneva 2004b.45; Clare et al. in press*). Following this break, a marked change is suggested in both the settlement structure and function of this same part of the settlement. This sees a broad shift from the 'domestic' to the 'agricultural', with the same part of the settlement now accommodating large rectilinear stone-based structures that have been interpreted as animal pens, followed in levels XXV ('Late Neolithic') and XXIV ('Final Neolithic') by the introduction of (communal?) storage facilities in the form of cobble-paved silos (*Caneva 2004b.49–50; Balossi Restelli 2006.14*).

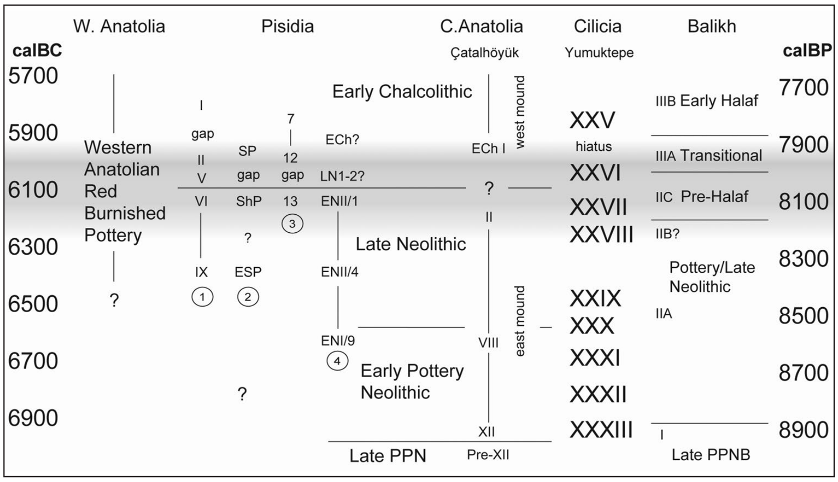


Fig. 9. Late Neolithic/Early Chalcolithic chronology. Western Anatolia after Lichter (2006); Pisidia after Schoop (2005), with recent observations from Bademağacı after Duru (2005); Mersin-Yumuktepe after Balossi Restelli (2006); Balikh valley after Akkermans et al. (2006). 1. Hacılar, 2. Kuruçay, 3. Höyücek, 4. Bademağacı. Grey shading marks the temporal extension of the 8200 calBP 'climate event'.

Moving eastwards, the northern Syrian settlement of Tell Sabi Abyad in the Balikh valley has also provided evidence of a significant reorganisation of its structure in the transition from the Early Pottery Neolithic (Balikh IIA/B) to the Pre-Halaf period (Balikh IIC), *i.e.* at around 6300/6200 calBC (*Akkermans et al. 2006*). This was connected with a substantial decline in the size of the settlement, during which "*the formerly densely occupied area on the western side of Tell Sabi Abyad was abandoned*" (*Akkermans et al. 2006.150*). In the wake of this reorganisation, settlement appears to have continued at two separate occupations on the eastern side of the mound. The subsequent 'Transitional' period (Balikh IIIA; *c.* 6050–5900 calBC) is associated with a number of major developments marking the run-up to the emergence of the Halaf culture in the early sixth millennium calBC. Particularly significant for the 'Transitional' period at Tell Sabi Abyad is the so called 'Burnt Village' (level 6) which, as its name implies, was destroyed by a major fire. New evidence suggests that not only the south-eastern part of the site was destroyed in this event, but that the same blaze may also have ravaged north-eastern parts of the settlement (*Akkermans et al. 2006.129–130*). The current hypothesis concerning the background of this conflagration lies in a ritual context, possibly an intentional (cleansing) act, perhaps in association with the death of (a) prominent individual(s), although accidental or warfare related causes cannot be ruled out entirely[2]. The end of the Transitional period sees the beginning of the Halaf sequence proper (from *c.* 5900 calBC), characterised by large numbers of small (0.1–1 ha) and short-lived (seasonal?) sites, widespread mobility, and a relatively low population density (*Akkermans and Schwartz 2003.119–120*). Pottery frequently displays a mainly black or brown painted decoration, also with highly standardised motifs (*Le Mière and Nieuwenhuyse 1996*).

To the west of Pisidia, research into contemporaneous settlement is still at a relatively early stage (*Lichter 2005; 2006*), with excavations and sondages so far conducted at only a small number of Western Anatolian sites, which include Ulucak Höyük (*Çilingiroğlu et al. 2004; Çilingiroğlu and Çilingiroğlu 2007*), Dedecik-Heybelitepe (*Lichter and Meriç 2007; cf. Yilderim and Gates 2007.287*), Yeşilova Höyük (*Derin 2007*), as well as Çukuriçi Höyük (*Horejs 2008*), although many more are known by surface finds, indicating that the region was densely populated at this time (*cf. Erdoğu 2003.12–14; Lichter 2005.62–63*). In addition to the archaeological evidence, absolute radiocarbon dates from the area are still limited to just a handful of measurements from Ulucak and Yeşilova. These suggest the first occurrence of Neolithic lifeways in this region not prior to the final centuries of the seventh millennium calBC, with the oldest date so far from Yeşilova (KN–5811: 7505 ± 30 ^{14}C-BP). Traces of earlier Neolithic settlement activity is still lacking, although deeper deposits at Ulucak, for example, still remain unexcavated. Exceptional are the slightly older dates from the lowermost level at Hoca Çeşme in Turkish Thrace, which may testify to the sporadic occurrence of earlier (fortified) Neolithic 'colonies' (*cf. Özdoğan 1998*) in the Turkish Aegean region from the mid-seventh millennium calBC. The absence of painted pottery is striking, and in stark contradiction to the ceramic assemblages recovered from contemporaneous sites in the Lake District. Recently referred to

2 http://www.sabi-abyad.nl/tellsabiabyad/projecten/index/0/8/?sub=9&language=en

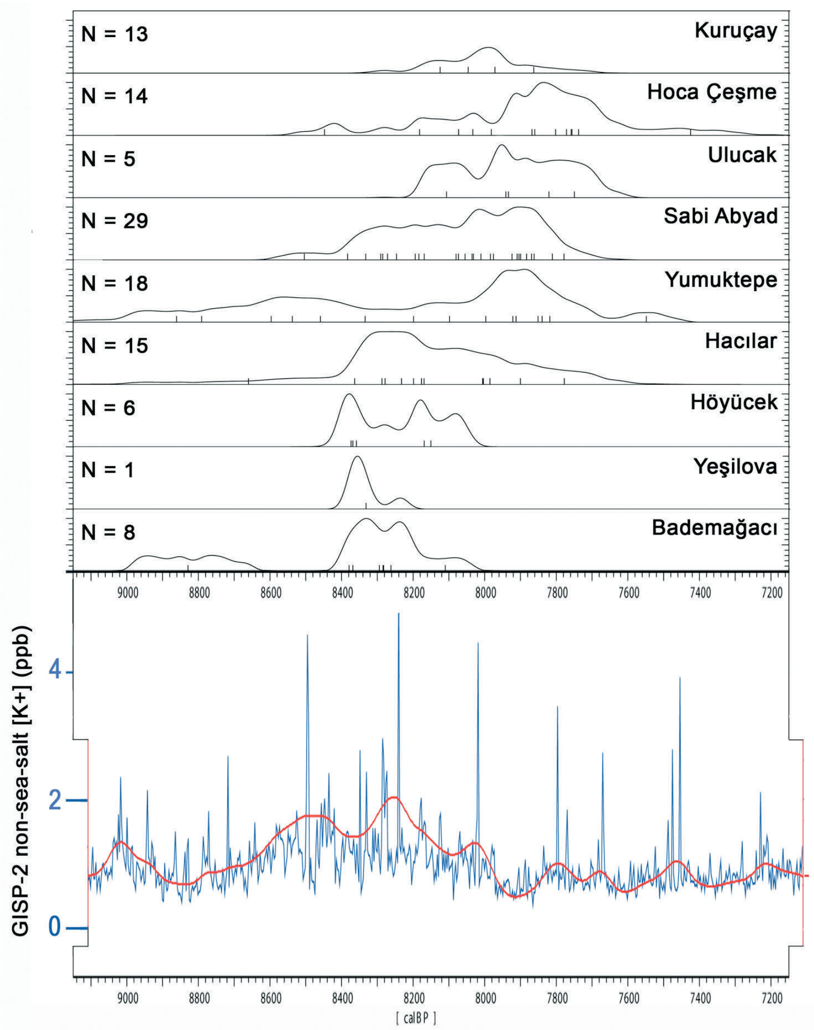


Fig. 10. Cumulative calibrated dating probability of radiocarbon data from nine archaeological sites in Turkey (Kuruçay Höyük/Table. 2, Hoca Çeşme/Table 9, Ulucak Höyük/Table 7, Mersin-Yumuktepe/Table 6, Hacılar/Table 1, Höyücek Höyük/Table 3, Yeşilova Höyük/Table 8, Bademağacı Höyük/Table 4) and Northern Syria (Tell Sabi Abyad/Table 10) in relation to the Holocene non-sea-salt [K+] series for the GISP2 ice core from Greenland (*O'Brien et al. 1995; Mayewski et al. 1997*) (bottom).

by Lichter (*2006*) as 'West Anatolian Red Burnished Pottery' ('*Westanatolische Rot Polierte Keramik*' or WARP), vessels from these assemblages are red to reddish brown, slightly burnished, and sometimes slipped; most frequent forms are hole-mouth and S-shaped pots, with flat bases or sometimes with low pedestals (*Lichter 2005.63; 2006.34*).

Discussion

Summarising the evidence presented in this paper, it appears that the 8200 calBP 'climate event' coincides not only with clear breaks (and possible lacunae) in sequences at major settlements in the Balikh valley, Cilicia, and the Konya plain, but also with potential evidence for warfare in Pisidia, as well as with an intensification of Neolithic dispersal into western Anatolia, the Aegean, and south-eastern Europe. In this context, it is of particular interest to note some remarks made recently by M. Özdoğan (*2005*) who, in reference to the spread of Neolithic lifeways and traditions westwards from their 'formative zone', writes: "*The fact that the expansion continued on [beyond western Anatolia and the Marmara region], rather quickly reaching the farthest extents of Europe, implies that some sort of social turbulence must have been the main reason, giving way to what can be described as the motivation to migrate*" (*Özdoğan 2005.20–21*).

Might then this 'social turbulence' be partly explained, at least for the Lake District, by the outbreak of warfare in the late seventh and early sixth millennium calBC? If so, how might this conflict relate to the roughly contemporaneous interludes of settlement reorganisation at the sites of Çatalhöyük, Yumuktepe and Tell Sabi Abyad? Although Özdoğan makes no suggestions himself as to the possible 'motivation' behind migration, the apparent coincidence of the 8.2 ka calBP 'climate event' with this period of intensive Neolithic dispersal may be critical. In the semi-arid interior of the Anatolian peninsular and in northern Syria, communities may have been struck by particularly cold/severe winters and springs, combined with either drought conditions or the effects of more extensive rainfalls and snowfalls. These would have placed an increased strain on resources, leading ultimately to food shortages and famine situations; substantiation for such a scenario is certainly found in historical accounts from central parts of the Anatolian peninsular (*Christiansen-Weniger 1964*).

As noted by J. Yakar (*2000.229*), the only sensible way to alleviate such problems "*is for farming communities to temporarily minimize the pressure on* *the carrying capacity of the land. The best solution is to relocate much of the livestock and part of the community to less affected habitats*". He stresses, however, that any translocation of even small groups of pastoralists and/or farmers to areas beyond the crisis zone can lead "*to territorial disputes, and large-scale intrusions may well have sparked serious conflicts and anarchy*". This same basic assumption, *i.e.* that climate change affects societies by altering agricultural productivity and consequently social stability, is encountered in most studies to have focused on the effects of climate deterioration on human society. Could this then also be a likely scenario for the late seventh and early sixth millennium calBC in Anatolia? Had the climate in central and eastern parts of the peninsular become too unpredictable? Did parts of the population from these regions seek alternative territories in adjacent, less afflicted areas? Indeed, this may have led not only to a reorganisation of their own communities, for example, as at Çatalhöyük, Mersin-Yumuktepe and Sabi Abyad, but also to the destruction and periodical abandonment of settlements encountered in the latter, *e.g.* in Pisidia. As noted by Keeley (*1996.139*), "*Droughts figure frequently in examples of disaster-driven warfare*".

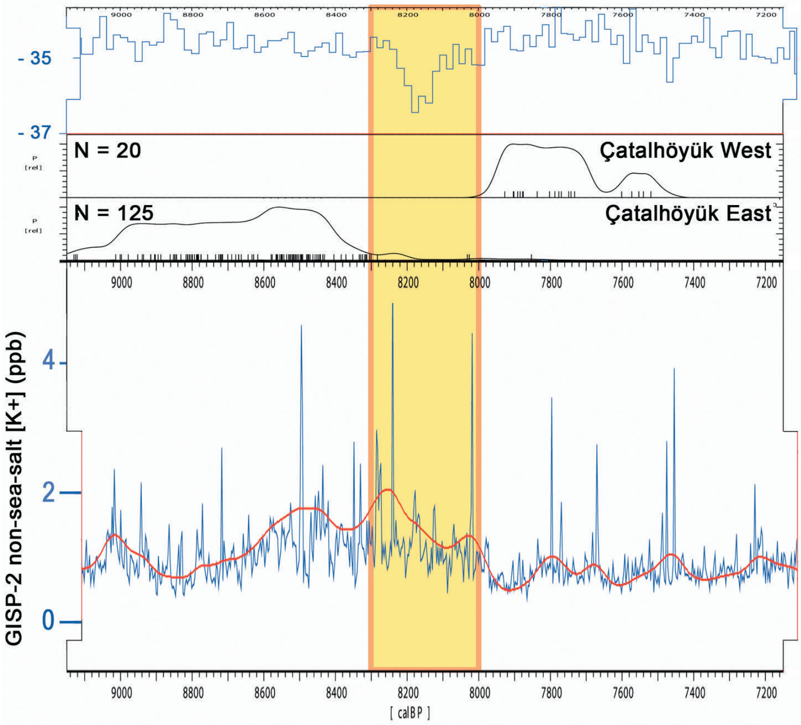


Fig. 11. Cumulative calibrated dating probability of radiocarbon data from Çatalhöyük East (*Weninger et al. 2005.Tab.4*) and Çatalhöyük West (Tab. 5) in relation to GISP2 δ¹⁶O/¹⁸O (*Grootes et al. 1993*) (top) and the Holocene non-sea-salt [K⁺] series for the GISP2 ice core from Greenland (*O'Brien et al. 1995; Mayewski et al. 1997*) (bottom). In contrast to published GISP2 ages (*Grootes er al. 1993*), GISP2 ¹⁶O/¹⁸O records (top) and GISP2 [K⁺] records (bottom) are shifted 40 yrs to the younger, as proposed by Weninger et al. (*2006*) and Vinther et al. (*2006*).

Finally, and perhaps most controversially, are we witnessing a climate induced ***intensification*** of Neolithisation processes from the semi-arid 'formative zone' of Neolithic genesis westwards into both the Aegean region and into centres of south-eastern European 'Early Neolithic' development, *e.g.* in Thessaly, in the Strumon valley, and beyond? Certainly, the aforementioned predominance of the sling over the bow at this time has been linked with the migration of specialised craftsmen from core areas of obsidian tool manufacture, located primarily in Central Anatolia (*Özdoğan 2002.443*).

REFERENCES

AKKERMANS P. M. M. G. 1993. *Villages in the Steppe – Later Neolithic Settlement and Subsistence in the Balikh Valley, Northern Syria*. International Monographs in Prehistory. Ann Arbor.

1992. Tell Sabi Abyad. *Chronique Archéologique en Syrie 1: 36–40*.

AKKERMANS P. M. M. G., SCHWARTZ G. M. 2003. *The Archaeology of Syria. From Complex Hunter-Gatherers to Early Urban Societies (ca. 16,000–300 BC)*. Cambridge University Press. Cambridge.

AKKERMANS, P. M. M. G., VERHOEVEN M. 1995. An image of complexity: The Burnt Village at Late Neolithic Sabi Abyad. *American Journal of Archaeology 99 (1): 5–32*.

AKKERMANS P. M. M. G., WITTMANN B. 1993. Khirbet esh-Shenef 1991, eine späthalafzeitliche Siedlung im Balikhtal, Nordsyrien. *Mitteilungen der Deutschen Orientgesellschaft 125: 143–166*.

AKKERMANS P. M. M. G., CAPPERS R., CAVALLO C., NIUWENHUYSE O., NILHAMN B., OTTE I. N. 2006. Investigating the Early Pottery Neolithic of Northern Syria: New Evidence from Tell Sabi Abyad. *American Journal of Archaeology 110: 123–156*.

AKMAN Y., KETENOĞLU O. 1986. The climate and vegetation of Turkey. *Proceedings of the Royal Society of Edinburgh 89B: 123–134*.

ALLEY R. B., ÁGÚSTSDÓTTIR A. M. 2005. The 8k event: cause and consequences of a major Holocene abrupt climate change. *Quaternary Science Reviews 24: 1123–1149*.

ALLEY R. B., MAYEWSKI P. A., SOWERS T., STUIVER M., TAYLOR K. C., CLARK P. U. 1997. Holocene climatic instability: A large event 8000–8400 years ago. *Geology 25: 482–486*.

BALOSSI F. 2004. New Data for the Definition of the DFBW Horizon and its Internal Developments. *Anatolica 30: 109–149*.

BALOSSI RESTELLI F. 2006. *The Development of 'Cultural Regions' in the Neolithic of the Near East. The 'Dark Faced Burnished Ware Horizon'*. BAR Int. Ser. 1482. The Basingstoke Press. Oxford.

BARBER D. C., DYKE A., HILLAIRE-MARCEL C., JENNINGS A. E., ANDREWS J. T., KERWIN M. W., BILODEAU G., MCNEELY R., SOUTHON J., MOREHEAD M. D., GAGNON J. M. 1999. Forcing of the cold event of 8,200 years ago by catastrophic drainage of Laurentide lakes. *Nature 400: 344–348*.

BARKER H., MACKEY C. J. 1960. British Museum natural radiocarbon measurements II. *Radiocarbon 2: 26–30*.

BARKER H., MACKEY J. 1963. British Museum natural radiocarbon measurements II. *Radiocarbon 5: 104–108*.

BAR-YOSEF O. 1986. The walls of Jericho: An alternative interpretation. *Current Anthropology 27: 157–162*.

BAUER E., GANOPOLSKI A., MONTOYA M. 2004. Simulation of the cold climate event 8200 years ago by meltwater outburst from Lake Agassiz. *Paleoceanography 19, doi: 10.1029/ 2004PA001030*.

BEARDAH C., BAXTER M. 1996. The Archaeological Use of Kernel Density Estimates. Internet Archaeology 1 [http://intarch.ac.uk/journal/issue1/beardah/kdeia1.html].

BIENERT H.-D. 2000. *Kult und Religion in prähistorischer Zeit. Eine Studie anhand von Fundmaterial epipaläolithischer und frühneolithischer Gesellschaften/ Kulturen Südwestasiens (12.–6. Jt. v.u.Z.)*. Unpublished PhD Dissertation. Universität Berlin.

BOND G., KROMER B., BEER J., MUSCHELER R., EVANS M. N., SHOWERS W., HOFFMANN S., LOTTI-BOND R., HAJDAS I., BONANI G. 2001. Persistent solar influence on north Atlantic climate during the Holocene. *Science 294: 2130–2136*.

BUDJA M. 2007. The 8200 calBP 'climate event' and the process of Neolithisation in south-eastern Europe. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 191–200*.

CACHO I., GRIMALT J. O., PELEJERO C., CANALS M., SIERRO F. J., FLORES J. A., SHACKLETON N. J. 1999. Dansgaard-Oeschger and Heinrich event imprints in Alboran Sea paleotemperatures. *Paleoceanography 14: 698–705*.

CACHO I., GRIMALT J. O., SIERRO F. J., SHACKLETON N. J., CANALS M. 2000. Evidence of enhanced Mediterranean thermohaline circulation during rapid climate coolings. *Earth and Planetary Science Letters 183: 417–429*.

CACHO I., GRIMALT J. O., CANALS M., SBAFFI L., SHACKLETON N. J., SCHÖNFELD J., ZAHN R. 2001. Variability of the western Mediterranean Sea surface temperatures during the last 25,000 years and its connection with the northern hemisphere climatic changes. *Paleoceanography 16: 40–52*.

CANEVA I. 1999. Early farmers on the Cilician coast: Yumuktepe in the Seventh Millennium BC. In M. Özdğan, N. Başgelen (eds.), *Neolithic in Turkey. The Cradle of Civilization. New Discoveries*. Arkeoloji ve Sanat Yayinlari. Istanbul: 105–114.

2004a. The Early Human Occupation (7000–6000 BC). In I. Caneva and V. Sevin (eds.), *Mersin-Yumuktepe: a Reappraisal*. Congedo Editore. Lecce: 33–44.

2004b. Of terraces, silos and ramparts (6000–5800 BC). In I. Caneva and V. Sevin (eds.), *Mersin-Yumuktepe: a Reappraisal*. Congedo Editore. Lecce: 45–56.

CASFORD J. S. L., ABU-ZIED R., ROHLING E. J., COOKE S., BOESSENKOOL K. P., BRINKHUIS H., DE VRIES C., WEFER G., GERAGA M., PAPATHEODOROU G., CROUDACE I., THOMSON J., WELLS N. C., LYKOUSIS V. 2001. Mediterranean climate variability during the Holocene. *Mediterranean Marine Science 2: 45–55*.

CASFORD J. S. L., ROHLING E. J., ABU-ZIED R. H., JORISSEN F. J., LENG M., THOMSON J. 2003. A dynamic concept for eastern Mediterranean circulation and oxygenation during sapropel formation. *Palaeogeography, Palaeoclimatology, Palaeoecology 190: 103–119*.

CASFORD J. S. L., ABU-ZIED R., ROHLING E. J., COOKE S., FONTANIER Ch., LENG M., MILLARD A., THOMSON J. 2007. A stratigraphically controlled multi-proxy chronostratigraphy for the eastern Mediterranean. *Paleoceanography 22: PA4215, doi:10.1029/2007PA001422*.

CHAPMAN J. 2004. The Origins of Warfare in the Prehistory of Central and Eastern Europe. In J. Carman, A. Harding (eds.), *Ancient Warfare. Archaeological Perspectives*. Sutton Publishing. Sparkford: 101–142.

CHRISTIANSEN-WENIGER F. 1964. Gefährdung Anatoliens durch Trockenjahre und Dürrekatastrophen. *Zeitschrift für ausländische Landwirtschaft 3: 133–147*.

ÇILINGIROĞLU C. 2005. The concept of "Neolithic Package": considering its meaning and applicability. In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 1–13*.

ÇILINGIROĞLU A., ÇILINGIROĞLU C. 2007. Ulucak. In M. Özdoğan, N. Başgelen (eds.), *Türkiye'de Neolithik Dönem. Yeni Kazılar – Yeni Bulgular*. Arkeoloji ve Sanat Yayınları. Istanbul: 361–372.

ÇILINGIROĞLU A., DERIN Z., ABAY E., SAĞLAMTIMUR H., KAYAN I. 2004. *Ulucak Höyük. Excavations conducted between 1995 and 2002*. Ancient Near Eastern Studies Supplement 15. Louvain.

CLARE L., JÖRIS O., WENINGER B. in press. *Der Übergang vom Spätneolithikum zur frühen Kupferzeit in Westasien um 8200 calBP – eine ethnoarchäologische Betrachtung*. RGZM-Tagungen 2.

CNN WEATHER, 19 December 2001. online http://archives.cnn.com/2001/WEATHER/12/19/greece.romania/index.html

CRUELLS W., NIEUWENHUYSE O. 2004. The Proto-Halaf Period In Syria. New Sites, New Data. *Paléorient 30: 47–68*.

DERIN Z. 2007. Yeşilova Höyüğü. In M. Özdoğan, N. Başgelen (eds.), *Türkiye'de Neolithik Dönem. Yeni Kazılar – Yeni Bulgular*. Arkeoloji ve Sanat Yayınları. Istanbul: 377–384.

DERIN Z., ÇILINGIROĞLU A., TASLIALAN M. 2004. Ulucak kazısı – 2002. *Kazı Sonçları Toplantısı 25(1): 239–250*.

DE VERNAL A., HILLAIRE-MARCEL C., VON GRAFENSTEIN U., BARBER D. 1997. Researchers look for links among paleoclimate events. Eos Trans. *AGU 78 (24): 247*.

DURU R. 1983. Excavations at Kuruçay Höyük, 1981. *Anadolu Araştırmaları 9: 41–50*.

1989. Were the Earliest Cultures at Hacılar really aceramic? In K. Emre, B. Hrouda, M. Mellink, N. Özgüc (eds.), *Anatolia and the Ancient Near East. Studies in Honor of Tahsin Özgüç/Tahsin Özgüç'e Armaghan*. Ankara: 99–105.

1994a. *Kuruçay Höyük I. 1978–1988 Kazilarinin Sonuclari Neolitik ve Erken Kalkolitik Cag Yerlesmeleri/Results of the Excavations 1978–1988 The Neolithic and Early Chalcolithic Periods*. Türk Tarih Kurumu. Ankara.

1994b. Höyücek kazıları – 1990. *Belleten 58: 725–750*.

1995. Höyücek kazıları – 1991/1992. Höyücek excavations, 1991–1992. *Belleten 59: 447–490*.

2001a. Surveys in the Burdur Region and the Kuruçay Höyük Excavations. In O. Belli (ed.), *Istanbul University's Contributions to Archaeology in Turkey (1932–2000)*. Istanbul Universitesi. Istanbul: 44–47.

2001b. Höyücek Excavation. In O. Belli (ed.), *Istanbul University's Contributions to Archaeology in Turkey (1932–2000)*. Istanbul Universitesi. Istanbul: 52–55.

2002. Bademagaci Kazıları 2000 ve 2001 yillari calisma raporu. *Belleten LXVI: 549–594*.

2004. Bademağacı Kazıları 2003/Excavations at Bademağacı in 2003. *Anadolu Akdenizi – Arkeoloji Haberleri/News of Archaeology from Anatolia's Mediterranean Areas, 2004: 15–20*.

2005. Bademağacı kazıları 2002 ve 2003. Yillari Calisma Raporu/Excavations at Bademağacı Preliminary Report, 2002 and 2003. *Belleten 68: 519–560*.

DURU R., UMURTAK G. 2005. *Höyücek. 1989–1992 Yillari Arasinda Yapilan Kazilarin Sonuclari/Results of the Excavations 1989–1992*. Türk Tarih Kurumu. Ankara.

2006. Excavations at Bademağacı 2005. *ANMED 4: 11–16*.

2007. Excavations at Bademağacı 2006. *ANMED 5: 6–11*.

ELLISON C. R. W., CHAPMAN M. R., HALL I. R. 2006. Surface and deep ocean interactions during the cold climate event 8200 years ago. *Science 312: 1929–1932*.

ERDOĞU B. 2003. Visualizing Neolithic landscape: the early settled communities in western Anatolia and eastern Aegean islands. *European Journal of Archaeology 6 (1): 7–23*.

EROL O. 1983. *Die naturräumliche Gliederung der Türkei*. Dr. Ludwig Reichert Verlag. Wiesbaden.

FRIEDRICH W. L., KROMER B., FRIEDRICH M., HEINEMEIER J., PFEIFFER T., TALAMO S. 2006. Santorini Eruption Radiocarbon Dated to 1627–1600 B.C. *Science 312: 548*.

FRIGOLA J., MORENO A., CACHO I., CANALS M., SIERRO F. J., FLORES J. A., GRIMALT J. O., HODELL D. A., CURTIS J. H. 2007. Holocene climate variability in the western Mediterranean region from a deepwater sediment record. *Paleoceanography 22: PA2209, doi:10.1029/2006PA001307*.

FRY D. P. 2006. *The Human Potential for Peace*. Oxford University Press. Oxford/New York.

GARSTANG J. 1953. *Prehistoric Mersin*. Clarendon Press. Oxford.

GAT A. 2006. *War in Human Civilzation*. Oxford University Press. New York.

GÖKTÜRK E., HILLEGONDS D., LIPSCHUTZ M., HODDER I. 2002. Accelerator mass spectrometry dating at Çatalhöyük. *Radiochimica Acta 90: 407–410*.

GROOTES P. M., STUIVER M., WHITE J. W. C., JOHNSEN S., JOUZEL J. 1993. Comparison of Oxygen Isotope Records from the GISP2 and GRIP Greenland Ice Core. *Nature 366: 52–554*.

HAAS J. 1990. Warfare and the Evolution of Tribal Polities in the Prehistoric Southwest. In J. Haas (ed.), *The Anthropology of War*. Cambridge University Press. New York: 171–189.

HAAS J., CREAMER W. 1993. *Stress and Warfare among the Kayenta Anasazi of the thirteenth Century A.D*. Field Museum of Natural History. Chicago.

HAMBLIN W. J. 2006. *Warfare in the Ancient Near East to 1600 BC*. Routledge. London/New York.

HAYES A., KUCERA M., KALLEL N., SBAFFI L., ROHLING E. J. 2005. Glacial Mediterranean Sea surface temperatures reconstructed from planktonic foraminiferal assemblages. *Quaternary Science Reviews 24: 999–1016*.

HERZOG I. 2007a. Simulationsexperimente zur Analyse von Siedlungsdichten. In St. Burmeister, H. Derks, J. von Richthofen (eds.), *Zweiundvierzig. Festschrift für Michael Gebühr zum 65. Geburtstag*. Internationale Archäologie – Studia honoraria 28. Verlag Marie Leidorf. Rahden/Westf: 2007: 3–14.

2007b. Testing GIS methods by means of simulation. Detecting and Describing Find Spot Densities. In W. Börner, S. Uhlirz (eds.), *Workshop 11, Archäologie und Computer*. Kulturelles Erbe und Neue Technologien, 18.–20.10.2006. PDF file on CD. Phoibos-Verlag. Vienna.

HIGHAM T. F. G., BRONK RAMSEY C., BROCK F., BAKER D., DITCHFIELD P. 2007. Radiocarbon dates from the Oxford AMS system: Archaeometry Datelist 32. *Archaeometry 49: S1–S60*.

HILPERT J., WENDT K.-P., ZIMMERMANN A. 2007. Estimation of prehistoric population densities with GIS-supported methods. In W. Börner, S. Uhlirz (eds.), *Workshop 11, Archäologie und Computer*. Kulturelles Erbe und Neue Technologien, 18.–20.10.2006. PDF file on CD. Phoibos-Verlag. Vienna.

in press. A hierarchical model of scale levels for estimations of population densities. CAA 2007.

HOREJS B. 2008. Çukuriçi Höyük. A New Excavation Project in the Eastern Aegean. 4 Feb. 2008. Aegeo-Balkan Prehistory. http://www.aegeobalkanprehistory.net/article.php?id_art=9 (8 Mar. 2008).

HÜTTEROTH W. 1982. *Türkei*. Wissenschaftliche Buchgesellschaft, Darmstadt.

KARUL N. 2000. *Gebäude aus Flechtwerk: die archäologischen Befunde aus den neolithisch-chalkolithischen Siedlungsschichten von Hoca Çeşme, AşağıPınar und Toptepe*. Unpublished PhD Dissertation, Freie Universität Berlin.

KEELEY L. H. 1996. *War Before Civilizations. The Myth of the Peaceful Savage*. Oxford University Press. New York/Oxford.

KLEIVEN H. (K.) F., KISSEL C., LAJ C., NINNEMANN U. S., RICHTER T. O., CORTIJO E. 2007. Reduced North Atlantic Deep Water Coeval with the Glacial Lake Agassiz Freshwater Outburst. *Science 319: 60–64*.

KORFMANN 1972. *Schleuder und Bogen in Südwestasien. Von den frühsten Belegen bis zum Beginn der historischen Stadtstaaten*. Rudolf Habelt Verlag GmbH. Bonn.

LEAMAN K. D., SCHOTT F. A. 1991. Hydrographic structure of the convection regime in the Gulf of Lions: Winter 1987. *Journal of Physical Oceanography 21: 575–598*.

LEBLANC S. A. 1999. *Prehistoric Warfare in the American Southwest*. University of Utah Press. Salt Lake City.

LEGRANDE A N., SCHMIDT G. A., SHINDELL D.T., FIELD C. V., MILLER R. L., KOCH D. M., FALUVEGI G., HOFFMANN G. 2006. Consistent simulations of multiple proxy responses to an abrupt climate change event. *Proceedings of National Academy of Science 103: 837–842*.

LE MIÈRE M., NIEUWENHUYSE O. 1996. The Prehistoric Pottery. In P. M. M. G. Akkermans (ed.), *Tell Sabi Abyad. The Late Neolithic Settlement. Report on the Excavations of the University of Amsterdam (1988) and the National Museum of Antiquities Leiden (1991–1993) in Syria. Volume I*. Nederlands Historisch-Archaeologisch Instituut. Leiden/Istanbul: 119–284.

LICHTER C. 2005. Western Anatolia in the Late Neolithic and Early Chalcolithic: the actual state of research. In C. Lichter (ed.), *How Did Farming Reach Europe? Anatolian-European Relations from the second half of the 7th through the first half of the 6th millennium cal BC*. Proceedings of the International Workshop, Istanbul, 20–22 May 2004. Ege Yayınları. Istanbul: 59–74.

2006. Zum Forschungsstand des Neolithikums und frühen Chalkolithikums in Westanatolien. In I. Gatsov and H. Schwarzberg (eds.), *Aegean-Marmara-Black Sea: The Present State of Research on the Early Neolithic*. ZAKSSchriften 5. Beier & Beran. Langenweissbach: 29–46.

LICHTER C., MERIÇ, R. 2007. Dedecik-Heybelitepe. In M. Özdoğan, N. Başgelen (eds.), *Türkiye'de Neolithik Dönem. Yeni Kazılar – Yeni Bulgular*. Arkeoloji ve Sanat Yayınları. Istanbul: 385–386.

LOLIS C. J., BARTZOKAS A., KATSOULIS B. D. 2002. Spatial and temporal 850 hPa air temperature and sea-surface temperature covariances in the Mediterranean region and their connection to atmospheric circulation. *International Journal of Climatology 22: 663–676*.

MAHERAS P., XOPLAKI E., DAVIES T., MARTIN-VIDE J., BARIENDOS M., ALCOFORADO M. J. 1999. Warm and cold monthly anomalies across the Mediterranean basin and their relationship with circulation; 1860–1990. *International Journal of Climatology 19: 1697–1715*.

MANGINI A., VERDES P., SPÖTL C., SCHOLZ D., VOLLWEILER N., KROMER B. 2007. Persistent influence of the North Atlantic hydrography on central European winter temperature during the last 9000 years. *Geophysical Research Letters 34: L02704, doi:10.1029/2006GL028600*.

MAYEWSKI P. A., MEEKER L. D., TWICKLER M. S., WHITLOW S., YANG Q., PRENTICE M. 1997. Major features and forcing of high latitude northern hemisphere atmospheric circulation using a 110,000-year-long glaciochemical series. *Journal of Geophysical Research 102: 26345–26366*.

MAYEWSKI P. A., ROHLING E. J., STAGER J. C., KARLÉN W., MAASCH K., MEEKER L. D., MEYERSON E., GASSE F., VAN KREVELD S., HOLMGREN K., LEE-THORP J., ROSQVIST G., RACK F., STAUBWASSER M., SCHNEIDER R. R., STEIG E. 2004. Holocene Climate Variability. *Quaternary Research 62: 243–255*.

MEEKER L. D., MAYEWSKI P. A. 2002. A 1400-year high-resolution record of atmospheric circulation over the North Atlantic and Asia. *Holocene 12: 257–266*.

MELLAART J. 1970. *Excavations at Hacilar*. Edinburgh University Press. Edinburgh.

MERCONE D., J. THOMSON I. W., CROUDACE G., SIANI M., PATERNE TROELSTRA S. 2000. Duration of S1, the most recent sapropel in the eastern Mediterranean Sea, as indicated by accelerated mass spectrometry radiocarbon and geochemical evidence. *Paleoceanography 15: 336–347*.

MOOK W. G., VAN DER PLICHT J. 1999. Reporting ^{14}C activities and concentrations. *Radiocarbon 41: 227–239*.

O'BRIEN S. R., MAYEWSKI P. A., MEEKER L. D., MEESE D. A., TWICKLER M. S., WHITLOW S. I. 1995. Complexity of Holocene climate as reconstructed from a Greenland ice core. *Science 270: 1962–1964*.

OTTERBEIN K. F. 2004. *How War Began*. Texas A&M University Press.College Station

ÖZDOĞAN M. 1997. The beginning of Neolithic economies in Southeastern Europe. *Journal of European Archaeology 5 (2): 1–33*.

1998. Hoca Çeşme. An Early Neolithic Anatolian Colony in the Balkans. In P. Anreiter, L. Bartosiewicz, E.

Jerem and W. Meid (eds.), *Man and the Animal World. Studies in Archaeozoology, Archaeology, Anthropology and Palaeolinguistics in Memoriam Sándor Bökönyi*. Archaeolingua. Budapest: 435–451.

2002. On Arrows and Sling Missiles: What happened to the Arrows? In R. Aslan, S. Blum, G. Kastl, F. Schweizer and D. Thumm (eds.), *MAUERSCHAU. Festschrift für Manfred Korfmann*. Verlag Bernhard Albert Greiner. Remshalden: 437–444.

2005. Westward expansion of the Neolithic way of life: what we know and what we do not know. In C. Lichter (ed.), *How Did Farming Reach Europe? Anatolian-European Relations from the second half of the 7th through the first half of the 6th millenium cal BC*. Proceedings of the International Workshop, Istanbul, 20–22 May 2004. Ege Yayınları. Istanbul: 13–27.

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

POULOS S. E., DRAKOPOULOS P. G., COLLINS M. B. 1997. Seasonal variability in sea surface oceanographic conditions in the Aegean Sea (eastern Mediterranean): an overview. *Journal of Marine Systems 13: 225–244*.

RALPH R., STUCKENRATH E. 1962. University of Pennsylvania radiocarbon dates V. *Radiocarbon 4: 144–159*.

RASMUSSEN S. O., ANDERSEN K. K., SVENSSON A. M., STEFFENSEN J. P., VINTHER B. M., CLAUSEN H. B., SIGGAARD-ANDERSEN M.-L., JOHNSEN S. J., LARSEN L. B., DAHL-JENSEN D., BIGLER M., RÖTHLISBERGER R., FISCHER H., GOTO-AZUMA K., HANSSON M. E., RUTH U. 2006. A new Greenland ice core chronology for the last glacial termination. *Journal of Geophysical Research 111: D06102, doi:10.1029/2005JD006079*.

REDMOND E. M. 1994. *Tribal and Chiefly Warfare in South America*. Ann Arbor. Museum of Anthropology, University of Michigan.

REIMER P. J., BAILLIE M. G. L., BARD E., BAYLISS A., BECK J. W., BERTRAND C. J. H., BLACKWELL P. G., BUCK C. E., BURR G. S., CUTLER K. B., DAMON P. E., EDWARDS R. L., FAIRBANKS R. G., FRIEDRICH M., GUILDERSON T. P., HOGG A. G., HUGHEN K. A., KROMER B., MCCORMAC F. G., MANNING S. W., RAMSEY C. B., REIMER R. W., REMMELE S., SOUTHON J. R., STUIVER M., TALAMO S., TAYLOR F. W., VAN DER PLICHT J., WEYHENMEYER C. E. 2004. Int Cal04 Terrestrial radiocarbon age calibration, 26–0 ka BP. *Radiocarbon 46: 1029–1058*.

RENSSEN H., GOOSSE H., FICHEFET T. 2002. Modelling the effect of freshwater pulses on the early Holocene climate: the influence of high-frequency climate variability. *Paleoceanography 17: doi:10.1029/2001PA000649*.

2007. Simulation of Holocene cooling events in a coupled climate model. *Quaternary Science Reviews 26: 2019–2029*.

RODWELL M. J., HOSKINS B. J. 1996. Monsoons and the dynamics of desserts. *Quarterly Journal of the Royal Meteorological Society 122: 1385–1404*.

ROHLING E. J., PÄLIKE H. 2005. Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature 434: 975–979*.

ROHLING E. J., JORISSEN F. J., DE STIGTER H. C. 1997. 200 Year interruption of Holocene sapropel formation in the Adriatic Sea. *Journal of Micropalaeontology 16: 97–108*.

ROHLING E. J., MAYEWSKI P. A., HAYES A., ABU-ZIED R. H., CASFORD J. S. L. 2002a. Holocene atmosphere-ocean interactions: records from Greenland and the Aegean Sea. *Climate Dynamics 18: 587–593*.

ROHLING E. J., CASFORD J., ABU-ZIED R., COOKE S., MERCONE D., THOMSON J., CROUDACE I., JORISSEN F. J., BRINKHUIS H., KALLMEYER J., WEFER G. 2002b. Rapid Holocene climate changes in the eastern Mediterranean. In F. Hassan (ed.), *Droughts, Food and Culture: Ecological Change and Food Security in Africa's Later Prehistory*. Kluwer Academic/Plenum Publishers. London: 35–46.

ROHLING E. J., HAYES A., MAYEWSKI P. A., KUCERA M. in press. Holocene climate variability in the eastern Mediterranean, and the End of the Bronze Age. In C. Bachhuber, G. Roberts (eds.), *Forces of Transformation: The End of the Bronze Age in the Mediterranean*. Oxbow Press. Oxford.

ROPER M. K. 1975. Evidence of Warfare in the Near East from 10,000–4,300 B.C. In M. A. Nettleship, R. Dale-Givens, A. Nettleship (eds.), *War. Its Causes and Correlates*. Mouton Publishers. The Hague/Paris: 299–340.

SAARONI H., BITAN A., ALPERT P., ZIV B. 1996. Continental Polar outbreaks into the Levant and Eastern Mediterranean. *International Journal of Climatology 16: 1175–1191*.

SCHOOP U.-D. 2002. Frühneolithikum im südwestanatolischen Seengebiet? Eine kritische Betrachtung. In R. Aslan, S. Blum, G. Kastl, F. Schweizer and D. Thumm (eds.), *MAUERSCHAU. Festschrift für Manfred Korfmann*. Verlag Bernhard Albert Greiner. Remshalden: 421–436.

2005. *Das anatolische Chalkolithikum. Eine chronologische Untersuchung zur vorbronzezeitlichen Kultursequenz in nördlichen Zentralanatolian und den angrenzenden Gebieten*. Verlag Bernhard Albert Greiner. Remshalden.

TAY PROJECT DATABASE. online http://www.tayproject.org/

TELEGRAPH, 5 January 2002. online: http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2002/01/05/wcold05.xml&sSheet=/portal/2002/01/05/por_right.html

THISSEN L. 2006. CANeW ^{14}C databases and ^{14}C charts. Southwest and Northwest Anatolia. online: http://www.canew.org/data.html.

THISSEN L., CESSFORD C., NEWTON M. 2007. CANeW ^{14}C-databases: Central Anatolia and Cilicia 9th–5th millennia calBC. online: http://www.canew.org/data.html.

THOMAS E. R., WOLFF E. W., MULVANEY R., STEFFENSEN J. P., JOHNSEN S. J., ARROWSMITH C., WHITED J. W. C., VAUGHN B., POPP T. 2007. The 8.2 ka event from Greenland ice cores. *Quaternary Science Reviews 26: 70–81*.

TRIGO I. F., DAVIES T. D., BIGG G. R. 1999. Objective climatology in the Mediterranean region. *Journal of Climate 12: 1685–1696*.

TÜRKEŞ M. 2003. Spatial and Temporal Variations in Precipitation and Aridity Index Series of Turkey. In H. Bolle (ed.), *Mediterranean Climate. Variability and Trends*. Springer. Berlin, Heidelberg: 181–213.

UMURTAK G. 2007. Die jungsteinzeitlichen Siedlungen im südwestanatolischen Seengebiet. In C. Lichter (ed.), *Vor 12.000 Jahren in Anatolien. Die ältesten Monumente der Menschheit. Begleitbuch zur Großen Landesausstellung Baden-Württemberg 2007 im Badischen Landesmuseum Schloss Karlsruhe*. Theiss. Stuttgart: 139–149.

UNIVERSITY OF CHICAGO NEWS OFFICE. online press release [16/12/2005]. University of Chicago-Syrian team finds first evidence of warfare in ancient Mesopotamia. online: http://www-news.uchicago.edu/releases/05/051216.hamoukar.shtml.

VINTHER B. M., CLAUSEN H. B., JOHNSEN S. J., RASMUSSEN S. O., ANDERSEN K. K., BUCHARDT S. L., DAHL-JENSEN D., SEIERSTAD I. K., SIGGAARD-ANDERSEN M.-L., STEFFENSEN J. P., SVENSSON A., OLSEN J., HEINEMEIER J. 2006. A synchronized dating of three Greenland ice cores throughout the Holocene. *Journal of Geophysical Research 111, doi: 10.1029/2005JD006921*.

VOGELSANG R., WENDT K. P. 2007. Changing settlement patterns in Namibia during the Holocene. In O. Bubenzer, A. Bolten, F. Darius (eds.), *Atlas of Cultural and Environmental Change in Arid Africa*. Africa Praehistorica 21. Cologne: 68–71.

VUTRIROPULOS N. 1991. *Fernwaffen in Südosteuropa – Neolithikum bis frühe Bronzezeit*. Verlag Marie L. Leidorf. Buch am Erlbach.

WENINGER B. 1986. High-precision calibration of archaeological radiocarbon dates. *Acta Interdisciplinaria Archaeologica IV. Nitra: 11–53*.

WENINGER B., ALRAM-STERN E., BAUER E., CLARE L., DANZEGLOCKE U., JÖRIS O., KUBATZKI C., ROLLEFSON G., TODOROVA H. 2005. Die Neolithisierung von Südosteuropa als Folge des abrupten Klimawandels um 8200 cal BP. In D. Gronenborn (ed.), *Klimaveränderung und Kulturwandel in neolithischen Gesellschaften Mitteleuropas, 6700–2200 v. Chr*. RGZM Tagungen 1: 75–117.

2006. Climate forcing due to the 8200 cal yr BP event observed at Early Neolithic sites in the eastern Mediterranean. *Quaternary International 66: 401–420*.

WENINGER B., ALRAM-STERN E., BAUER E., CLARE L., DANZEGLOCKE U., JÖRIS O., KUBATZKI C., ROLLEFSON G., TODOROVA H., VAN ANDEL T. 2007. Abrupt Climate Forcing observed at Early Neolithic sites in South-East Europe and the Near East. In H. Todorova, M. Stefanovich, G. Ivaniv (eds.), *In the Steps of James Harvey Gaul, Volume 2. The Struma/Strymon River Valley in Prehistory*. Proceedings of the International Symposium 'Strymon Praehistoricus', Kjustendil-Blagoevgrad (Bulgaria) and Serres-Amphipolis (Greece), 27.09–01.10.2004. Sofia: 7–28.

WIERSMA A. P., RENSSEN H. 2006. Model-data comparison for the 8.2 ka BP event: confirmation of a forcing mechanism by catastrophic drainage of Laurentide lakes. *Quaternary Science Reviews 25: 63–88*.

WORLD WEATHER NEWS 2001. online: http://www.met.rdg.ac.uk/~brugge/world2001.html

XOPLAKI E., MAHERAS P., LUTERBACHER J. 2001. Variability of climate in meridional Balkans during the periods 1675–1715 and 1780–1830 and its impact on human life. *Climatic Change 48: 581–615*.

YAKAR J. 1991. *Prehistoric Anatolia. The Neolithic Transformation and the Early Chalcolithic Period*. Tel Aviv University, Sonia and Marco Nadler Institute of Archaeology. Monograph Series no. 9. Institute of Archaeology of Tel Aviv University, Publications Section. Jerusalem.

2000. *Ethnoarchaeology of Anatolia. Rural Socio-Economy in the Bronze and Iron Ages*. Emery and Claire Yass Publications in Archaeology. Jerusalem.

YILDERIM B., GATES M. 2007. Archaeology in Turkey, 2004–2005. *American Journal of Archaeology 111. 275–356*.

ZIMMERMANN A. 2003. Landschaftsarchäologie I: Die Bandkeramik auf der Aldenhovener Platte. *Bericht der Römisch-Germanischen Kommission 83: 17–38*.

ZIMMERMANN A., RICHTER J., FRANK T., WENDT K.-P. 2004. Landschaftsarchäologie II – Überlegungen zu Prinzipien einer Landschaftsarchäologie. *Bericht der Römisch-Germanischen Kommission 85: 37–95*.

∴

Appendix

Date List: ^{14}C-Data from archaeological sites referenced in the text

The radiocarbon dates are cited according to the original publication (*reference*). There are cases when the archaeological sample description is only available from secondary and higher order data descriptions, and notably from the following on-line databases:
Reingruber and Thissen 2004: www.canew.org/download.html
Gérard 2001: www.canew.org/download.html
Thisssen 2007: www.canew.org/download.html
Böhner 2006: www.context-database.uni-koeln.de.

Conventional ^{14}C-ages [BP ± 1 σ] are defined as dimensionless logarithmic ^{14}C count rates of dated samples relative to the standard NBS Oxalic Acid (*Mook and van der Plicht 1999*). Calibrated ages [calBC ± 1 σ] are calculated with the CalPal program (www.calpal.de) using methods of Weninger (*1986*) as the base of the INTCAL04 ^{14}C-age tree-ring calibration database (*Reimer et al. 2004*). Numeric calibrated ages are given as median values, with errors (p = 68.2% interval derived from the calibrated age distribution) rounded to the nearest decade.

Lab code	^{14}C age (BP)	δ^{13}C	Material	Species	Period	Site Locus	Cal age (calBP)	Reference
P–315	6926 ± 95	n.d.	charcoal	(poutre)	level IA	Room 5, Roof Beam	7780 ± 90	*Ralph and Stuckenrath 1962*
P–315A	7047 ± 221	n.d.	charcoal		level IA	Room 5, Roof Beam	7900 ± 210	*Ralph and Stuckenrath 1962*
P–313	7150 ± 98	n.d.	charcoal		level VI	Area E, ash from fireplace	7990 ± 110	*Ralph and Stuckenrath 1962*
P–326A	7169 ± 131	n.d.	n.d.				8000 ± 140	*Bienert 2000*
P–316	7170 ± 134	n.d.	charcoal		level IIA	Area N, Room 4, Roof Beam	8000 ± 140	*Ralph and Stuckenrath 1962*
P–316A	7172 ± 127	n.d.	charcoal		level IIA	Area N, Room 4, Roof Beam	8010 ± 130	*Ralph and Stuckenrath 1962*
P–314	7340 ± 94	n.d.	charcoal		level IX	Area E, ash from fireplace	8170 ± 110	*Ralph and Stuckenrath 1962*
P–313A	7350 ± 85	n.d.	charcoal		level VI	Area E, ash from fireplace	8180 ± 110	*Ralph and Stuckenrath 1962*
P–326	7386 ± 131	n.d.	charcoal				8200 ± 130	*Bienert 2000*
AA–41604	7398 ± 63	n.d.	charcoal	juniper	level VI	Area P, Burnt Post, id BM–48	8230 ± 80	*Thissen 2006*
AA–41603	7452 ± 51	n.d.	charcoal	juniper	level VI	Area P, Burnt Post, id BM–48	8280 ± 60	*Thissen 2006*
AA–41602	7468 ± 51	n.d.	charcoal	juniper	level VI	Area P, Burnt Post, id BM–48	8290 ± 60	*Thissen 2006*
BM–48	7550 ± 180	n.d.	charcoal		level VI	Area P, Burnt Post	8360 ± 180	*Barker and Mackey 1960*
BM–125	7770 ± 180	n.d.	charcoal		level VII	Area P, Corner Beam from room	8660 ± 230	*Barker and Mackey 1963*
BM–127	8700 ± 180	n.d.	charcoal		level V “aceramic”	Area Q, ash from fireplace	9810 ± 240	*Barker and Mackey 1963*

***Tab. 1. Hacılar (37.57°N, 30.08°W). Database references:* Gérard 2001; Thisssen 2006; Böhner 2006.**

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Cal age (calBP)	Reference
Hd–9988/10341	4620 ± 60	n.d.	charcoal	n.d.	L–CH	5310 ± 140	*Duru 1994*
Hd–9992/10363	4650 ± 55	n.d.	charcoal	n.d.	L–CH	5400 ± 70	*Duru 1994*
Hd–9990/10361	4690 ± 60	n.d.	charcoal	n.d.	L–CH	5440 ± 100	*Duru 1994*
Hd–9991/10362	4720 ± 60	n.d.	charcoal	n.d.	L–CH	5450 ± 100	*Duru 1994*
Hd–9989/10360	4740 ± 50	n.d.	charcoal	n.d.	L–CH	5460 ± 100	*Duru 1994*
–	4795 ± 82	n.d.		n.d.	L–CH	5490 ± 110	*Duru 1994*
–	5170 ± 70	n.d.	charcoal	n.d.	PN	5910 ± 110	*Duru 1983*
–	5450 ± 52	n.d.		n.d.	L–CH	6240 ± 50	*Duru 1994*
HD–12917/12830	7045 ± 95	n.d.	bone	n.d.	PN	7850 ± 90	*Duru 1994*
HD–12916/12674	7140 ± 35	n.d.	bone	n.d.	PN	7940 ± 50	*Duru 1994*
–	7214 ± 38	n.d.	charcoal	n.d.	PN	8040 ± 60	*Duru 1983*
HD–12915/12673	7310 ± 70	n.d.	bone	n.d.	PN	8100 ± 70	*Duru 1994*

Tab. 2. Kuruçay Höyük (37.63°N, 30.16°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Site Locus	Cal age (calBP)	Reference
HD–14217/13822	7349 ± 38	n.d.	charcoal	n.d.	Shrine Phase	post	8150 ± 70	*Duru 1995*
–	7350 ± 50	n.d.	charcoal	n.d.	Shrine Phase	post	8170 ± 90	*Duru 1994b*
–	7350 ± 50	n.d.	charcoal	n.d.	Shrine Phase	post	8170 ± 90	*Duru 1994b*
–	7540 ± 45	n.d.	charcoal	n.d.	Shrine Phase	post	8360 ± 40	*Duru 1994b*
HD–14218/14002	7551 ± 46	n.d.	charcoal	n.d.	Shrine Phase	post	8370 ± 40	*Duru 1995*
HD–14219/14007	7556 ± 45	n.d.	charcoal	n.d.	Shrine Phase	post	8370 ± 30	*Duru 1995*

Tab. 3. Höyücek (37.45°N, 30.55°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Cal age (calBP)	Reference
Hd–21046	7307 ± 41	n.d.	n.d.	n.d.	EN II/1	8110 ± 50	*Thissen 2006*
Hd–21016	7424 ± 37	n.d.	n.d.	n.d.	EN II/4	8260 ± 50	*Thissen 2006*
Hd–21058	7459 ± 51	n.d.	n.d.	n.d.	ENII/3	8280 ± 60	*Thissen 2006*
Hd–22279	7465 ± 27	n.d.	charcoal	n.d.	EN II/4A	8280 ± 60	*Duru 2004*
Hd–21015	7481 ± 40	n.d.	n.d.	n.d.	EN II/4	8290 ± 60	*Thissen 2006*
Hd–20910	7546 ± 41	n.d.	n.d.	n.d.	EN II/3	8370 ± 30	*Duru 2002*
Hd–22339	7553 ± 31	n.d.	charcoal	n.d.	EN II/4–3A	8380 ± 30	*Duru 2004*
Hd–22340	7949 ± 31	n.d.	charcoal	n.d.	EN I/8	8830 ±110	*Duru 2004*

Tab. 4. Bademağacı (37.22°N, 30.49°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Cal age (calBP)	Reference
PL– 980524A	6940 ± 80	n.d.	charcoal	n.d.	Early Chalcolithic	5840 ± 80	*Göktürk et al. 2002*
AA–27981	7040 ± 40	n.d.	charcoal	n.d.	Early Chalcolithic	5940 ± 50	*Göktürk et al. 2002*
OxA–11763	6626 ± 36	–22,20	seeds	cereal	Early Chalcolithic	7520 ± 40	*Higham et al. 2007*
OxA–11762	6662 ± 38	–21,80	seeds	hackberry	Early Chalcolithic	7540 ± 40	*Higham et al. 2007*
OxA–12105	6682 ± 34	–19,60	seeds	cereal	Early Chalcolithic	7550 ± 40	*Higham et al. 2007*
OxA–11764	6707 ± 38	–22,10	seeds	cereal	Early Chalcolithic	7570 ± 40	*Higham et al. 2007*
OxA–11764	6730 ± 40	–22,00	seeds	hackberry	Early Chalcolithic	7600 ± 40	*Higham et al. 2007*
OxA–12106	6894 ± 34	–10,10	seeds	cereal	Early Chalcolithic	7730 ± 40	*Higham et al. 2007*
OxA–11760	6904 ± 39	–22,40	seeds	cereal	Early Chalcolithic	7740 ± 50	*Higham et al. 2007*
OxA–11773	6915 ± 34	–23,90	seeds	cereal	Early Chalcolithic	7750 ± 40	*Higham et al. 2007*
OxA–11756	6937 ± 38	–20,80	seeds	cereal	Early Chalcolithic	7770 ± 50	*Higham et al. 2007*
OxA–11754	6945 ± 39	–21,90	seeds	cereal	Early Chalcolithic	7780 ± 50	*Higham et al. 2007*
OxA–11774	6969 ± 36	–22,70	seeds	cereal	Early Chalcolithic	7800 ± 50	*Higham et al. 2007*
OxA–12089	6990 ± 40	–22,20	seeds	cereal	Early Chalcolithic	7840 ± 60	*Higham et al. 2007*
OxA–11758	7028 ± 37	–23,10	seeds	cereal	Early Chalcolithic	7880 ± 50	*Higham et al. 2007*
OxA–11759	7028 ±39	–23,60	seeds	cereal	Early Chalcolithic	7880 ± 50	*Higham et al. 2007*
OxA–11755	7049 ±39	–23,40	seeds	cereal	Early Chalcolithic	7890 ± 40	*Higham et al. 2007*
OxA–11750	7065 ± 40	–21,50	seeds	cereal	Early Chalcolithic	7900 ± 40	*Higham et al. 2007*
OxA–11751	7070 ± 45	–23,50	seeds	cereal	Early Chalcolithic	7900 ± 50	*Higham et al. 2007*
OxA–11757	7103± 39	–23,60	seeds	cereal	Early Chalcolithic	7930 ± 50	*Higham et al. 2007*

Tab. 5. ÇatalhöyükWest (37.66°N, 32.82°W). Database references: Thissen 2007 (CaNEW, March 2007).

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Phase	Cal age (calBP)	Reference
R–805	5360 ± 80	n.d.	seeds	Triticum	XIIB	6140 ±110	*Caneva 1999*
R–602	5940 ± 70	n.d.	charcoal	n.d.	XIIB	6780 ± 90	*Caneva 1999*
R–1010	6675 ± 70	n.d.	charcoal	n.d.	XVI	7550 ± 60	*Caneva 1999*
R–809	6980 ± 80	n.d.	charcoal	n.d.	XXV	7820 ± 90	*Caneva 1999*
R–1345	7010 ± 75	n.d.	charcoal	n.d.	XXV	7840 ± 80	*Caneva 1999*
R–806	7030 ± 90	n.d.	charcoal	n.d.	XXV	7850 ± 90	*Thissen 2007*
R–7090	7090 ± 70	n.d.	charcoal	n.d.	XXV	7910 ± 70	*Caneva 1999*
R–956	7090 ± 70	n.d.	charcoal	n.d.	XXVI	7910 ± 70	*Caneva 1999*
R–957	7100 ± 70	n.d.	charcoal	n.d.	n.d.	7920 ± 70	*Caneva 1999*
R–807	7160 ± 80	n.d.	charcoal	n.d.	XXVI	8000 ± 90	*Caneva 1999*
R–1226	7280 ± 70	n.d.	charcoal	n.d.	XXVI	8100 ± 70	*Caneva 1999*
R–808	7380 ± 80	n.d.	charcoal	n.d.	XXVI	8200 ±110	*Thissen 2006*
R–1011	7545 ± 75	n.d.	charcoal	n.d.	XXVI	8330 ± 80	*Caneva 1999*
R–1343	7640 ± 80	n.d.	charcoal	n.d.	XXX–XXXIII	8460 ± 70	*Caneva 1999*
R–1344	7750 ± 80	n.d.	charcoal	n.d.	XXX–XXXIII	8540 ± 80	*Thissen 2007*
R–734	7790 ± 80	n.d.	charcoal	n.d.	XXX–XXXIII	8600 ±110	*Thissen 2007*
R–467	7920 ± 90	n.d.	charcoal	n.d.	XXX–XXXIII	8790 ±140	*Caneva 1999*
W–617	7950 ± 250	n.d.	charcoal	n.d.	XXXIII	8860 ±310	*Caneva 1999*

Tab. 6. Mersin-Yumuktepe (36.80°N, 34.60°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Cal age (calBP)	Reference
Beta–178748	6900 ± 70	n.d.	charcoal	n.d.	Phase IVb2	7750 ± 70	*Derin et al. 2004*
Beta–178747	6980 ± 60	n.d.	charcoal	n.d.	Phase IVb2	7820 ± 80	*Derin et al. 2004*
Beta–188371	7110 ± 40	n.d.	charcoal	n.d.	Phase V	7930 ± 50	*Derin et al. 2004*
Beta–188370	7120 ± 50	n.d.	charcoal	n.d.	Phase V	7940 ± 50	*Derin et al. 2004*
Beta–188372	7300 ± 40	n.d.	charcoal	n.d.	Phase V	8110 ± 50	*Derin et al. 2004*

Tab. 7. Ulucak (38.46°N, 27.35°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Site Locus	Cal age (calBP)	Reference
KN–5811	7505 ± 30	–26.40	charcoal	n.d.	Early Chalcolithic	Phase III.8, AGZ–L1b, 15.25–14.80 m	8330 ± 50	*Derin 2007*

Tab. 8. Yeşilova (38.45°N, 27.22°W)

Lab code	^{14}C age (BP)	$\delta^{13}C$	Material	Species	Period	Site Locus	Cal age (calBP)	Reference
GrN–19356	6520 ±110	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7420 ±100	*Özdoğan 1997*
GrN–19782	6890 ± 60	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7740 ± 60	*Özdoğan 1997*
GrN–19310	6890 ±280	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7760 ±250	*Özdoğan 1997*
GrN–19781	6900 ±110	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7760 ±110	*Özdoğan 1997*
GrN–19780	6920 ± 90	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7770 ± 90	*Özdoğan 1997*
GrN–19311	6960 ± 65	n.d.	charcoal	n.d.	Early Chalcolithic	phase II	7800 ± 80	*Özdoğan 1997*
Hd–16726/17084	7005 ± 33	n.d.	n.d.	n.d.	Pottery Neolithic	phase III	7860 ± 50	*Karul 2000*
Hd–16727/17038	7028 ± 50	n.d.	n.d.	n.d.	Pottery Neolithic	phase III	7870 ± 60	*Karul 2000*
GrN–19357	7135 ±270	n.d.	charcoal	n.d.	Pottery Neolithic	phase III	7980 ±260	*Özdoğan 1997*
GrN–19355	7200 ±180	n.d.	charcoal	n.d.	Pottery Neolithic	phase IV	8030 ±180	*Özdoğan 1997*
Hd–16724/17186	7239 ± 29	n.d.	n.d.	n.d.	Pottery Neolithic	phase III	8070 ± 60	*Özdoğan 1997*
GrN–19779	7360 ± 35	n.d.	charcoal	n.d.	Pottery Neolithic	phase IV	8180 ± 80	*Karul 2000*
Hd–16725/119145	7496 ± 69	n.d.	n.d.	n.d.	Pottery Neolithic	phase IV	8300 ± 70	*Karul 2000*
Bln–4609	7637 ± 43	n.d.	n.d.	n.d.	Pottery Neolithic	phase IV	8450 ± 50	*Karul 2000*

Tab. 9. Hoca Çeşme (40.70°N, 26.13°W)

^{14}C age (BP)	$\delta^{13}C$	Material	Period	Operation/Phase	Cal age (calBP)	Reference
6670 ±100	n.d.	charcoal	Halaf	Op.I, NE–Mound	7550 ± 80	*Akkermans 1997*
6930 ± 45	n.d.	seeds	Transitional Balikh IIIA	Op. II, level 2, on floor of oven	7770 ± 50	*Akkermans et al. 2006*
6930 ± 80	n.d.	charcoal	Transitional Balikh IIIA	Op. I, level 4	7780 ± 80	*Akkermans 1993*
6975 ± 30	n.d.	seeds	Early Halaf	Op. I, level 1	7810 ± 50	*Akkermans 1993*
7005 ± 30	n.d.	charcoal	Early Halaf	Op. I, level 2	7860 ± 50	*Akkermans 1993*
7025 ± 25	n.d.	seeds	Transitional Balikh IIIA	Op. I, level 6, floor of building	7880 ± 40	*Akkermans & Verhoeven 1995*
7025 ± 45	n.d.	seeds	Transitional Balikh IIIA	Op. II, level 2, in fill of hearth	7870 ± 60	*Akkermans et al. 2006*
7065 ± 30	n.d.	seeds	Early Halaf	Op. I, level 3	7900 ± 40	*Akkermans 1992*
7075 ± 30	n.d.	seeds	Transitional Balikh IIIA	Op. I, level 4	7910 ± 40	*Akkermans 1993*
7080 ± 80	n.d.	seeds	Pre-Halaf	Op.I, Level 8	7900 ± 80	*Akkermans 1993*
7100 ± 60	n.d.	charcoal	Transitional Balikh IIIA	Op. I, level 6, SE area room 7, floor	7920 ± 60	*Akkermans & Verhoeven 1995*
7145 ± 30	n.d.	charcoal	Pre-Halaf	Op. I, level 8–10	7980 ± 30	*Akkermans 1993*
7150 ± 90	n.d.	charcoal	Pre-Halaf	Op.I, NE-mound	7980 ±100	*Akkermans 1993*
7170 ± 90	n.d.	charcoal	Pre-Halaf	Op.I, NE-mound	8010 ±100	*Akkermans 1993*
7190 ± 55	n.d.	seeds	Pre-Halaf	Op. I, level 7, in fill of pit	8030 ± 60	*Akkermans et al. 2006*
7190 ± 60	n.d.	seeds	Transitional Balikh IIIA	Op. I, level 5, in fill of oven	8040 ± 70	*Akkermans et al. 2006*
7225 ± 30	n.d.	charcoal	Pre-Halaf	Op.I, NE-mound	8050 ± 60	*Akkermans 1993*
7240 ± 50	n.d.	charcoal	Pre-Halaf	Op. I, level 7, on floor of circular building	8070 ± 70	*Akkermans et al. 2006*
7240 ± 50	n.d.	charcoal	Pre-Halaf	Op. V, level 2, in fill of oven	8070 ± 70	*Akkermans et al. 2006*
7250 ± 50	n.d.	charcoal	Pre-Halaf	Op. V, level 2, in fill of oven	8080 ± 60	*Akkermans et al. 2006*
7250 ± 50	n.d.	charcoal	Pre-Halaf	Op. V, level 2, in fill of oven	8080 ± 60	*Akkermans et al. 2006*
7350 ± 50	n.d.	charcoal	Pre-Halaf	Op. V, level 2, in fill of oven	8170 ± 90	*Akkermans et al. 2006*
7360 ± 25	n.d.	seeds	Early Ceramic Neolithic	Op. III, level 2, slightly above floor in building II	8180 ± 40	*Akkermans et al. 2006*
7370 ± 55	n.d.	charcoal	Pre-Halaf	Op. V, level 2, in fill of building III	8190 ±100	*Akkermans et al. 2006*
7400 ± 25	n.d.	seeds	Early Ceramic Neolithic	Op. III, level 2, slightly above floor in building II	8250 ± 50	*Akkermans et al. 2006*
7440 ± 50	n.d.	charcoal	Early Ceramic Neolithic	Op. IV, level 1, on floor in room of building I	8270 ± 60	*Akkermans et al. 2006*
7465 ± 35	n.d.	seeds	Early Halaf	Op. I, level 1–3	8280 ± 60	*Akkermans 1993*
7475 ± 45	n.d.	charcoal	Early Ceramic Neolithic	Op. III, level 3, floor in room	8290 ± 60	*Akkermans et al. 2006*
7525 ± 45	n.d.	charcoal	Early Ceramic Neolithic	Op. III, level 3, slightly above floor in room	8330 ± 60	*Akkermans et al. 2006*
7570 ± 50	n.d.	charcoal	Early Ceramic Neolithic	Op. III, level 2, in fill of building IV	8380 ± 40	*Akkermans et al. 2006*
7720 ± 50	n.d.	charcoal	Early Ceramic Neolithic	Op. III, level 2, on floor in oven	8500 ± 50	*Akkermans et al. 2006*

Tab. 10. Sabi Abyad (36.52°N, 39.10°W)

back to contents

UDK 903'12/'15(5-191.2+4-16)"633/634":314.17
Documenta Praehistorica XXXV (2008)

Communities, households and animals. Convergent developments in Central Anatolian and Central European Neolithic

Arkadiusz Marciniak
Institute of Prehistory University of Poznań, Poland
arekmar@amu.edu.pla

ABSTRACT – *This paper intends to scrutinize striking similarities in cultural developments and social transformations in Neolithic communities in the North European Plain of Central Europe and Central Anatolia in the early phase of their development and in the following post-Early Neolithic period. They will be explored through evidence pertaining to architecture and the organization of space, alongside changes in settlement pattern, as well as animal bone assemblages and zoomorphic representations. Social changes, in particular a transition from communal arrangements of local groups in the Early Neolithic to autonomous household organization in the following period, will be debated.*

IZVLEČEK – *Članek preiskuje osupljive podobnosti v kulturnem razvoju in družbenih premenah neolitskih skupnosti na Severnoevropskem nižavju in osrednji Anatoliji v zgodnjih in kasnejših, srednje in pozno neolitskih fazah razvoja. Razlike opazujemo skozi arhitekturo, organizacijo prostora, spremljajoče spremembe v poselitvenih vzorcih kot tudi v zbirih živalskih kosti in zoomorfnih upodobitvah. Še posebej se posvetimo družbenim spremembam, vezanim na razpad komunskih skupin v zgodnjem neolitiku na avtonomna gospodinjstva v kasnejših obdobjih.*

KEY WORDS – *Central Anatolia; North European Plain; house; cattle; space*

Introduction

The archaeology of the early Neolithic in the Near East and Europe reveals a range of similarities across various geographical zones as regards arrangement of space, the function of architecture, the similar utilization of bounded space, the integrative character of communal rituals, the communality of technological solutions or human-animal relations. Transformations in these domains in the course of time also reveal some striking parallels.

These parallel developments, however, do not mean that the Neolithic communities across different regions are identical and no idiosyncrasies are reported. On the contrary, trajectories of developments in particular areas are inevitably differentiated, due to the range of social, cultural and historical contexts in which they operated. In particular, these regional sequences differ as much as a peculiar cultural and social milieu at their beginning is differentiated.

In this paper, I intend to present and then to interpret some of these apparent affinities in cultural developments and social transformations in early Neolithic communities in Central Anatolia and Central Europe, in particular in the North European Plain. Some of them are clearly more obvious and better attested than others.

The Neolithic in Central Anatolia is a distinct phenomenon, and it differs in such matters as settlement form, burial customs, and chipped stone industries from that of the Fertile Crescent (*Özdoğan 1995. 58; 1999.229–232; Balkan-Atlı and Binder 2001. 194*). Moreover, it is the developments in this region that set the conditions for the spread of the Neolithic way of life westwards into the Balkans and then Europe. The Neolithic in the North European Plain is an area equally rich in data, with tight chronological controls, and marks the beginning of the entry of early farming groups into vast previously uninhabited areas. It lays the foundation for the development of food producing societies across much of the northern part of the continent.

In both cases, we are dealing with regions in which the Neolithic mode of life was introduced from elsewhere. However, a point of departure for its development, as well as the time frame in each case, was clearly different. The Central Anatolian Neolithic developed as a result of complex transformations of the tradition inherited from the northern Levant, while the Neolithic in Central Europe originated from the Carpathian Basin. However, centuries long developments in both regions led to the emergence of a very distinct and coherent mode of the Neolithic. It consolidated and strengthened to such a degree that communities in both regions had the potential to significantly contribute to the dispersal of this new mode of life beyond their original settings, first into different zones within both regions, and then outside those regions. The internal logic of developments of early Neolithic communities in both regions appears to be very similar.

The character of social transformations of Central Anatolian and the North European Plain Neolithic communities will be explored through evidence pertaining to settlement patterns and the organisation of space, alongside changes in architecture, as well as animal bone assemblages and zoomorphic representations. Other aspects of these transformations need to be studied in more detail in the future.

The point of departure for this analysis is my own work in the North European Plain, mostly in the Kujavia region, and in Central Anatolia, in particular at Çatalhöyük East, where I co-direct the excavation project focused on the last sequence of the mound occupation. Having been working in both regions for a long time and observing a range of striking similarities, I feel in position to try explicating them and grasping their nature. This paper is the first such attempt.

However, it is not my intention to go into any details here regarding the regional culture-historical schemes that are used to capture changes in the Neolithic. Instead, special attention will be devoted to diachronic interrelations, in order to outline the manner in which the fabric of Neolithic societies was transformed over time. Hence, I will use the terms early Neolithic and post-early Neolithic to pinpoint this diachronic perspective, rather than referring to existing conventional chronological schemes in both regions.

The first part of the paper aims to present an overview of the major characteristic features of architecture and spatial organization in the early Neolithic sequence in both regions. I will also challenge the meat-based livestock-rearing system of early European farming and point out the idiosyncratic nature of the introduction of secondary products in both regions. The early Neolithic in both regions became a point of reference for a local trajectory of development, but the process involved the localized transformation and modification of these constituent principles and rules.

The second part aims to discuss social transformations in the post-Neolithic period. As regards Central Anatolian Neolithic, the changes will be examined both on a microscale, using Çatalhöyük East as a case study, and on a regional scale across the region. Changes observed in the last phase of the Çatalhöyük East occupation will then be assessed within the broader regional context, and the overall trajectory of development for local communities in Central Anatolia in this time frame. As regards the North European Plain, I will refer to social transformations from its earliest Neolithic phase throughout the further developments of the Danubian tradition.

Introducing the Neolithic of Central Anatolia and the North European Plain

Central Anatolia is defined here as the area to the south of the Anatolian Plateau divided into three zones: the region of the Beyşehir-Suğla lakes in the west, the Konya Plain in the centre, and the Cappadocian region in the east. The Early Central Anatolia (ECA) cultural sequence has recently been divided by Özbaşaran and Buitenhuis (*2002*) into five stages. The paper discusses developments in ECA II, ECA III and ECA IV periods. The ECA II period is dated from the late 9th millenium BC to 7500 calBC. The following ECA III is divided into two sub-phases, A & B. The A subphase is dated back to the years 7500–6700/6600 calBC, while subphase B to 6700/6600–6000 BC. The following ECA IV period is dated to the years 6000–5500 BC. Both stages of ECA III correspond well with the stratigraphy of the Çatalhöyük

East. To date, 13 building horizons have been excavated at this site, labelled levels XII to 0. The sequence as a whole can be dated to approximately 7400–6000 calBC (*Cessford 2001; Marciniak and Czerniak 2007*). In the Özbaşaran and Buitenhuis chronological scheme, levels XII–VI, dated to between 7400 and 6600 calBC belong to the ECA IIIA, whereas levels V–0, dated to 6600–6000 calBC, fall within the ECA IIIB period (*Cessford 2001; Marciniak and Czerniak 2007*).

The considerable changes in the last period of Çatalhöyük East occupation are accompanied by the emergence of farming settlements in the region. The ECA IIIA settlement pattern in the Konya Plain is characterised by long-term aggregation, and marked by an extreme concentration of population at one site – Çatalhöyük. An apparent lack of permanent sedentary communities in the region during this period is in sharp contrast with succeeding periods. The following ECA IIIB is marked by the appearance of many smaller sites which continue to be occupied into the subsequent ECA IV (*Baird 2002*). These smaller settlements were inhabitated for shorter periods than previously. In comparison with the steady rate at which changes occurred earlier, around 6500 calBC developments occurred more quickly and their internal dynamics intensified.

The earliest Neolithic communities appeared in Central Europe around 5450 calBC. They are represented by the Linear Band Pottery Culture (Linearbandkeramik – LBK), which is dated in this part of the continent from *c.* 5450 to 4600 calBC (*Milisauskas, Kruk 1989.404*). The LBK covered large areas of Europe, from the Paris Basin in the west to the Dniester in the east, and from the Drava in the south to northern Poland in the north (*e.g. Kruk and Milisauskas 1999; Barker 1985; Starling 1983; 1985; Wiślański 1970*).

The early farmers of the Linear Band Pottery Culture emerged in the North European Plain in the second half of the 6th millennium BC, and continued uninterrupted development through the first half of the 5th millennium BC. This region was colonized by immigrants from South-eastern Europe, who brought with them a whole array of new material culture, including longhouses, a simple style of pottery, with curvilinear and rectilinear motifs, and stone technology in the form of symmetrical axes and heavy adzes, with a plano-convex cross section. They practiced mixed-farming subsistence techniques. The LBK, especially its earlier phases, was characterized by remarkable uniformity over vast geographical distances, and its material culture was of limited stylistic variability in various regions (*e.g. Ammerman and Cavalli-Sforza 1973; 1984; Starling 1985; Kulczycka-Leciejewiczowa 1970; 1979; 1993; Milisauskas and Kruk 1989; Wiślański 1970; Keeley 1992; Price et al. 1996*).

This early Neolithic phase was followed by the dynamic development of farming communities in the region associated with the late phases of the Danubian tradition – in particular, Lengyel culture – and dated back to the second half of the 5th millennium BC. The late phases of the Danubian tradition are represented by the Late Band Pottery, Stroke Ornamented Pottery, Lengyel, Polgár, Hinkelstein, and Rössen cultures. These archaeological entities mark a second important phase in the development of farming communities in Central Europe. They are dated from *c.* 4600 to 4000 calBC (*Kruk and Milisauskas 1999.303*). This late phase of the Danubian tradition (*Milisauskas and Kruk 1989*) is often defined as the Early Middle Neolithic (*Kruk and Milisauskas 1999*; see also *Czerniak 1994*).

Architecture and spatial organization

Central Anatolia

Architecture and spatial arrangement in Central Anatolian Early Neolithic can be discerned at two major settlements in the region, namely Asıklı Höyük and Çatalhöyük. One its unique feature is the phenomenon of clustered neighbourhood settlements (*Özbaşaran 2000.135*). In Asıklı Höyük and in the early building levels XII–VI at Çatalhöyük, individual loam buildings are typically constructed directly adjacent to one another in neighbourhood clusters of approximately 30 to 40 buildings (Fig. 1). These will normally be separated from one another by streets, alleys and midden areas, and additional midden areas may be located within the neighbourhood clusters. Houses have a great degree of continuity, being rebuilt on the same location for up to six building levels in a sequence stretching over several hundreds of years (*e.g. Düring 2005; Farid 2005; Hodder 2005a; 2006*).

Domestic structures were built of loam brick and accessed from the roof by a ladder. They were occupied for hundreds of years, after which they were generally emptied of portable items and the house carefully and systematically dismantled. The lower portion of the building was then levelled to set up a foundation for a new house. Continuity is particularly clear in the internal organisation of the buildings, which displayed a high degree of similarity across the site. This was characterised by the placement of hearths and the oven in the south part of the building, a platform with a burial underneath in the north part of the building, bucrania on the west wall, and the access-ladder near the hearths/ovens. Considerable continuity is visible in platform and floor divisions through successive replasterings and rebuilding, with only minor changes observable through time regarding the location of ovens and hearths (Fig. 2).

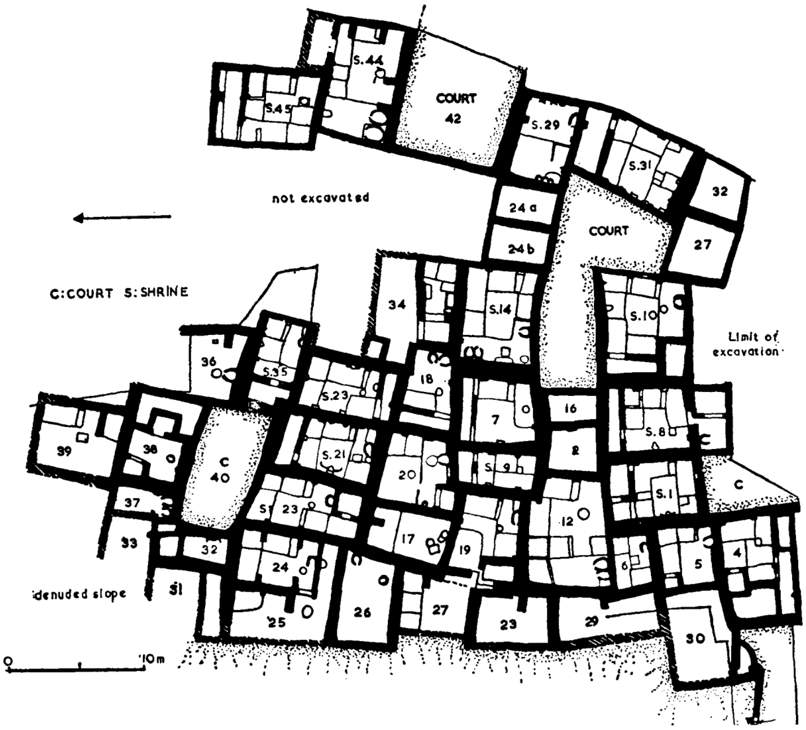


Fig. 1. Çatalhöyük East, Level VII (after* Mellaart 1967.57, Fig. 10*).

Social structures appear to be based around neighbourhood communities, as indicated by clustered distributions of houses and burials. The rooms at Asıklı Höyük are of a restricted size range, with an average of about 6.5m^2, and 80% are smaller than 12m^2. This may indicate that they are perhaps too small to have served as household residences. Remarkably, only about 30% of the rooms excavated at Asıklı Höyük contained a hearth. The distribution of these hearths over the settlement does not seem to be clearly patterned, and it is not possible to discern clusters of rooms centred on a room with a hearth (*Düring and Marciniak 2006.8–10; Tab. 3*). The situation is slightly different at Çatalhöyük, as there is a common category of rooms that can be positively identified as living rooms containing a range of more or less standard features (*Mellaart 1967.61, Fig. 11*). However, in contrast to Asıklı Höyük, there is good evidence for dwellings constituted on the basis of both co-residence and economic pooling, but integrated into larger neighbourhood associations.

The dominance of larger social collectivites is additionally supported by burial arrangements. In total, only 70 sub-floor burials were found in the approximately 400 rooms excavated at Asıklı Höyük (*Esin and Harmankaya 1999.126*), indicating that only a small selection of the dead were interred in the settlement. Some buildings clearly served as burial sites for groups that outnumbered their inhabitants. This may indicate that the deceased were interred as part of communally organised ceremonies.

A major shift seems to have occurred at Çatalhöyük in the transition from Level VI to V. These radical changes are particularly well-attested in the architecture and spatial organisation in the structures excavated by the Polish team in Levels IV–0 (*Czerniak et al. 2001; 2002; Czerniak and Marciniak 2005*). They are marked by the abandonment of the pronounced building continuity seen in earlier levels, as well as the appearance of exterior doorways and the emergence of probable courts and streets, which made the houses more accessible than hitherto (*Düring 2001*).

The buildings seem to mark a significant departure from the hitherto prevailing pattern both in terms of their construction and organisation of space. Houses have different shapes and sizes, with internal features which are placed in an irregular order and sometimes are not present at all. The beginning of the demise of internal organisation of the buildings is already clear in Level IV/III as manifested in Building 74 (Fig. 3). Its internal size and the layout of the walls was different than in earlier buildings. It was composed of two rooms and divided by a partition wall that was probably built during its later reconstruction. The internal layout of both rooms was very simple with no platforms, benches, bins and other kind of features. The building had a large doorway. Deliberately placed cattle bones (mandibles, scapulae, ribs), forming some kind of installation,

Fig. 2. Çatalhöyük East. Aerial view of Building 3. Photo by M. Ashley.

An interesting sequence of occupation levels was discovered underneath the floor of Building 62. An entire sequence is composed of infill, destructional and midden-like deposits, whose homogeneity varied considerably. At the same time, the presence of five fire installations of different size and character is indicative of some sort of activity area. All of them were carefully designed and manufactured. This sequence has no relation to any older buildings, which implies a different relation to the past of the group constructing the Building 62.

Two structures from Level I (Buildings 33 & 34) seem to mark another significant departure from the hitherto prevailing pattern, both in terms of their construction and organisation of space. Building 33 is a rectangular irregular structure, with a small niche in SW corner in which a rectangular oven was placed. Other features comprised two small fire installations in its central sections and a hearth associated with a feasting deposit located in the south east corner of the building. One of the fire installations appeared to be positioned in the centre of the building, in marked contrast to the location of such structures in the ECA IIIA period (Fig. 4). The

were found in its western room. They were placed on the floor in relation to some kind of abandonment rituals/activities. Both rooms were originally connected by some kind of a crawlhole in the northern part of the partition wall. This was later intentionally blocked, probably in relation to sealing off all deposits in the western room when it went out of use.

The following occupation episodes dated to Level II, I and 0 are indicative of the further decline of the previously dominant house arrangements (*Czerniak et al. 2001; 2002; Czerniak and Marciniak 2005*). This is well manifested by a sequence of Buildings 61 & 62 from Level II. They were reconstructed a number of times, as indicated by a complex sequence of floors and partition walls. However, only a few features were revealed in the Buildings. A solid square oven placed in its central part was composed of two superstructures, one placed on top of the other, which is indicative of two phases of its construction. Interestingly, the oven was built in a place that was earlier used by the previous inhabitants of this area to construct some kind of fire installations.

Fig. 3. Çatalhöyük East, Building 74. Photo by A. Leszczewicz.

exact length of building 34 is unknown, as it stretches beyond the northern edge of the excavated area, but in general it appears to be a small structure, with its interior dimensions within the trench covering only 2.24m².

North European Plain

The beginning of the Neolithic in Central Europe is marked by the emergence of a new spatiality created by the house. Of special significance was the space of the longhouse, the eminent signature of LBK occupation. They were constructions supported by postholes, with numerous rows of posts running perpendicular to the long axis of the houses. Their walls were made of wattle and daub. Modderman (*1970*) divided the longhouse interiors into three parts: northwest, middle and southeast. The northwest was the most elaborate and solidly built and has been interpreted as the living/sleeping area. The middle part is believed to have been used as the living/working area. A main door to the house was located at the southeast shorter end. The prefered construction material was oak, the prime building timber. There are, however, also examples of conifer use, *e.g.* in Olszanica (*Milisauskas 1986*).

Most of the settlements in the uplands included up to ten longhouses, 7 to 45 meters in length and 6 to 7 meters in width. A number of such constructions in the lowlands of the North European Plain is smaller. They were flanked by ditches and pits dug out to provide clay daub for the walls. Longhouse size differed considerably depending on the region, but the meaning of such variations has not been satisfactorily elucidated (see *e.g. Keeley 1992.82; Price et al. 1996.97*).

An outstanding example of the lowlands longhouse comes from Bożejewice, site 22 (*Czerniak 1998.26–27*) in Kujavia, where one of the largest building constructed by the early farmers in this region has been found (Fig. 5). It was 43 meters long and 6.5–7.3 meters wide, and was roughly rectangular in shape. The house was divided into three parts, and the function of the specific parts has been interpreted in accordance with the proposals of Modderman (*1970*) and Lüning (*1982*). Long pits were dug out on both sides of the building, arguably for extracting daub for wall construction.

Erecting a longhouse was clearly a complicated and time-consuming task and could not have been done by a single family. This was certainly a communal activity, and it is estimated that a house 45 meters long and 7 meters wide took 3900 person-hours to build (*Startin 1978.146*).

As with any other types of vernacular architecture, longhouses were the product of a long-standing process, incorporating a wide range of elements, both new and old. Their significance was further supplemented and enforced by the architectural permanence of these structures, which contributed to a perception of long-term social stability (see *Pollard 1999.85*). Over time, longhouse settlements became cultural landmarks and repositories of memory, and the focal locales of communal identity.

The early Neolithic settlements in the North European Plain can be characterized as clusters of longhouses. Evidence for units occupying discrete residences in which most domestic activities were performed is conspicuously absent. Instead, a larger form of association, probably incorporating smaller constituencies, seems to have been central to this society. This social configuration persisted during the whole of the early Neolithic sequence, as implied by a general lack of changes over time in house layout and in the spatial arrangement of the settlements. This may indicate that the early Neolithic was characterized by the predominance of the communal

Fig. 4. Çatalhöyük East, Building 33. Photo by L.Czerniak.

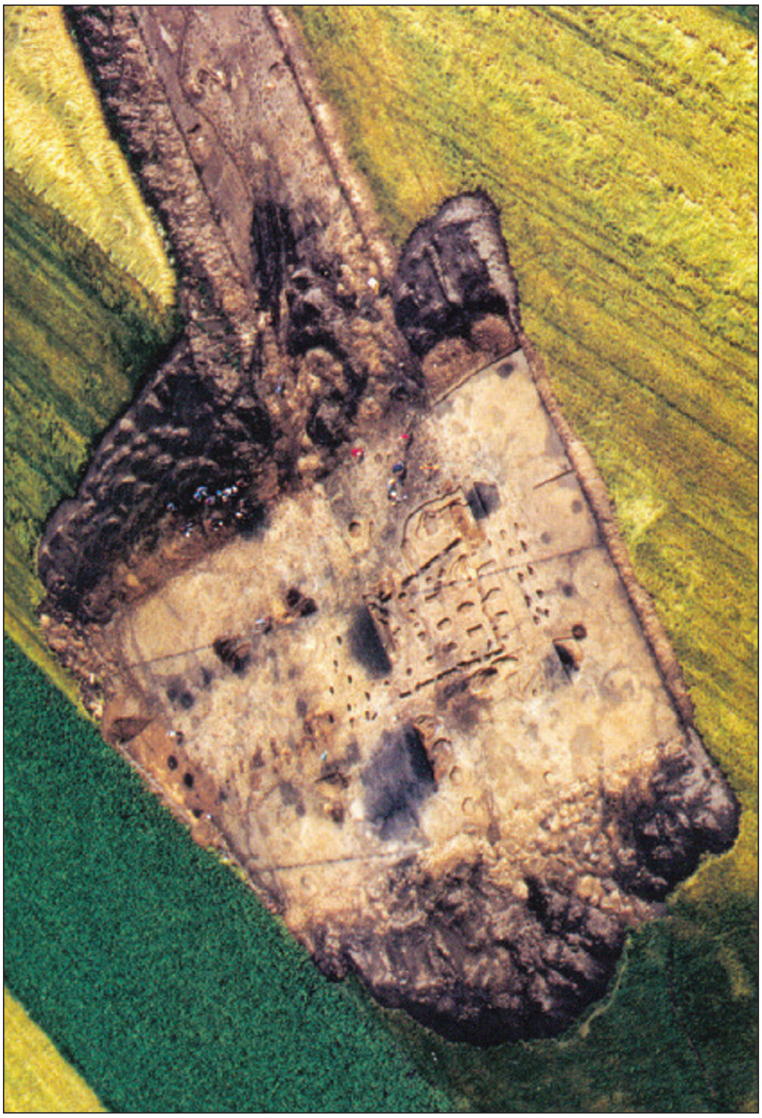


Fig. 5. Bożejewice, LBK, Kujavia. Aerial view of the LBK longhouse (after* Czerniak 1998.23*).

constitution of local groups and that this communal life was focused on longhouses.

Towards the end of Early Neolithic in the region, previously dominant villages/settlements that were the basic social units creating definable groups eventually lost their significance. This is well manifested in decreasing importance of longhouses. The previously homogenous use of longhouse space, became an arena of considerable change, manifested by the appearance of human graves, storage facilities and rubbish pits.

From the formal standpoint, the Late Danubian longhouses, *e.g.* from the Stroke Ornamented Pottery or Lengyel cultures, were similar to LBK constructions. The most apparent difference was their unquestionably trapezoidal shape, especially in the Lengyel tradition (*Bogucki 1982.19*), although some rectangular structures remained. These oaken trapezoidal constructions featured bedding trenches and posts. They were usually oriented NW–SE, like their rectangular LBK predecessors, with a narrow north and a wide south end. The entrance to almost all of them was placed at the broader part facing east or southeast. However, house size tended to decrease over time. It is estimated that longhouses were used for between 20 years (*Gabałówna 1966.46*) and 50 years (*Jażdżewski 1938.6*). Numerous settlements of this kind have been identified in the Kujavia region in the North European Plain. The best known is Brześć Kujawski, in addition to Krusza Zamkowa, Kościelec Kujawski, Dobre, or Osłonki (*Bogucki and Grygiel 1997*).

In the course of time, spatial organization within and around longhouses changed considerably. This is manifested by the emergence of aggregates of longhouses associated with pits and activity areas. They were reported at Brześć Kujawski, sites 3 & 4 (*Grygiel 1986*). They have been interpreted as household clusters, directly implying the existence of the household (*Bogucki and Grygiel 1980; 1981*) and identified by longhouses associated with a set of features including activity areas, ovens, storage pits, disposal pits/middens, burials, etc. (see *Winter 1977; Flannery and Winter 1976*). All of these facilities were placed in a certain proximity to each other, usually outside of the house, and were separated from similar clusters by open areas (Fig. 6). One part of the house has been identified as a dwelling place, while two others comprised storage and animal facilities. This was also an area in which food was prepared and consumed. The house was arguably used by an extended family, whose members are believed to have specialized in some craft production (*Grygiel 1986*).

These changes are indicative of the emergence of the household as an independent social entity defined as an entity residing in discrete buildings, with evidence of most domestic and some craft activities performed within the residence, as manifested in the presence of special-purpose activity areas and features in buildings. Interestingly, it appeared first in regions with a long trajectory of development (*e.g.* Kujavia), and it was a much later development in regions being colonised for the first time at that time. In the long run, the North European Plain early Neolithic house was transformed from a communal domain into a private sphere in the post-Neolithic period (see also *Stea and Turan 1993.110*). In the final phase of this sequence the longhouse clusters were in the process of disintegration and were finally abandoned. At the same time, village-like agglomerations comprised of individual farmsteads began to emerge.

Human-animal relations

Central Anatolia

Differences in treatment of major domestic species in the ECA II, IIIA and IIIB periods in Central Anatolia are striking. In particular, the special significance of cattle in the early Neolithic was convincingly proved. This is part of broader pattern in the Near Eastern Neolithic which, however, will not be elucidated here (*e.g. Akkermans, Schwartz 2003.75; Russell and Martin 2005*).

Abundant evidence of the special importance of cattle come from the Anatolian early Neolithic sequence, more particularly from Çatalhöyük (*e.g. Mellaart 1967, Hodder 1990*). The most spectacular and well known evidence of cattle's special significance are plastered bucrania, with insert horns, as well as cattle horns set into benches and pillars (*Mellaart 1964; 1967; Bogdan 2005*) (Fig. 7). There is a disproportionately high representation of not only horn cores, but also cattle scapulae. They are also built into walls and seem to be placed in houses at abandonment (*Russell and Meece 2006*). Either these elements are preserved from some of the attritional forces affecting other body parts, or extra horns and scapulae were brought back from animals not otherwise transported to the site. Horns are very heavy, with no meat, while scapulae are covered with meat which is easily filleted off. It is argued that both of these body parts carried strong symbolic and ceremonial value associated with their consumption (*Russell and Martin 2005*). Both also seem to be tied to houses and the cycle of building.

The age as well as sex data further suggest that bulls were selected for feasts and ceremonies in the ECA IIIA period of the Çatalhöyük East development. Females form approximately half the bones from the contexts related to everyday consumption, while only a third from other categories of deposit, including ceremonial settings. Considering that feasting deposits often contain a substantial number of daily remains, the contribution of males to ceremonial consumption was probably even greater. The predominance of male remains in the area outside the mound (the so-called KOPAL Area) further strengthens its interpretation as a ceremonial setting and/or deposition of the remains of ceremonies (*Russell and Martin 2005*). This is further supported by the results of stable isotope analysis. They indicate that cattle contributed only negligibly to the diet of the tell inhabitants (*Richards et al. 2003*).

This short summary of the available evidence clearly indicates that at Çatalhöyük and other early Neolithic Anatolian Neolithic settlements, cattle were clearly of considerable ceremonial and symbolic importance (*e.g. Mellaart 1967; Hodder 1990*). This implies that first contact with then undomesticated

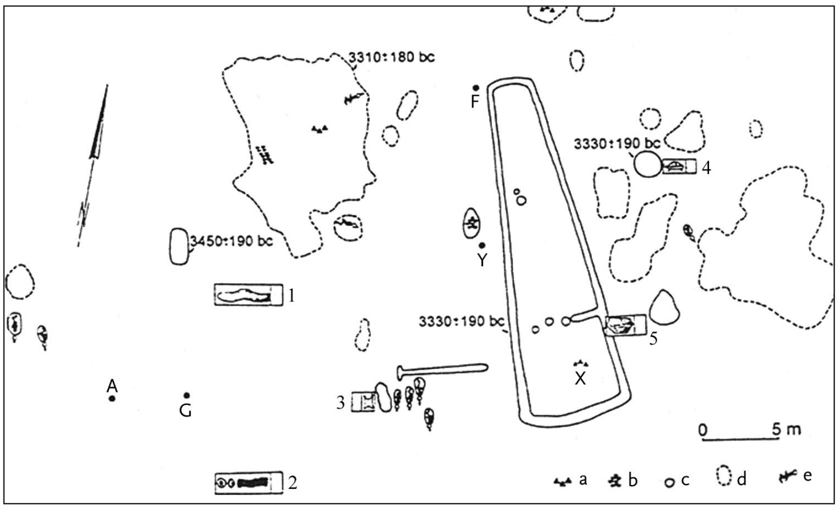


Fig. 6. Brześć Kujawski, Lengyel culture, Kujavia. Household cluster (after* Kruk & Milisauskas 1999.79*). 1. antler workshop; 2. shell artefact; 3. hide processing workshop; 4. storage pit for shellfish and turtles; 5. sherds; A. flint axe; F. Jurassic flint artefact; G. antler; X. flint working area within house; Y. chocolate flint artefact for antler working; a. cluster of ceramic sherds; b: shellfish; c. pits associated with economic activities; d. clay pits; e. burials.

Fig. 7. Çatalhöyük East. Cattle bucrania in Building 52. Photo by J. Quinlan.

The age distribution of the sheep/goat looks also very different from that of the cattle, appearing to show the typical management of sheep and goats for meat and herd reproduction. The age data show most animals culled as juveniles and sub-adults, the optimal ages for meat yield (see *Payne 1973*). Far fewer survived to be older adults, which would require pasturing. This segment may only be the breeding stock. This mortality profile does not, however, suggest the intensive use of dairy products or wool. However, one has to bear in mind that sheep were unlikely to have been woolly in this period. This is further corroborated by the results of stable isotope analysis indicating sheep as the main source of animal proteins.

cattle was very complicated and primarily involved factors of a social and ideological nature. Hodder (*1990.35*) claims that cattle were first symbolically domesticated and only later acquired their economic significance. This was supposedly achieved through the practice of bringing the cattle into the house and controlling them within various 'cattle cults'.

An analysis of the available evidence as regards the use of sheep/goats among inhabitants of Çatalhöyük in the ECA IIIA phase has proved significant differences in comparison with cattle. Sheep/goat bones are the most abundant faunal remains at this site. In most cases, they are found in middens and fills used as a primary location for dumping consumption debris. This may indicate that both species were used for ordinary food consumption.

This is further supported by analysis of their body part representation, revealing a fairly even distribution subjected to attritional processes. All carcass parts are brought onto the site, and perhaps even whole carcasses, although there is some evidence for the selective importation of sheep-size ribs, and under-representation of sheep-size vertebrae (Fig. 8), suggestive of slaughter and primary butchery taking place off-site. Filleting cuts are considerably more frequent than dismemberment cuts in sheep as outnumber frequency of these kind of cuts in cattle. It appears that meat may have been more often filleted off the bone and cooked in smaller pieces, while larger animals, in particular cattle, may have been cooked in larger pieces still on the bone (*Russell and Martin 2005*).

The character of people-animal relationships and changes over time are well attested at Çatalhöyük also in the ECA IIIB period. The distinctive pattern of cattle and sheep/goat consumption underwent considerable transformations. Special treatment of cattle as manifested in the high representation of horn cores and scapulae is significantly less common. No plastered bucrania are recorded from the phase of the mound occupation. Cattle age and sex distribution is now dominated by females and more subadults, which appears to indicate a genuine shift, at least in some parts of the site. Its significance remains somewhat enigmatic (*Twiss et al. 2005*).

As regards species composition, whereas pre-Level V assemblages consistently include approximately 65–70% caprines and 20–25% cattle (*Russell and Martin 2005*), from Level V on it appears that caprines provide more than 80% of the remains and cattle only some 10% (*Twiss et al. 2005*). Similarly, as in earlier levels, in most cases sheep and goat bones are found in middens and fills, where their deposition primarily resulted from food consumption.

Equally transformed was the sex and age distribution of sheep/goats, with substantially more adults represented (Fig. 9). This might indicate changes in herding practices and a switch to the use of dairy products (*Twiss at al. 2005*). However, we have to bear in mind that while material from earlier levels comes from a range of different context, the late levels are represented by only a single area. Hence, the results need to be treated with caution.

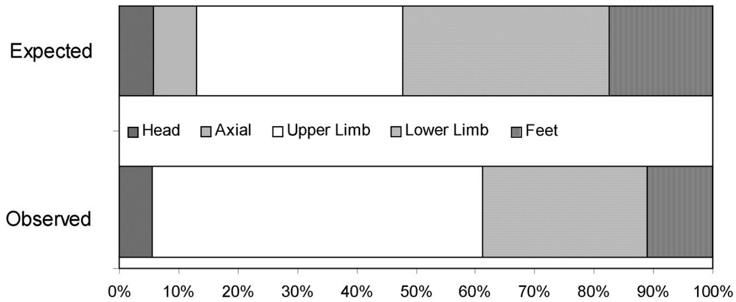


Fig. 8. Çatalhöyük East. Sheep/goat body part distribution (after* Russell, Martin 2005.Fig. 2.31*).

In any case, the small samples analysed to date (*e.g. Russell et al. 2004; Twiss et al. 2005*) indicate a significant change in various aspects of human-animal relations indicative of considerable socio-economic shifts. A more detailed view of human-animal relations in the upper levels of the Çatalhöyük East following extensive excavations of this sequence will only be possible when detailed results of these invesigations are available.

North European Plain

Early farmers in the North European Plain also treated different taxa in different ways, in particular sheep/goats and cattle. While the former was an ordinary source of meat, the latter was embedded in different social and ceremonial contexts.

Detailed studies of animal bone remains and their archaeological context from the early Neolithic settlements of the Polish part of the North European Plain revealed striking differences in the taphonomic pattern, body part representation, spatial distribution, as well as association with other kinds of archaeological evidence, between cattle, sheep-goats and pigs (*Marciniak 2005*). These statistically significant differences in all contexts throughout the studied settlements are indicative of the considerably varied treatment of these animals at these settlements. The small number of pig bones makes it difficult to discern rules of pig treatment in more detail. However, a revealed pattern may imply some similarities with cattle, but one needs to treat this conclusion with caution.

Cattle bones are the most abundant faunal remains in the early Neolithic of Central Europe. Taphonomic analysis implies a very peculiar method of consuming cattle marrow. As indicated by characteristic jagged fractures, with signs of ash, burning and numerous scratches, the bones were first roasted, broken and then the cooked marrow consumed (Fig. 10). This kind of marrow consumption appears as a common and quite peculiar culinary practice of the early lowland farmers and might have had a discursive character. Interestingly, sheep/goat marrow, albeit not roasted, was also consumed on a daily basis.

Cattle body part representation is characterized by a deliberate selection of certain anatomical segments – in particular, skulls, scapulae, and axial segments – and marked by the avoidance of limbs. At the same time, body part representation of sheep/goats was considerably different. It is characterized by varied compositions of highly processed anatomical parts, which implies that all of them were eaten.

Cattle meat and marrow eating was clearly regarded as appropriate in one social context and inappropriate in another. It is indicated by cattle bones deposited in specific locales at the settlement, particularly in the open space between longhouses. The remains of cattle consumption were deposited exclusively in the so-called clay pits located between longhouses and do not appear in other types of pits used at these settlements. Contrary to cattle consumption, sheep/goat took place in the house and/or directly around the house. A small number of pig bones have made their spatial distribution analysis hardly conclusive.

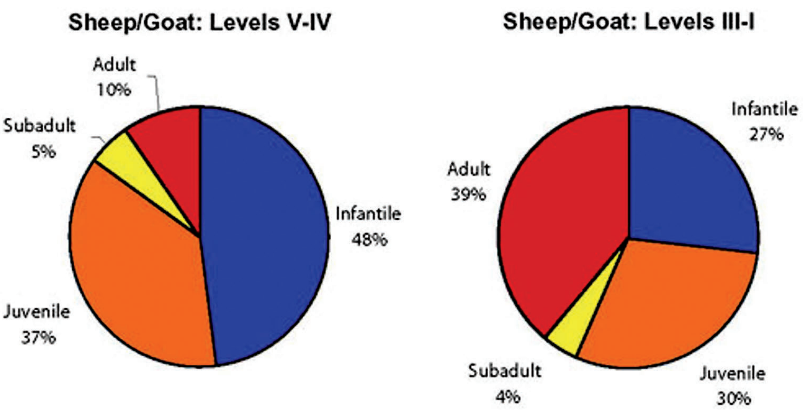


Fig. 9. Çatalhöyük East. Sheep/goat mortality profile (after* Twiss, Martin, Pawłowska and Russell 2005*).

The available evidence from the Early Neolithic settlements from the Polish part of the lowlands implies the practice of at least two kids of consumption among local farmers. The first focused on cattle, and the other on sheep/goats. Fragmentary evidence implies that pigs were also an important element in feasting, and pork was not consumed on a daily basis. Cattle marrow and meat was arguably consumed ceremonially in a very standardized and repeatable manner over a long period of time. At the same time, sheep/goats were used as a source of meat and were eaten in an apparently ordinary fashion, and consumption took place in the house and/or directly around the house. No roasted marrow of sheep/goats was consumed. Fragmentary evidence implies that pigs were also an important element in feasting, and pork was not consumed on a daily basis.

The post-early Neolithic in the North European Plain brought about considerable and multiscalar changes in relations between people and domesticated animals. They were no longer considerably uniform and standardized as in the preceding period, but rather highly variable and diverse. This applies both to differences between particular species and differences at particular settlements. Interestingly, the overall picture of human-animal relations among Lengyel communities in Kujavia, a traditionally farming region, is far more diverse than among their LBK predecessors. At the same time, it is also more diverse than in the newly occupied regions that retain a range of elements originating from their early Neolithic predecessors, albeit considerably transformed.

Changes in patterns of consumption involved the decline of the ceremonial consumption of cattle. The social and ceremonial importance of animals in the post-early Neolithic, however, remained significant, but it was executed in a different way and in different settings. Cattle remained an important status and wealth animal, which is manifested in the form of cattle graves (*Barker 1985.150*). This seems to represent a transformed way of indicating the significance of cattle, which began in the early Neolithic.

Fig. 10. Łojewo, site 35, LBK, Kujavia. Marrow post-fire transverse breakage. Photo by A.Marciniak.

A new component in this period was the economically more efficient exploitation of domestic animals, not only sheep/goats, but also cattle. The practice of marrow eating, very common in the early Neolithic, was significantly less popular. In particular, cooked and roasted cattle marrow was not commonly eaten.

Discussion and final remarks

In this paper I examined evidence pertaining to the organisation of space and changes in architecture alongside settlement patterns, as well as animal bone assemblages, in the early phases of the Neolithic in Central Anatolia and the North European Plain. The similarities revealed in the cultural developments and social transformations in both regions are so striking that they need to be investigated and scrutinized in some depth. They refer to both initial arrangements in the analyzed domains, as well as their further developments in the post-early Neolithic period.

In the most general terms, one can argue that these parallels imply the existence of similar trajectories of development of early farming groups irrespective of the regional context. It does not mean, however, that we opt for any kind of universal rules or patterns in this respect. The obvious significance of these parallels needs always be contextualized and referred to the historical, social, and cultural embedding of regional developments.

The emergence of the Neolithic in both regions was accompanied by the production of new spaces. Special attention should be paid to the new form of house and its space, as manifested both in the form of the Central Anatolian house and the Central European longhouse. They initiated a new sequence of Neolithic spatiality in both regions. The house space was organized in a rather normative manner, as they were an embodiment of the past, history and memory, not only a place for living. They were a focus of meaning and action in which social cooperation and practice were undertaken. It is where the everyday lives of the inhabitants were linked to the timeless and stable world of the ancestors, preserving stability and security for them. This was further enforced by the architectural permanence of these houses, which contributed to a perception of long-term social stability.

As with any other vernacular architecture, longhouses were the product of a long-standing process, incorporating a wide range of elements, both new and old (*Stea, Turan 1990.21*). They should not be treated as finished artefacts. Each house has its own life history and/or replacement cycle. It was (re)created, (re)built and modified in the course of its occupation within a unique historical context.

The characteristic features of the houses in both regions indicate that communal organization among early Neolithic groups dominated the constitution of social arrangements. As argued elsewhere (*Düring and Marciniak 2006*), the earlier Neolithic in Central Anatolia is characterized by the predominance of clustered neighbourhood communities. Local groups appear to be organized into a number of tightly nucleated neighbourhoods that shared a number of facilities and resources. Within these neighbourhoods would have lived a large number of families who probably did not run autonomous households.

The very nature of the communal character of social arrangements in the early Neolithic of the North European Plain has not been satisfactorily scrutinized to date. A majority of scholars stress, however, their communal over household organization. More recent proposals advocate that longhouses were occupied by extended rather than nuclear families (*Hodder 1984.63*). LBK settlements were believed to consist of a number of patrilineages. Each settlement may have had its own chief, whose power was either achieved or ascribed. The coexistence of several houses at the same time, a common feature of LBK settlements, may suggest lineages being reproduced in such a way (*van de Velde 1979.130*). The contrary theory, advocating longhouses as the loci of matrilocal units inhabited by a maternal grandmother along with her daughters, their husbands and children, has been proposed by Ehrenberg (*1989.96*). Other authors, such as *e.g.* Milisauskas (*1986*), have argued that groups inhabiting subsequent settlements were homogenous, with only slight social and economic differences. LBK communities were perceived as being small-scale, largely acephalous, egalitarian and non-stratified. Communal identity was probably of crucial importance for these egalitarian communities, with consensual decision-making (*Milisauskas 1986.215–218*).

Similarities between these two regions in the early Neolithic are not limited to architecture and spatial arrangements, but are also visible in human-animal relations. In both, we are dealing with different uses of sheep/goats and cattle. While the former was an ordinary source of meat, the latter was embedded in different social and ceremonial contexts. In no way can the early use of cattle be equated with meat focused exploitation. Interestingly, similar differences are discernible across other geographical regions. The special significance of cattle has been convincingly demonstrated in other parts of the Near East, in particular in the Levant (*e.g. Akkermans, Schwartz 2003.75*), but also in the Balkans (*Greenfield 2005. 28*) or the British Isles (*Edmonds 1999.28; Thomas 1999.74*).

The first period of the Neolithic saw steady and uninterrupted development that was characterized by a high degree of similarity in the domains discussed in this paper as well as many others. After more then fifteen hundred years of predominance of the clustered neighbourhoods of the Central Anatolia Neolithic, these social arrangements disintegrated and were finally abandoned. At the same time, after roughly the same time span, the larger community that constituted the predominant social arrangement in the early Neolithic in the North European Plain was also abandoned.

Intriguing parallels are discernible as regards regional developments. We are dealing with two types of communities here. The community of continuation typical of pre-pottery Levels both at Asıklı Höyük and Çatalhöyük was replaced by the community of change in the post-Level VI/V level at Çatalhöyük East. Around 6000/5900 BC, the mound was finally abandoned.

In the first phase of Neolithic occupation in Central Anatolia, in the ECA II and ECA IIIA phases, the settlement pattern is characterised by long-term aggregation, and marked by extreme concentrations of population at one site, first at Asıklı Höyük and then at Çatalhöyük. Only a few, smaller Neolithic sites dated to the second half of the 8th millennium have been discovered to date. This long and considerably homogenous sequence at Asıklı Hoyuk and Çatalhöyük is followed by a much shorter 500–600 years of the Late Neolithic period (ECA IIIB), which is distinguished by dynamic changes that increased in pace in subsequent phases. The apparent lack of permanent sedentary communities in the region during the ECA II and ECA IIIA is in sharp contrast with succeeding periods. The following ECA IIIB period is marked by the appearance of many smaller sites (*Baird 2002*).

It is only in the ECA IIIB that local farming groups emerged as strong and independent entities both in the region and beyond. A number of co-existing communities were formed in both regions, bound within intensive communication networks. Inherited practices were selected, reconstructed, maintained, modified and given a transformed meaning (*Said 2000.185*). Social changes took the form of small scale modifications and transformations of the early farming tradition. The process was uneven and highly localized, and its dynamics varied both between different parts of regions and in subsequent periods. As a result, the landscape was largely dispersed and fragmented and local communities were linked by different communication networks.

This trend continued in the ECA IV period. Settlements were smaller and were occupied for shorter periods than previously. Environmental conditions, such as extensive flooding, in this period do not adequately account for this regional change (*Baird 2002.150*). Rather, the settlement pattern seems to reflect the presence of a settled agricultural population in the region. The subsistence economy was based on the full domestic exploitation of plants and animals, although hunting and gathering still played a minor role (*Özbaşaran and Buitenhuis 2002.71*; also *Gérard 2002.107*).

As revealed in the North European Plain, these evident changes were manifested differently in regions continuously inhabited since the early Neolithic and in areas occupied for the first time in this period. The core region enjoyed a high degree of stability following the strengthening of communal identity. A conceptual frame of reference for these groups provided recontextualised resources mobilized in the preceding period.

Further transformations in both regions imply considerable changes in human-animal relations, particularly in herding practices and a switch to the use of dairy products. Animal use became economically more efficient. The disassociation of animals from ceremonial and social domains, so characteristic of the earlier period, proved to be a prerequisite for the dynamic expansion of the post-early Neolithic communities and had far-reaching consequences for the whole economy.

These significant changes in both regions in the post-early Neolithic period may be indicative of the emerging dominance of a domestic mode of production and consumption, with the associated development of the autonomous household as the paramount mode of social association (see more in *Düring and Marciniak 2006*). This increased autonomy of the household in the post-Early Neolithic was based on its durable and successful economy, in which crop and livestock husbandry were closely integrated and intensively managed.

The emergence of the household mode of production in this period is discernible in both regions. In the last levels of Çatalhöyük East occupation, lithic industries became more complicated, which possibly relates to craft specialisation by skilled individuals (*Conolly 1999*). The increased number of prismatic blades is probably associated with dependence on domestic food sources and with cooking habits, as indicated by bipolar truncation and bilateral wear-retouch. All these changes may be linked to a radical reorganisation of chipped stone production in this phase (*Carter 2005*). Major changes are also identified in pottery manufacture and use, manifested by a shift from the chaff-tempered tradition to grit-tempered and burnished wares suitable for cooking (*Mellaart 1966.170; Last 1996.118*). They are also marked by the occurrence of stamp seals that arguably acted as portable forms of art, making symbolism more mobile (*Hodder 2005b.190*). At the same time, household social arrangements the North European Plain is manifested in emergence of spatially bounded household clusters accompanied by debris of specialized activities (*Grygiel 1986*).

The emergence of the household as an independent social entity had far-reaching consequences, as it challenged the social, ceremonial and economic foundations of early Neolithic communities. As households became more economically robust, imbalances in household production more frequent, and descent-based claims on land more individualized, one may argue that powerful social sanctions came into force to hold the community together. Furthermore, it arguably resulted in a significant change to past resemblance politics. The previously dominant organisation was constructed using collective- and long-term memories within social structures operating at the supra-house level. This was replaced by heterogeneous arrangements based on individualised, short-term memory regimes, within a predominantly house-based social structure (see also *Kuijt 2001; Hodder 2005b.190*).

These transformations are indicative of considerable social and symbolic changes. Changes in individual houses in relation to the disaggregation of the settlement layout may have been related to disaggregation on the regional scale. As a result of these transformations, post-Early Neolithic groups had a more practical style of life, largely disassociated from the symbolic and social domain that had hampered any changes in the preceding period. This contributed to significantly more efficient husbandry and consequently facilitated the large-scale expansion of these communities into hitherto unoccupied areas. Transformations in this domain also facilitated the dynamic development of small mobile groups and became a driving force of the intensified process of agricultural colonization of vast territories. This enabled local groups to inhabit small settlements in strategic locations, start economically efficient lives and fully exploit the available resources.

It is worth reiterating that social changes in this period in both regions had the form of small scale modifications and transformations of the early farming tradition. Autonomous households initially developed as an intrinsic component of the Çatalhöyük building, as well as the Central European longhouse, and eventually contributed to their demise. A conceptual frame of reference for these groups provided recontextualised resources mobilized in the preceding period. As a result of this longstanding process, subsequent generations tended to refer mainly to a common experience rather than to a normatively understood, inherited tradition. At the same time, these transformed traditions provided a solid foundation for communities moving from these centres to previously unoccupied areas.

ACKNOWLEDGEMENTS

I would like to thank Mihael Budja for inviting me to participate in the 14th Neolithic Seminar The Neolithic Mind, Populations and Landscapes

∴

REFERENCES

AKKERMANS P. M. M. G., SCHWARTZ G. M. 2003. *The archaeology of Syria. From complex hunter-gatherers to early urban societies (ca. 16,000–300 BC)*. Cambridge University Press. Cambridge.

AMMERMAN A., CAVALLI-SFORZA L. L. 1973. A population model for the diffusion of early farming in Europe. In C. Renfrew (ed.), *The Explanation of Culture Change. Models in Prehistory*. Duckworth. London: 343–358.

1984. *The Neolithic transition and the genetics of populations in Europe*. Princeton University Press. Princeton.

BAIRD D. 2002. Early Holocene settlement in Central Anatolia. Problems and prospects as seen from the Konya Plain. In F. Gérard and L. Thissen (eds.), *The Neolithic of Central Anatolia, Internal Developments and External Relations during the 9th – 6th millennia cal. BC*. EGE Yayinlari, Istanbul: 139–159.

BALKAN-ATLI N., BINDER D. 2001. Les ateliers de taille d'obsidienne. Fouilles de Kömürcü-Kaletepe 2000. *Anatolia Antiqua 9: 193–205*.

BARKER G. W. 1985. *Prehistoric farming in Europe*. Cambridge University Press. Cambridge.

BOGDAN D. 2005. 4040 Area. Neolithic sequence, Building 52. Çatalhöyük 2001 Archive Report: on-line: http://www.catalhoyuk.com/archive_reports/2005/ar05_13.html

BOGUCKI P. 1982. *Early Neolithic subsistence and settlement in the Polish lowlands*. British Archaeological Reports. International Series 150. Oxford.

BOGUCKI P., GRYGIEL R. 1980. On the socioeconomic system of European Neolithic populations. *Current Anthropology 21: 803–804*.

BOGUCKI P., GRYGIEL R. 1981. The household cluster at Brześć Kujawski 3. Small-site methodology in the Polish lowlands. *World Archaeology 13(1): 59–72*.

BOGUCKI P., GRYGIEL R. 1997. Early farmers in North-Central Europe: 1989–1994 excavations at Osłonki, Poland. *Journal of Field Archaeology 24: 161–178*.

CARTER T. 2005. Chipped stone. Team Poznan. Çatalhöyük 2005 Archive Report, on-line: http://www.catalhoyuk.com/archive_reports/2005/ar05_31.html.

CESSFORD C. 2001. A new dating for Çatalhöyük. *Antiquity 75: 717–25*.

CONOLLY J. 1999. Technical strategies and technical change at Neolithic Çatalhöyük, Turkey. *Antiquity 73: 791–800*.

CZERNIAK L. 1994. *Wczesny i środkowy okres neolitu na Kujawach, 5400–3650 p.n.e*. Wydawnictwo Instytutu Archeologii i Etnologii PAN. Poznań.

1998. The first farmers. In M. Chłodnicki and L. Krzyżaniak (eds.), *Pipeline of Archaeological Treasures*. Poznańskie Towarzystwo Prehistoryczne, Poznań: 23–36.

CZERNIAK L., KWIATKOWSKA M., MARCINIAK A., PYZEL J. 2001. The excavations of the TP (Team Poznań) Area in the 2001 season. Çatalhöyük 2001 Archive Report. on- line: http://www.catalhoyuk.com/archive_reports/2001/ar01_04. html.

CZERNIAK L., MARCINIAK A., PYZEL J. 2002. The excavations of the TP (Team Poznań) Area in the 2002 season. Çatalhöyük 2002 Archive Report. on-line: http://www.catal hoyuk.com/archive_reports/2002/ar02_07.html.

CZERNIAK L., MARCINIAK A. 2005. Excavations of the TP Area. Çatalhöyük 2005 Archive Report. on-line: http:// www.catalhoyuk.com/archive_reports/2005/ar05_17.html

DÜRING B. S. 2001. Social dimensions in the architecture of Neolithic Çatalhöyük. *Anatolian Studies 51: 1–18*.

2005. Building continuity in the Central Anatolian Neolithic. Exploring the meaning of buildings at Aşıklı Höyük and Çatalhöyük. *Journal for Mediterranean Archaeology 18: 1–20*.

DÜRING B. S., MARCINIAK A. 2006. Households and communities in the central Anatolian Neolithic. *Archaeological Dialogues 12(2): 165–187*.

EDMONDS M. 1999. *Ancestral geographies of the Neolithic. Landscapes, monuments and memory*. Routledge. London and New York.

EHRENBERG M. 1989. *Women in prehistory*. University of Oklahoma Press. Norman and London.

ESIN U., HARMANKAYA S. 1999. Aşıklı. In M. Özdoğan and N. Başgelen (eds.), *The Neolithic of Turkey*. Istanbul: 115–132.

FARID S. 2005. Çatalhöyük – two mounds, one site. *ZAKS Newsletter 2005: 3–6*.

FLANNERY K. V., WINTER M. C. 1976. Analyzing household activities. In K. V. Flannery (ed.), *The Early Mesoamerican Village*. Academic Press. New York: 34–47.

GABAŁÓWNA L. 1966. *Ze studiów nad grupą brzesko-kujawską kultury lendzielskiej*. Acta Archaeologica Lodziensia 14. Łódź.

GÉRARD F. 2002. Transformations and societies in the Neolithic of Central Anatolia. In F. Gérard and L. Thissen (eds.), *The Neolithic of Central Anatolia. Internal developments and external relations during the 9th–6th millennia cal. BC*. Istanbul, EGE Yayinlari: 105–17.

GREENFIELD H. J. 2005. A reconsideration of the secondary products revolution. 20 years of research in the central Balkans. In J. Mulville and A. Outram (eds.), *The Zooarchaeology of Milk and Fats*. Oxbow Press. Oxford: 14–31.

GRYGIEL R. 1986. The household cluster as a fundamental social unit of the Lengyel culture in the Polish lowlands. Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi. *Seria Archeologiczna 31: 43–270*.

HODDER I. 1984. Burials, houses, women and men in the European Neolithic. In D. Miller and C. Tilley (eds.), *Ideology, Power and Prehistory*. Cambridge University Press. Cambridge: 51–68.

1990. *The domestication of Europe. Structure and contingency in Neolithic societies*. Basil Blackwell. Cambridge.

2005a. Introduction. In I. Hodder (ed.), *Çatalhöyük Perspectives. Reports from the 1995–99 Seasons*. Mc Donald Institute for Archaeological Research/British Institute of Archaeology at Ankara Monograph, Cambridge: 1–14.

2005b. Memory. In I. Hodder (ed.), *Çatalhöyük Perspectives. Reports from the 1995–99 seasons*. McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara Monograph, Cambridge: 183–195.

2006. *Çatalhöyük the Leopard's Tale: Revealing the mysteries of Turkey's ancient 'town'*. Thames and Hudson. New York.

JAŻDŻEWSKI K. 1938. Cmentarzyska kultury ceramiki wstęgowej i związane z nimi ślady osadnictwa w Brześciu Kujawskim. *Wiadomości Archeologiczne 15: 1–105*.

KEELEY L. H. 1992. The introduction of agriculture to the western north European Plain. In A. B. Gebauer and T. D. Price (eds.), *Transitions to Agriculture in Prehistory*. Prehistory Press. Madison, Wisconsin: 81–95.

KRUK J., MILISAUSKAS S. 1999. *Rozkwit i upadek społeczeństw rolniczych neolitu*. Wydawnictwo Instytutu Archeologii i Etnologii Polskiej Akademii Nauk. Kraków.

KUIJT I. 2001. Meaningful masks. Place, death, and the transmission of social memory in early agricultural communities of the Near Eastern Pre-Pottery Neolithic. In M. S. Chesson (ed.), *Social Memory, Identity, and Death. Interdisciplinary Perspectives on Mortuary Rituals*. American Anthropological Association. Arlington, VA: 80–99.

KULCZYCKA-LECIEJEWICZOWA A. 1970. Kultura ceramiki wstęgowej rytej w Polsce. Zarys problematyki. In J. K. Kozłowski (ed.), *Studies on the Linear Pottery Culture*. Polskie Towarzystwo Archeologiczne. Kraków: 11–28.

1979. Pierwsze społeczeństwa rolnicze na ziemiach polskich. Kultury kręgu naddunajskiego. In W. Hensel and T. Wiślański (eds.), *Prahistoria ziem polskich, t. II, neolit*. Zakład im. Ossolińskich, Wrocław, Warszawa, Kraków and Gdańsk: 19–164.

1993. *Osadnictwo neolityczne w Polsce południowo-zachodniej*. Wydawnictwo Instytutu Archeologii i Etnologii PAN. Wrocław.

LAST J. 1996. Surface pottery at Çatalhöyük. In I. Hodder (ed.), *On the Surface. Çatalhöyük 1993–95*. Monograph of the McDonald Institute and the British Instituts of Archaeology at Ankara. Cambridge: 115–72.

LÜNING J. 1982. Research into the Bandkeramik settlement of the Aldenhovener Platte in the Rhineland. *Analecta Praehistorica Leidensia 15: 1–29*.

MARCINIAK A. 2005. *Placing animals in the Neolithic. Social zoo-archaeology of prehistoric farming communities*. UCL Press. London.

MARCINIAK A., CZERNIAK L. 2007. Social transformations in the Late Neolithic and the Early Chalcolithic periods in central Anatolia. *Anatolian Studies 57: 115–130*.

MELLAART J. 1964. Excavations at Çatal Hüyük, third preliminary report, 1963. *Anatolian Studies 14: 39–119*.

1966. Excavations at Çatal Hüyük. Fourth preliminary report, 1965. *Anatolian Studies 16: 165–91*.

1967. *Çatal Hüyük. A Neolithic town in Anatolia*. Thames and Hudson. London.

MILISAUSKAS S. 1986. *Early Neolithic settlement and society at Olszanica*. University of Michigan Museum, Ann Arbor. Michigan.

MILISAUSKAS S., KRUK J. 1989. Neolithic economy in Central Europe. *Journal of World Prehistory 3: 403–46*.

MODDERMAN P. J. R. 1970. *Linearbandkeramik aus Elsloo und Stein*. Leiden University Press. Leiden.

ÖZBAŞARAN M. 2000. The Neolithic site of Musular, Central Anatolia. *Anatolica 26: 129–151*.

ÖZBAŞARAN M., BUITENHUIS H. 2002. Proposal for a regional terminology for Central Anatolia. In F. Gérard and L. Thissen (eds.), *The Neolithic of Central Anatolia*. EGE Yayinlari, Istanbul: 67–78.

ÖZDOĞAN M. 1995. Neolithic in Turkey. The status of research. In anonymous (ed.), *Readings in Prehistory, Studies presented to Halet Çambel*. Istanbul: 41–59.

1999. Concluding remarks In M. Özdoğan and N. Başgelen (eds.), *The Neolithic of Turkey*. Istanbul: 225–236.

PAYNE S. 1973. Kill-off patterns in sheep and goats. The mandibles from Aşvan Kale. *Anatolian Studies 23: 281–303*.

POLLARD J. 1999. These places have their moments. Thoughts on settlement practices in the British Neolithic. In J. Brück and M. Goodman (eds.), *Making Places in the Prehistoric World: Themes in Settlement Archaeology*. UCL Press. London: 76–93.

PRICE T. D., GEBAUER A. B., KEELEY L. H. 1996. The spread of farming into Europe North of the Alps. In T. D. Price and A. B. Gebauer (eds.), *Last Hunters-First Farmers. New Perspectives on the Prehistoric Transition to Agriculture*. School of American Research Press, Santa Fe. New Mexico: 95–126.

RICHARDS M. P., PEARSON J. A., MOLLESON T. I., RUSSELL N., MARTIN L. 2003. Stable isotope evidence of diet at Neolithic Çatalhöyük, Turkey. *Journal of Archaeological Science 30: 67–76*.

RUSSELL N., PAWŁOWSKA K., TWISS K., JENKINS E., DALY R. 2004. Animal bone reports. Çatalhöyük 2004 Archive Report. on-line: http://www.catalhoyuk.com/archive_reports/2004/ar04_17.html

RUSSELL N., MARTIN L. 2005. Çatalhöyük mammal remains. In I. Hodder (ed.), *Inhabiting Çatalhöyük: Reports from the 1995–99 Seasons*. Monograph of the Mc Donald Institute and the British Instituts of Archaeology at Ankara. Cambridge: 33–98.

RUSSELL N., MEECE S. 2006. Animal representations and animal remains at Çatalhöyük. In I. Hodder (ed.), *Çatalhöyük Perspectives: Reports from the 1995–99 Seasons*. Monograph of the McDonald Institute and the British Instituts of Archaeology at Ankara. Cambridge: 209–230.

SAID E. W. 2000. Invention, memory, and place. *Critical Inquiry 26: 175–192*.

STARLING N. J. 1983. Neolithic settlement patterns in Central Germany. *Oxford Journal of Archaeology 2(1): 1–11.*

1985. Colonization and succession. The earlier Neolithic of Central Europe. *Proceedings of the Prehistoric Society 51: 41–57.*

STEA D., TURAN M. 1990. A statement on placemaking. In M. Turan (ed.), *Vernacular Architecture. Paradigms of Environmental Response. Ethnospace: volume 4*. Avebury. Aldershot: 102–121.

THOMAS J. S. 1999. An economy of substances in earlier Neolithic Britain. In J. Robb (ed.), *Material Symbols. Culture and Economy in Prehistory*. Southern Illinois University Press. Carbondale: 70–89.

TWISS K., MARTIN, L, PAWŁOWSKA K., RUSSELL N. 2005. Animal Bone. Çatalhöyük 2005 Archive Report. on-line: http://www.catalhoyuk.com/archive_reports/2005/ar05_21.html.

VELDE VAN DE P. 1979. *On Bandkeramik social structure. An analysis of pot decoration and hut distribution from the Central European Neolithic communities of Elsloo and Hienheim*. Analecta Praehistorica Leidensia XII, University of Leiden Press. Leiden.

WINTER M. C. 1977. The archaeological household cluster in the valley of Oaxaca. In K. V. Flannery (ed.), *The Early Mesoamerican Village*. Academic Press. New York: 25–34.

WIŚLAŃSKI T. 1970. Uwagi o kulturze ceramiki wstęgowej rytej na terenie Polski północno-zachodniej. In J. K. Kozłowski (ed.), *Studies on the Linear Pottery Culture*. Polskie Towarzystwo Archeologiczne. Kraków: 29-36.

back to contents

UDK 903'01(497.2)"634"
Documenta Praehistorica XXXV (2008)

Towards an understanding of Early Neolithic populations: a flint perspective from Bulgaria

Maria Gurova
National Institute of Archaeology and Museum, Bulgarian Academy of Sciences, Bulgaria
gurovam@yahoo.fr

ABSTRACT – *The evidence from the Bulgarian Early Neolithic chipped stone industry reveals coherent and diagnostic flint assemblages for the vast Karanovo I and II cultural area, characterized by high quality yellow-honey coloured flint, quite long and regular blades, with (bi)lateral semi-abrupt high retouch and sometimes with rounded or pointed ends, as well as highly (re-)used sickle inserts. These assemblages possess many characteristics of so-called 'formal tools' (as distinct from expedient ones), the production of which required a special raw material, advanced preparation, anticipated use, and transportability. The wide geographical distribution and circulation of this formal toolkit implies that lithics could be conceived as a factor in identity and social cohesion, and as an important aspect of the Neolithic mentality for 'doing things'.*

IZVLEČEK – *Bolgarski zgodnjeneolitski zbiri kamnitih orodij kažejo koherentno sliko diagnostičnih tipov, značilnih za kulture Karanovo I in II. Značilna je uporaba visoko kakovostnega kremena rumeno-medene barve, dolge in pravilne kline z (bi)lateralno polstrmo retušo, občasno zaobljene konice in preuporabo armature za srpe. Ti zbiri kažejo značilnosti 'formalnih orodij' (za razliko od* ad hoc *orodij); za njihovo proizvodnjo so potrebne posebne surovine, zahtevna priprava, načrtna uporaba in prenosljivost. Veliko geografsko območje kroženja teh formalnih orodij kaže, da lahko kamnita orodja razumemo kot element identitete, družbene kohezije in pomemben vidik neolitskega pristopa k 'delanju stvari'.*

KEY WORDS – *Early Neolithic; formal flint toolkit; diagnostic tool; big retouched blades; raw material; Balkan flint; functional analysis*

> "*Archaeologists can only study the past by means of surviving material, and it is perhaps understandable that the primary archaeological concern has been to explain the creation of the archaeological record by reference to past human actions.*" J. Barrett

Introduction

The richness of Bulgarian Neolithic culture, with the paraphernalia of its artistic representations and deep semantic connotations, is well known and still vividly interpreted and debated. This paper discusses a kind of material not often considered in this context – flint assemblages – being far less attractive in embodied depictions and cognitive suggestions.

In terms of the traditional distinction between different theoretical approaches in archaeology, Bulgarian archaeology has tended to follow the conventional culture-historical paradigm which focuses on placing archaeological material... "*in time and space, [guiding] archaeologists in their successful development of archaeological sequences ... and [grouping] related materials into 'cultures' with clear spatial and temporal boundaries*" (*Renfrew and Bahn 2005.213*). There have been no systematic attempts to apply some challenging and relevant processual/post-processual explanatory or interpretive models.

In this sense the level of enquiry and knowledge is based more on the 'what, where, when' questions, than on the 'how and why' (*ibid. 214*). This could be regarded as a retrograde (or at least old-fashioned) style of pursuing archaeological research; at the same time, the lack of cognitive conceptualism has protected Bulgarian archaeology from excessive theoretical proxies, rhetorical speeches, and improvable scenarios. This protective effect could be seen as a positive consequence of the dominant research orthodoxy.

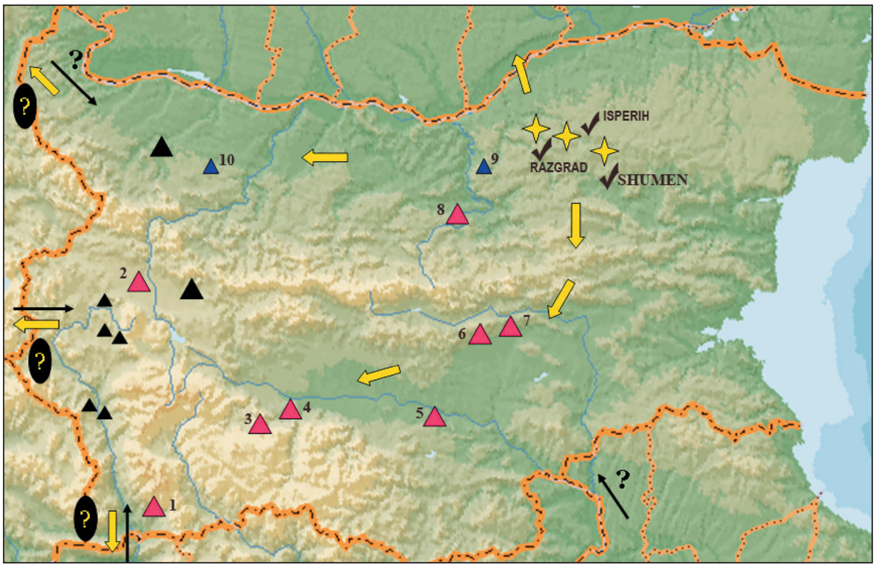


Fig. 1. Map with Early Neolithic sites: black symbol – western group studied by I. Gatsov; red symbol – study and direct observation of the author; blue symbol – 'monochrome pottery' sites. The three main flint outcrops are indicated by yellow signs in relation to modern cities. Arrows indicate presumed directions of: spread of Neolithisation – black; distribution of Dobrudzha flint – yellow. Numbered sites: 1 – Kovačevo; 2 – Slatina; 3 – Rakitovo; 4 – Kapitan Dimitrievo; 5 – Yabalkovo; 6 – Azmak; 7 – Karanovo; 8 – Dzhuljunitsa; 9 – Koprivets; 10 – Ohoden.

Whatever the advantages or disadvantages of existing approaches to archaeological research in Bulgaria, there is undoubtedly a poverty of language, terminology and connotations, which would otherwise permit recent archaeological studies to be appreciated and evaluated without ideological and epistemological scepticism from the wider scientific community. Notions and concepts such as 'identity, artefact biography (together with the functional and symbolic meaning of the artefacts), deliberate fragmentation, enchainment and accumulation, (in-)dividual personhood, social interactions, cultural adaptation and transformation, symbolic metaphors', etc., unfortunately are not yet in sufficiently frequent or adequate use. An exception is the study of flint industries, where the postulate of a '*chaîne opératoire*' is (unavoidably!) appropriated, but usually quite marginally and superficially applied and presented. Other exceptions are the studies by scholars such as D. Bailey, J. Chapman and, more recently, B. Gaydarska, which have introduced new epistemological and explanatory aspects to the interpretation of the material culture of the Balkan Neolithic and Chalcolithic periods (*Bailey 2000; 2005; Chapman 2000; Chapman and Gaydarska 2007*).

Concerning the Neolithic period, very few general and fundamental studies have been published (*Todorova and Vaisov 1993*); instead, there is a preponderance of specialized studies of different aspects of material culture and spirituality, almost exclusively of pottery (*Nikolov 1998; 2006; 2007*). Ceramic vessel ornamentation and the variability of sculptured objects (especially figurines), being particular artistic depictions of the human mind and imagery in the past, have unavoidably focused the attention of scholars on the search for the paraphernalia of (in)dividual ability, mentality and behaviour of Neolithic people.

Another way of approaching the mind of Neolithic society involves a more 'prosaic' interpretation of subsistence and household activities, skill and technology, toolkit style and evolution (in terms of retardation, innovation and standardization) decision making, resilience and revival of technology and behavioural strategy, etc. The study of flint assemblages is an intrinsic part of this alternative research direction, and the present paper tries to improve the interpretive scope of flint toolkits in relation to the perpetual debate about the Neolithisation process and its emphasis on social agency (with particular reference to Bulgaria, but with some indispensable references to adjacent regions).

Current problems and research objectives

The focus of this study is the diagnostic flint toolkits which form an intrinsic part of the Early Neolithic assemblages of the Karanovo I and II cultures. Apart from their distinctive techno-typological and functional features, another key feature is the special raw material from which the toolkits are made: high quality, yellow-honey coloured flint, with sporadic whitish spots (well known and often referred to in the literature as Balkan Platform flint). The complex of significative traits of these toolkits permits them to be conceived as one of the diagnostic elements of Early Neolithic material culture (*Gurova 2005*).

Typologically, these toolkits consist mostly of medium to long, regularly-shaped blades, ranging between 12 and 15cm long, frequently with (bi-)lateral semi-abrupt retouch (from marginal to high and steep), and sometimes with rounded or pointed ends. Most of the artefacts in these toolkits possess macro- and micro-wear traces of use. The flint assemblages reveal many characteristics of so-called 'formal tools', whose production requires "*... a special raw material, advanced preparation, anticipated use and transportability*" (*Andrefski 1994.22*). From a technological point of view, this industry indicates the application of indirect percussion (punch technique). Pressure flaking with an organic stick is used for the characteristic high and steep retouching. It must be stressed that neither cores nor common debitage linked with their preparation are attested among the assemblages. In this sense, any attempt to apply some diacritic concept of '*chaîne opératoire*' reconstruction of the toolkits fails.

These formal tools are recorded in varying density and quantity among the flint assemblages of many Early Neolithic settlements, some of which had short life-spans, and others reveal only limited archaeological evidence. Only a few sites offer the possibility of studying the formal tools in conditions of changing contextual data. For example, Tell Karanovo, with its representative cultural sequence from Early Neolithic to Bronze Age, provides a rare opportunity to trace the development and evolution of flint assemblages belonging to different strata. The observation made is that formal tools as elements of the typological repertoire are frequently attested from the Karanovo I to Karanovo II–III periods. During Karanovo III and even in Karanovo III–IV they appear sporadically as reminiscent forms (*Gurova 2002; 2004*). In the new periodization of the Karanovo sequence, periods III and III–IV belong to the first stage of the Late Neolithic (*Nikolov 1998.18*). To date, no other well-stratified site permits observations regarding the 'evolution' of formal toolkits.

In spite of the fact that an impressive corpus of flint studies has been done over the last two decades, too many questions still arise with regard to these flint toolkits: tracing their (becoming mythologically overexposed!) raw material, its outcrops and procurement strategy; the location of their workshops, identification of their manufacturers (flint knappers) and technological origin; the identification of their distribution and exchange network mechanisms; elucidating their interactions and impacts with adjacent Early Neolithic cultural groups and identities, etc. Undoubtedly, this article, will not find satisfactory answers to all these questions, but will try to present and offer relevant comments on the current state of research and, without offering an attractive new scenario, will suggest that there are still key problems concerning the perpetual debate on the Neolithisation of the Balkans.

Fig. 2. Formal toolkit from Kovačevo (photo M. Gurova).

In order to make visible and understandable some of the features of the formal toolkits, colour photographs of the artefacts are presented, mainly to highlight the distinctive appearance of the high quality yellow-waxy-honey flint from north Bulgaria.

Chronological and spatial limits of the formal toolkits

As a first step it is useful to outline the chronological framework of the Early Neolithic in Bulgaria, with some comments on the sites concerned. The Early Neolithic can be divided into two phases (*Boyadziev 1995. 179*):

- Early pottery ('monochrome' phase) – 6300/6200–6000/ 5900 calBC;
- Early ('classical' phase) – 6000/5900– 5500/5450 calBC.

The earliest ^{14}C date from Polianitsa-Platoto – 6420–6230 calBC (*Görsdorf and Bojadžiev 1996.122*) – is not taken into consideration, since there is no published evidence from the site directly relating to the problem under discussion.

Apart from the relatively new dates from Kovačevo, the very promising Yabalkovo site (^{14}C dates not yet published) could refine the dating of the start of the 'classical' Early Neolithic period. Kovačevo has two early dates of 6159–5926 calBC and 6064–5808 calBC, and a cluster of three dates *c.* 5980–5730 calBC (*Lichardus-Itten et al. 2006.85*).

Two sites belonging to the monochrome phase of the Neolithic are briefly discussed below, and it is worth mentioning their dating. Ohoden (northwest Bulgaria), although sometimes attributed to the monochrome phase, dates to the beginning of the VI millennium BC (*Ganetsovski 2008*).

Some dates from Dzhuljunitsa (north central Bulgaria), according to the excavator, fall in the last three centuries of the VII millennium BC[1]. The pottery features confirm the attribution of the site to the earliest Neolithic in Bulgaria (*Elenski 2004; 2007*).

Fig. 3. Formal toolkit from Yabalkovo (photo M. Gurova).

With regard to the time span of the toolkits under discussion and their function, it is useful to point out that they are abundant during the whole 'classical' Early Neolithic Karanovo I and II periods of the Tell Karanovo sequence, or until *c.* 5500 calBC. On the other hand, in terms of their lasting 'retardation' in the same sequence, the end of the Karanovo III period at Tell Karanovo: 5500–5280 calBC (*Görsdorf 1997.379*) can be regarded as a *terminus ante quem* for the presence of formal toolkits.

Spatial distribution of the formal toolkits

Local distribution

The formal toolkits are commonly found in the vast area of the Karanovo I and II cultures and their constituent regions in southern Bulgaria: Thrace – Tells Azmak, Karanovo and Kapitan Dimitrievo, and the Yabalkovo site; the northern foothills of the Rhodopes Mountains – the Rakitovo site, Sofia Plain – Slatina; and Struma Valley – Kovačevo (Fig. 1). The map shows sites in western Bulgaria which have been published, albeit briefly, by Ivan Gatsov (black symbols). Other research has been undertaken by the author, and some of this work is still in progress (red symbols). In north Bulgaria the flint industry exhibits a very different pattern (exclusively expedient in character, and an absence of the formal tools under discussion here), despite the fact that a proportion of the artefacts were made using the same raw material as used for manufacturing the formal tools discussed. Two sites belonging to the 'monochrome' phase of the Early Neolithic sequence are marked in blue, in recognition of their important position in the context of the Neolithisation debate (*see below*).

Supra-regional distribution

Formal toolkits as a distinguishable category of the Early Neolithic flint repertoire have never before been discussed in the literature in their complex technological and social dimensions. Nevertheless, some aspects of their stylistic 'coherence' have often been observed in the course of work on different assemblages from adjacent major cultural areas – Proto-Sesklo, Starčevo, Körös-Criş. The most common feature mentioned in these studies is the presence of raw material from the Pre-Balkan platform among the Early Neolithic assemblages from the Balkans.

1 Personal communication by N. Elenski with confirmation of forthcoming publication of ^{14}C dates.

According to Catherine Perlès, a characteristic feature of the chipped-stone assemblages of Neolithic Greece is the "*predominant use of non-local raw materials often obtained from considerable distances*" (*Perlès 2001.201*). She claims that... "*honey flint was never worked in the settlements, and the number of imported blades in each assemblage – often less than a dozen – was too small to warrant expeditions to the sources*" (*ibid. 207*). Perlès further observes that 'sickle blades' were the dominant 'typological' (formal) tools in Early Neolithic assemblages, and that..."*Larger, heavier 'sickle-blades' of honey or yellow flints were imported and always as blades rather than cores. They were produced by indirect percussion and also pressure-flaking. The origin of these blades is still unknown: the west coast is the most likely candidate, but the quarries have still to be found*" (*ibid. 202*).

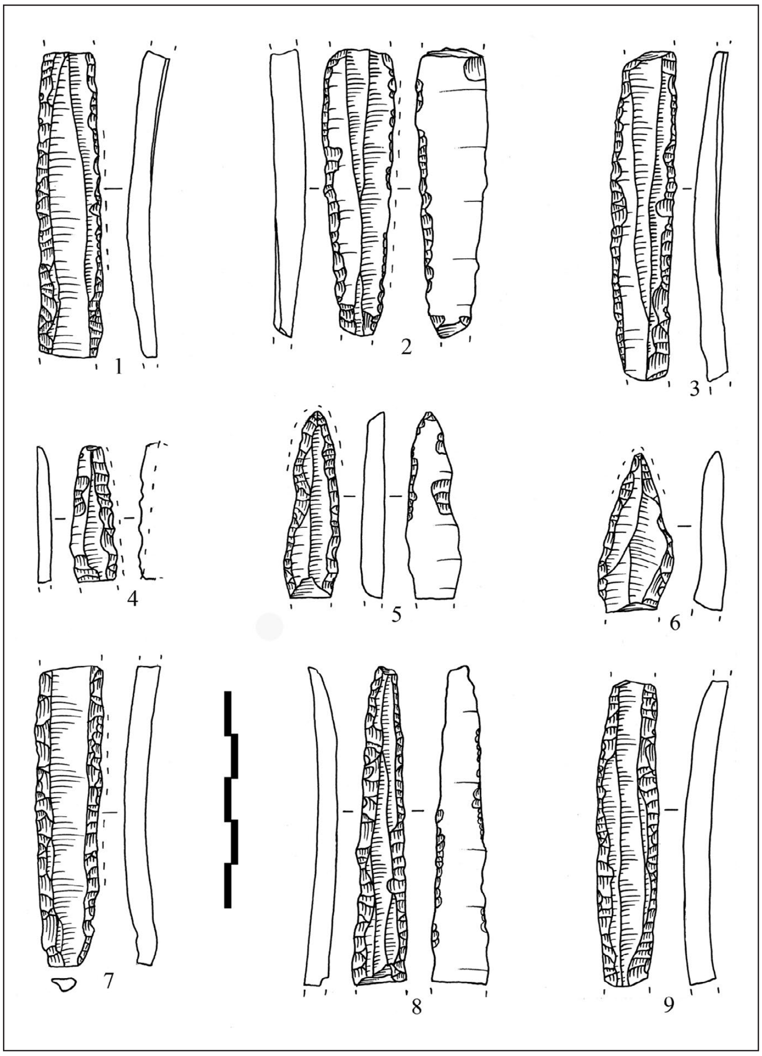


Fig. 4. Typological characteristics of the toolkit from Yabalkovo (drawing M. Gurova).

Unfortunately, there is no up-to-date data base that would permit comparison with the chipped-stone industries from Nea-Nikomedeia and Giannitsa in Greek Macedonia. Recently, interesting and promising research has been done by G. Philippakis on north Greek Neolithic assemblages coming from outside the obsidian area. I hope our further study and collaboration will lead to positive issues of reliable comparison of the assemblages from both regions – Bulgarian Thrace and Greek Macedonia.

From the Ovče Pole region the crucial culture group of Anzabegovo-Vršnik is very promising, but still enigmatic from a lithic point of view. The affinities of this group are uncertain, and will only be revealed when comparative studies are possible. The material from Anza was studied by E. Elster, but there is no strictly stratified approach to the assemblages, and consideration of the chronological sequence is rather complicated. However, Elster mentioned that among the implements was "*honey-brown flint, appearing to be similar to well known eastern European flint with no known local source*" (*Elster 1977.161*).

The Iron Gates region will be briefly discussed on the basis of Borić's new interpretation of the succession of sites, cultural phenomena and problems in this area. The conformity of Early Neolithic Balkan flint assemblages in terms of the relative abundance and uniformity of their raw material was underlined a decade ago, with the intention of putting into comparative perspective the studies of Vlasac and Lepenski Vir, undertaken by Kozłowski and Kozłowski (*Borić 1999*). Concerning the flint assemblage of Lepenski Vir (potentially a key site for clarifying many aspects of the transition from the local Mesolithic to the Neolithic), clear stratigraphic ambiguities are documented, which probably explain the fact that Balkan flint was found 'associated' with the architectural features of Lepenski Vir I and II (Mesolithic strata) (*Borić 1999.53*). An assessment of the later, Neolithic lithics is presented by Borić as follows: "*With the start of the Neolithic in the Balkans, there is a general trend toward the laminarization of blades* *and the use of steep retouch, as well as a tendency to use good quality raw material of attractive appearance, such as yellow-spotted flint from pre-Balkan platform that most likely originated in the region of Shumen in north-east Bulgaria*" (*Borić 2005.19*). It is worth mentioning two hoards of blanks and cores made from Balkan flint placed in Early Neolithic pots (according to *Srejović 1969; 1972*) and a nodule refitted with a retouched blade made of Balkan flint from sector I at Padina (*Borić 1999.54*). These can be regarded as evidence of exchange practices among the Iron Gates communities. Hopefully, new excavations at Vlasac will produce reliable evidence and will extend the study of Early Neolithic flint assemblages to the larger supra-regional scale. It should be stressed that in chronological terms the transition between Mesolithic- and Neolithic-type diets "*... centred around... 6156–5721 calBC, and that agriculture was being practised in the Lepenski Vir – Vlasac area by...c. 5700 calBC*" (*Bonsall et al. 2000.130*).

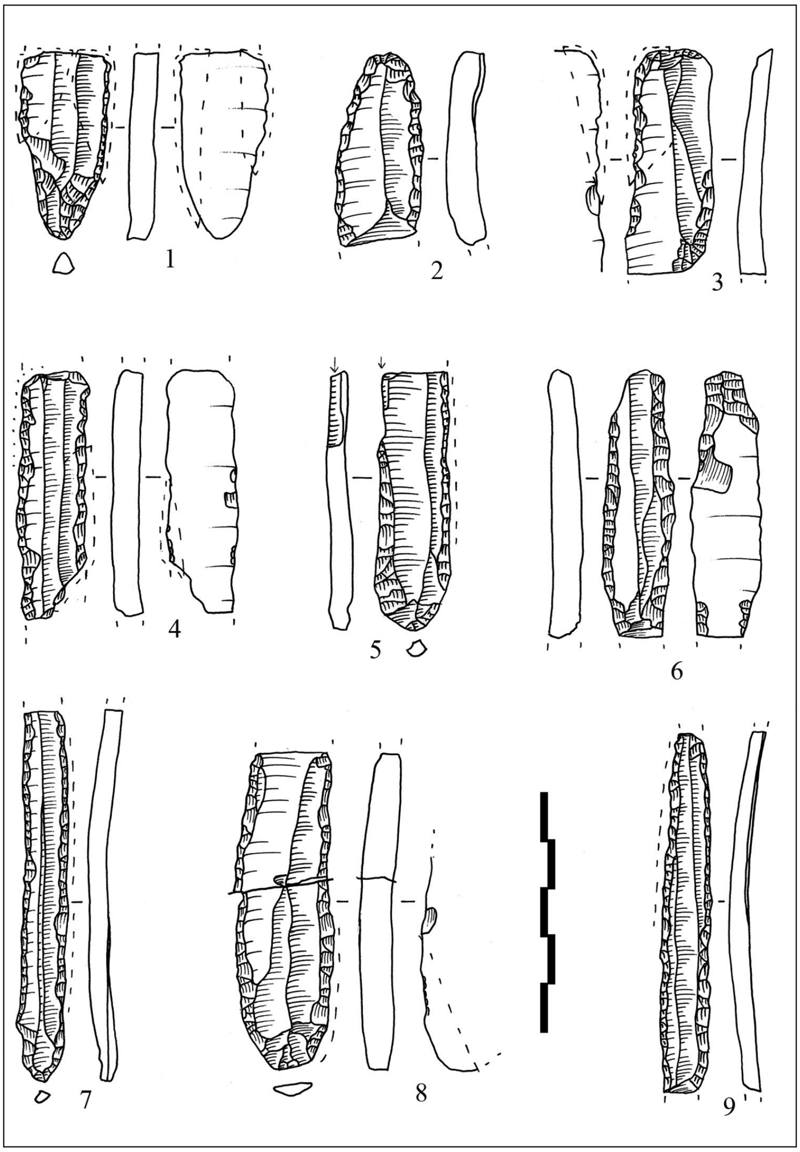


Fig. 5. Typological characteristics of the toolkit from Yabalkovo (drawing M. Gurova).

According to J. Kozłowski, the 'tardif' phase of Golocut (Voyvodina) offers some dozen implements of yellow flint from the Pre-Balkan platform; the drawings of some implements from the site confirm the typological similarity with the formal tools discussed in this paper (*Kozłowski 1982.150*; Figs. 11, 12). The same author concludes that in the area of the Körös-Criş culture there are retouched blades and unretouched sickle segments made of yellow imported flint – as a result of direct diffusion from the Balkans (*Kozłowski 1982.154*).

In the southeast there is undeniable evidence of the penetration of formal tools of Karanovo I aspect in Hoca Çeşme phase II (*Gatsov 2000; 2005*).

Comparative evidence from Romanian Early Neolithic flint assemblages is very limited and the distribution of 'yellow-spotted' raw material and items in this direction is still to be adequately documented, although Bonsall has reported the presence of Balkan flint artefacts in Criş culture contexts at Schela Cladovei on the left bank of the Danube, a few kilometres downstream from the Iron Gates gorge (*Bonsall 2003; 2008*).

As a concluding remark, it should be stressed that no special study elucidating the scale and intensity of the circulation and spread of yellow-spotted flint artefacts has been undertaken. The reasons are many, the most important being the scarcity of publications with relevant and detailed information about Early Neolithic flint assemblages among which these formal toolkits are detectable. This applies particularly to some emblematic sites adjacent to Bulgarian lands and cultural areas.

Present state of research on discussed assemblages

In the early 1990s, a study of the Neolithic chipped-stone industry of western Bulgaria was published by I. Gatsov, with the following general observations and conclusions (these are quoted directly because of the important further comments that are derived from them):

- During the Early Neolithic a highly developed technology of macroblade production took place; the exploitation of cores (mainly single-platform) "*took place sometimes* outside the settlement's area" (*Gatsov 1993.40*);

- This technology "*was connected with the exploitation of high quality yellow (or wax-coloured) flint with white or grey spots*";...“*Early Neolithic groups were able to exploit raw material sources which were very distant from their settlements*"; ...“*typical macroblades, especially made from yellow flint, were obtained either by exchanging goods or during special trips to the area of location of yellow flint outcrops, most probably in North-West Bulgaria*" (*ibid. 40–41*);

- "*...in the quarry areas, in the workshops, these groups (of manufacturers) had the possibility to 'waste' the material, selecting only standardized macroblades. Consequently, in the area of their settlements, the population was forced to conform to the restrictions caused by distant sources of raw material*" (*ibid. 44*);

- Part of the macroblades were treated with high, semi-abrupt retouch on one or both sides (*ibid. 45*).

Essentially, Gatsov's observations contain all the elements necessary for distinguishing the formal toolkit, but he stopped short of doing so, perhaps because of scarce empirical data, or simply because at that time it was probably beyond the scope of his research. In his study he presents five Early Neolithic flint assemblages from sites belonging to the southwest variant of the Karanovo I culture: Slatina, Eleshnitsa, Rakitovo, Sapareva Bania, Kovačevo (*Nikolov 1996*). The sites of Galabnik, Pernik and Gradeshnitsa show an affinity in pottery style with the Karanovo I and II cultures, but instead are interpreted as belonging to the culture of west Bulgarian painted pottery (*Todorova, Vaisov 1993.98*). Later, Gatsov continued his study of Neolithic assemblages from Bulgaria, Turkish Trace and northwest Anatolia, with a particular emphasis on tracing the roots of Neolithic industries (*e.g. Gatsov 2001; 2006; Özdoğan and Gatsov 1998; Gatsov and Gurova 1998*). An important aspect of the study was undertaken in collaboration with a geologist, with the aim of defining the raw materials of Karanovo I and II assemblages and tentatively identifying their outcrops (*Gatsov and Kurčatov 1997*, see below).

Over the last decade the present author has carried out a study (focusing on use-wear analysis) of the main (Early) Neolithic sites in Bulgaria: the Karanovo, Azmak, and Kapitan Dimitrievo tells, and sites at Kovačevo, Rakitovo, Yabalkovo, Slatina, Dzhuljunitsa – the study of the latter three is still in progress (*Gurova 1997; 2001a; 2002; 2004*). The flint assemblages from two early farming sites in the Marmara region have also been included: Ilipinar and Menteşe (*Gurova 2001b; 2006*). The results of these studies lead the author to conclude that among all Early Neolithic flint assemblages belonging to the sites of the Karanovo I and II cultural area, there is a distinguishable part of the typological repertoire, consisting of several formal tools, which suggests they should be conceived as diagnostic tool-markers (*Gurova 2005*). A diachronic analysis of the most representative sequence from

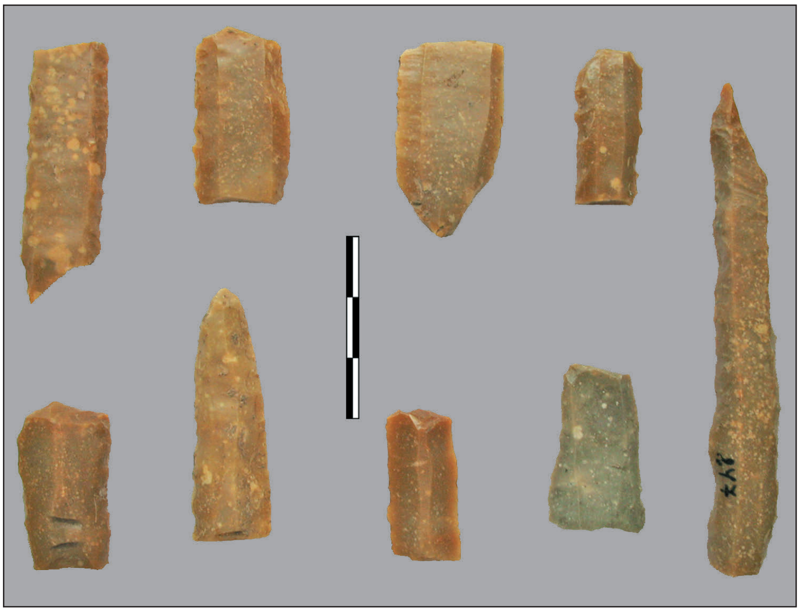


Fig. 6. Formal toolkit from Rakitivo (photo M. Gurova).

Tell Karanovo enabled the maximum time span of their currency among the flint assemblages of later Neolithic periods/phases to be established (*Gurova 2004*, see above).

It is worth mentioning briefly some of the sites I consider to be very promising for trying to answer the questions formulated above concerning the formal toolkits. According to the Kovačevo excavation team, it appears that "*...stratigraphical and stylistic evidence from Kovačevo clearly shows that this region was occupied at a period earlier that the currently known for the Thracian Early Neolithic Karanovo culture*"...*"If ever there were direct contacts between Kovačevo and Karanovo I in Bulgarian Thrace, they must only have taken place, judging from the pottery styles, in a late period*." (Kovačevo Id) (*Lichardus-Itten at al. 2006.87*). This general conclusion is supported by my own observations on the evolution of the lithics: the Kovačevo sequence starts with a rich repertoire of artefacts that are made from mainly grey to black raw material that originates from the Western Rhodopes. In the upper levels of the Kovačevo I sequence (Ic and Id), a representative presence of the discussed flint toolkit is documented (Fig. 2)[2]. This site, on the basis of detailed stratigraphic indications leading to reliable units, will permit us to establish the precise stratigraphic position/relationship between these tools and other cultural indicators, such as white-on-red painted pottery, or some another still invisible marker.

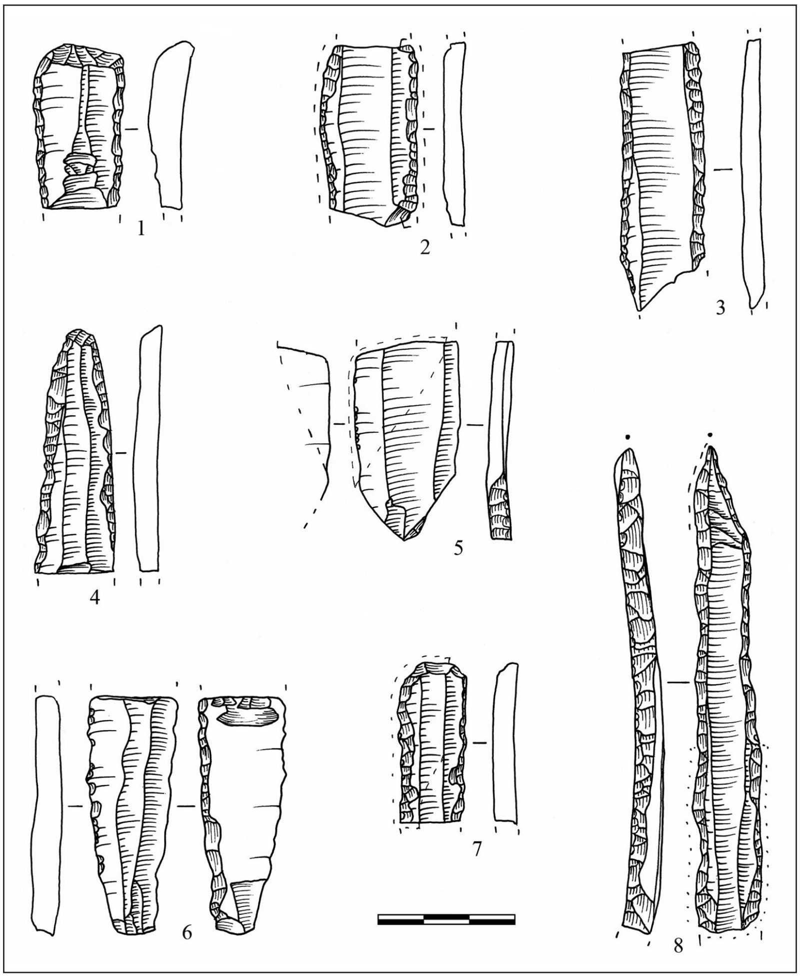


Fig. 7. Typological characteristics of the toolkit from Rakitovo (drawing M. Gurova).

Another site where these toolkits are very prominent is Yabalkovo, situated in the Maritsa River valley, in Upper Thrace, with cultural attribution to the Karanovo I horizon and a strong detectable Anatolian influence (*Leshtakov et al. 2007.208*). The impressive abundance of the flint industry from this site (and the richness of formal toolkits) provides an opportunity to focus on their technological parameters and eventually trace their origin in some Anatolian technocomplex (Figs. 3–5). There is already a published preliminary report on a series of flint artefacts, which will be discussed below.

The Early Neolithic site of Rakitovo (in the foothills of the Rhodopes) is one of the most interesting settlements, combining elements of the Karanovo I culture on the one hand, and the complex of west Bulgarian painted pottery with strong similarities to the Starčevo culture, on the other (*Raduncheva et al. 2002*). The flint assemblage is very small (50 artefacts) and comprises mainly a formal toolkit – 18 tools made of honey-yellow flint (Figs. 6, 7). The rest of the collection consists of 16 blades, 14 flakes and fragments, and 2 cores. The debitage items are made predominantly of a local raw material which is widespread throughout the Rhodope Mountains.

2 This reasoning is argued in my last three reports of Kovačevo, for example: Fouilles néolithique franco-bulgare de Kovačevo- rapport 21, Paris 2007.

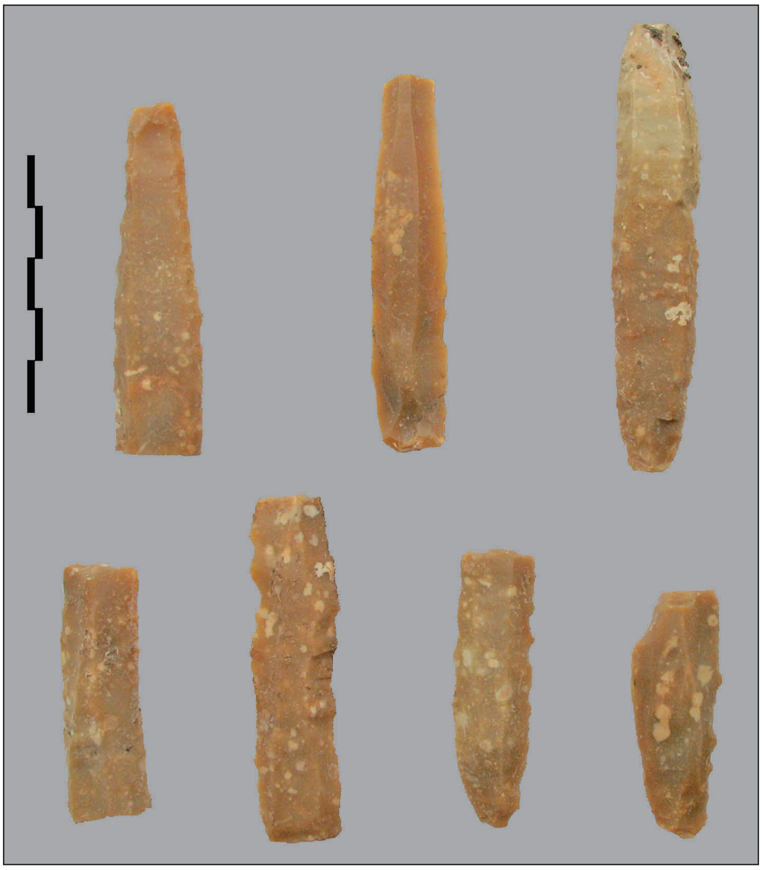


Fig. 8. Formal toolkit from Slatina (photo M. Gurova).

The differences between the Early Neolithic assemblages from the southern cultural area and those located north of the Stara Planina are well known and require no further emphasis (*Todorova and Vaisov 1993*). As already mentioned, formal toolkits are not documented among the assemblages from Early Neolithic sites in central and northwest Bulgaria. It should be remembered that the Early Neolithic has yet to be discovered in the northeastern part of the country, possibly linked to adverse environmental conditions at the end of the VII millennium BC (*ibid. 128*).

Nevertheless, it is interesting to note that two sites, Ohoden and Dzuljunitsa, both belonging to the 'monochrome' Neolithic – best represented in the area by the Koprivets culture – show rather divergent cultural affiliations. The former is equated with the final phase of the Proto-Starčevo culture, with apparent parallels at sites such as Divostin, Donja Branjevina, Padina, Lepenski Vir IIIa, Gura Baciului and, respectively, in Bulgaria at Koprivets, Polianitsa-platoto, and Dzhujunitsa (*Ganetsovski 2008*). The latter, through its links to the same Koprivets culture, shows affinities with the Fikirtepe culture in the Marmara region, as well as with the pottery assemblage from the Anatolian colony on the Aegean coast at Hoca Çeşme (*Elenski 2004; 2006*).

Slatina, an Early Neolithic site in Sofia city, is equally rich in formal tools, but the most spectacular evidence is the identification of the workshop area, with about 2800 artefacts in the large dwelling. The flint implements were studied and very briefly presented as an appendix in the publication by N. Skakun and I. Gatsov (*Nikolov 1992*) (Fig. 8). Of particular interest here is the 'coexistence' of the formal tools located in the living space of the dwelling with the bulk of debitage items concentrated in the knapping area. Unfortunately, the biggest part of the workshop implements were damaged in the fire that destroyed the building, and the 'burned' aspect of their surfaces makes their study very difficult and limited.

The flint assemblages from Tells Karanovo and Azmak have been studied and published by I. Gatsov and M. Gurova, and later came to be considered as a diagnostic feature of the tell settlements. The percentage of formal tools is extremely high in the layer of the Karanovo I and II periods in the eponymous tell (Fig. 9), as well as in layers I–V of Tell Azmak belonging to the Karanovo II culture (Fig. 10). There is a clear predominance of blades with high, steep retouch among the assemblages from both tells.

T. Tsonev has carried out a study of flint assemblages from central-north Bulgaria, which represents a relevant and basic technological approach toward the particular local facies of expedient industries, focusing dominantly on blade production and showing similarities with Early Neolithic sites in Serbia and Romania. Some similarities (but not convincingly presented) with the lithic inventory from Lepenski Vir are mentioned (*Tsonev 2000; 2007*). My pilot study on a part of the Koprivets flint assemblage and a preliminary series from Dzuljunitsa shows the use of a honey-yellow type of raw material (identical with that of the Karanovo I culture formal toolkit), but also quite different structure, typological repertoire and functional features of the assemblages in comparison with south Bulgarian ones. There are no sickle inserts among the collections, which is a significant observation with regard to the subsistence activities of local Early Neolithic communities.

Raw material for the toolkits: where from?

How should we summarize our knowledge of the raw material parameters of Early Neolithic assemblages and, in particular, their formal toolkits? It has already been mentioned that foreign specialists have drawn attention to the high quality and yellow-honey-waxy colour of a particular raw material originating from north-east Bulgaria (pre-Balkan platform), and its spread across the region. One study fixed the provenance in the vicinity of Shumen (*Voytek 1987*).

On the local level the research has gone more slowly. There have been some sporadic studies of cryptocrystalline siliceous rocks ('flint') over the past three decades. The first to show the abundance and variety of the flint sources from north-east Bulgaria, and who tried to establish a database and link the identified flint outcrops with prehistoric artefacts and their circulation, was K. Kanchev (*Kanchev 1978; Kanchev et al. 1981*).

In his publication, I. Gatsov presumed north-west Bulgaria was the region of provenance of the raw material used for Early Neolithic assemblages from western Bulgaria (see below). At the same time, N. Skakun noticed that "*certain specimens are probably made of Dobrudzha flint*". On the basis of her deep knowledge of north-east Bulgarian flint assemblages both from the Neolithic and Chalcolithic, she conceived this fact rather as accidental, emphasizing that the exploitation of Dobrudzha flint started no earlier than the Chalcolithic (*Skakun 1993.54*). She had already reached the same conclusion regarding a dozen implements from the 'big house' of Slatina (*Skakun 1992.102*).

There are two general types of flint recognised among the assemblages from Tells Karanovo and Azmak. The investigation was done by geologist Kurčatov, who suggested that the abundance of artefacts was due to the proximity of local outcrops and he (more theoretically than actually) identified them in the region of the Saint Ilia hills in eastern Thrace and not very far from the tells (*Gatsov, Kurčatov 1997.215*). This assumption has been quoted repeatedly, but never substantiated by further serious research. In fact, it could be considered as having been disproved.

Preliminary research on a series from Yabalkovo has led R. Zlateva to reveal that "*...the predominant raw material with identified origin comes from deposits in Upper Thrace, Sredna gora, north (understand western) Bulgaria and eastern Rhodopes*" (*Leshtakov et al. 2007.201*).

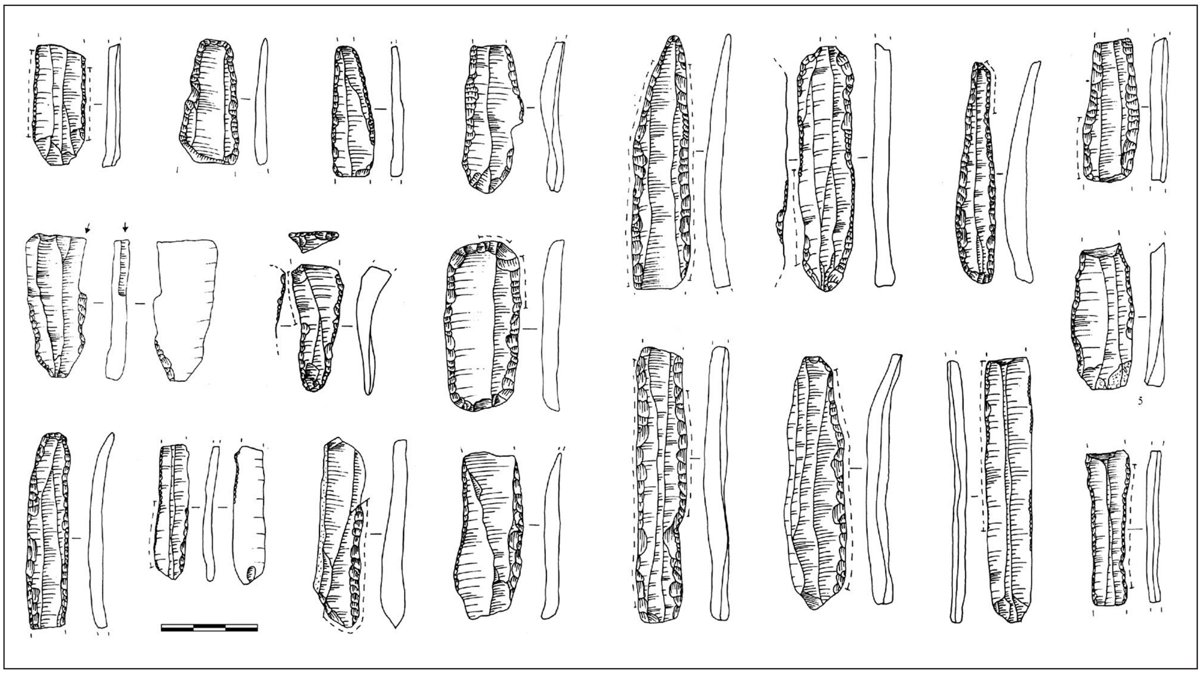


Fig. 9. Typological characteristics of the toolkit from Tell Karanovo – Karanovo I and II periods (after* M. Gurova 1997.Taf. 92 and 94*).

In fact, the first to presume, somewhat theoretically, a north-eastern provenance for the raw material used for Neolithic big blades was T. Tsonev. He did this in the context of his theory about the role of long blades in the "*communal perception of long distance exchange through common metaphors*" (*Tsonev 2004.262*).

The research initiated by the present author, in collaboration with the mineralogist Ch. Nachev, has yielded quite different results. In Bulgaria, according to the geological data, four distinguishable flint types are recorded: Hemus, Dobrudzha, Moesia, and Rhodope flint. Each type has a different geographical distribution, geological age and diagnostic features (Fig. 11). Mineralogical comparison of these different types of flints from Bulgaria unequivocally distinguishes Dobrudzha flint as the most desired material for knapping, and the unique homogeneity and dimensions of the nodules permitted core preparation and debitage of big laminar blanks (*Nachev, forthcoming*). Nachev's investigation is based on geological samples and archaeological artefacts from the sites of Kovačevo, Rakitovo, Yabalkovo, and Dzhuljunitsa. His macroscopic observation suggests that the flint that is most similar to the archaeological samples derives from the Dobrudzha flint strata in lower Cretaceous limestone deposits. This flint has perfect conchoidal fracture, which makes it of optimal quality for knapping. The outcrops where this material originates come from the districts of Rasgrad, Isperih, and Shumen. Macroscopic examination and comparative analysis of archaeological samples (Fig. 12. A) and the contemporaneous flakes taken from the Chakmaka outcrops near Isperih (Fig. 12.B), and Kriva reka secondary deposits, located north from Shumen (Fig. 12.C) show that they are visually identical in character. Therefore it is most likely that the formal flint toolkits from the Early Neolithic Karanovo I and II cultural sequence in Bulgaria, originated from the outcrops in the vicinity of three towns – Razgrad, Isperih and Shumen (Fig. 1). Further thin section analyses by Nachev should reduce the potential candidates for original outcrops of the toolkits under discussion. To resolve the problem of the reliable characterization of 'Balkan flint' sources

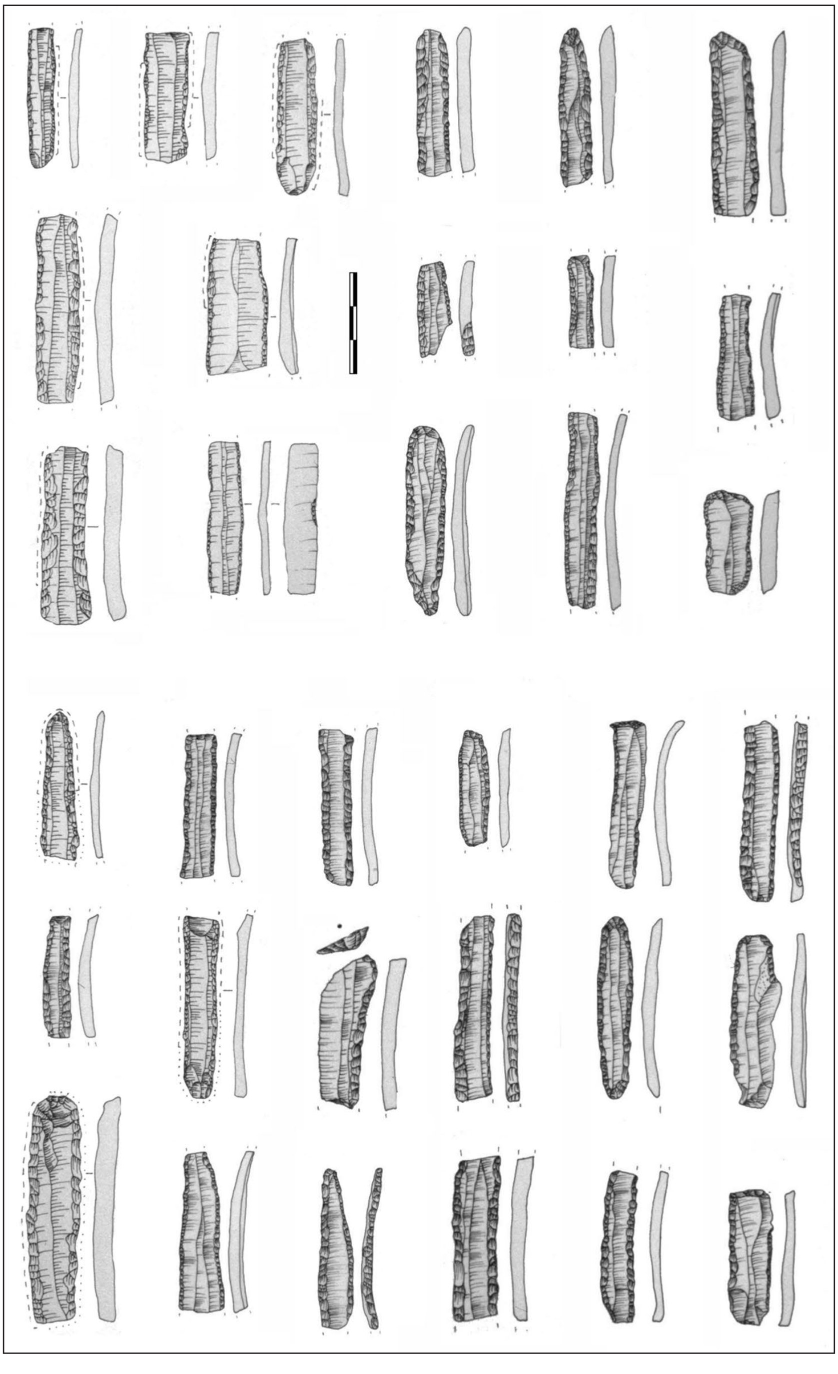


Fig. 10. Typological characteristics of the toolkit from Tell Azmak (drawing M. Gurova).

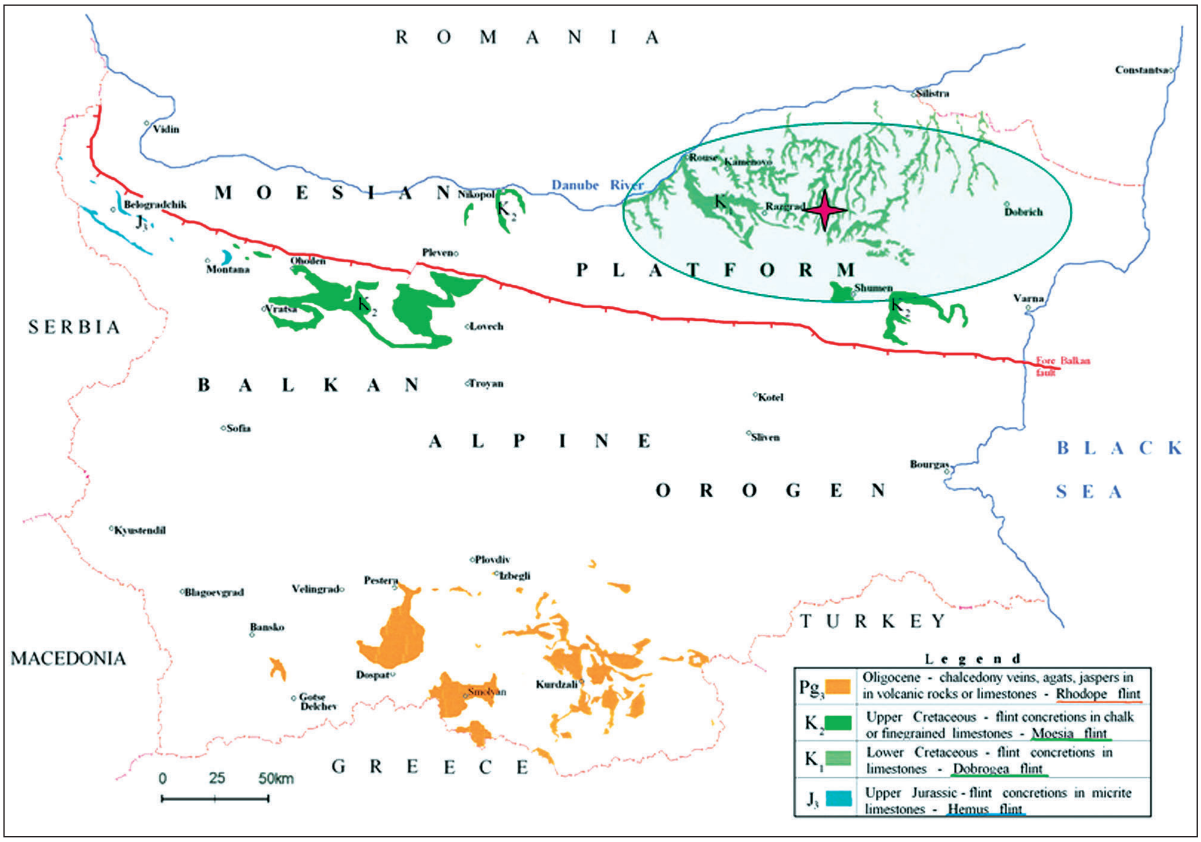


Fig. 11. Geological map showing the distribution of the four major geological units containing 'flint' deposits in Bulgaria (according to* Nachev, forthcoming, Figure 1*, adapted version).

inductively coupled plasma mass spectrometry (ICP-MS) is initiated by analyzing flint samples from various sources in northern Bulgaria.[3] Although archaeological evidence for Neolithic workshops in the region is absent, we have to presume that they existed in the Early Neolithic for ensuring suitable nodules, cores (about 18–20cm long) and debitage (blades): all these products were predestined for the long-distance exchange of good and perhaps embodied know-how.

Tracing the origin of the technological features

As mention above, recent examination of the technical traits of blades (especially with conserved butts and proximal parts) from sites such as Kovačevo, Yabalkovo, Slatina and Rakitovo reveals the use of indirect percussion by punch technique. Retouching was done by simple soft percussion or pressure in the case of high steep retouch. These observations were confirmed by J. Pelegrin, in direct conversation and after observation of a selected series of retouched blades from Yabalkovo.

Chronologically, indirect percussion has been convincingly identified in the Western European Mesolithic, *c.* 7800 BP (6650 calBC). This technique assures the production of big blades, and in special cases, super-blades, as exemplified by the Neolithic phenomena of Grand Pressigny (France) and Spiennes (Belgium) (*Pelegrin 2006.40*). Pelegrin's research on blades (most of them fragmented) from Neolithic strata at Franchthi (6624–6378 calBC) led him to deduce that lever pressure (the most sophisticated debitage technique) was used to produce most if not all of them (*Pelegrin 2006.48*). This sensational discovery suggests that there is *a priori* no theoretical reason to deny the appearance and local development of some advanced technological approach.

Concerning the Balkan Neolithic lamellar tradition, one attempt at tracing its origin was made by J. Kozłowski at 1982. His conclusion was that even in Greece with its Mesolithic and preceramic Neolithic, there was a hiatus before the classical Neolithic (*Kozłowski 1982.142*). Even more drastic is the situation in Bulgaria where no pre-Neolithic substratum

3 The work will be undertaken in collaboration with C. Bonsall and Rob Ellam at the Isotope GeoScience Facility of the Scottish Universities Environmental Research Centre, East Kilbride, UK.

Fig. 12. Macroscopic photographs of raw materials: top to bottom, A – archaeological items from: 1– Dzhuljunitsa, 2 – Rakitovo, 3 – Yabalkovo; B – flint flake from Chakmaka outcrops (near Isperih); C – flakes from Kriva reka outcrops – near Shumen. Photo: M. Gurova.

has been identified and the affinity of the Karanovo I flint industry with the cultural group of Anzabegovo-Vršnik totally excluded the possibility of a local origin of this industry among an epipalaeolithic population (*ibid. 149*). This rather discouraging concept is repeated consistently by I. Gatsov in his research (*Gatsov 2001; 2005; 2006*). He concluded that "*the bearers of painted ceramic who brought this technology and its roots were outside of Europe. In Bulgaria, it then appears as already established know-how*" (*Gatsov 2006.153*). Even more explicit is H. Todorova who assumed that the analysis of the flint industries with macroblades from the Early Neolithic cultures of Karanovo I, Starčevo and Magulitza reflects their Anatolian roots (*Todorova and Vaisov 1993.55*).

The problem of tracing our chipped-stone industry to the comfortable milieu of Anatolia is somehow cognitive, and as noticed by M. Özdoğan... "*any attempt at comparing Anatolian assemblage with that of the Balkans has to consider the nature of the assemblage as a whole, without overstating the presence or the absence of selected objects*" (*Özdoğan 2006.23*). In the present state of research, such a relevant comparison is not feasible, and our efforts should be focused instead on detailed technological studies of the available assemblages from Kovačevo, Dzhuljinitsa and Yabalkovo, in order to elucidate the fundamental and variable technological skills and decision-making of the Neolithic flint knappers. Many objective obstacles are unavoidable, including our lack of knowledge about quarries for obtaining raw material, about workshops for initial core preparation and subsequent debitage, about exchange networks and strategy, etc. Hopefully, some of these limitatons could be surmounted through new planned surveys and research. Only then would we be able to resolve the problem of Early Neolithic macroblade technology in the Balkans.

Functional aspects of the formal tools

By definition, the formal tools are made with some anticipated functions, and this kind of utilitarian determination represents one of the most peculiar traits of formal toolkits, whatever their contextual affiliation. An attempt at use-wear analysis of Early Neolithic assemblages from Bulgaria was made in the early 1990s by N. Skakun (*Skakun 1992; 1993*). Her study of the functional parameters of west Bulgarian Neolithic assemblages is informative in a general sense and demonstrated a large repertoire of implement functions, but no possibility of correlation between functional types and their precise stratigraphic positions. The multifunctional aspect of the artefacts was underlined in the context of common cereal, hide, bone and wood processing. The presence of threshing sledge inserts was noted, but without any contextual data (*Skakun 1993.53*).

The present author's use-wear observations on numerous collections also show quite variable utilization detected on unretouched blades, but mainly on retouched tools (*Gurova 1997; 2001a; 2002; 2004; 2006; Gurova and Gatsov 2000*). Blades with marginal retouch are the most polyfunctional among the artefact categories. Detecting the functions of enough narrow blades with high steep retouch proved particularly challenging – in fact, they were mainly used for scraping wood and hide. Perforators/borers on bilaterally-retouched blades were mostly used for drilling different materials.

Among the most impressive and even visually recognisable tools are sickle inserts. These pieces possess typical cereal polish induced by harvesting (Fig. 13). Typologically, they comprise unretouched blades, as well as retouched and truncated blades and end-scrapers. It is worth noting that these sickle inserts were often re-sharpened in order to permit reuse for the same or another function. This approach, if done repeatedly, resulted in progressive modification of edges, until they became relatively steep and inefficient. In some cases, after use in their primary function, some sickle inserts were reused for hide scraping.

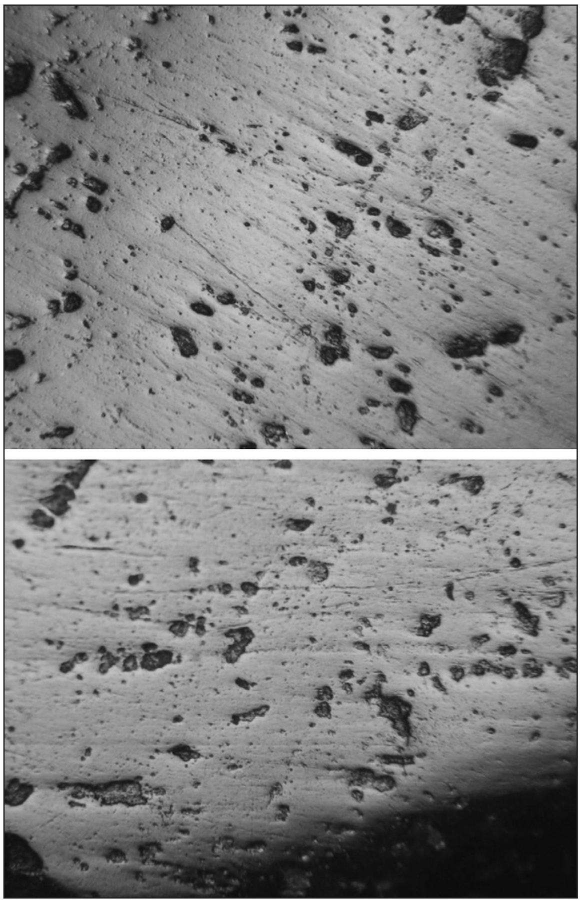


Fig. 13. Microphotographs of cereal polish on a tool from Kovačevo (*cf. *Fig. 2, first row, second from right). Microphoto – M. Gurova, using a Leitz Orthoplan microscope with a Nikon optical camera. Magnification x 100.

Discussion

The formal toolkits in their contextual embodiment are intimately linked with the debate and paradigms of Balkan Neolithisation. Conceivably, they could be treated as cultural markers, in the same way as the white-on-red painted pottery of the Karanovo I culture. Of course, one could say the discriminatory role of flints as chrono-cultural markers is much more limited, but the important point here is that white-on-red pottery, whether linked (or not!) to the formal toolkit, cannot be considered as an indicator of the beginning of the Neolithic (this refers particularly to Bulgaria). As Özdoğan has argued, it is "*...because painted pottery in Western Anatolia that bears significant similarities to those of the Balkans begins rather late in the Neolithic sequences*" (*Özdoğan 2006.22*).

On the other hand, white-painted pottery appears from the very beginning of the Kovačevo sequence, but as the excavators of the site have underlined, "*it appears that early levels of Kovačevo have produced pottery which is earlier than the Karanovo I culture as it is defined in Bulgarian Thrace. In the earliest period Kovačevo was really part of a regional facies that extends from Greek western Macedonia in the south (Nea Nikomedeia, Giannitsa) to the Ovče Pole in the north Anzabegovo, Vršnik.*" (*Lichardus-Itten at al. 2002.130*). This conclusion does not contradict the theory of an initial Neolithic diffusion along the Struma valley, but simply advocates that the first Neolithic settlers in the region were not those from Thrace, *i.e.* the bearers of the Karanovo I culture. This assumption is supported by the above-mentioned fact that the formal toolkit appears approximately in level Ic–Id of the Kovačevo sequence. In this regard, if Struma (as seems likely) was one of the first and direct routes of Neolithic diffusion into Balkans, then the part of the 'Neolithic package' consisting of typical Karanovo I pottery and formal flint toolkits could not be linked with this first stage of demic and cultural diffusion. The recently envisaged north-east provenance of the raw material for these toolkits is an additional reason for discarding the idea of a Struma (and consequently via Mesta) spread of the Karanovo I culture in Thrace.

How does the situation look if we turn to another scenario for the first wave of Neolithisation in Bulgaria, via the old Struma, Vardar and Morava rivers to the north, and then a 'west to east' movement along the Danube to north-central and north-eastern Bulgaria (*Todorova and Vaisov 1993.61*). As explained above, there is no Early Neolithic site containing formal toolkits, and the problem of the 'monochrome' pottery cultural alliance is complicated enough. The fact that the formal toolkits were likely made of Dobrudzha flint, and in that area there are no recorded Early Neolithic settlements, could become a critical point for the assumption that after reaching the stage of white-painted pottery, the 'monochrome' Neolithic area settlers penetrated into Thrace *c.* 6200 calBC and established the beginning of the Karanovo I culture (*Todorova and Vaisov 1993.62*).

Recently, a new scenario for the origin and spread of the monochrome Neolithic was advanced, utilising evidence from pottery analysis of the Koprivets culture. The idea of M. Özdoğan (*1997; 1999*) suggesting an interaction zone between north-central Bulgaria, north-west Anatolia and Turkish Thrace, is gaining adherents and serves to promote the theory of the penetration of Neolithic elements from northwest Anatolia to the north via the Maritsa River valley,..."*then along the valleys of the Tundzha and the Sazlijka Rivers, and through the passes of the Stara Planina into northern Bulgaria (the basin of the Iantra River)*" (*Boydzhiev 2006.9*). On the basis of analysis and correlation of the available clusters of ^{14}C dates related to the transitional period from the Mesolithic to the Neolithic in local variations (pre-pottery, aceramic, monochrome), the same author concluded that the penetration route of the Monochrome Neolithic from the northwest Balkans along the Danube proposed by Todorova and Vaisov (*1993*) should be rejected (*ibid. 9*).

Whatever theories of routes and 'waves of succession' of the Neolithic spread into Balkans have been formulated, no one has been able to explain the appearance of the formal flint toolkits – were they brought with the migrants along their unclear route from some part of Anatolia (central or north western), or were they created in the milieu of local pre-Karanovo enclaves? There were two potential candidates for this 'nuclear area' of creation of the toolkit's technological and stylistic features: the region of the Struma and Vardar valleys, which "*must have been directly and independently colonized*", but which settlers have been keeping as "*their own, probably direct connection with Asia Minor*." (*Lichardus-Itten et al. 2006.88*). If so, then we have to suppose that from the very beginning of their adaptation to the local conditions, they initiated very long distance trips to the completely unknown north east of Bulgaria to discover and start to supply flints, and establish the big blade industry, and subsequently go back with the material and the new know-how for working with it. Then from this nuclear area, the population with distinctive, white-on-red pottery and the available formal flint toolkit could start to move into the east and the Thracian plain. The idea of west-east movement in the settling of Thrace is not new, and has been convincingly argued by Thissen on the basis of the chronological framework established for the south Balkan Neolithisation process (*Thissen 2000*). This scenario may work vis-à-vis the pottery evidence, but it is not viable in relation to the lithic phenomenon discussed.

Not yet proved, but at least more reasonable, is the possibility that the 'monochrome' population from central Bulgaria, already sufficiently experienced in simple lamellar production, as shown by Tsonev's research, moved to the east in search of something better than their local flint raw material and reached the Dobrudzha region with its abundant flint outcrops. On the basis of their local and independent elaborating of their technological skills, they could have become the 'new flint knappers' – in Chapman's sense of people with a newly-acquired ability and decision-making capacity. Unavoidably, they could reach the Thracian plain for establishing the Karanovo I culture (as suggested by Todorova) or simply to join an enigmatic pre-Karanovo I substratum in this area (?). As a consequence, these people could have predestined their production, especially for the distribution network of goods, values, and social messages. In this sense it is worth quoting the original post-processual interpretation of Early Neolithic 'macroblades' and their circulation offered by T. Tsonev: "...*the social model of tell settlements also influenced the composition and raw material distribution of flint assemblages...Thracian tells relied on powerful metaphors that underpin much larger and more distant exchange mechanisms with flint raw materials*." (*Tsonev 2004.261*).

Of course, a range of contradictory rhetorical questions could be formulated if one wanted to object to this assumption. One of the most crucial is why the new flint knappers did not leave evidence of these toolkits in and around settlement sites in northern Bulgaria? An unsatisfactory answer for the lack of evidence in north-east Bulgaria (Dobrudzha) could be that there is no theoretical need to expect the establishment of longstanding settlements and buildings in the area – only temporary camps in the vicinity of raw material outcrops serving the flint workshop activities are required, and the remains of these camps may never be discovered. However, the remnants of workshops with their particular *instrumen-*

tarium (however restricted) must be found and, in the author's opinion, this should be made a priority for future prehistoric research in Bulgaria.

To answer all questions in the sphere of the problems and research on formal toolkits would require an immense amount of work. In my opinion, the relevant issue for this rather complex and complicated situation is to complete and collate all the data for these toolkits from the Balkans. This is necessary in order to advance further with questions of raw material supply strategy (were there other outcrops apart from those in Dobrudzha), and the manufacturing, functioning and spread of these particular flint assemblages across a wide and varied eastern European landscape. To resolve these problems will undoubtedly assist in answering some of the more controversial questions raised within the archaeology of prehistoric identity and the mind of the Early Neolithic Balkans.

ACKNOWLEDGEMENTS

I would like to thank Mihael Budja for inviting me to the 14th Neolithic Seminar in 2007. My thanks also to Clive Bonsall for his critical reading of the first draft of this paper, and for suggesting improvements to the English.

∴

REFERENCES

ANDREFSKI W. 1994. Raw material availability and the organization of technology. *American Antiquity 59/1: 21–34*.

BAILEY D. 2000. *Balkan Prehistory*. Exclusion, incorporation and identity. Routledge. London and New York.

2005. *Prehistoric figurines. Representation and Corporeality in the Neolithic*. Routledge. London and New York.

BONSALL C. 2003. The Iron Gates Mesolithic. In P. Bogucki, P. Crabtree (eds.), *Ancient Europe 8000 B.C. to A.D. 1000: Encyclopedia of the Barbarian World*. Scribner. New York: 175–178.

2008. The Mesolithic of the Iron Gates. In G. Bailey, P. Spikins (eds.), *Mesolithic Europe*. Cambridge University Press. Cambridge: 238–279.

BONSALL C., COOK G., LENNON R., HARKNESS D., SCOTT M., BARTOSIEWICZ L. and McSWEENEY K. 2000. Stable Isotopes, radiocarbon and the Mesolithic–Neolithic Transition in the Iron Gates. In M. Budja (ed.), *7th Neolithic Studies, Documenta Praehistorica 27: 119–132*.

BORIĆ D. 1999. Places that created time in the Danube Gorges and beyond, c. 9000–5500 BC. In M. Budja (ed.), *6th Neolithic Studies, Documenta Praehistorica 26: 41–70*.

2005. Deconstructing essentialisms: unsettling frontiers of the Mesolithic-Neolithic Balkans. In D. Bailey, A. Whittle and V. Cummings (eds.), *(Un)settling the Neolithic*. Oxbow Books. Oxford: 16–31.

BOYADZIEV Y. 1995. Chronology of Prehistoric Cultures in Bulgaria. In D. Bailey, I. Panayotov (eds.), *Prehistoric Bulgaria*. Madison Wisconsin. Monographs in World Archaeology 22:149–191.

2006. The role of absolute chronology in clarifying the Neolithization of the eastern half of Balkan Peninsula. In I. Gatsov and H. Schwarzberg (eds.), *Aegean – Marmara – Black Sea: the Present State of research on the Early Neolithic*. Beier & Beran. Langenweissbach: 7–14.

CHAPMAN J. 2000. *Fragmentation in Archaeology. People, places and broken objects in the prehistory of south-eastern Europe*. Routledge. London and New York.

CHAPMAN J. and GAYDARSKA B. 2007. *Parts and Wholes. Fragmentation in prehistoric context*. Oxbow Books. Oxford.

ELENSKI N. 2004. Cultural Contacts of North-Central Bulgaria with Thrace and the Marmara Area in the Early Neolithic. In V. Nikolov, K. Bacvarov, P. Kalchev (eds.), *Prehistoric Thrace*. Sofia-Stara Zagora: 71–79.

2006. Trench Excavation at Dzhulyunitsa-Smardesh Early Neolithic Site, Veliko Tarnovo Region (Preliminary Report). *Arheologia 1–4: 96–117*.

ELSTER E. 1977. *Neolithic technology: a Case Study in Lithic Analysis for Old Europe, 6500–4000 BC*. Ph.D dissertation. University of California. Los Angeles.

GANETSOVSKI G. 2008. An Early Neolithic grave from Ohoden, Vraca district. In M. Gurova (ed.), *Prehistoric*

Research in Bulgaria: New Challenges. Faber. Veliko Tarnovo (forthcoming).

GATSOV I. 1993. *Neolithic Chipped Stone Industries in Western Bulgaria*. Jagellonian University Press. Kraków.

2000. Chipped Stone Assemblages from South Bulgaria an North-West Turkey (Epipalaeolithic/Mezolithic and Neolithic). In L. Nikolova (ed.), *Technology, Style and Society. Contributions to the Innovations between the Alps and the Black Sea in Prehistory*. Oxford: BAR International Series 854: 1–30.

2005. Some observation about bullet core technique during 7th/6th millennium BC. In C. Lichter (ed.), *How did farming reach Europe? Anatolian-European relations from the second half of the 7th through the first half of the 6th millennium calBC*. BYZAS 2. Istanbul: 213–220.

2006. The state of research into the problem of the Pleistocene-Holocene transition in the present area of Bulgaria. In I. Gatsov and H. Schwarzberg (eds.), *Aegean – Marmara – Black Sea: the Present State of Research on the Early Neolithic*. Beier & Beran. Langenweissbach: 151–156.

GATSOV I., KURČATOV V. 1997. Neolithische Feuersteinartefakte. Mineralogische Untersuchung und technisch-typologische Charakteristik. In S. Hiller and V. Nikolov (eds.), *Karanovo, I, Die Ausgrabungen im Südsektor 1984–1992*. Verlag Ferdinand Berger & Söhne, Horn/ Wien. Salzburg – Sofia: 213–227.

GATSOV I., GUROVA. M. 1998. Izsladvane na kremachni artefakti ot rannoneolithiya plast na Azmashkata selishtna mogila krai Stara Zagora. *Izvestiya na muzeite ot Yugoiztochna Balgaria XIX: 7–20*.

GÖRSDORF J. 1977. C^{14} – Altersbestimmungen. In S. Hiller and V. Nikolov (eds.), *Karanovo, I, Die Ausgrabungen im Sudsektor 1984–1992*. Verlag Ferdinand Berger & Söhne, Horn/Wien. Salzburg – Sofia: 377–384.

GÖRSDORF J. and BOJADŽIEV J. 1996. Zur absoluten Chronologie der bulgarischen Urgeschichte. *Eurasia Antiqua 2: 105–173*.

GUROVA M. 1997. Gebrauchsspurenanalyse des neolithischen Feuersteininventars. In S. Hiller and V. Nikolov (eds.), *Karanovo, I, Die Ausgrabungen im Südsektor 1984–1992*. Verlag Ferdinand Berger & Söhne, Horn/ Wien. Salzburg – Sofia: 363–375.

2001a. Funktsionalen analiz na kremachen ansambal ot selishtna mogila Kapitan Dimitrievo. *Arheologia 2–3: 38–47*.

2001b. Analyse fonctionnelle des assemblages en silex d'Ilipinar, phases X et IX. In J. Roodenberg, L. Thissen (eds.), *The Ilipinar Excavation II, Pihans 93*. Leiden, 2001: 297–325.

2002. Feuersteininventar aus Sondage O 19 in Tell Karanovo: typologische und funktionale Analyse. In S. Hiller and V. Nikolov (eds.), *Karanovo, II. Die Ausgrabungen in O19*. Phoibos Verlag. Wien: 149–175.

2004. Evolution and Retardation: Flint Assemblages from Tell Karanovo. In V. Nikolov, K. Bačvarov, P. Kalchev (eds.), *Prehistoric Thrace*. Sofia-Stara Zagora: 239–253.

2005. Flint artefacts in the context of the diagnostic finds. *Annuary of New Bulgarian University, Department of Archaeology VI: 88–103*.

2006. Functional Aspects of the Early Neolithic Flint Assemblages from Bulgaria and NW Anatolia. In I. Gatsov and H. Schwarzberg (eds.), *Aegean – Marmara – Black Sea: the Present State of Research on the Early Neolithic*. Beier and Beran. Langenweissbach, 2006, 157–175.

GUROVA M., GATSOV I. 2000. Research Problems of the Early Neolithic Flint Assemblages from Thrace (Bulgaria). In S. Hiller and V. Nikolov (eds.), *In Karanovo, III. Beiträge zum Neolithikum in Südosteuropa*. Phoibos Verlag. Wien: 155–163.

KANCHEV K. 1978. Prouchvaneto na flintovia material ot arheologicheski razkopki, problemi I zadachi. *Interdistsiplinarni Izsledvaniya II: 81–89*.

KANCHEV K., NACHEV I., KOVNURKO G. 1981. Kremachnite skali v Balgaria i tiahnata eksloatatsiya. *Interdistsiplinarni Izsledvaniya VII–VIII: 41–59*.

KOZŁOWSKI J. 1982. La Néolithosation de la zone Balkano-Danubienne du point de vue des industries lithiques. In J. Kozłowski (ed.), *Origin of the Chipped Stone Industries of the Early Farming Cultures in Balkans*. Państwowe Wydawnictwo Naukowe. Warszawa – Kraków: 132–170.

LESHTAKOV K. 2006. Arheologicheski razkopki na praistorichesko selishte do s. Yabalkovo, Dimitrovfradsko. Ranen neolit. In V. Nikolov, G. Nehrizov and Y. Tsvetkova (eds.), *Arheologicheski razkopki po traseto na zhelezopatnata liniya Plovdiv-Svilengrad prez 2004 g. Faber*. Veliko Tarnovo: 166–204.

LESHTAKOV K., TODOROVA N., PETROVA V., ZLATEVA-UZUNOVA R., ÖZBEK O., POPOVA TS., SPASSOV N. and ILIEV N. 2007. Preliminary report on the salvage archaeological excavations at the Early Neolithic site at Yabalkovo in the Maritsa Valley, 2000–2005 field seasons. *Anatolica XXXIII: 185–234*.

LICHARDUS-ITTEN M., DEMOULE J.-P., PERNICHEVA L., GREBSKA-KULOVA M., KULOV I. 2002. The Site of Kovacevo and the Beginnings of the Neolithic Period in Southwestern Bulgaria. The French-Bulgarian excavations 1986–2000. In M. Lichardus-Itten, J. Lichardus, V. Nikolov (eds.), *Beiträge zu jungsteinzeitlichen Forschungen in Bulgarien*. Dr. Rudolf Habelt GMBH. Bonn: 99–158.

2006. Kovačevo, an Early Neolithic site in South-West Bulgaria and its importance for European Neolithization. In I. Gatsov and H. Schwarzberg (eds.), *Aegean – Marmara – Black Sea: the Present State of research on the Early Neolithic*. Beier and Beran. Langenweissbach: 83–94.

NACHEV CH. in press. Osnovnite tipove flint na teritorijata na Balgaria kato iztochnitsi na surobini za naprava na artefakti. *Interdistsiplinarni Izsledvaniya XX, in press*.

NIKOLOV V. 1992. *Rannoneolithno zhilishte ot Slatina (Sofia)*. Razkopki i prouchvaniya 25. Izdatelstvo na BAN. Sofia.

1996. Iugozapaden variant na kultura Karanovo I. *Arheologia 2–3: 1–8*.

1998. *Proucvanija varhu neolitnata keramika v Trakija. Keramicnite kompleksi Karanovo II–III, III i III–IV v konteksta na Severozapadna Anatolija i Jugoiztocna Evropa*. Agato. Sofia.

2006. *Kultura i izkustvo na praistoricheska Trakia*. Letera. Plovdiv.

2007. *Neolithi kultovi masichki*. NAIM-BAN. Sofia.

ÖZDOĞAN M. 1997. The beginning of Neolithic economies in South-eastern Europe: an Anatolian perspective. *Journal of European Archaeology 5(2): 1–33*.

1999. Nortwestern Turkey: Neolithic Cultures in Between the Balkans and Anatolia. In M. Özdogan. (ed.), *Neolithic in Turkey. The Cradle of Civilization*. Arkeoloji ve Sanat Yay. Istanbul: 202–224.

2006. Neolithic cultures at the contact zone between Anatolia and the Balkans – Diversity and homogeneity of the Neolithic frontiers. In I. Gatsov and H. Schwarzberg (eds.), *Aegean – Marmara – Black Sea: the Present State of research on the Early Neolithic*. Beier & Beran. Langenweissbach: 21–28.

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

PELEGRIN J. 2006. Long blade technology in the Old World: an experimental approach anf dome archaeological results. In J. Appel and K. Knutsson (eds.), *Skilled production and Social reproduction. Aspects of Traditional Stone-Tool Technology*. SAU- Uppsala University. Uppsala: 37–68.

PERLÈS C. 1990. L'outillage de Pierre taillée néolithique en Grèce: approvisionnement et exploitation des matières premières. *Bulletin de Correspondance Hellénique 114 (IV): 1–42*.

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

RADUNCHEVA A, MATSANOVA V., GATSOV I., KOVACHEV G., GEORGIEV G., CHAKALOVA E. and BOZHILOVA E. 2002. *Neolitno selishte do grad Rakitovo*. Razkopki I prouchvaniya 29. Gal-Iko. Sofia.

RENFREW C. and BAHN P. 2005. *Archaeology. The Key Concepts*. Routledge. London and New York.

SKAKUN N. 1992. Tipologo-trasologicheski analiz na oradiyata na truda ot zhilishtnoto pomeshtenie. In V. Nikolov (ed.), *Rannoneolitno ziliste ot Slatina (Sofia)*. Razkopki i prouchvaniya 25. Izdatelstvo na BAN. Sofia: 102–106.

1993. Results of traseological examination of flint implements from Neolithic settlements in Western Bulgaria. In I. Gatsov (ed.), *Neolithic Chipped Stone Industries in Western Bulgaria*. Jagellonian University Press. Kraków: 52–54.

SREJOVIĆ D. 1969. *Lepenski Vir, Nova praistorijska kultura u Podunavlju*. Srpska književna zadruga. Beograd.

1972. *Europe's First Monumental Sculpture. New Discoveries at Lepenski Vir*. Thames and Hudson. London.

THISSEN L. 2000. A Chronological Framework for the Neolithisation of the Southern Balkans. In S. Hiller and V. Nikolov (eds.), *In Karanovo, III. Beiträge zum Neolithikum in Südosteuropa*. Phoibos Verlag. Wien: 193–212.

TODOROVA H. (ed.) 2002. *Durankulak, Band. II, Teil 1 1, 2, Die prähistorischen Gräberfelder von Durankulak*. Deutsches Archäologisches Institut. Sofia.

TODOROVA H. and VAISOV I. 1993. *Novokamennata epoha v Balgaria (kraiat na sedmo-shesto hiliadoletie predi novata era)*. Nauka i izkustvo, Sofia.

TSONEV T. 2000. Knapping Technology vs. Patten of Raw Material Supply (On the Example of Early Neolithic Flint Assemblages from the Orlovets and Koprivets sites, Northern Bulgaria). In L. Nikolova (ed.), *Technology, Style and Society. Contributions to the Innovations between the Alps and the Black Sea in Prehistory*. Oxford: BAR International Series 854: 29–35.

2004. Long Blades in the Context of East Balkan and Anatolian Complex Sedentary Society, distribution and appearance of Early Neolithic tulip-like pottery in eastern Balkans. In In V. Nikolov, K. Bacvarov, P. Kalchev (eds.), *Prehistoric Thrace*. Sofia-Stara Zagora: 259–263.

2007. *Flint knapping techniques and paleo-environment on North Central Bulgaria*. NAIM-BAN. Sofia.

VOYTEK B.1987. Analysis of lithic raw materials from sites in eastern Yugoslavia. In K. Bíro (ed.), *Papers for the first international conference on prehistoric flint mining and lithic raw material identification in the Carpathian Basin*. Budapest-Sümeg. Budapest: 287–295.

back to contents

UDK 903.01'12/'15(4-15)"633/634"
Documenta Praehistorica XXXV (2008)

Becoming Neolithic. The Mesolithic-Neolithic transition and its impact on the flint and stone industry at Swifterbant (the Netherlands)

Izabel Devriendt
Groningen Institute of Archaeology, University of Groningen, the Netherlands
i.i.j.a.l.m.devriendt@rug.nl

ABSTRACT – *The Mesolithic-Neolithic transition is traditionally defined by a change in subsistence strategy. New ideas are picked up, and animal husbandry and cereal cultivation are adopted as hunter-gatherers evolve. This article examines whether these economic changes stand on their own or lead to changes in other aspects of life. The study will illustrate the innovations in the flint and stone industry (including ornaments) during the Swifterbant period (5000–3400 BC). These include changing debitage techniques and preferences, and the abandonment of the micro-burin technique, but also the introduction of grinding stones, polished axes and amber ornaments. The significance of these new features will be investigated as characteristics of the changing identity of the Swifterbant Culture.*

IZVLEČEK – *Mezolitsko-neolitska tranzicija je običajno definirana s pomočjo spremenjenih subsistenčnih strategij. Predstavljeni so novi razmisleki o razvoju živinorejskega gospodarstva in kultiviranju žitaric pri lovcih in nabiralcih. V članku ugotavljamo, ali so spremembe v pleogospodarskih strategijah povzročile spremembe tudi v drugih segmentih življenja. Predstavljamo spremembe in inovacije v produkciji (in ornamentiki) kamenih izdelkov v obdobju Swifterbant (5000–3400 BC). Te so vezane na spremembe v odbitkovnih tehnikah in opustitvi mikrovbadalne tehnike ter vpeljavi žrmelj, glajenih sekir in okrasa iz jantarja. Pomen novih predmetov vidimo v spreminjanju identitete kulture Swifterbant.*

KEY WORDS – *Neolithic; flint; stone; bipolar knapping technique; ornaments*

Introduction

The Swifterbant Culture encompasses the Late Mesolithic and the Early Neolithic in the main part of the Netherlands, the north of Belgium and the northwest of Germany. This cultural period runs from 5000 to 3400 BC, between the Linear Band Ceramic Culture (LBK) and the Funnel Beaker Culture. In the Netherlands, the LBK is limited to the small loess area in the south of the country, while in the other parts the Late Mesolithic still continues. Over time these Late Mesolithic hunter-gatherers become early farming communities by adopting Neolithic trade marks. The first of these novelties is pottery, produced in typical Swifterbant tradition from around 5000 BC onwards. Later on, animal husbandry was introduced. The earliest evidence for cattle and sheep/goat is now dated at 4600 BC, while pig is introduced around 4200 BC (*Raemaekers 2003.742; Raemaekers 2005.261, 277*). For years, the presence of grinding stones, charred grains and chaff remains (*Cappers and Raemaekers in prep.*) were strong indicators of cereal cultivation, but the exact nature, magnitude and location remained indistinct. Grain was presumably cultivated in the vicinity of the sites, but more accurate evidence was lacking. Recent discoveries at site S4 proved beyond a doubt the introduction of cereal cultivation at some time in the middle phase of the

Swifterbant Culture (4300–4000 BC). Although the lasting importance of wild food resources cannot be underestimated, the introduction of animal husbandry and cereal cultivation indicate that the Swifterbant Culture developed into a Neolithic tradition by adopting certain traits from its Neolithic neighbours.

The transition from the Mesolithic to the Neolithic is traditionally defined by a change in subsistence strategy. Hunter-gatherers change their way of life and become farming communities. New ideas are picked up as animal husbandry and cereal cultivation are adopted. One can imagine that this economic change does not stand on its own. These new ideas will lead to new discoveries and, finally, will bring about a cascade of changes in all aspects of life. But old routines and traditions are not lost or discarded when new traits are introduced. What new aspects trickle through into the flint industry? How will the existing stone tool production alter when new items are introduced? Which tool types, production techniques and raw materials are adopted, and which artefact types are maintained within the existing tool-kit?

Although many aspects of everyday life change in this transitional phase, this article will focus only on the innovations, alterations and transformations this change brings about in the flint and stone industry, including stone ornaments, during the Swifterbant period. First, a general introduction will highlight the different phases within the Swifterbant Culture. Then the New Swifterbant Project, in which this research is set, is presented. The flint and stone industry are then discussed and special attention is given to stone ornaments. In order to give a clear insight into the evolution of the lithic industries, and their corresponding sites, they will be presented chronologically. The late Swifterbant phase will not be described in detail, as the little information that is available will be given in the general introduction. Finally, all the new features will be considered as characteristics of the changing identity of the Swifterbant Culture.

The Swifterbant Culture is defined by its distinctive pottery and, therefore, the division of the period into three phases is based on the stylistic elements of this pottery (*e.g. Raemaekers 1999; 2005*). The major sites from the early phase (5000–4600 BC) are Hoge Vaart, Polderweg and De Bruin – all thoroughly investigated find locations (*Hogestijn and Peeters 2001; Louwe Kooijmans 2001a; 2001b*). Besides pottery, the material culture of this period is characterised by a Late Mesolithic flint industry and by stone artefacts such as cooking stones, tempering material, hammer stones, and anvils. The organic material culture includes T-shaped antler axes and other antler tools, bone awls, bows, fish-weirs, fyke nets, peddles and canoes. Subsistence is still based on hunting, gathering, fishing and fowling, while animal husbandry will be introduced at the transitional stage from the early to the middle phase, around 4600 BC.

The type-site of Swifterbant (Fig. 1) is an example of the middle phase (4600–3900 BC). In this paper it will be compared to well known sites from the early phase in order to better comprehend the evolution of the Swifterbant Culture as it traverses the boundary from the Late Mesolithic to the Neolithic. During this middle phase, the Swifterbant Culture experiences a dichotomy into a northern and southern cultural sphere. The Swifterbant type-site, located in the northern cultural sphere, is found in an area characterised by Late Pleistocene river dunes (with Mesolithic and Neolithic occupation) and a Holocene freshwater tidal creek system, with Neolithic levee sites inhabitable between 4300–4000 BC. During this period, at least three of these levee sites were inhabited, namely S2, S3 and S4. It is important to state that most of the other sites from this middle phase, such as Bergschenhoek, Brandwijk and Hazendonk, yielded only very small amounts of flint artefacts, so it is hard to compare these Swifterbant type-sites within their own timeline.

The late phase (3900–3400 BC) is poorly documented because only one reliable site (Schokkerhaven) has been found thus far. During this phase the dichotomy deepens, as the southern group evolved into the Hazendonk 3 group, while its northern counterpart developed into the Late Swifterbant Culture. For the northern group, the trend started in the middle phase seems to continue. The flint industry is still based on flake production which possibly becomes increasingly important. The arrowhead type is the same as at the Swifterbant type-sites (trapezes) and thus presumably remains the same as in the middle phase. Polished axes also still occur. Then again, the isolation of this site makes this conclusion provisional (*Hogestijn 1990; Raemaekers 2003–2004*). Another site from this phase (P14), with a very long inhabitation sequence and poor stratigraphical evidence, is characterised by transverse arrowheads, trapezes, triangular points and leaf-shaped points (*Wilhelm 1996*). However, the significance and reliability of this find cannot be attested.

Since the discovery of the type-site near the village of Swifterbant in the 1960's, research has periodically made new discoveries, whether related to flint technology, raw material usage or agricultural innovations. Still, several aspects of the social and economic organisation remained obscure. Therefore new research in different areas of expertise has been conducted since the New Swifterbant Project started in 2004, with new fieldwork and research into several topics. The focal points of the project are the relations between human occupation and landscape development, the suitability of the area for cereal cultivation, and the use of the landscape outside the settled areas (see *Raemaekers et al. 2005*). One of the sub-research fields re-evaluates the flint and stone material from the type-site of Swifterbant, in order to investigate, for example, debitage techniques, or determine typological differences and gain an insight into raw material usage and imported items. This research is in progress, so this paper needs to be regarded as a status quo of the new insights gained as of March, 2008. A full and definite report will be published in 2009 (*i.e. Devriendt in prep.a*).

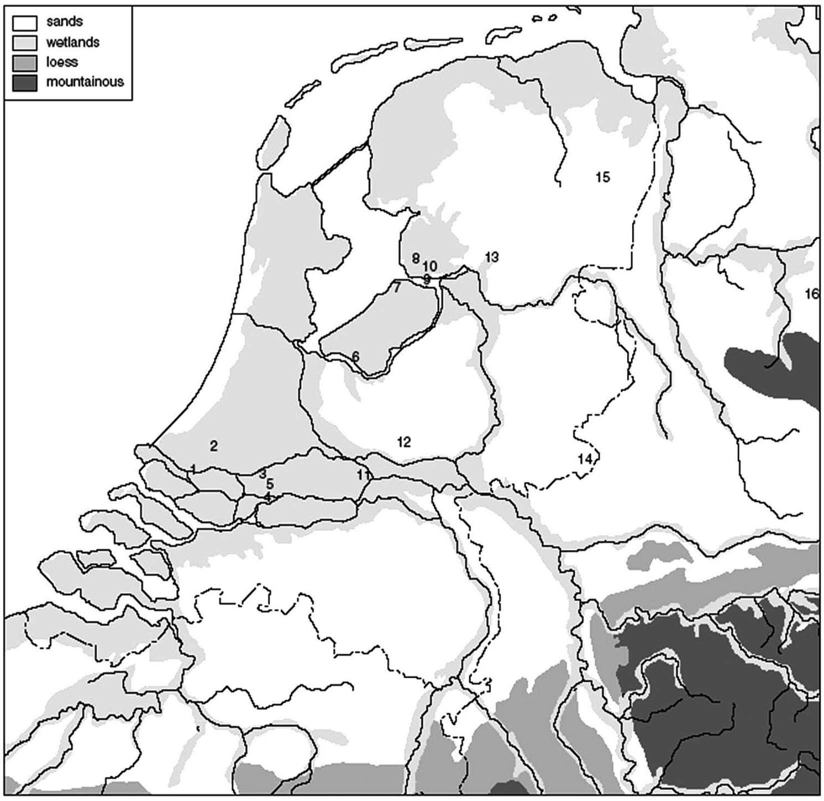


Fig. 1. The sites (known in 1999) belonging to the Swifterbant Culture: 1 – Schiedam; 2 – Bergschenhoek; 3 – Brandwijk; 4 – Polderweg; 5 – Hazendonk; 6 – Hoge Vaart; 7 – Swifterbant cluster; 8 – J112; 9 – P14; 10 – Schokkerhaven; 11 – Zoelen-Buren; 12 – Ede-Rietkamp; 13 – De Gaste-Meppel; 14 – Winterswijk; 15 – Bronneger; 16 – Hûde (taken from **Raemaekers 1999.Fig. 3.1*). The Swifterbant type-site is no. 7.***

The flint industry

The early Swifterbant phase (5000–4600 BC)

Sites of relevance for this phase are Hoge Vaart, Polderweg and De Bruin. The first site, Hoge Vaart, has been studied in detail and reported fully (*Peeters, Schreurs and Verneau 2001*). In this early stage of the Swifterbant Culture, strong Late Mesolithic affinities are still present within the flint industry. The debitage sequence is based on the production of regular blades from platform cores. The rolled nodules were tested and prepared at the procurement sites and transported to the settlement site, where they were exploited until abandonment. Direct, hard percussion was applied in the first stages of the core preparation, while blade production was performed by indirect percussion. The regular blades have parallel edges and ridges, and are usually between 3–6cm long. They were selected for the production of predominantly arrowheads, namely trapezes. Other arrowhead types found less frequently are different kinds of microlith. The use of the micro-burin technique to divide the blade into two or more fragments is typical. More irregular shaped blades were chosen to be used unmodified as knives. Only in some cases were they lightly retouched (backed blades). Thicker examples and accidentally produced flakes were predominantly used as blanks for scrapers. Of course, other tools such as retouched pieces, borers and burins, also occur, being made from both blades and flakes. Use-wear analysis shows that fresh hide working was the main activity, while tools for bone and antler processing were almost absent. There is also some indication of ritual flint deposition (*Peeters, Schreurs and Verneau 2001*).

The flint industry of the other two sites, Polderweg and De Bruin, is characterised by flakes, largely because of the very small size of the used nodules, which do not allow the production of blades (*Van Gijn, Beugnier and Lammers-Keijsers 2001; Van Gijn, Lammers and Houkes 2001*). The arrowhead types which occur are trapezes and transverse arrowheads, combined with a large variety of microliths. The strong Mesolithic character of this industry is illustrated. It must be noted that all three sites mentioned here also have Late Mesolithic inhabitation phases. For most or all microliths it is furthermore unclear how long into the Mesolithic they were used as arrowhead types.

These last two sites give a dual impression of the flint industry of the Swifterbant Culture in this phase; both blade and flake production predominate. Therefore, we might cautiously presume that both the Hoge Vaart site, like the two other sites, Polderweg and De Bruin, are good representatives of the early phase of the Swifterbant Culture.

The middle Swifterbant phase (4600–3900 BC)
As mentioned above, the middle phase is characterised by a dichotomy into a northern and southern cultural sphere. The Swifterbant type-sites S2, S3 and S4, dated 4300–4000 BC, are distinctive of the northern group. These settlements are located on levees in a fresh water creek system consisting of a main gully and several tributaries[1].

During the middle phase, lithic production focused on flakes from platform cores. At S2 the flakes comprise 23% of the material, while blades only take up 14%. The same tendency is visible in S3, with 38% of flakes and 12% of blades, while at S4 these numbers are respectively 18% and 6%. Cores are worked on from one or two platforms and only seldom from three or more platforms.

Although one of the Swifterbant sites of the southern cultural sphere, Brandwijk, shows more new arrowhead types, such as leaf shaped and drop shaped points (*Raemaekers 1999.58*), on the Swifterbant type-sites only one new type is seen. This transverse arrowhead reminds one of a trapezoid arrowhead, but it differs in dimensions. Instead of being long rather than wide, it is now wide rather than long. The trapezes, however, remain the dominant arrowhead type. We must bear in mind that this typological difference was perhaps not seen in the same way by the Swifterbant people. The only difference is, after all, in the shifting dimensions. With 20 000 artefacts analysed, which is almost 65% of the material, and since no micro-burins have been found, it is presumed that trapezes and transverse arrowheads were no longer produced with the micro-burin technique, but by breaking blades[2].

The analysis of the debitage material shows that the bulk of the material was produced at the site. As a case in point, the material from site S3 is used, as it is the most numerous. When the measurements of the non-fractured flakes and blades are compared to those of the preparation and rejuvenation pieces, it can be seen that the larger blades and some larger flakes are not covered (Fig. 2). It is perceivable that these would be decortication pieces. For the flakes, some of the larger pieces are indeed decortication flakes (Fig. 3). This implies that all or most flakes were produced at the site. For the blades, this picture is different. The group of blades larger than 5cm that were not covered by the preparation or rejuvenation pieces are not decortication blades either. This implies that these large blades are not produced at the site, but imported as ready-made products from somewhere else[3].

The importation of blades or any other item does not always involve movement over long distances. The raw material used hints at this. All the large blades mentioned above are of the regular type, with parallel edges and ridges, produced from platform cores. The raw material used is the same as that of the smaller blades and flakes found on all sites and is of local origin. The most likely sources are two boulder clay outcrops at 12km and 15km distance of the Swifterbant type-site. This indicates that the large blades were possibly not imported over a long distance and that the raw material used for these blades presumably came from the same procurement sites as all the other flint artefacts. But the procurement site does not need to be the production site. Moreover, boulder clay deposits are found over a larger area in the north of the Netherlands, so imports from further located sources cannot be ruled out.

As these regular blades show great similarities to those from the early phase, they can be seen as the continuation of this tradition, but innovations within the flint industry also occur. The presence of a second debitage method, the bipolar technique, also known as the hammer and anvil technique, has been

1 At two other levee sites, S41 and S51, habitation is attested by archaeological evidence while levee sites S31 and S42–S43 are only mapped through auger surveys.

2 Of course, it cannot be ruled out that they were all made somewhere else, although this is highly unlikely.

3 However, it might also entail that all large preparation and rejuvenation pieces, as well as decortication blades, were taken from the site, although that is improbable.

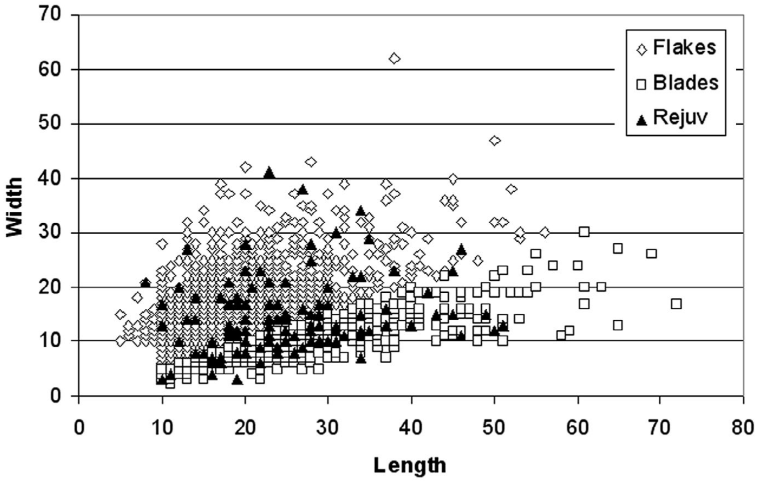


Fig. 2. Preparation and rejuvenation pieces set against complete flakes and blades (site S3, Swifterbant).

detected. It is especially the systematic employed of this technique that is significant. The core is no longer handheld or placed on the thigh, but is set on a stone anvil and smashed with a hammer stone from above. Bipolar cores and splintered pieces or *pièces esquilées* have been defined in the past. The description and the function of the technique and the end-products have been a topic of debate since their first definition.

Bipolar pieces are mostly functionally defined as tools, like wedges (*pièce esquilée*) (*Hayden 1980*) or burins (*MacDonald 1968*), or are sometimes defined as cores (*Guyodo and Marchand 2005; Ballin 1999; White 1968*). The use of the bipolar technique has also been interpreted as the solution to a raw material shortage (*Callahan 1987; Deckers 1982; Kamminga 1978*), the opening of rounded nodules (*Van Gijn and Niekus 2001*), or as the work of apprentices or children, thus skill related (*Stapert 2007; Sternke and Sörensen 2007*). It is even seen as the work of women, as it is sometimes considered a "low prestige" technique (*Flenniken 1979*), while in other parts of the world bipolar flakes are used predominantly by men (*Kosambi 1967*). Of course, one cannot rule out that two or more functions may coexist. This paper will only provide an insight into the material from the Swifterbant type-sites and will give a site-specific interpretation. Although tradition and social organisation probably have an influence on the bipolar matter, these topics will not be discussed here. They will be brought up, along with gender related issues and other, more detailed information, in a separate paper which focuses solely on the bipolar technique (*Devriendt in prep.b*).

Regular bipolar cores, irregular bipolar pieces and splintered pieces have been found on the Swifterbant sites S2, S3, and S4. This distinction is based mostly on morphology and technology, and partially on presumed function. Typical of all the pieces is the lack of a striking platform and the lenticular shape in side-view created by two opposing striking ridges or striking points. They are produced from small nodules of local flint with a length up to 5cm. The high degree of uniformity of the regular bipolar cores and the standardisation of dimensions of the splintered pieces is remarkable.

Several trains of thoughts are being pursued at the moment. The first presented itself during the study of the bipolar pieces. In this theory, I considered the three types as different steps in a *chaîne opératoire*, with the splintered pieces as an end result. This would be a functional interpretation with a tool, the splintered pieces, as goals for production. In order to verify this assumption, use-wear analysis was preformed[4] on 4% of the bipolar pieces (n = 18) and on 11% of the splintered pieces (n = 10). Surprisingly, only two artefacts showed traces of use. One bi-

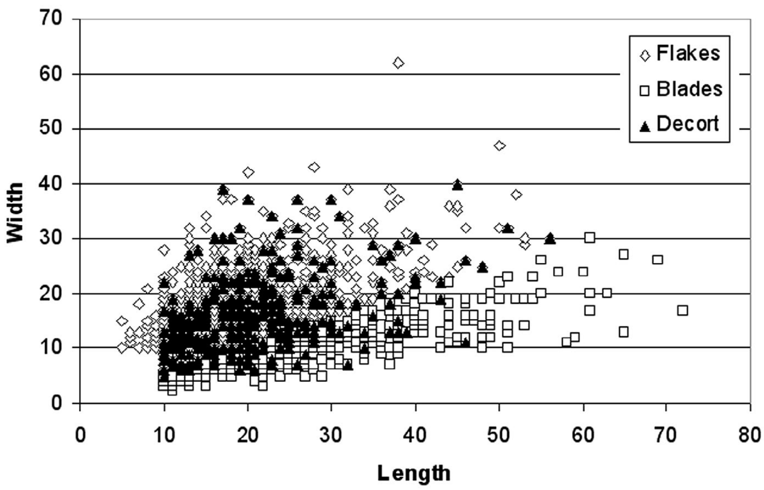


Fig. 3. Decortication pieces set against complete flakes and blades (site S3, Swifterbant).

4 This research was done by Karsten Wentink, Lithic Laboratory, Faculty of Archaeology, Leiden University.

polar core was used as a burin, and one splintered piece was used on plant material. Most unexpected was that the majority of the splintered pieces, or all the other bipolar pieces for that matter, had not been used at all. With only 4 or 11% of the bipolar pieces analysed, it is possible that the sample size was too small. However, if they had been used systematically as a wedge, the analysis would have picked it up. If the functional interpretation of bipolar pieces as wedges is off the table, two other possible functional explanations remain. Firstly, the bipolar pieces are used as tools but so rarely or in such a way that it leaves no visible use-wear traces. Secondly, they are cores.

This leads to the second train of thought: that the bipolar technique is a response to a raw material shortage (*Callahan 1987; Deckers 1982; Kamminga 1978*). Two related hypotheses present themselves. The bipolar technique is used for opening small nodules without wasting flint on extensive platform preparation, or even in the initial stages of core reduction for testing nodules and for cortex removal. Callahan (*1987*) works along the same lines when he writes that the bipolar technique is a part of the *chaîne opératoire* which starts with the freehand debitage of platform cores, and when these become smaller, the platform core is placed on an anvil. It is only in the final stage that, according to him, bipolar percussion is applied.

A third train of thought has been gaining ground recently. Some scholars (*Stapert personal communication November 2007*) and recent experiments have shown that young children steady the core on the floor for a better grip (*Sternke & Sørensen 2007; Sternke personal communication March 2008*), possibly as compensation for lack of motor skills. Whether it is the result of mimicry by children, or just children playing, or whether it is a structural part within skill transmission to apprentices, is still under investigation.

With Occam's Razor[5] in mind a fourth train of thought forces itself upon us. The bipolar technique is used alongside the platform technique as an opportunistic way of exploiting all the flint available. Thus they can be considered as two separate methods of working flint. Of course, none of these lines of thought need stand on their own. A combination of different aspects and factors is therefore more than likely. Furthermore, as research continues, it is not even sure the division into three types still holds. The function, meaning and interpretation of the bipolar technique might still be obscure, but the fact that the technique is being introduced as a systematically applied debitage technique in this period is not. It can be seen as an important innovation, as it is not the portent of declining debitage techniques: it is evidence of an opportunistic and highly adaptive and flexible way of knapping flint.

The stone industry

The early Swifterbant phase

As with flint production, strong Late Mesolithic affinities are still present in the stone industry. On the site of Hoge Vaart, the bulk of the stone material comprised small granite and quartz fragments, whereas only a limited amount of larger, stone artefacts was found (*Peeters 2001*). The small stone fragments were used as temper for the on-site production of pottery. Others were presumably the result of cobbles being used as cooking stones. This high fragmentation rate prohibits a good insight into, and definition of larger stone tools on this site. Even so, a hammer stone, an arrow shaft polisher, a chopping tool, several flakes and other stone tools have been defined. The study of the flint blades and scrapers made it apparent that anvils must also have been present at the site, not only for retouching tools, but also possibly for the production of temper. Unfortunately, no such tools or tool fragments have been identified, presumably due to fragmentation (*Peeters personal communication April 2008*).

On the sites at Polderweg and De Bruin (*Van Gijn, Louwe Kooijmans and Zandstra 2001; Van Gijn and Houkes 2001*), where roughly the same variety of tools was found as on the Hoge Vaart site, anvils were even used for the opening of rounded nodules. Although this use of hammer stone and anvil would fall under the definition of bipolar technique, some remarks should be made. The bipolar technique was already used during the Palaeolithic and the Mesolithic, but it is its frequency that becomes different in the Neolithic. Possibly starting in the early phase of the Swifterbant Culture, but definitely in the middle phase, it is introduced as a systematically employed technique and no longer applied sporadically.

The middle Swifterbant phase

The stone industry of the middle phase of the Swifterbant Culture is characterised by tools like grinding stones, hammer stones, anvils, and polished axes and adzes. The distinction between this phase and

5 "*All things being equal, the simplest solution tends to be the right one.*"

the previous one is overwhelming. New tools and particularly their abundance stand out.

One of the most important, if not the most important, tools of this period is the grinding stone. With the rise of grain as a new food source, a new tool type meeting the specific requirements of this specific plant was needed. And although grinding stones are not a new invention, they are introduced into the Swifterbant Culture during this middle phase. It is apparent that the Swifterbant grinding stones lack any form modelling or stylistic elements. The only rule that seems to apply is ease of use and work comfort. This stands in sharp contrast with the Linear Band Ceramic Culture or the Beaker Cultures, where bowl or saddle shaped grinding stones are common (*Beuker 1990*). A grinding tool consists of two components that need to be used together, a handheld stone (handstone or mano) and a lying stone (netherstone or metate) (*Adams 2002*). For handstones, natural rounded cobbles were selected that lie comfortably in the palm of the hand. The netherstones need to remain firmly on the ground, so boulders were chosen with either two opposing flat surfaces or with a flat surface opposing a protruding area which could be dug into the ground.

A second interesting aspect here is the fragmentation rate. When all stone tools are compared, it stands out that five times as many grinding stones[6] are broken as hammer stones or anvils. This might, of course, point towards taphonomy, but the frequency rather indicates special treatment of grinding stones. Could it be possible that this tool type was intentionally destroyed when people, by example, left the settlement? Several other explanations may be valid. Some of the small grinding stones may be used as cooking stones. When a grinding surface has become too smooth to perform, it is roughened by pounding on it with a hammer stone or even perhaps with another, small grinding stone. Sometimes a grinding stone is used as a multifunctional tool and is employed as an anvil or hammer stone. And when a grinding stone can no longer be exploited, it can always be used as tempering material if the raw material is suitable, all of which can lead to fragmentation.

Although anvils were present during the early phase, their use must have been increasingly important and systematic in the middle phase for their number rises significantly. Anvils become standard issue in the tool-kit. They are no longer solely used for the retouching of tools or for the sporadic opening of rounded nodules, but for a wide variety of tasks. Impact traces differ greatly in depth and extensiveness, suggesting diverse applications. Centred impact traces sometimes even create small hollows, while some anvils have the appearance of mortars as the hollow deepens.

All these tools were produced out of local raw material (see section on flint), except for several polished adzes. These were imported from the south of the Netherlands, or even from Germany or Poland, the area of the Rössen Culture; a contemporary, fully developed Neolithic culture in the Central-European loess areas which can be seen as the successor of the LBK. The imported Rössen adzes are characterised by a straight perforation oriented parallel to the cutting edge of the adze. The raw material used for these tools is of German and/or Polish origin. Remarkable are two adzes found at site S3, which have a deviant shape. The perforation is bi-conical or hour-glass shaped and is oriented obliquely to the cutting edge of the adze. The reason for this oblique orientation is not yet known, but the difference in perforation is significant. The use of pecking or a solid drill, which results in an hour-glass shaped perforation is considered a Mesolithic characteristic (*Geröllkeulen* and *Spitzhauen*), while the use of a hollow drill resulting in a straight perforation is typical of fully developed Neolithic cultures (*Schuhleistenkeilen* and *Breitkeilen*). Furthermore, the raw material used for these deviant adzes is of local origin. This makes the interpretation as local copies plausible.

The amber ornaments

This special find category that appeals to everybody's imagination forms only a small part of the stone industry at the Swifterbant sites. Lumps of this fossil resin were perforated and worn as pendants or beads, sometimes individually, sometimes strung together with or without pendants made from other raw materials. Only 17% (n = 4) of the inhumations at the Swifterbant cemeteries showed evidence of ornaments (*Devriendt in prep.c; Raemaekers et. al. in prep; Meiklejohn and Constandse-Westerman 1978*). These were not only made from amber, but also from stone pebbles and animal teeth. It appears that for the Swifterbant-type sites the ornaments fa-

6 Due to the fragmentation it is not always possible to define the pieces as handstone or netherstone, therefore, the more neutral term 'grinding stone' is chosen.

bricated from stone pebbles were produced on-site (there are many semi-finished products) while the amber beads and pendants were clearly imported. The pendants made of animal teeth were presumably imported as well (*Devriendt in prep.c*).

The most remarkable finds were discovered in the grave of a man on site S2. He was buried with five amber ornaments strung across his forehead, along with one sandstone pendant, located near his right ear, and a perforated fragment of a boar's tusk on his chest. Three of these five amber ornaments are the biggest found in all the Swifterbant burials. Equally compelling is the grave of a woman on the same site. She was buried with seven beads around her neck, one bead near her pelvis and, probably, three beads around her head, thus possibly eleven amber ornaments in total. Another special find, is the small amber pendant found in the grave of a child on S4. Although this is the only child buried with ornaments, it shows that men and women as well as children were, in some circumstances, buried with ornaments. This example also illustrates the different number, composition and even size of the ornaments given to different people. The man was buried with seven artefacts made of three different raw materials. The woman even had eleven artefacts but only made of one raw material. The child was buried with just one gift. Whether this is an indication of status, sex, age, personal wealth, or some other form of social differentiation is still under investigation. We must also bear in mind that gifts made of organic material have long perished. And although a fair number of graves is known (n = 37) (*Raemaekers et al. in prep*) the limited number of Swifterbant sites with graveyards, three to be precise, also impedes this research.

The funerary practises, *i.e.* the inhumation of people on their back in an extended position (*e.g. Alberthsen and Brinch Petersen 1976*), as well as the presence of animal teeth pendants, are still very Mesolithic minded. Even the presence of amber lumps have been attested at archaeological sites in the Netherlands from the Palaeolithic onwards (*Waterbolk and Waterbolk 1991*). The introduction of amber ornaments in graves during the Swifterbant period is, however, of great importance. It is the first time that amber lumps have been transformed into beads and pendants. In this pioneering phase, amber lumps are only perforated and not altered in any other way. In later phases, when they are being produced more systematically, for example during the Single Grave Culture, amber lumps are not only perforated, but also cut, scraped, and ground (*Piena and Drenth 2001; Bulten 2001*). It is also during the middle Swifterbant phase that amber beads and pendants are recovered from graves for the first time.

The analysis of the new features

It has long been common practice that subsistence is the main feature in defining the difference between the Mesolithic and Neolithic (*e.g. Zvelebil 1998*). This would imply that the introduction of animal husbandry and cereal cultivation would have been the most important innovation of that time. It is most likely that the Swifterbant people did not see it in that way.

The introduction of pottery at the beginning of their cultural period, or is it the other way around, is probably of more significance. This could imply that the Swifterbant people had more use for an innovation like a decent pot for storage or cooking than they had for animal husbandry. Of course, it is easy to take the functional explanation as the prime one. Cultural restrains, social taboos or even technical complexity make the adoption of new aspects by a culture an unequal fight. One might think that the adoption of successful cereal cultivation is harder to accomplish than the herding and feeding of animals. Whether this is the reason animal husbandry was adopted first is difficult to fathom. It is also possible that the Rössen people were more protective of their agricultural technology and thus more reluctant to share this information with others.

Regardless of how, when and why cereal cultivation was adopted, the introduction of grain apparently implied the introduction of grinding stones. Perhaps the properties of emmer wheat and naked barley make it necessary to crush and grind the grains before they are cooked. Therefore, the one could not go without the other. We might assume that this led to the special standing of grinding stones, as it was a material symbol of the new agricultural technique.

The imported adzes must also have been a very special item for the Swifterbant people, presumably with high significance (*Louwe Kooijmans 2005; Verhart 2000*). The exoticism of the raw material, the time invested during production, and the technical ingenuity, must have appealed to the Swifterbant people's imagination. Therefore, grinding stones and polished adzes might have been Neolithic icons or symbols of the new way of life.

Thus, the Swifterbant Culture might be characterised by their interest in Neolithic traits, and defined by all sorts of innovations, adoptions and introductions, regardless of the importance we give them. Still, the lithic industry, the burial practises and the perseverance of collecting wild food, prove that they remained loyal to their Mesolithic traditions and did not change their ways overnight. We must also bear in mind that the Neolithisation process was more likely to be one of trial and error than a straightforward success story.

Conclusion

That the Swifterbant Culture evolved from a Late Mesolithic tradition towards an almost fully Neolithic one can be illustrated by comparing the sites of the Swifterbant early phase with the type-sites from the middle phase. The lithic industry of sites S2, S3, and S4 is being analysed systematically to gain insight into how this culture was affected by the Neolithisation process.

The flint industry of the Swifterbant Culture started out as Late Mesolithic. Over time, it developed into a more Neolithic tradition by adopting new tools and debitage techniques. This began with a change from a blade to a more flake orientated industry and by abandoning the micro-burin technique for making arrowheads. More precisely, for the Swifterbant type-sites it has been attested that on the one hand, small flakes and blades, produced with the platform technique from local flint were created on the site itself. On the other hand, large blades also produced with the platform technique and from local flint were brought to the site. So, regardless of where they were manufactured, flakes and blades were produced from local raw material. Furthermore, the bipolar technique was introduced as a systematically applied debitage technique. A new set of arrowheads was being used, ranging from trapezes and transverse arrowheads to leaf and drop shaped points, depending on the sites.

The stone industry depended on Mesolithic types, such as hammer stones and anvils, but was at the same time radically changed by the introduction of grinding stones. The high fragmentation rate of these artefacts leads one to suspect that they were treated in a special way. Amber beads and pendants were produced for the first time, and only a small number of the Swifterbant people were buried with them. Finally, imported polished adzes brought influences with them from the south of the country, where a true Neolithic culture resided. By making their first polished adzes, the Swifterbant people took into their own hands the final step to becoming fully Neolithic.

∴

REFERENCES

ADAMS J. L. 2002. *Ground Stone Analysis: A Technological Approach*. University of Utah Press, Salt Lake City.

ALBERTHSEN S. E., BRINCH PETERSEN E. 1976. Excavations of a Mesolithic Cemetery at Vedbaek, Denmark. *Acta Archaeologica 47: 1–26*.

BALLIN T. B. 1999. Bipolar Cores in Southern Norway. Classification, Chronology and Geography. *Lithics 20: 13–22*.

BEUKER J. 1990. *Werken met steen*. Drenths Museum. Assen.

BULTEN E. 2001. Het barnsteen van de laat-neolithische nederzetting 'Mienakker': Een onderzoek naar de bewerking van barnsteen in een nederzetting van de Enkelgrafcultuur. In R. M. van Heeringen and E. M. Theunissen (eds.), *Kwaliteitsbepalend onderzoek ten behoeve van duurzaam behoud van neolithische terreinen in West-Friesland en de Kop van Noord-Holland. Deel 3: Archeologische onderzoeksverslagen*. Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort: 471–483.

CALLAHAN E. 1987. *An evaluation of the lithic technology in Middle Sweden during the Mesolithic and Neolithic*. Societas Archaeologica Upsaliensis. Uppsala (= Aun 8).

CAPPERS R. T. J., RAEMAEKERS D. C. M. in prep. Cereal cultivation at Swifterbant? About being a Neolithic wetland farmer in the western part of the North European Plain. *Current Anthropology*.

DECKERS P. H. 1982. Preliminary notes on the Neolithic flint material from Swifterbant (Swifterbant Contribution 13). *Helinium 22: 33–39*.

DEVRIENDT I. in prep.a. *The stone and flint artefacts from Swifterbant* (provisional title). Ph. Dissertation. University of Groningen. Groningen.

in prep.b. Bipolar pieces: a question of function, raw material availability or skill. A case-study of the Neolithic sites at Swifterbant (The Netherlands). *Lithic Technology*.

in prep.c. "Diamonds are a girl's best friend". Neolithische kralen en hangers uit Swifterbant. *Westerheem*.

FLENNIKEN J. J. 1979. *Replicative systems analysis of the lithic artifacts from Hoko River archaeological site*. Unpublished Ph.D. dissertation. Department of Anthropology, Washington State University. Washington.

GUYODO J.-N., MARCHAND G. 2005. La percussion bipolaire sur enclume dans l'Ouest de la France de la fin du Paléolithique au Chalcolithique: une lecture économique et sociale. *Bulletin de la Société Préhistorique Française 102 (3): 539–549*.

HAYDEN B. 1980. Confusion in the Bipolar World: Bashed Pebbles and Splintered Pieces. *Lithic Technology 9 (1): 2–7*.

HOGESTIJN J. W. 1990. From Swifterbant to TRB in the IJssel-Vecht Basin – Some Suggestions. In D. Jankowska (ed.), *Die Trichterbecherkultur. Teil I. Neue Forschngen und Hypothesen*. Poznan: 163–180.

HOGESTIJN J. W. H., PEETERS J. H. M. 2001. *De mesolithische en vroeg-neolithische vindplaats Hoge Vaart–A27 (Flevoland).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= ROB Rapportage Archeologische Monumentenzorg 79).

KAMMINGA J. J. 1978. *Journey into the microcosms: a functional analysis of certain classes of prehistoric Australian stone tools*. Unpublished Ph.D. dissertation. Department of Anthropology, University of Sydney. Sidney.

KOSAMBI D. D. 1967. Living prehistory in India. *Scientific American 216 (Feb.): 105–114*.

LOUWE KOOIJMANS L. P. 2001a. *Hardinxveld-Giessendam Polderweg. Een mesolithisch jachtkamp in het riviergebied (5500–5000 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 83).

2001b. *Hardinxveld-De Bruin: een kampplaats uit het Laat-Mesolithicum en het begin van de Swifterbant-cultuur (5500–4450 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 88).

2005. Ook de jagers worden boer. Vroeg-neolithicum B en midden-neolithicum A. In L. P. Louwe Kooijmans, P. W. van den Broeke, H. Fokkens and A. van Gijn (eds.), *Nederland in de Prehistorie*. Bakker, Amsterdam: 249–271.

MACDONALD G. 1968. *Debert: a Paleo-Indian site in central Nova Scotia*. Anthropology Papers, National Museum of Canada 16.

MEIKLEJOHN C., CONSTANDSE-WESTERMAN T. S. 1978. The human skeletal material from Swifterbant, Earlier Neolithic of the Northern Netherlands: I. Inventory and demography. Final Reports on Swifterbant I. *Palaeohistoria 20: 39–89*.

PEETERS J. H. M. 2001. Deel 19. Natuursteen: karakterisering en gebruik. In J. W. H. Hogestijn and J. H. M. Peeters (eds.), *De mesolithische en vroeg-neolithische vindplaats Hoge Vaart–A27 (Flevoland).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= ROB Rapportage Archeologische Monumentenzorg 79).

PEETERS J. H. M., SCHREURS J., VERNEAU S. M. J. P. 2001. Deel 18. Vuursteen: typologie, technologische organisatie en gebruik. In J. W. H. Hogestijn and J. H. M. Peeters (eds.), *De mesolithische en vroeg-neolithische vindplaats Hoge Vaart–A27 (Flevoland).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= ROB Rapportage Archeologische Monumentenzorg 79).

PIENA H., DRENTH E. 2001. Doorboorde sieraden van de laat-neolithsche site Aartswoud, gem. Opmeer. In R. M. van Heeringen and E. M. Theunissen (eds.), *Kwaliteitsbepalend onderzoek ten behoeve van duurzaam behoud van neolithische terreinen in West-Friesland en de Kop van Noord-Holland. Deel 3: Archeologische onderzoeksverslagen.* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort: 433–469.

RAEMAEKERS D. C. M. 1999. *The Articulation of a 'New Neolithic'. The meaning of the Swifterbant Culture for the process of neolithisation in the western part of the North European Plain (4900–3400 BC).* Faculty of Archaeology. University of Leiden. Leiden. (=Archaeological Studies Leiden University 3)

2003. Cutting a long story short? The process of neolithization in the Dutch delta re-examined. *Antiquity 77: 740–748*.

2003–2004. An outline of Late Swifterbant pottery in the Noordoostpolder (provincie of Flevoland, the Netherlands) and the chronological development of the pottery of the Swifterbant culture. *Palaeohistoria 45/46: 11–36*.

2005. Het vroeg- en midden-neolithicum in Noord-, Midden- en West-Nederland. In J. Deeben, E. Drenth, M.-F. van Oorsouw and L. Verhart (eds.), *De steentijd* *van Nederland*. Stichting Archeologie, Zutphen. (= Archeologie 11/12): 261–282.

RAEMAEKERS D. C. M., DEVRIENDT I., CAPPERS R. T. J., PRUMMEL W. 2005. Het Nieuwe Swifterbant Project. Nieuw onderzoek aan de mesolithische en neolithische vindplaatsen nabij Swifterbant (provincie Flevoland, Nederland). *Notae Praehistoricae 25: 119–127*.

RAEMAEKERS D. C. M., MOLTHOF H. M., SMITS E. in prep. The textbook 'dealing with death' from the Neolithic Swifterbant culture (5000–3400 BC), The Netherlands.

STAPERT D. 2007. Neanderthal children and their flints. *PalArch's Journal of Archaeology of Northwest Europe 1 (2): 16–38*.

STERNKE F., SÖRENSEN M. 2007. The Identification of Children's Flintknapping Products in Mesolithic Scandinavia. In S. McCartan, R. Schulting, G. Warren and P. C. Woodman, (eds.), *Mesolithic horizons*. Papers presented at the Seventh International Conference on the Mesolithic in Europe, Belfast 2005. Oxbow Books, Oxford.

VAN GIJN A. L., BEUGNIER V., LAMMERS-KEIJSERS Y. 2001. Vuursteen. In L. P. Louwe Kooijmans (ed.), *Hardinxveld-Giessendam Polderweg. Een mesolithisch jachtkamp in het riviergebied (5500–5000 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 83): 119–161.

VAN GIJN A. L., LAMMERS Y., HOUKES R. 2001. Vuursteen. In L. P. Louwe Kooijmans (ed.), *Hardinxveld-De Bruin: een kampplaats uit het Laat-Mesolithicum en het begin van de Swifterbant-cultuur (5500–4450 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 88): 153–191.

VAN GIJN A. L., LOUWE KOOIJMANS L. P., ZANDSTRA J. G. 2001. Natuursteen. In L. P. Louwe Kooijmans (ed.), *Hardinxveld-Giessendam Polderweg. Een mesolithisch jachtkamp in het riviergebied (5500–5000 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 83): 163–179.

VAN GIJN A. L., HOUKES R. 2001. In L. P. Louwe Kooijmans (ed.), *Hardinxveld-De Bruin: een kampplaats uit het Laat-Mesolithicum en het begin van de Swifterbant-cultuur (5500–4450 v. Chr.).* Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort (= Rapportage Archeologische Monumentenzorg 88): 193–207.

VAN GIJN A., NIEKUS M. 2001. Bronze Age Settlement Flint from the Netherlands: the Cinderella of Lithic Research. In W. H. Metz, B. L. Van Beek and H. Steegstra (eds.), *Patina*. Essays Presented to Jay Butler on the Occasion of his 80th Birthday. Groningen: 305–320.

VERHART L. B. M. 2000. *Times fade away: the neolithization of the Southern Netherlands in an anthropological and geographical perspective*. Faculty of Archaeology, Leiden University. Leiden.

WATERBOLK H. J., WATERBOLK H. T. 1991. Amber on the Coast of the Netherlands. In H. Thoen, J. Bourgeois, F. Vermeulen, Ph. Crombé and K. Verlaeckt (eds.), *Liber Amicorum Jaques A. E. Nenquin*. (= Studia Archaeologica). Seminarie voor Archeologie, Gent: 201–209.

WHITE J. P. 1968. Fabricators, outils écaillés, or scalar cores? *Mankind 6: 658–666*.

WILHELM L. C. G. 1996. *De vuurstenen pijlpunten van P14*. Internal report Amsterdam University. Amsterdam.

ZVELEBIL M. 1998. What's in a Name: the Mesolithic, the Neolithic, and Social Change at the Mesolithic-Neolithic Transition. In M. Edmonds and C. Richards (eds.), *Understanding the Neolithic of north-western Europe*. Gruithne Press, Glasgow: 1–36.

back to contents

UDK 903.5(536.2)"631/634"
Documenta Praehistorica XXXV (2008)

Funerary rites in a Neolithic nomad community in Southeastern Arabia: the case of al-Buhais 18

Roland de Beauclair
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters, Universität Tübingen
roland.de.beauclair@student.uni-tuebingen.de

ABSTRACT – *Al-Buhais 18 is a Neolithic site in the United Arab Emirates. It consists of a graveyard with more than 420 individuals, an ancient spring, and a campsite. It is interpreted as a central place for a group of mobile herders in the 5th millennium BC. More than 24 000 ornamental objects have been found, many of them in a secure funerary context, making it possible to reconstruct ornamental ensembles, and shedding light on specific rules concerning the way jewellery was worn by different sub-groups of the population. Based on these observations, some hypotheses are developed on the intentions and beliefs structuring mortuary practices and the role of jewellery within these rites. Finally, questions of continuity and change in mortuary practices can be addressed by comparing al-Buhais 18 with other, younger, sites in the region.*

IZVLEČEK – *Al-Buhais 18 je neolitsko najdišče v Združenih Arabskih Emiratih. Najdišče obsega grobišče z več kot 480 grobovi, taborom in izvirom vode. Najdišče je interpretirano kot centralni tabor mobilnih živinorejcev v 5. tisočletju BC. Najdenih je bilo 24 000 okrasnih predmetov. Mnogi so bili odkriti v grobovih. Mogoče je rekonstruirati okrasne zbire in prepoznati pravila, ki so veljala pri nošnji okrasa pri različnih skupinah. Predstavljamo nekaj razmislekov o pomenu in vlogi okrasja pri pogrebnih praksah. S pomočjo primerjave najdišča al-Buhais 18 z mlajšimi najdišči predstavljamo oceno kontinuitete pogrebnih praks v regiji.*

KEY WORDS – *Neolithic; Arabia; burials; personal ornaments; mortuary practices*

Introduction

Personal ornaments offer a wealth of information for archaeologists. They can be analyzed in terms of production technique, provenance of raw materials or object typology. But it is also evident that ornamental objects are used in a social context, as a means of communication – for example as exchange goods or in rituals. Of course, there are many more possible meanings of jewellery, and several concepts may have been important simultaneously, a fact that has been described as the "*caractère polysémique*" (*Vanhaeren 2002.7*) of jewellery.

The Neolithic site of al-Buhais 18, United Arab Emirates, provides an excellent opportunity for investigations on several of these levels. After an introduction to the site and a presentation of the ornamental objects, it is my aim in this paper to show how information related to personal ornaments can be used to reconstruct aspects of funerary rites. Also, data on jewellery and burial practice is used to place the occupation of the site in a regional and chronological context.

The site

The Neolithic graveyard and settlement site of al-Buhais 18 (BHS18) is situated on the Oman Peninsula at a distance of about 60km from both the Arabian Gulf and the Gulf of Oman (Fig. 1). The site lies at the eastern foot of Jebel al-Buhais, just north of al-Madam in the Emirate of Sharjah, United Arab Emirates. Jebel al-Buhais is part of a hill range running parallel to the Oman Mountains, separating the sand dunes in the west from a large and relatively fertile floodplain and then the Mountains in the east.

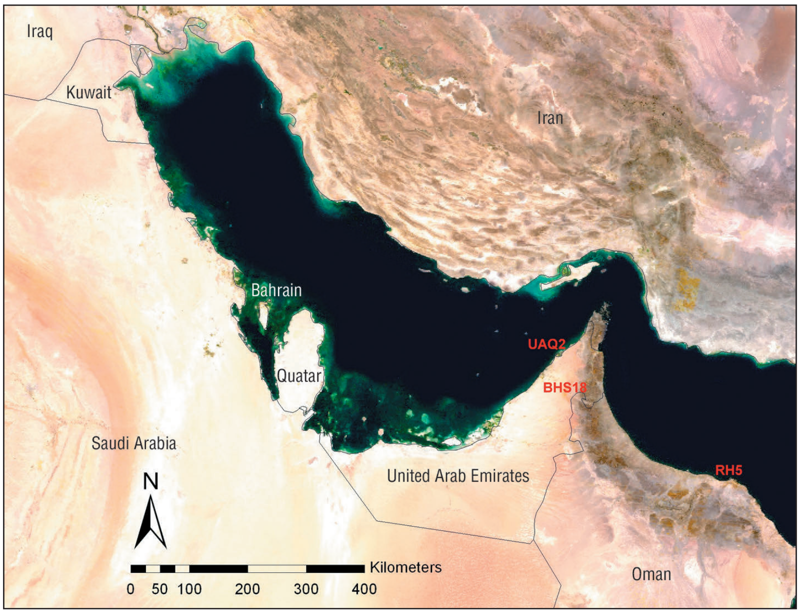


Fig. 1. Location of sites mentioned in the text.

Al-Buhais 18 was discovered in 1995 by archaeologists from the Sharjah Directorate of Antiquities, under the direction of Dr. Sabah Jasim. From 1996 to 2004, it was excavated in annual campaigns as a joint project of the Directorate of Antiquities and the University of Tübingen, Germany, co-directed by Hans-Peter and Margarethe Uerpmann (*Jasim et al. 2005; Uerpmann et al. 2006a*).

Radiocarbon dates indicate that al-Buhais 18 was frequented from about 5200 to 4000 BC (*de Beauclair et al. 2006.175; Uerpmann et al. 2000.231; Uerpmann et al. 2006b.90*). The abandonment of the site would thus coincide with the end of the major moist phase of the Early Holocene (*Uerpmann 2003*).

The site can be divided into several areas. The central feature is the graveyard. On a relatively small area of about 12 by 15 meters, more than 420 individuals have been recovered. Directly adjacent to the graveyard in the east, there is a midden of limestone rubble mixed with stone artefacts and animal bones. As many of the stones show signs of heating, the area is thought to be related to food processing. The last important structure on the site is an ancient spring a few meters up the slope of the hill. Uranium/Thorium dating of the sinter deposits has not given satisfactory results yet, but it seems very probable that the spring was active during the time of occupation of al-Buhais. Its drying up may have led to the abandonment of the site.

A great number of animal bones have been recovered, almost exclusively from domestic animals – sheep, goats, cattle. It was a big surprise to find a Neolithic economy in south-eastern Arabia at such an early date. The age profile of animal bones suggests that the site was used only seasonally, pointing to a nomadic lifestyle. The culling of young animals, which is necessary to maintain stable herd sizes, must have taken place somewhere else.

The site is interpreted as a central place for a population of mobile herders, used seasonally over hundreds of years (*Jasim et al. 2005; Uerpmann and Uerpmann 2000.47–48; Uerpmann et al. 2000. 232; Uerpmann et al. 2006b.99–100*). They would have come to Jebel al-Buhais to graze their herds in spring, to bury their dead and perhaps for clan reunions. Winter may have been the time to exploit the coasts, where a considerable number of shell middens attest to the presence of Neolithic populations. Summer or autumn camps may have been located in the cooler mountain regions of Oman, where pasture was more likely to be available. However, even though ophiolite pebbles link the al-Buhais population to the mountains, we do not have any information about specific localities or the seasonal position of this occupation. All in all, it has to be said that we still know only very few sites. Further discoveries can be expected, which probably will make it necessary to re-adjust these hypotheses.

Burial practices

A variety of burial types is present. There are single and multiple interments, which can also be grouped into primary and secondary ones. A detailed study of burial practice and physical anthropological evidence has been carried out by H. Kiesewetter (*2006*). From a total of 420 burials recorded up to the year 2004, information on burial type is available in 280 cases (Tab. 1). Primary burials occur in 115 cases.

There, the body was buried shortly after death, without prior manipulations of the skeleton. The bones were still articulated and therefore have been found in the correct anatomical position. The bodies were buried in a flexed position, usually lying on the right side, but sometimes also on the left side (Fig. 2). Primary burials are most often oriented along an east-west axis, with the cranium to the east (Fig. 3). Due to right/left sidedness, facial orientation is more variable, but still predominantly to the north.

Secondary burials are more frequent, with 165 (60%) cases. Most often, they consist of only the skull and some long bones arranged in a small pile, often with the skull laid on top (Fig. 4). Sometimes, only the skull was buried. Usually, several individuals are interred together. The primary decomposition of the dead bodies must have taken place prior to their burial at al-Buhais 18. As a special case of secondary burials, there are eight semi-articulated, mummy-like skeletons. In these cases, most of the joints must still have existed at the time of reburial, but the whole body was compressed, and some joints were disarticulated or overstretched in an unnatural way.

Secondary burials are interpreted as pertaining to group members who had died at a point in the yearly nomadic cycle, when the group was moving or staying at some place other than Jebel al-Buhais. These individuals must have been buried locally in a first phase. After some time, their bones were exhumed in part or in total, in order to rebury them at the graveyard of BHS 18. We can only guess what

Primary burials	**115**
Right side	86
Left side	28
Secondary burials	**165**
Skull deposits	29
Bone deposits	128
Semi-articulated skeletons	8
Undetermined	**140**
Total	**420**

Tab. 1. Burial types.

made the site of al-Buhais 18 so singular – perhaps its importance is related to the spring, or to the view over the al-Madam plain with the rising sun behind the Oman Mountains. In any case, it is clear that it was important to the group to place its ancestors in this specific location. The two-stage burial indicates that the group spent part of its nomadic cycle at distances too far from al-Buhais to permit an immediate return to the site for an interment. Also, it may not have been possible for the group to carry the whole corpse with them along the nomadic routes until it eventually was time to head for Jebel al-Buhais again. This model also explains the high frequency of multiple interments – those who had died in a certain period were reburied together in one ceremony. There are some indications as to where some of the first burials took place. In the semi-articulated skeleton TG, sediment of the first burial location is still mingled with the bones: pebbles of grey-green ophiolite indicate that the body had been buried in a Wadi river bed somewhere in the Oman Mountains, the closest location where these pebbles occur naturally.

Fig. 2. Primary burial of individuals BX, BY, HS.

Interestingly, the proportion of secondary burials is higher in males than in females, and higher in mature than in younger individuals. Should this indicate that men spent more time away from al-Buhais 18 than women? And what does that mean for old people? For the moment, these questions must remain open.

The ornamental objects

More than 24 000 objects of presumed ornamental purpose were recorded during the excavations (*de Beauclair 2005; de Beau-*

clair in press; de Beauclair et al. 2006; Kiesewetter et al. 2000). They can be divided into pierced molluscs, beads and other ornamental objects (Tab. 2).

Pierced molluscs

The mollusc species list shows that gastropods are very dominant. The important species are *Ancilla cf. farsiana, Engina mendicaria, Polinices mammilla, Anachis fauroti*, an unidentified species of the Marginellidae family, and *Planaxis niger*. Bivalves are represented by some Venerids. There are also an important number of pearls. Interestingly, there is a concentration on relatively few species. *Ancilla* alone constitutes 75% of all molluscs. What is also striking is the absence of *Dentalium*, which was used at many other sites of the period. Additionally, there was a preference not only for specific species, but also for certain sizes. Both *Ancilla* and *Engina* show a size distribution with two peaks. Further analysis of the small and the big subgroup shows that they were in fact used differently.

With only very few exceptions, every shell is perforated. The position and method of the perforation is formalized for every species: for instance, *Ancilla* snails are almost always perforated by cutting away the apex, whereas in *Polinices* the hole is located on the flat part of the body and executed by picking.

Beads

When it comes to beads with an artificial shape, also very few types are quantitatively important. Disc beads are most numerous (>16 000). Their diameters range from 1.7 to 18.2mm, but sizes between 3 and 5mm are most common. They are usually made of a whitish or orange shell material. Sometimes an internal layering of orange and white is visible. They make up 2/3 of all ornamental objects. Next in quantity are tubular beads. They are made of whitish shell or dark grey soft-stone, probably some mixture of serpentinite and other minerals. These two materials occur in almost equal numbers. The tubular beads are up to 31.6mm long. The diameter of the perforation is always less than 3mm, even less in the middle of the pieces. No suitable tools for the production of these beads have been found on the site or, for that matter, in the whole region. I therefore believe that these

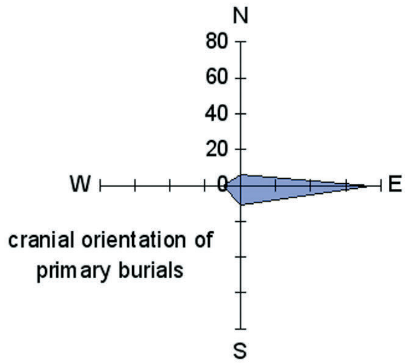


Fig. 3. Orientation of primary burials.

beads – and probably others – were imported. Barrel shaped beads constitute another important group (114 pieces). Here, a wide variety of materials was used, mainly shell and limestone, but also serpentinite and other stones. Light colours dominate. Next, oval beads have to be mentioned. There are 40 examples of this type. The majority are made of shell and limestone. What is interesting about them is the fact that only two are perforated completely. The rest have two depressions or short bore-holes at either end, but the holes do not meet. One might think of these as unfinished objects, but a considerable number have been found in burials in positions that indicate their having been used as jewellery. Notably, they were found as single beads on the upper lip or near the earlobes. Other bead types are less frequent: they include spherical, conical and rhomboid beads. Their shapes do not seem so well defined, and material seems to be more important (for instance, carnelian).

Fig. 4. Secondary burial of individuals HD, HE, EX, LK.

type	n
Ancilla cf. farsiana	3902
Engina mendicaria	524
Polinices mammilla	423
Anachis fauroti	101
Marginellidae	74
Planaxis niger	56
Nerita adenensis	13
Pyrene cf. propinqua	9
Conus	7
Mitrella blanda	7
Veneridae	67
pearls	62
subtotal molluscs	**5245**
disc beads	16 654
tubular beads	2218
cylindrical beads w. lateral perforation	2
barrel-shaped beads	114
oval beads	40
spherical beads	20
conical beads	10
rhomboid beads	4
subtotal beads	**19 051**
leaf-shaped pendants	7
other pendants	2
elongated shell object	1
earring	2
ring	1
'buttons'	2
subtotal other ornamental objects	**15**
total	**24 311**

Tab. 2. Ornamental object types.

Finally, some other ornamental objects have been found, most importantly a number of leaf-shaped pendants made of mother-of-pearl, and *Conus* shell and soft-stone pendants.

All in all, the close relationship of the al-Buhais population to the sea is very evident. *Engina* and *Planaxis niger* point to the Omani coast, but this naturally does not imply that the Arabian Gulf coast was not used. Much work still lies ahead concerning the reconstruction of nomadic mobility.

How ornamental objects were worn

The importance of the jewellery from al-Buhais lies not only in the mass of material, but also in the fact that a large portion, almost 70 percent, was found within a burial context. Secondary burials have yielded very little jewellery, and not in any recognizable anatomical context. The analysis of how jewellery was worn is therefore based on primary burials. As these results have been presented in more detail elsewhere (*de Beauclair et al. 2006*), only a brief overview is given here.

As a first step, different types of ornamental ensembles and their characteristic features were identified. For example, ***head decorations*** are very common, either covering the whole neurocranium or only forming a headband. Two different styles were observed: a preference for disc and tubular beads, or the dominance of *Ancilla* shells. Generally, the objects are relatively small.

Earrings: there are eight cases of a semi-perforated oval bead being placed at the earlobe. An equal number of individuals had what I term a ***facial decoration***, that is a single bead on the maxilla, placed between the upper lip and the nose. The bead types are diverse, but the preferred material is carnelian. Some have incomplete perforations.

Necklaces were very common, occurring in 34 cases. The most important bead type is tubular, which occurred in 27 individuals. Black and white beads are often used in an alternating pattern. Barrel shaped beads make up the second most popular style of necklace.

The ***hip area***, again, was an important place for jewellery, for both sexes. In several cases, neat parallel rows have been observed. The objects were probably sewn onto a belt or onto the lower hem of shirts. There is a very strong preference for big *Ancilla* shells. On the other hand, the total absence of *Engina mendicaria* is also remarkable. Again, a second style is also popular, involving a mix of disc and tubular beads.

Bracelets are also common (28 cases, 21 individuals). They occur in three styles: one with tubular beads, one mainly with disc beads, and one consisting only of *Ancilla* shells.

Some general observations:

- Any piece of jewellery consists only of a very limited number of bead and shell types, and not every bead type was considered appropriate for every anatomical position. For instance, carnelian beads and pearls, both of which could be considered very valuable, were concentrated in the head area.

- There is an apparent dualism of pierced gastropods on one side and tubular beads on the other in several types of ornamental ensemble, including headdresses, hip decorations and bracelets.

- Finally, garment trimmings need to be mentioned here. Judging from their positions, headdresses, chest and hip decorations and, perhaps, also elbow decorations, may have been sewn onto pieces of clothing. These are the same places at which gastropods tend to occur frequently, so arguably, trimming was deemed more suitable for pierced shells (and disc beads) than for other beads.

In the second step of analysis, I tried to find typical combinations of different ornamental ensembles. The goal was to reconstruct aspects of the prehistoric dress code or garb for the population as a whole and for subgroups. This was done with the help of a contingency analysis. The results of this analysis were not very clear. Almost any combination of ornamental ensembles was possible.

The results for different subgroups are more interesting.

Gender differences are only minor. Apparently, the society did not emphasise this distinction. One of the observed differences concerns facial decorations: beads on the upper lip have been recorded for five women and two men. The women's beads are all perforated and all made of carnelian, except for one pearl. The men's beads are both only partially perforated, which implies a different mechanism for holding the beads in place. However, this distinction is not statistically significant.

Age clearly was a more important factor in determining the burial garb than gender:

- Children's burials were as rich as those of adolescents or adults. Mature individuals, on the other hand, were rarely and very poorly decorated (Figs. 5 and 6).

- The preferred bead types for children were disc and tubular beads. Namely, necklaces made of tubular beads are typical of children's and adolescents' burials. Children also feature a high number of disc bead bracelets and hip decorations with disc and tubular beads.

- Pierced molluscs, on the other hand, were only popular for adults and especially mature individuals, corresponding to a decreasing importance of disc and other beads.

- Shell size also depended on the age of the deceased: small varieties were preferred for children and youths. Small and big shells are balanced in adults between 20 and 40 years, and big specimens were preferred for older people.

The role of jewellery in burial rites

The data presented above makes it possible to formulate some ideas on the function and importance of jewellery in the course of the funerary rites or beyond.

- First of all, we do not know whether the use of jewellery for the dead corresponded to its use in the living community. The low number of ornamental objects outside the graveyard area rather suggests that jewellery was not worn in everyday life. Otherwise, more broken and lost objects should have been found. *Polinices* shells, however, do occur in relatively great number. So maybe they are part of a more simple ornamental style for everyday use.

- Second, the main function of jewellery probably wasn't the display of acquired status or wealth. If this were the case, children's burials should not be as rich as they are. Of course, if status was inherited, other mechanisms may be relevant.

- The differences in jewellery between different age groups and the poorness of mature individuals furthermore indicate that jewellery was not a per-

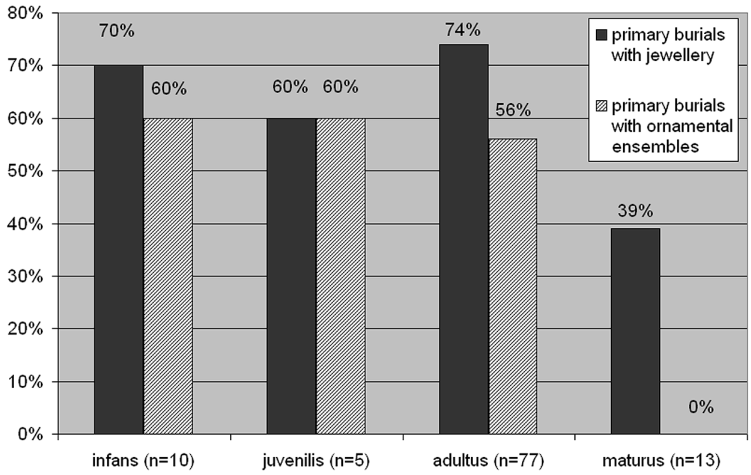


Fig. 5. Jewellery frequency by age.

sonal possession; it was not something individuals accumulated in the course of their lives. If this were the case, adults and mature bodies should have the same equipment as children, plus some more.

- Finally, there is the absence of jewellery in secondary burials. After the first stage of burial, jewellery was obviously no longer important. If the aim was to document wealth, jewellery could have been added to the bone piles of the secondary burials as well.

- All this leads me to think of jewellery as having its place in the process of burial, in some "*rite de passage*" (*Van Gennep 1986.142–159*). Community members would decorate the dead for the passage. After completion of the burial process, jewellery may have lost its importance. This would explain the absence of jewellery in secondary burials. Finally, the age differences need to be explained. This is a difficult question, and many hypotheses could be brought forward. I only want to mention one idea, evidence for which can be found in the ethnographic record (*Hertz 1907. 134*): I could imagine that the untimely death of a child or young adult would have caused greater anxiety and required a more lavish burial than the death of an old person whose life had been accomplished.

Continuity and change in funerary rites

There are only a small number of contemporary sites in the region which can be used to compare the burial rites of al-Buhais 18. A very promising site was discovered by the al-Buhais excavation team in 2006, only a few kilometres north of BHS 18, at the foot of Jebel Fayah (*Kutterer and de Beauclair in press*). It is called Fayah NE15. A dwelling area with fireplaces, flint artefacts, faunal remains and the burials of three individuals have been recovered so far. The jewellery associated with the burials resembles BHS18, and places the site in the Neolithic period. The similarities concerning ornamental objects are very striking, but there are some differences nonetheless. It remains open to discussion whether these reflect different temporal settings or the need of two contemporary groups to distinguish themselves from one another. There are also some shell middens on the coast of the Arabian Gulf which might be contemporaneous. One, Umm al-Qaiwain 2 'UAQ2', has yielded burials. It has been excavated under the direction of C. Phillips. Only a preliminary report is available at present (*Phillips 2002*). Forty-two individuals have been found in the cemetery. Nine skeletons were articulated, all placed in a flexed position, and most of them facing southeast. The others are assumed to have been disturbed by later burials. It is unclear whether secondary burials similar to BHS 18 were also considered as an interpretation. A number of ornamental objects were found at UAQ2. Some may be similar to BHS 18, but there are also marked differences: for instance, there are bitumen beads which have no parallel at BHS 18. A rounded stone pendant differs in material and style from the pointed mother-of-pearl pendants at BHS 18. The presence of composite bracelets made of shell plates, well attested at UAQ2, is not secure at BHS 18.

So, even though the burial types seem similar, the case is not clear for the jewellery. It remains an open question how close the relationship between the two sites was.

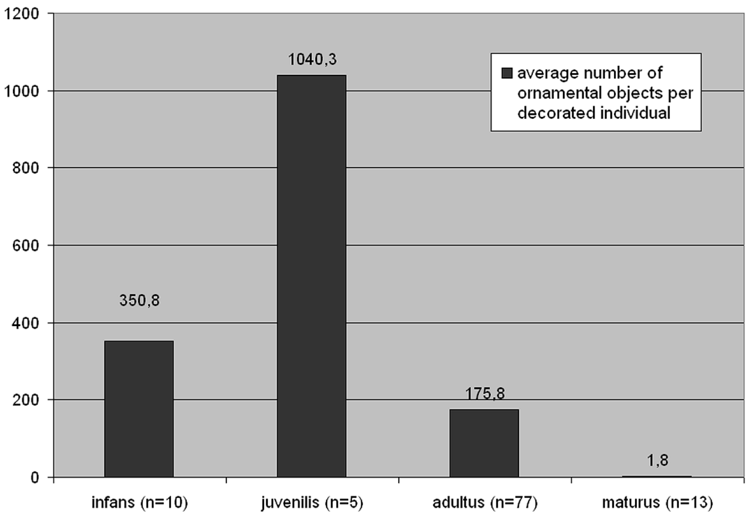


Fig. 6. Number of ornamental objects per decorated individual by age.

Another shell midden site with settlement and graveyard areas is Ra's al-Hamra 5 (RH5). The site was excavated in the Eighties by the Italian Archaeological Mission to Oman and Baluchistan (*Salvatori 1996; Santini 2002*). It is located not far from Muscat on the coast of Oman. The graveyard is dated to *c.* 3800 to 3300 BC (*Biagi 1994*), thus being younger than BHS 18. At least 170 individuals were discovered, some of them in a flexed position, mostly on the right side; others were in bone piles, which are interpreted as secondary burials. Both types show a northeast-southwest orientation, with the skull to the North-East. The graves often have stone coverings and contain animal bones, *e.g.* of marine turtles. Apart from the last characteristic, the similarities to BHS 18 are striking.

Grave goods were mostly personal ornaments. Among these, several types of shell pendant are present: there are laurel-leaf shaped pendants, often decorated with diagonal incisions along the edges: drop shaped ones, which in addition to incisions, feature a pattern of engraved dots; and finally, there are pendants in the shape of a shark tooth. Only the leaf shaped pendants have a resemblance to objects from BHS 18, although the latter lack the incisions. Cylindrical beads apparently occur mainly in necklaces. They are made of dark soapstone and shell, and are often arranged in an alternating pattern similar to BHS 18, but seem to be relatively short in comparison (*Coppa et al. 1985.plate 3*). Interestingly, pierced gastropods do not play an important role at RH5. Only one headdress of *Nassarius sp*. is mentioned. Pearls are also rare. Other ornamental objects include an important number of composite shell bracelet elements, as well as soapstone earrings and bone pins. None of these can serve as a link to the BHS 18 graveyard. Finally, some oval soapstone beads and cylindrical beads made of bird bones and *Dentalium sp*. are noteworthy. They are rare and occur only in a certain part of the site (area 43), thus appearing to be intrusive.

The best link between the jewellery from BHS 18 and RH5 may be seen in the tubular beads, and especially in the alternating arrangement of these beads, as well as in the presence of leaf-shaped pendants. On the other hand, there are ornamental objects which lack any parallel at BHS 18, while conversely, certain bead types from BHS 18, like the massive barrel shaped beads, do not occur at RH5. The same can be said for the most common gastropod species, *Ancilla cf. farsiana*. Both populations made use of different resources and probably of different mollusc habitats. In the end, the observed parallels in burial types, especially skeletal position and orientation, document a relatively widespread homogeneity – spatially and chronologically – in these questions in the Neolithic of the Oman Peninsula (*Charpentier et al. 2003*). The importance of personal ornaments as grave goods was also a widespread phenomenon. Seemingly, jewellery types were subject to more local variability, but certain aspects also show much continuity.

Conclusion

The observed continuities from BHS 18 to RH5 in burial style and jewellery are the starting point for some thoughts on the end of occupation at BHS 18. The abandonment of the site around 4200 BC is seen as the result of a major climatic deterioration around this time. Increased aridity had dramatic effects in Southeast Arabia. Probably, the drying up of the spring at Jebel al-Buhais is part of this development. Apparently, it was no longer possible to maintain the mobile herding economy with seasonal stays in the interior of the Oman Peninsula. The coasts could be considered possible areas of retreat for the desert pastoralists. On the Arabian Gulf coast, however, the depopulation is only delayed for some time. The situation is different on the Omani coast, where shell midden sites are well attested for the 4^{th} millennium BC. This can be explained by a more favourable geomorphology, which not only assures fresh water from the wadi beds in the nearby mountains, but also leads to a more diverse environment, potentially richer in resources. Consequently, the relocation of the al-Buhais population to this coast has to be considered a very likely possibility.

In this context, the observed similarities in jewellery and burial style between BHS 18 and RH5 are an important indication of cultural continuity. Several hundred years lie between the end of BHS 18 and the beginning of the RH5 graveyard, so that a direct continuation of jewellery style would be surprising, even more because the population experienced major changes in their subsistence economy and activity areas. It is natural that new preferences in ornamental objects developed. On the other hand, some traditions remained alive, such as the fondness for leaf-shaped shell pendants and tubular beads in contrasting colours, and help us trace the fate of the al-Buhais desert nomads.

REFERENCES

BIAGI P. 1994. A radiocarbon chronology for the aceramic shell-middens of coastal Oman. *Arabian Archaeology and Epigraphy 5: 17–31*.

CHARPENTIER V., MARQUIS P., PELLÉ É. 2003. La nécropole et les derniers horizons Ve millénaire du site de Gorbat al-Mahar (Suwayh, SWY-1, Sultanat d'Oman): premiers résultats. *Proceedings of the Seminar for Arabian Studies 33: 11–19*.

COPPA A., MACCHIARELLI R., SALVATORI S., SANTINI G. 1985. The Prehistoric Graveyard of Ra's al-Hamra (RH5): (A short preliminary report on the 1981–83 excavations). *Journal of Oman Studies 8: 97–102*.

DE BEAUCLAIR R. 2005. Seashells in the Desert. A Study of Personal Adornments from the Neolithic Graveyard of al-Buhais 18, Sharjah, U.A.E. Master thesis, Eberhard Karls Universität Tübingen.

in press. *La parure funéraire de la nécropole néolithique de Jebel al-Buhais 18 (Émirats Arabes Unis)*. Préhistoire Anthropologie Méditerranéennes 14.

DE BEAUCLAIR R., JASIM S. A., UERPMANN H.-P. 2006. New results on the Neolithic jewellery from al-Buhais 18, UAE. *Proceedings of the Seminar for Arabian Studies 36: 175–187*.

HERTZ R. 1907. Contribution à une étude sur la représentation collective de la mort. *L'année sociologique 10: 48–137*.

JASIM S. A., UERPMANN H.-P., UERPMANN M. 2005. Neolithic Life and Death in the Desert – 8 seasons of excavations at Jebel al-Buhais. In P. Hellyer and M. C. Ziolkowski (eds.), *Proceedings of the 1st Annual Symposium on Recent Palaeontological & Archaeological Discoveries in the Emirates, Al Ain 2003*. Al Ain: Zayed Center for Heritage and History: 29–36.

KIESEWETTER H. 2006. Analyses of the Human Remains from the Neolithic Cemetery at al-Buhais 18 (Excavations 1996–2000). In H.-P. Uerpmann, M. Uerpmann, S. A. Jasim (eds.), *Funeral Monuments and Human Remains from Jebel al-Buhais, vol. 1*. The Archaeology of Jebel al-Buhais. Sharjah, United Arab Emirates. Tübingen: Department of Culture and Information, Government of Sharjah, U.A.E./Kerns Verlag: 103–380.

KIESEWETTER H., UERPMANN H.-P., JASIM S. A. 2000. Neolithic jewellery from Jebel al-Buhais. *Proceedings of the Seminar for Arabian Studies 30: 137–146*.

KUTTERER A. U., DE BEAUCLAIR R. in press. FAY–NE15 – Another Neolithic graveyard in the Central Region of Sharjah Emirate? Arabian Archaeology and Epigraphy.

PHILLIPS C. S. 2002. Prehistoric Middens and a Cemetery from the Southern Arabian Gulf. In S. Cleuziou, M. Tosi, J. Zarins (eds.), *Essays on the Late Prehistory of the Arabian Peninsula, vol. 93*. Serie Orientale Roma. Roma: Istituto Italiano per l'Africa e l'Oriente: 169–186.

SALVATORI S. 1996. Death and ritual in a population of coastal food foragers in Oman. In G. E. Afanas'ev, S. Cleuziou, J. R. Lukacs, M. Tosi (eds.), *The prehistory of Asia and Oceania*. Colloquium XXXII: Trade as a Subsistence Strategy. Post-Pleistocene Adaptations in Arabia and Early Maritime Trade in Indian Ocean. XIII International Congress of Prehistoric and Protohistoric Sciences, vol. Coll. 16. Forli, Italy: Abaco: 205–222.

SANTINI G. 2002. Burial Complex 43 at the Prehistoric Graveyard of Ra's al-Hamra in Northern Oman. In S. Cleuziou, M. Tosi, J. Zarins (eds.), *Essays on the Late Prehistory of the Arabian Peninsula, vol. 93*. Serie Orientale Roma. Roma: Istituto Italiano per l'Africa e l'Oriente: 147–167.

UERPMANN H.-P., UERPMANN M., JASIM S. A. (eds.) 2006a. *Funeral Monuments and Human Remains from Jebel al-Buhais. Vol. 1. The Archaeology of Jebel al-Buhais, Sharjah, United Arab Emirates*. Tübingen: Department of Culture and Information, Government of Sharjah, U.A.E./Kerns Verlag.

UERPMANN M. 2003. The Dark Millennium – Remarks on the Final Stone Age in the Emirates and Oman. In D. T. Potts, H. Al Naboodah, P. Hellyer (eds.), *Proceedings of the First International Conference on the Archaeology of the United Arab Emirates*, CD-ROM edition. Trident Press: 73–81.

UERPMANN M., UERPMANN H.-P. 2000. Faunal Remains of Al-Buhais 18: an Aceramic Neolithic site in the Emirate of Sharjah (SE–Arabia) – excavations 1995–1998. In M. Mashkour, H. Buitenhuis, A. L. Choyke, F. Poplin (eds.), *Archaeozoology of the Near East*. Proceedings of the fourth international symposium on the archaeozoology of southwestern Asia and adjacent areas, vol. IV B, Archaeological Research and Consultancy 32. Oxford: Oxbow: 40–49.

UERPMANN M., UERPMANN H.-P., JASIM S. A. 2000. Stone Age nomadism in SE-Arabia – paleo-economic considerations on the neolithic site of Al-Buhais 18 in the Emirate of Sharjah, U.A.E. *Proceedings of the Seminar for Arabian Studies 30: 229–234*.

2006b. Früher Wüstennomadismus auf der Arabischen Halbinsel. In S. R. Hauser (ed.), *Die Sichtbarkeit von Nomaden und saisonaler Besiedlung in der Archäologie*. Multidisziplinäre Annäherungen an ein methodisches Problem. Mitteilungen des SFB "Differenz und Integration", 9, vol. 21, Orientwissenschaftliche Hefte. Halle/Saale: Orientwissenschaftliches Zentrum der Universität Halle-Wittenberg: 87–103.

VAN GENNEP A. 1986. *Übergangsriten (Les rites de passage)*. Frankfurt, New York: Campus.

VANHAEREN M. 2002. Les fonctions de la parure au Paléolithique supérieur: de l'individu à l'unité culturelle. Doctorate, Université Bordeaux I.

back to contents

UDK 903.7(410)"634"

Documenta Praehistorica XXXV (2008)

The Stonehenge Riverside Project: exploring the Neolithic landscape of Stonehenge

Mike Parker Pearson[1], Joshua Pollard[2], Colin Richards[3], Julian Thomas[3], Chris Tilley[4] and Kate Welham[5]

1 Department of Archaeology, University of Sheffield; 2 Department of Archaeology and Anthropology, University of Bristol, Julian.Thomas@manchester.ac.uk*; 3 School of Arts, Histories and Cultures, University of Manchester; 4 Department of Anthropology, University College London; 5 School of Conservation Sciences, University of Bournemouth*

ABSTRACT – *The Stonehenge Riverside Project is a collaborative enterprise directed by six academics from five UK universities, investigating the place of Stonehenge within its contemporary landscape. In this contribution, a series of novel approaches being employed on the project are outlined, before the results of investigations at the Greater Stonehenge Cursus, Woodhenge, the Cuckoo Stone and Durrington Walls are discussed.*

IZVLEČEK – *Stonehenge Riverside Project je skupen projekt, ki ga vodi šest profesorjev s petih univerz Združenega kraljestva Velike Britanije. Ukvarjamo se s položajem Stonehenga v takratni pokrajini. V prispevku predstavljamo vrsto novih pristopov, ki smo jih uporabili v projektu, kot tudi rezultate raziskav Greater Duringhton Cursus, Woodhenge in Durrington Walls.*

KEY WORDS – *Stonehenge; Durrington Walls; Southern Britain; monumentality; landscape*

Introduction: the landscape of Stonehenge

Stonehenge is a national symbol, recognised throughout the world, and interpreted in different ways by a wide variety of constituencies, from Druids to New Age enthusiasts (*Chippindale 1990*) (Fig. 1). It has served as a focus for contemporary cultural and political struggles, and has a special place in popular culture and the public imagination (*Bender 1998; Worthington 2004; 2005*). Yet the attention that Stonehenge attracts sometimes occludes its place within a broader landscape, a World Heritage Site composed of a great many structures and deposits that built up over dozens of generations (*Darvill 2005*) (Fig. 2). This process arguably began with the construction of an arrangement of huge post-holes dating to the eighth millennium BC (in the earlier Mesolithic), discovered when the car-park for Stonehenge itself was constructed in 1966 (*Cleal, Walker and Montague 1995.43*). This clearly refutes the argument that only agriculturalists build monuments (*e.g. Rowley-Conwy 2004.85*), but it also potentially demonstrates the longevity of special places within this particular landscape. During the early 1980s, a very important programme of investigation was conducted by Julian Richards, under the rubric of the Stonehenge Environs Project. This combined targeted excavations with extensive field walking to identify the surface concentration of lithics (*Richards 1990*). The intention of this project was to place the known field monuments into a clearer chronological framework, and to identify complementary domestic and industrial activity in their immediate surroundings.

The publication of the Stonehenge Environs Project, and that of the various excavations by Gowland, Hawley, Atkinson, Piggott, Stone, and the Vatchers at Stonehenge itself during the course of the twentieth century (*Cleal, Walker and Montague 1995*) represent an unparalleled contribution to knowledge. However, for more than twenty years the pursuit of archaeological investigations on any scale within the Stonehenge landscape has been curtailed by the continuing deliberations over the future of the A303 trunk road (which runs immediately to the south of the monument). Potential options have included the possibility of running the major road through a bored tunnel, closing the stretch of the A344 road that severs Stonehenge from the Avenue which connects it to the River Avon, and establishing a visitor centre to replace the present subterranean structure beside the car-park. At present, it appears that only the improvements to visitor facilities are likely to proceed in the foreseeable future (*Harris 2007*). Irrespective of the view that one might take of this outcome, the effective hiatus affecting archaeological research in the Stonehenge landscape has coincided with a period of heightened debate over the character of social archaeology, particularly as it relates to the British Neolithic (*e.g. Barrett 1994; Bradley 1998; Whittle 2003*). As a result, until now the opportunity has not arisen to 'field trial' a variety of new ideas and approaches in the immediate context of Stonehenge. While hypotheses and arguments concerning Stonehenge have continued to be constructed, they have had to rely on existing evidence, often collected according to the research agendas of past generations.

New approaches to the landscape

The Stonehenge Riverside Project is a collaborative research initiative directed by six academic archaeologists from five different British universities. It brings a series of novel approaches to bear on the development of the Stonehenge landscape, and we can begin this contribution by outlining each. The first is a concern with what we might call the 'materiality of monuments': that is, an interest in the physicality and constituent substances involved in monument building. These issues animated a pioneering study by Parker Pearson and Ramilsonina (*1998*), who drew on a parallel with contemporary Madagascar to suggest that monuments constructed of timber and stone respectively may have been understood in different ways by Neolithic people. For many Malagasy communities, the human body is considered to be soft and wet at birth, maturing to greater hardness and dryness, and culminating in the exceptionally hard and dry character of the bones of the ancestral dead. Consequentially, while the living inhabit houses made of wood, whose organic character has much in common with human flesh, stone tombs and standing stones are the exclusive prerogative of the dead. In a similar way, Parker Pearson and Ramilsonina noted that while Stonehenge is distinguished by its multiple stone settings, the presence of numerous cremation burials, and a general paucity of ceramics and human remains, the much larger henge monument at Durrington Walls,

Fig. 1. Stonehenge, seen from the north-east (photo: Aerial-Cam).

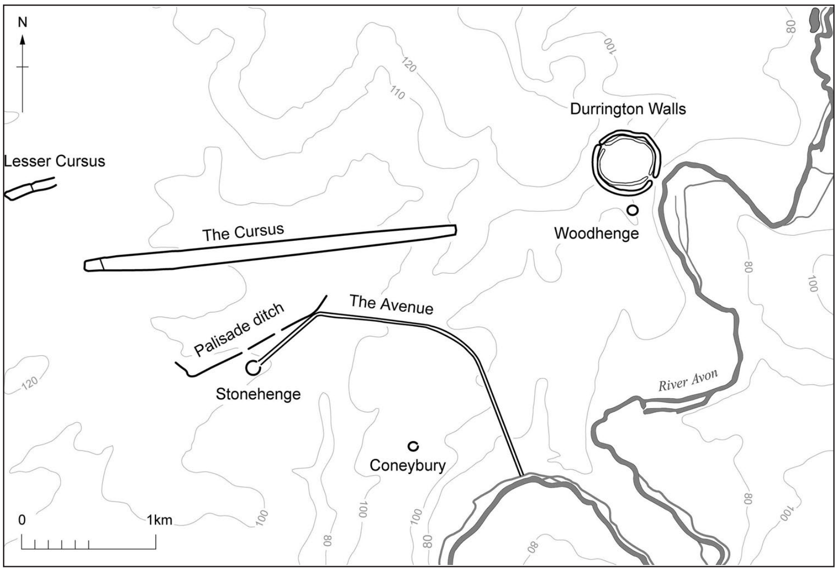


Fig. 2. Map of prehistoric monuments in the Stonehenge area (drawing: Anne Leaver).

3 kilometres to the north-east, showed a very different pattern. Here, there were multiple settings of upright timbers inside a massive earthwork enclosure, and colossal quantities of animal bones and Grooved Ware pottery (*Wainwright and Longworth 1971*). On this basis, Parker Pearson and Ramilsonina hypothesised that the two monuments might have been focal to two distinct areas of the landscape, reserved for the living and the dead, and linked by the River Avon. The transformation of the newly dead into ancestors might then be physically expressed through the passage downriver, from Durrington Walls to Stonehenge. Such an argument at once draws our attention to the complementarity of the two monuments, to the way that what are often understood as separate structures may form parts of a single complex, and to the axial role of the River Avon within the Stonehenge landscape.

This emphasis on the material substance of monumental constructions is complemented by a concern with the construction of monuments as a collective social practice (*Richards 2004*). Rather than a simple exercise in ergonomics, the creation of elaborate works like Stonehenge and Durrington Walls involved the mobilization of large numbers of people, materials, animals and food, in an enterprise that could generate prestige and fame for the builders, but which also risked shame and failure if the desired outcome was not achieved. Moreover, addressing the physical composition of monuments encourages us to think about their varying temporal qualities: the way that their decay, destruction or endurance conditions and contributes to quite different histories or biographies of place (*Thomas 2004*).

A second theme is provided by a new attentiveness to the disposition of materials in the archaeological record, informed by the concept of 'structured deposition'. This originated in work undertaken by two of the authors in the 1980s, re-assessing the evidence from Geoffrey Wainwright's excavations at the Durrington Walls henge, and suggesting that many of the deposits at the site had been deliberately placed, as one aspect of ritual activity (*Richards and Thomas 1984*). More recently, increasingly sophisticated analyses have drawn attention to the important role of depositional practice in transforming the meaning of place, and in engendering memory (*Pollard 1995; 2001*). Both within monumental structures and in isolated pits dispersed across the landscape, the placement of artefacts and other materials appears to have been one of the key means by which people expressed their connection with specific locations during the British Neolithic (*Garrow 2006*).

Fig. 3. The Greater Stonehenge Cursus under excavation, summer 2007 east (photo: Aerial-Cam).

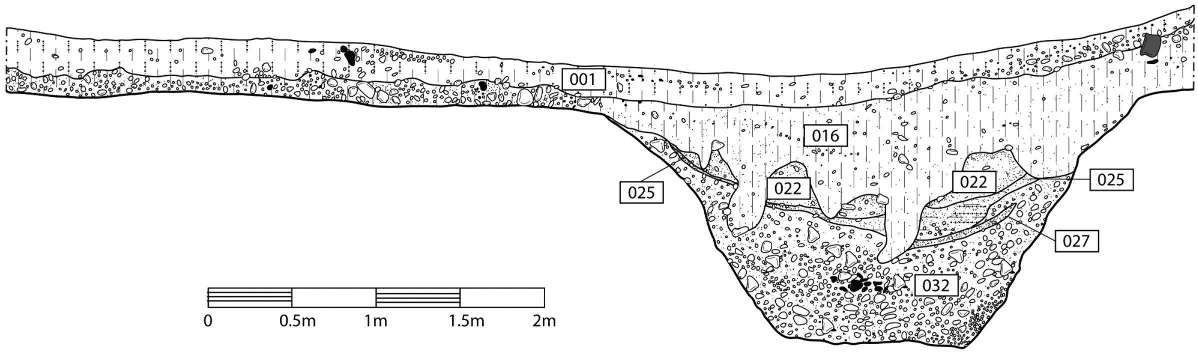


Fig. 4. Section of the Greater Stonehenge Cursus at its western terminal (drawing: Julia Roberts).

Our third preoccupation is what we might call the 'phenomenology of landscape', or an approach to field survey that stresses the experiential qualities of places and monuments (*Tilley 1994*). Although the area surrounding Stonehenge has been subject to exhaustive survey and mapping, from the work of Sir Richard Colt Hoare and Philip Crocker (*Hoare 1810*) down to the high quality investigations of English Heritage (*e.g. McOmish, Field and Brown 2002*), it is arguable that a concern with the way that the landscape might be engaged with from a human perspective is capable of generating fresh insights. Both in terms of the architectural organisation of specific monuments, and in relation to the wider landscape, a number of novel observations have been generated (*Tilley et al. 2007*). In harmony with some of the arguments already outlined, it is clear that the River Avon and the system of dry valleys with which it articulates had a fundamental role in influencing the location of a variety of structures throughout the Neolithic and Early Bronze Age. As well as delimiting areas of higher ground, the valley systems define a series of potential routes through the landscape, so that significant structures may have been positioned in such a way as to be encountered by people and their animals in the course of their daily or seasonal movements. Equally, Beacon Hill, a distinctive natural eminence formed by the intersection of the chalk with the pebble deposits of the Reading Beds, seems to be visible from or aligned upon by almost all of the Neolithic and Early Bronze Age constructions in the whole landscape, including Stonehenge itself (*Tilley et al. 2007.189*). While Beacon Hill possesses no upstanding prehistoric features of its own, its evident influence on the development of the monumental landscape demonstrates that 'natural' topographic features often hold great significance.

Finally, the Stonehenge Riverside Project has sought to employ a series of new field technologies, many of which have not previously been used in the Stonehenge area. As well as very large areas of GPS, magnetometer and resistivity survey, the project has made use of ground-penetrating radar, laser scanning of archaeological features, and unmanned photographic aircraft. At the Durrington Walls henge, for instance, this work has revealed two formerly unknown blocked entrances through the henge bank, and the causewayed character of the ditch, indicating that this was probably dug in sections by a series of work-gangs.

Monuments as places of enduring significance

The earliest site investigated under the aegis of the project is also the largest. The Greater Stonehenge Cursus is a linear enclosure over a mile long, which runs between the King Barrow Ridge and Fargo Ridge, immediately north of Stonehenge (*Stone 1947; Christie 1963*) (see Fig. 2). The Cursus is intimately associated with a series of Early Neolithic long barrows, including Amesbury 42, which runs parallel with its eastern terminal (*Richards 1990. 96*). However, the only radiocarbon date that has previously been derived from it falls in the mid-third millennium cal BC, in our Later Neolithic (2890–2460 cal BC; OxA-1403). In the summer of 2007, excavations were able to demonstrate that this date had come from one of a series of intrusive features, which formed the first of two phases of re-cutting in the cursus ditch (Fig. 3) (*Thomas et al. 2008*). Clearly, the cursus was a very long-lived structure, which was repeatedly re-established over a long period of time. This was underlined by radiocarbon determinations from a piece of antler located on the bottom of the ditch at its western terminal, which calibrated to 3632–3375 BC and 3630–3370 BC at the 95.4% confidence level (OxA-17953 and OxA-17954) (Fig.4). This is roughly half a millennium earlier than the earliest phase of construction at Stonehenge itself, so that the cursus can be said to have had an impor-

Fig. 5. The Cuckoo Stone: excavations 2007 (photo: Aerial-Cam).

tant role in structuring the landscape into which Stonehenge was placed. In the course of excavation it was also recognised that the initial laying-out of the structure involved an alignment on Beacon Hill, tying the enclosure into the local topography. Neither geophysics nor excavation could locate any internal features, and the ditches contain so little material culture that we were very lucky to recover the one piece of antler noted above. So, unlike other Neolithic structures in the area, the cursus gives little indication of having been used for ceremonial, consumption or deposition, and this supports the idea that it enclosed a venerated, sanctified or cursed area, which was set apart from the rest of the landscape.

Immediately to the east of the Cursus, and in line with its axis, excavation was conducted during 2007 at the Cuckoo Stone, a formerly upstanding sarsen monolith (Fig. 5). This is one of two isolated sarsen stones that have been investigated by the project, and both here and at the Tor Stone on Bulford Hill, the stone socket and the hole from which the stone was quarried were discovered. This is of particular importance as there has been a continuing debate in the literature over the question of whether some of the sarsens at Stonehenge could have been acquired locally, or whether they must all have been dragged from the Marlborough Downs, nearly 20 miles to the north (*Stone 1924.69; Atkinson 1956.110*). Evidently, we have two examples of sarsen stones recovered from the chalk of Salisbury Plain. Both the Cuckoo Stone and the Tor Stone seem to have been set up in the Neolithic, and to have formed a focus for Neolithic pits, Early Bronze Age urned cremations, and in the case of the Cuckoo Stone, a Roman shrine. So as at the Cursus we have a sense of a particular site maintaining its importance over an exceedingly long period.

The same is true of Woodhenge, the small late Neolithic enclosure just south of Durrington Walls originally excavated by Maud Cunnington in the 1920s (*Cunnington 1929*). Here, excavation in 2006 revealed that the bank overlay a tree-hole which had been filled with large quantities of Early Neolithic carinated bowl pottery, before being covered over by a chalk capping. Moreover, the concentric timber circles that Cunnington had excavated proved to have been succeeded by two separate phases of stone settings, again indicating a very long-lived structural sequence (*Pollard and Robinson 2007. 162*) (Fig. 6). In 2007, immediately to the south of Woodhenge, in an area of Bronze Age ring-ditches which had also been investigated by Cunnington,

Fig. 6. Excavations at Woodhenge, 2006 (photo: Aerial-Cam).

three separate Late Neolithic timber structures were encountered, each composed of four main uprights, with two entrance posts and, in some cases, an enclosing palisade (Fig. 7). Although these were not roofed structures, their architecture seems to relate to the small houses of the Late Neolithic Grooved Ware tradition (see below). In this respect, they are very relevant to the evidence that was recovered immediately to the north, at Durrington Walls.

Fig. 7. Exacavation of Late Neolithic timber structures, amongst Early Bronze Age ring ditches, south of Woodhenge 2007 (photo: Aerial-Cam).

Durrington Walls

Durrington Walls is the largest henge monument in Britain, with an overall diameter of nearly half a kilometre (Fig. 8). Henges are a type of enclosure dating to the later Neolithic, from 3000 BC onwards, distinguished by having an external bank surrounding an internal ditch. For the most part, they are considered to have been ceremonial, and non-domestic in character, the enclosure keeping something in – or at least secluding it, rather than keeping enemies out (*Wainwright 1989. 14*). When Geoffrey Wainwright excavated at Durrington in 1966–7, in advance of road-building, the strip that he cut across the enclosure was the largest prehistoric excavation that had ever taken place in Britain (*Wainwright and Longworth 1971; Pitts 2000.55*). Wainwright's excavation revealed colossal banks and ditches and massive timber circles, and produced prodigious quantities of Grooved Ware, animals bones, and stone tools. His work transformed our understanding of the Neolithic in southern Britain but, because it was a rescue project conducted under formidable time constraints, it left a series of questions unanswered. Forty years later, new excavations conducted as part of the Stonehenge Riverside Project sought to complement the extensive work of the 1960s with a more targeted, intensive approach.

The initial decision to excavate outside of the eastern entrance of the Durrington Walls henge was based on the hope of discovering an avenue connecting the henge to the River. This would confirm the link between Durrington and Stonehenge. Just such an avenue was found in 2005, actually a huge metalled roadway, 30 metres wide, with a bank and gully on either side, leading for 170 metres down to the river. The avenue had traces of extensive trampling down the middle, and large quantities of highly fragmented animal bones and Grooved Ware pottery scattered on either side. It was re-surfaced on two occasions, and had a line of upright sarsen stones running down one side (*Parker Pearson 2007.130*).

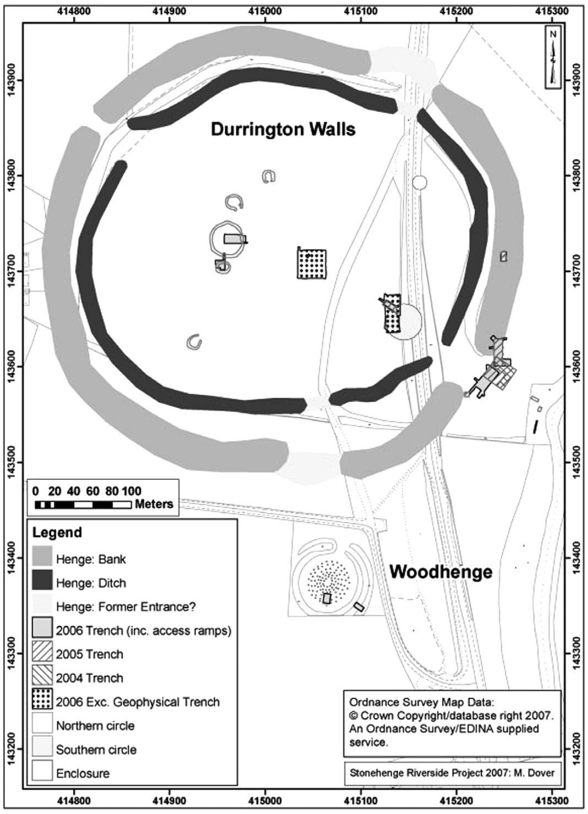


Fig. 8. Durrington Walls: areas excavated 2004–7 (drawing: Mark Dover).

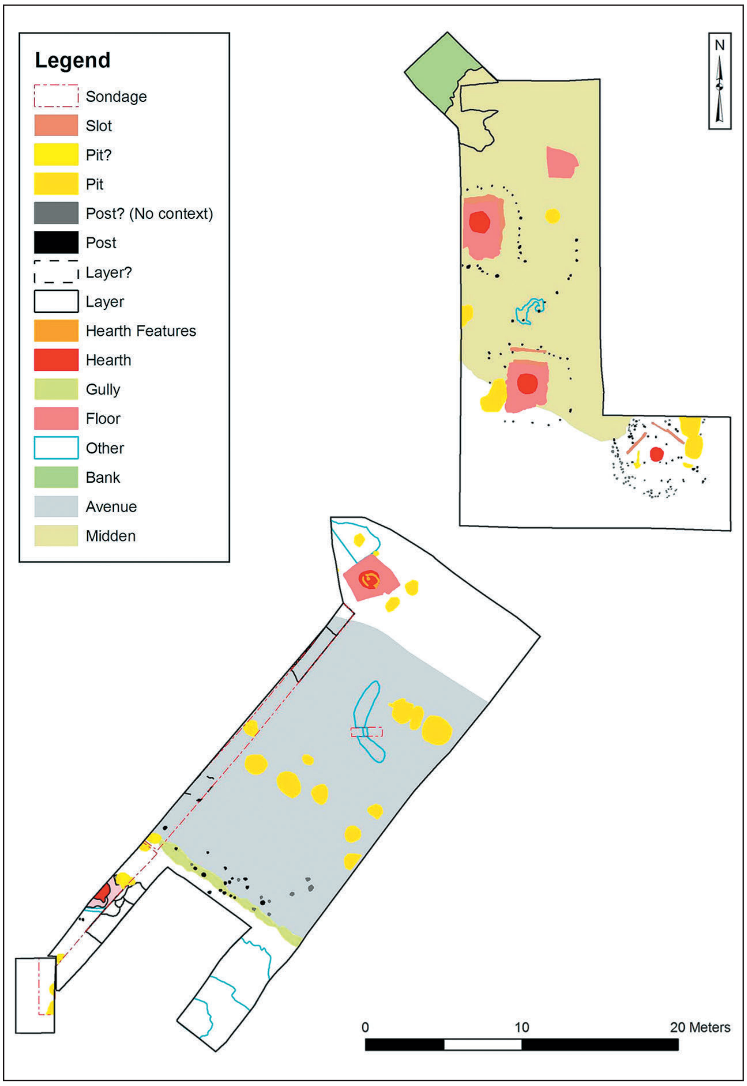


Fig. 9. Plan of excavations at the eastern entrance, Durrington Walls, 2004–7, showing the Avenue and Neolithic house floors (drawing: Mark Dover).

This last point invites comparison with the West Kennet Avenue, connected to the Avebury henge in north Wiltshire, but in the local context, it is clear that this roadway is the equivalent of the Stonehenge Avenue, linking the henge to the river, and in a way that has an astronomical alignment complementary to that at Stonehenge. The stone settings at Stonehenge face the midsummer sunrise, while the Stonehenge Avenue is aligned on the midwinter sunset; the southern timber circle inside Durrington Walls faces the midwinter sunrise, and the Durrington Avenue aligns on the midsummer sunset. The implication is that one might process from Durrington to Stonehenge at midwinter, and in the opposite direction at midsummer, passing over or through the purifying or transforming waters of the river in the process. Recent reconsideration of the radiocarbon dates from Stonehenge has demonstrated that the sarsen stones and the avenue can be placed in the mid-third millennium cal BC, contemporary with Durrington Walls (*Parker Pearson et al. 2007.627*), so we are entitled to see the two monuments as parts of a single, integrated structure.

Although the potential presence of the avenue was the initial reason for excavating at the eastern entrance, the presence of seven small houses of Late Neolithic date, clustered around the roadway (Fig. 9) was a complete surprise. Two of these were located on opposite banks of the avenue, and appear to have been open on their eastern sides, facing toward the river. Only a very few such houses have been found on the British mainland, and never as a substantial settlement, so the only real parallels are the villages of stone cellular buildings in the Orkney Isles of northern Scotland, such as Skara Brae, Rinyo and Barnhouse (*Childe 1931; Childe and Grant 1947; Richards 2003*). Like the Orcadian houses, the Durrington buildings have clay floors and central hearths, but their walls were of wattle and daub rather than stone (Fig. 10). Several of the houses had floor levels that had been terraced back into the hillside, and some were separated by fence-lines, against which waste materials in the form of burnt flint, flint cores and animal bones had been flung (Fig. 11). Associated with the houses were borrow pits, from which the daub had been acquired, and other pits containing dense deposits of animal bone and pottery, as well as large numbers of flint arrowheads. The buildings appear to have been abandoned with some formality: three had a single human bone deposited close to them, and two had deposits of cattle vertebrae placed into their hearths.

Several of the structures were stratified beneath the henge bank, which indicates that both the houses and at least the first phase of the avenue pre-date the construction of the bank and ditch. It is likely that the enclosure of the great natural amphitheatre of Durrington Walls may have been made at the very end of the Neolithic (at around 2500–2400 BC), and that there was a complex sequence of structures of

Fig. 10. Two of the house floors at the eastern entrance, Durrington Walls (photo: Aerial-Cam).

various kinds that culminated in this event, and which paralleled the sequence at Stonehenge. At various points around its circumference, excavations (whether for the purposes of research or for pipe trenches) have cut through the bank, and in every case a dense spread of cultural material has been encountered, similar to that spread over the settlement area (*e.g. Stone, Piggott and Booth 1954*). The implication is that a Late Neolithic settlement covered the entire area covered by the henge bank, and that it was very large indeed. None the less, this settlement was clustered around a roadway leading to an enormous timber circle (see below) and was close to the group of non-domestic timber structures identified south of Woodhenge (see above), indicating that the immediate location was rather special even before the henge bank and ditch were constructed. It is open to question whether the huge accumulation of houses at Durrington represents a typical Late Neolithic habitation, fortuitously preserved under the combination of bank and hill-wash, and whether we should expect to find numerous such settlements in future.

There are several strands of evidence that suggest that the situation was not straightforward. Some of the anticipated signs of year-round domestic activity are missing. Despite having subjected enormous numbers of soil samples to flotation, no cereal grains or glume fragments have been recovered from the settlement area: the only cereal remains came from the surface of the avenue. This is complemented by a complete absence of grinding stones. Amongst the assemblage of 80 000 pig and cattle bones, there are no neonates at all, suggesting that animals were brought to the site and not raised in the immediate area. The lithic assemblage from the settlement is dominated by transverse arrowheads, with few scrapers and knives, and no flint or stone axes. All of this suggests temporary (perhaps seasonal) rather than permanent habitation. There are very large numbers of domesticated pig bones, but some of these animals seem to have been shot with arrows and then barbequed. This does not suggest conventional culinary behaviour, and there are strong indications that periodic feasting took place (*Albarella and Serjeantson 2002*). An unusual proportion of the animal bones are complete and hundreds were discarded still in articulation. Tooth eruption evidence suggests that most of the pigs were killed at about nine months old, most likely in the midwinter period. Given the

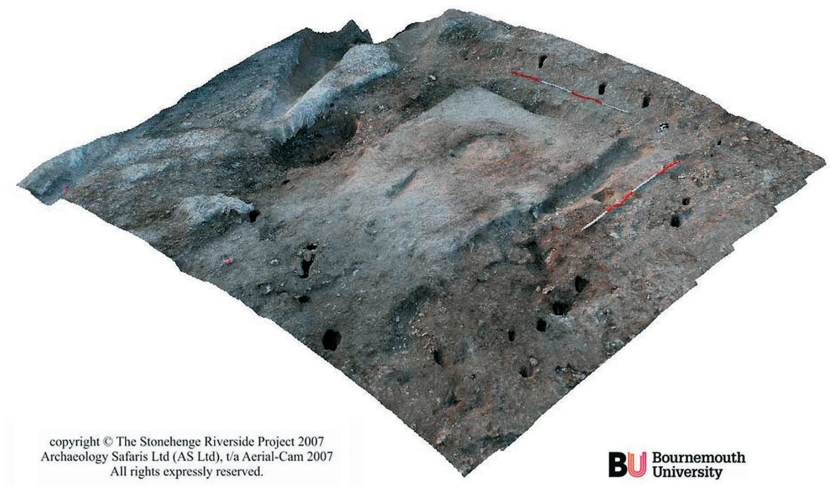


Fig. 11. Laser scan of the surface of a Neolithic house-floor, eastern entrance, Durrington Walls (image: Kate Welham/Mark Dover).

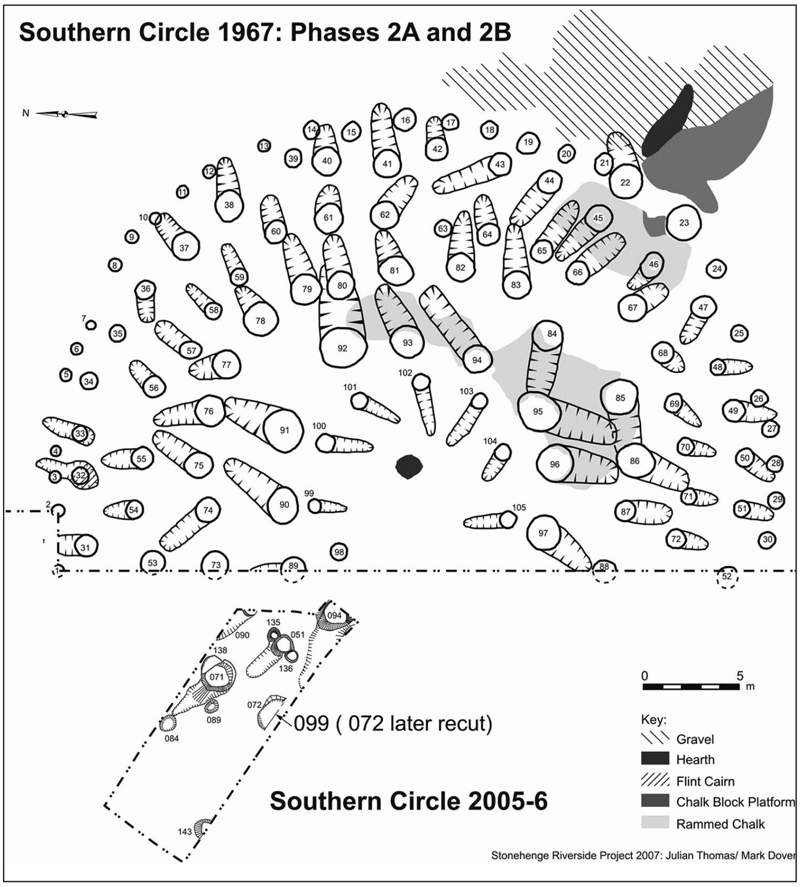


Fig. 12. The Southern Circle, Durrington Walls: plan of excavations 1967 and 2005–6 (drawing: Mark Dover).

midwinter solstice alignments at Stonehenge and at four of the Durrington timber monuments, it is likely that this was a major calendrical event. The first few radiocarbon determinations for the settlement show that it was occupied in the 26th century BC. Some of the house floors were re-plastered up to seven times, and the inter-cutting of the borrow pits associated with each house suggests up to a dozen episodes of repair for the walls and floors. However, this might still mean that the overall inhabitation of the settlement was comparatively brief. Further radiocarbon dates may tell us whether the site served as a centre for seasonal gatherings or pilgrimage for many decades, or whether it represents a single significant episode, such as an accumulation of population to build the stone settings at Stonehenge.

The Southern and Western Circles at Durrington Walls

Some indication of the character of the activity at Durrington Walls is provided by a series of structures enclosed inside the henge bank and ditch further to the west. The Southern Circle was a two-phase timber structure composed of six concentric rings of upright posts, 60% of which was excavated by Wainwright in 1967 (*Wainwright and Longworth 1971.23*) (Fig. 12). A further timber structure, the Northern Circle, was also identified in the same excavation. On its eastern side the Southern Circle intersected with a chalk and gravel platform, which we can now identify as the western extremity of the Durrington Avenue, leading down to the river. This provides a stratigraphic link that places the circle earlier than the henge bank and ditch: the timbers of the Southern Circle penetrated the surface of the avenue, but their post-holes were in some cases masked by it. Another element of the Southern Circle complex, originally identified as an enclosed midden, can now be reconsidered in the light of the discoveries at the eastern entrance. It is very likely that this represented a large, hall-sized building with a terraced floor area surrounded by stakehole-defined walls. Wainwright considered that the timber circle had itself been a massive roofed building, comparable with the 'council houses' of certain Native American communities (*Wainwright and Longworth 1971.232*). However, subsequent investigation of some even larger timber circles has demonstrated that they were simply too big to be roofed, and the same was probably true of the Southern Circle (*David et al. 2004*) (see Fig. 13 for the probable appearance of the Southern Circle in its second phase). While there were indeed two phases of construction, our re-excavation in 2005–6 demonstrated that some of what had been identified as postholes of the first phase were actually integral to the second, standing on either side of individual larger posts, and perhaps supporting sections of fencing or shuttering. The structure thereby defined establishes a secluded inner space within the circle, comparable with the innermost area of Stonehenge. Tellingly, this structure respects the spiral entrance passage to the second-phase circle. The implication of this is that the first phase circle was comparatively modest, composed of four main posts, surrounded by a single post-ring, attached to an avenue and façade. This would make it very similar to both the Northern Circle, and the structures excavated south of Woodhenge (see above).

Fig. 13. Full size reconstruction of the Southern Circle, constructed for the Time Team TV programme (photo: Julian Thomas).

Another issue addressed through re-investigating the Southern Circle was that of deposition. Wainwright's original interpretation for the concentration of finds in the upper parts of the post-hole fills was that, within the roofed building, sherds of pottery, animal bones and other objects had been placed as offerings at the bases of the timber uprights. When the latter had rotted out, the objects fell into what he referred to as 'weathering cones' (*Wainwright and Longworth 1971.24–5*). These he argued to have been formed by the erosion of the post-packing, following the decay of the posts. However, this interpretation was open to question. If we accept that the structure was unroofed, it is hard to see how pottery sherds and animal bones could have survived on the surface for some decades in an unabraded state, before falling into the weathering cones. In all of the post-holes excavated in 2005–6, it was clear that the so-called 'weathering cones' were actually conical re-cuts, dug after the posts had rotted out (see Fig. 14).

Inside these re-cut features, deposits of flints and animal bones had clearly been placed, or at least dumped, rather than having fallen haphazardly into eroding post-pipes. Animal bone predominated, but flint occurred as clusters of waste, often higher in the fill (*Thomas 2007.149*). In all cases, pottery sherds were found almost exclusively in the upper part of the re-cut fill. This suggests a pattern in which sherds were being carefully placed into the tops of the re-cuts following the more summary deposition of flint and bone. It is clear, though, that our excavated area, located opposite the entrance to the circle, produced far smaller quantities of cultural material than the postholes facing toward the avenue and the river, dug in 1967. In other words, the densities of objects placed in each posthole reflected the individual importance of each feature. If this material had been deposited in features that were cut after the posts had rotted out, it must have post-dated the construction and initial use of the circle by one or two generations, if not more. It is possible that this re-cutting took place at much the same time as the enclosure of the Durrington landscape by the henge bank and ditch. It follows that the Southern Circle was ancient and ruinous by the time the re-cutting took place, indicating that the depositional activity was essentially *commemorative* in character. That is to say, digging a hole and placing cultural materials in it was a means of venerating the Circle, its component elements, and the past activities that had taken place within it. The richness of the material deposited in the re-cuts reflected the relative significance of the different parts of the timber circle, even though the structure was by then decrepit. The physical manifestation of the circle

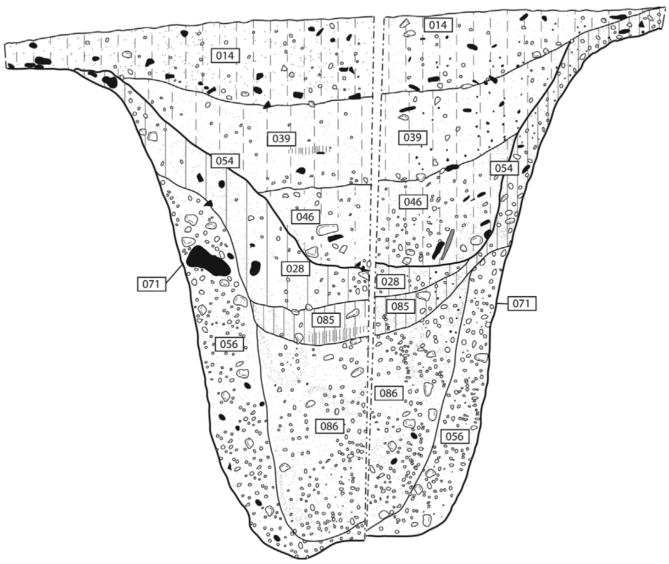


Fig. 14. Section of post-hole 071 in the Southern Circle, showing re-cut pit in the upper fill (drawing: Julia Roberts).

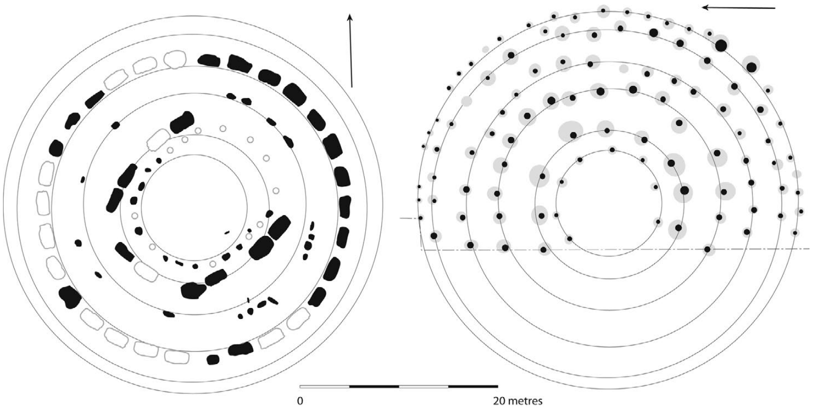


Fig. 15. Comparison of the plans of the Stonehenge stone settings and the Southern Circle (drawing: Julian Thomas).

was then one of collapsed timbers, slumped post-holes, and memories that were brought to mind through acts of deposition. So this was now an 'architecture of memory', commemorated in its absence.

We have noted that the discovery of the roadway demonstrates that Durrington Walls and Stonehenge are effectively parts of a single structure linked by the two avenues and the river. This challenges some of our implicit expectations of monumentality, for rather than being a cultural imposition onto a natural landscape, the Stonehenge-Durrington complex threads together built elements and topography. We might argue that both the Stonehenge and the Durrington avenues were conceptually indistinguishable from the river, and that the two henge enclosures were linked by flows and movements of various kinds. This encourages us to consider the relationship between the Southern Circle and the Stonehenge stone settings at each end of this passage. We might see them as complementary structures: while composed of stone and timber respectively, they are remarkably similar in plan (Fig. 15). The principal sarsen and bluestone settings at Stonehenge have much the same diameters as the four inner rings at Durrington, and similar units of measurement appear to have been used in laying them out (*Chamberlain and Parker Pearson 2007*). Significantly, the interiors of both structures are much the same size, and would have admitted the same number of people. Moreover, we have seen that the Southern Circle may have had a secluded inner space comparable with the Stonehenge sarsen 'horseshoe', while a geophysical survey of the unexcavated portion of the Southern Circle undertaken in 2006 suggests some elements of the Southern Circle may be oval rather than truly circular. It is highly likely that some relationship of mirroring or mimicry existed between the Durrington Southern Circle and the stone settings at Stonehenge.

Further to the west again, on a terrace overlooking the Southern Circle and the eastern entrance, a group of at least six penannular enclosures have been revealed by geophysical survey. While these

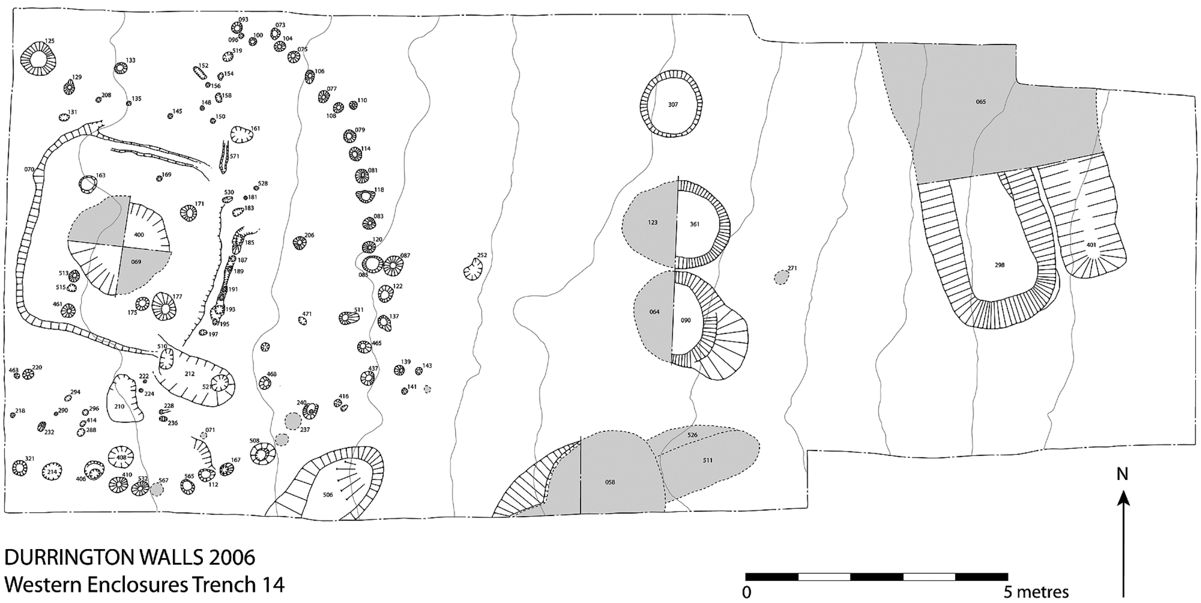


Fig. 16. Plan of enclosed building (Trench 14), Western Enclosures, Durrington Walls 2006 (drawing: Julian Thomas).

Fig. 17. Reconstruction of enclosed building (Trench 14), Western Enclosures, Durrington Walls (image: Aaron Watson).

were reasonably expected to have enclosed burials or more timber circles, the two that were excavated actually contained small buildings not dissimilar to those at the eastern entrance (*Thomas 2007.152*). However, in each case the building was enclosed inside a timber palisade, while each 'house' had four post-holes, presumably roof-supports, surrounding the central hearth (Fig. 16). These were not present in the houses at the eastern entrance. The building in the larger of the two ring-ditches investigated also had a façade of huge posts, so closely-set that they may have represented the equivalent in timber of the Stonehenge trilithons (see Fig. 17). Both buildings appear to have been kept clean in comparison with the filthy houses at the eastern entrance, and the larger one had a pit immediately outside the entrance to the palisade containing distarticulated animal bones and abraded pottery that may have been accumulated in the course of cleaning up.

So were these buildings inside the Western Enclosures elite residences, or were they shrines or cult-houses? The key to this question may lie in their similarity with the first phase of the Southern Circle, with the Northern Circle, and with the structures investigated south of Woodhenge. Here, the familiar architecture of the Grooved Ware house was elaborated upon, and elements that were more usually found in monumental contexts were added to draw attention to the separation between the small enclosed space of the building and the outside world, including the more obviously domestic dwellings. Significantly, Richards (*1993*) has described a similar process in Neolithic Orkney, in which the modular form of the house found echoes in the layout of chambered tombs and henge monuments. At an early stage, the natural amphitheatre of Durrington Walls was occupied by a series of structures that developed a single basic plan in different ways, providing spaces for dwelling and for ritual. Only later did the more complex concentric architecture of the Southern Circle and Woodhenge develop, at a time when the former came to be physically linked to Stonehenge in a new and grand design that drew the entire landscape together. Recognising this, however, depends on acknowledging the long and complex histories of place that the Stonehenge Riverside Project has revealed.

ACKNOWLEDGEMENTS

We thank our colleagues on the Stonehenge Riverside Project, particularly Umberto Albarella, Mike Allen, Mark Dover, Charly French, Karen Godden, Dave Robinson, the site supervisors (Dave Aspden, Ian Heath, Neil Morris, Bob Nunn, Becca Pullen, Jim Rylett, Dave Shaw, Anne Teather), the outreach team and the many students and volunteers who have made this work such a success so far. We also thank Amanda Chadburn, Richard Osgood, Mike Pitts and Julian Richards for their advice and support. Funding for the SRP was provided by the Arts and Humanities Research Council, the British Academy, English Heritage, the McDonald Institute, the National Geographic Society, the Prehistoric Society (who awarded it the Bob Smith Prize), the Royal Archaeological Institute and the Society of Antiquaries. We thank the Rawlins family, the National Trust, Wiltshire County Council and the Ministry of Defence for permission to excavate on their land.

REFERENCES

ALBARELLA U. and SERJEANTSON D. 2002. A passion for pork: meat consumption at the British Late Neolithic site of Durrington Walls. In P. Miracle and N. Milner (eds.), *Consuming Passions and Patterns of Consumption*. McDonald Institute. Cambridge: 33–49.

ATKINSON R. J. C. 1956. *Stonehenge*. Hamish Hamilton. London.

BARRETT J. C. 1994. *Fragments from Antiquity*. Blackwell. Oxford.

BENDER B. 1998. *Stonehenge: Making Space*. Berg. London.

BRADLEY R. J. 1998. *The Significance of Monuments*. Routledge. London.

CHAMBERLAIN A. and PARKER PEARSON M. 2007. Units of measurement in Late Neolithic southern Britain. In M. Larsson and M. Parker Pearson (eds.), *From Stonehenge to the Baltic. British Archaeological Reports. International Series 1692*. Archaeopress, Oxford: 169–74.

CHILDE V. G. 1931. *Skara Brae: A Pictish Village in Orkney*. Kegan Paul. London.

CHILDE V. G. and GRANT W. G. 1947. A Stone-Age settlement at the Braes of Rinyo, Rousay, Orkney (Second Report). *Proceedings of the Society of Antiquaries of Scotland 81: 16–42*.

CHIPPINDALE C. 1990 (ed.). *Who Owns Stonehenge?* Batsford. London.

CHRISTIE P. 1963. The Stonehenge Cursus. *Wiltshire Archaeological Magazine 58: 370–382*.

CLEAL R., WALKER K. and MONTAGUE R. 1995. *Stonehenge in its Landscape: Twentieth Century Excavations*. English Heritage. London.

CUNNINGTON M. E. 1929. *Woodhenge*. Simpson. Devizes.

DARVILL T. C. 2005. *Stonehenge World Heritage Site: An Archaeological Research Framework*. English Heritage. London.

DAVID A., COLE M., HORSLEY T., LINFORD N., LINFORD P. and MARTIN L. 2004. A rival to Stonehenge? Geophysical survey at Stanton Drew, England. *Antiquity 78: 341–358*.

GARROW D. 2006. *Pits, Settlement and Deposition during the Neolithic and Early Bronze Age in East Anglia*. British Archaeological Reports. British Series 414, Archaeopress. Oxford.

HARRIS T. 2007. A303 Stonehenge improvement scheme: statement by the Parliamentary Under-Secretary for Transport. http://www.dft.gov.uk/press/speechesstatements/statements/a303. Consulted 15th March 2008.

HOARE R. C. 1810. *The Ancient History of Wiltshire*. William Miller. London.

MCOMISH D., FIELD D. and BROWN G. 2002. *The Field Archaeology of the Salisbury Plain Training Area*. English Heritage. London.

PARKER PEARSON M. 2007. The Stonehenge Riverside Project: excavations at the east entrance of Durrington Walls. In M. Larsson and M. Parker Pearson (eds.), *From Stonehenge to the Baltic*, British Archaeological Reports. International Series 1692. Archaeopress, Oxford: 125–44.

PARKER PEARSON M. and RAMILSONINA 1998. Stonehenge for the ancestors: the stones pass on the message. *Antiquity 72: 308–26*.

PARKER PEARSON M., CLEAL R., MARSHALL P., NEEDHAM S., POLLARD J., RICHARDS C., RUGGLES C., SHERIDAN A., THOMAS J., TILLEY C., WELHAM K., CHAMBERLAIN A., CHENERY C., EVANS J., KNÜSEL C., LINFORD N., MARTIN L., MONTGOMERY J., PAYNE A. and RICHARDS M. 2007. The age of Stonehenge. *Antiquity 81: 617–39*.

PITTS M. 2001. *Hengeworld*. Arrow Books. London.

POLLARD J. 1995. Inscribing space: formal deposition at the later Neolithic monument of Woodhenge, Wiltshire. *Proceedings of the Prehistoric Society 61: 137–56*.

2001. The aesthetics of depositional practice. *World Archaeology 33: 315–33*.

POLLARD J. and ROBINSON D. 2007. A return to Woodhenge: the results and implications of the 2006 excavations. In M. Larsson and M. Parker Pearson (eds.), *From Stonehenge to the Baltic*. British Archaeological Reports. International Series 1692. Archaeopress, Oxford: 159–68.

RICHARDS C. C. 1993. Monumental choreography: architecture and spatial representation in late Neolithic Orkney. In C. Tilley (ed.), *Interpretative Archaeology*. Berg. London: 143–78.

2004. A choreography of construction: monuments, mobilization and social organization in Neolithic Orkney. In J. Cherry, C. Scarre and S. Shennan (eds.), *Explaining Social Change: Studies in Honour of Colin Renfrew*. McDonald Institute. Cambridge: 103–30.

RICHARDS C. (ed.) 2003. *Dwelling among the Monuments: The Neolithic Village of Barnhouse, Maeshowe Passage Grave and Surrounding Monuments at Stenness, Orkney*. McDonald Institute for Archaeological Research. Cambridge.

RICHARDS C. C. and THOMAS J. S. 1984. Ritual activity and structured deposition in later Neolithic Wessex. In R. Bradley and J. Gardiner (eds.), *Neolithic Studies*. British Archaeological Reports. British Series 133. Oxford: 189–218.

RICHARDS J. 1990. *The Stonehenge Environs Project*. London: English Heritage.

ROWLEY-CONWY P. 2004. How the west was lost: a reconsideration of agricultural origins in Britain, Ireland, and southern Scandinavia. *Current Anthropology 45: 83–113*. Supplement.

STONE E. H. 1924. *The Stones of Stonehenge*. Robert Scott. London.

STONE J. F. S. 1947. The Stonehenge Cursus and its affinities. *Archaeological Journal 104: 7–19*.

STONE J. F. S., PIGGOTT S. and BOOTH A. 1954. Durrington Walls, Wiltshire: recent excavations at a ceremonial site of the early second millennium BC. *Antiquaries Journal 34: 155–77*.

THOMAS J. S. 2004. Materiality and traditions of practice in Neolithic south-west Scotland. In V. Cummings and C. Fowler (eds.), *The Neolithic of the Irish Sea: Materiality and Traditions of Practice*. Oxbow. Oxford: 174–84.

2007. The internal features at Durrington Walls: investigations in the Southern Circle and western Enclosures, 2005–6. In M. Larsson and M. Parker Pearson (eds.), *From Stonehenge to the Baltic*. Oxford: British Archaeological Reports. International Series 1692. Archaeopress. Oxford: 145–58.

THOMAS J., PARKER PEARSON M., POLLARD J., RICHARDS C., TILLEY C. and WELHAM K. 2008. The date of the Greater Stonehenge Cursus. *Antiquity 82: 1–14*.

TILLEY C. 1994. *A Phenomenology of Landscape*. London. Berg.

TILLEY C., RICHARDS C., BENNETT W. and FIELD D. 2007. Stonehenge – its landscape and architecture: a re-analysis. In M. Larsson and M. Parker Pearson (eds.), *From Stonehenge to the Baltic*. British Archaeological Reports. International Series 1692. Archaeopress, Oxford: 183–204.

WAINWRIGHT G. J. 1989. *The Henge Monuments*. Thames and Hudson. London.

WAINWRIGHT G. J. and LONGWORTH I. H. 1971. *Durrington Walls: excavations 1966–1968*. Society of Antiquaries. London.

WHITTLE A. 2003 *The Archaeology of People: Dimensions of Neolithic Life*. Routledge. London.

WORTHINGTON A. 2004. *Stonehenge: Celebration and Subversion*. Alternative Albion. Loughborough.

(ed.) 2005. *The Battle of the Beanfield*. Enabler Publications. Teignmouth.

back to contents

UDK 903.4(4-014)"631/634"
Documenta Praehistorica XXXV (2008)

Cultural landscapes in the lower Danube area. Experimenting tell settlements

Dragos Gheorghiu
Centre of Research, National University of Arts – Bucharest, Romania
Gheorghiu_dragos@yahoo.com

ABSTRACT – *In archaeological research Chalcolithic tells are generally approached as distinct, decontextualized, architectural objects, separated from the other cultural traits which form a whole dwelling complex. A goal of the present paper is to present tells as part of a larger dwelling strategy, under the form of a cultural landscape structured by numerous rites of passage and modelled with fire. The experimental and experiential approaches to understanding the process of construction and of intentional firing, as well as the importance of firescapes in the construction of collective memory are discussed.*

IZVLEČEK – *Arheološke raziskave halkolitskih tellov so ponavadi usmerjene v dekontekstualizirane arhitekturne objekte, ločene od drugih kulturnih elementov, ki sicer definirajo naselbinski kompleks. V razpravi predstavljamo tell naselje kot element širše poselitvene strategije v kontekstu kulturne krajine, ki jo strukturirajo številni rituali povezani z ognjem. Analiziramo eksperimentalne in izkustvene pristope k proučevanju gradnje in namernega požiganja ter njihovega pomena pri oblikovanju kolektivnega spomina.*

KEY WORDS – *experiment; tells; separation; cultural landscapes*

Introduction

Recent decades have witnessed the rise of landscape archaeology, an archaeological sub-discipline which has contributed to a nuanced understanding of the past. A relatively recent trend, based on the spatial experimentation of virtual landscapes reconstructed in 3D (*Forte et al. 2003; Forte 2005; Campana and Forte 2006*), or GIS (*Llobera 2001*), represents a step forward in the evocation of ancient territories, but in spite of its contextualized knowledge, it remains a disembodied intellectual exercise (contra *Horner 2001*), missing the possibility of an authentic approach to the materiality of the environment, as well as to the sensory/motor bodily experience of the populations studied. In this respect, the studies in phenomenological archaeology of the end of the 20th century (*Tilley 1994; Edmonds 1999*) have given rise to a more sensitive interpretation (*Tilley 2004; Thomas 2006; Thomas and Brück 2006; Hamilton et al. 2006*).

Consequently, besides visual experience, the embodied knowledge of the direct sensory experience of the context, representing the experience of the construction of the meaning in the field by relating fragments of geomorphology with cultural traits, and the experience of their materiality, would influence the interpretation of 3rd millennium AD archaeologist (for the dangers of a modern-centrist interpretation in explaining personal phenomenological experience see *Hodder and Hutson 2006.119–121*), and would direct archaeological research to motivating directions in interpreting some vague concepts like space, water, fire or dwelling (*i.e.* landscape) which cannot be explored in depth by current scientific methods.

The present paper tries to implement a mixed approach between archaeological experiment and the sensory embodied experientialism of relevant features of the context, to identify and (partly) explain a number of patterns which define the landscape of the Lower Danube area in the 5th millennium BC. Through the study of the relationship between the body and the structured, built environment (*Bourdieu 1977.89; Bell 1992.98*) of Chalcolithic communities, landscape is approached as a ritualised space (*cf. Turner 1975.69*).

Fig. 1. Harsova tell, the Boian layer of fired houses (all the photos by D. Gheorghiu).

Experiment – experientiality

When approaching a complex and fluctuating concept like the prehistoric landscape, one can experiment on the limits of the current methodologies, as well as of the constraints of the representation of the scientific discourse, a state of fact challenged by post-processualism.

As a reaction to the limitations of ethnographic narrativity, as early as the '80ies, an "*allegorical anthropology*" (*Tyler 1985; Clifford 1986*) was created, but the first attempt to use allegory in an archaeological text dates back to the '90ies (*Tringham 1992; Edmonds 1999; Bailey 2000*); the latter exploited fiction and poetic texts ascribed to diverse imagined characters in order to transcend the limits of the disembodied intellectual experience of scientific description.

One solution to this problem would have been experimental archaeology, but it was limited as an academic discipline (*Reynolds 1999; Mathieu 2002; Jeffrey 2004*) to operating only within material culture, and any sensorial relation with the material world was accepted only at the level of objects (see *Hurcombe 2007*). Consequently, the study of non-material subjects like the experience of a place (*Tamisari and Wallace 1988*), or of landscape, were approached through the phenomenological perspective of the experiential 'archaeologies of inhabitation', promoted by post-processualists, now criticized for having produced hyper-interpretive texts (*Fleming 2006*), but which generated fertile sources of inspiration like theatre/archaeology (*Shanks and Pearson 2001*).

For my research on the cultural landscape in the Lower Danube area, I began with an experimental archaeology approach, by inferring a set of hypotheses (*Cavulli and Gheorghiu 2008*) which should have been accepted or rejected after some "*clearly defined procedures and reasoning*" (*Jeffrey 2004.13*; see also *Kelterborn 1987*), in order to reconstruct architectural structures and processes (the combustion of these structures).

Since I was physically involved in the making of different kind of objects (from ceramic vases to wattle and daub houses), I became aware that the division in the current archaeological research (*i.e.* scientific experiment vs. sensory experience) is not possible, since nobody can experiment without also embodying the sensory experience of the action.

By avoiding experiential knowledge, one reduces the odds of understanding the construction of past reality, like the somatic mode of awareness. Due to the limitations of scientific experimentation and therefore reconsidering the importance of the body as the site of lived experience (*Joyce 2005*), I consider that the phenomenological knowledge resulting from experimentation should be used, with caution, as a thinking through the body instrument (see *Hamilakis et al. 2001; Hamilakis et al. on-line*), when it can reveal behavioural elements not observed before.

Complex scenery like a cultural landscape cannot be understood without a combination of the measurable results of archaeological experiment and the (subjective) personal experiential embodiment of a cultural phenomenology (*Csordas 1999*) generated by geomorphology and the built environment.

The geographic context and dwelling strategies

The Lower Danube is a geographical area which includes the low wetlands from the north banks of the Danube, between the Olt River and the Dobroudja plateau and the flat South Romanian Plain (*Cotet 1976*), with a landscape characterised by medium high loess terraces and lower areas acting as buffers for the cyclical floods of the hydrosystem. This cyclical wetland (*Gheorghiu 2006a*), without significant vertical dominant locales, was progressively settled during the Neolithic and Chalcolithic along its river valleys (*Comsa 1987; 1994; Davison et al. 2006*).

At the beginning of the 6th millennium BC, the intense dynamism of the Early Neolithic Starčevo-Criş or Dudeşti populations (*Bailey et al 2002*), probably determined also by the lack of balance of the hydrographic system of the Danube, left in the archaeological record only thin horizons of dispersed areas of dwelling (*Comsa 1997; Bailey 2000*).

In the Early Chalcolithic, along the flat, dispersed settlements, a new form of occupation of the land emerged in the Lower Danube area, *i.e.* the overlapped, compact settlements or tells (*Morintz 1962; Dumitrescu 1965; 1966a; 1966b; Comsa 1997; Andreescu et al. 2001*). During the development of the Gumelnita tradition, Phase A1 4700–4350 BC, and Phase A2 4500–3950 BC (*Bem 2000–2001.43*), this mode of dwelling will spread north along the river valleys, and in the final phase, B1, tell settlements are documented on islands (Cascioarele Ostrovelul, *Dumitrescu 1965*), terraces (Brailita, *Hartzuchi and Dragomir 1957;* Teiu, *Nania 1967*) or levees (Liscoteanca and Largu, *Dragomir 1959*). Unfortunately, the partial excavation of most of the tells, as well as the insufficiency of advanced research to document all the types of Chalcolithic dwelling in the Lower Danube area, compared to other geographical zones (see *Menze et al. 2006; ArchAtlas: Tellspotting, on-line*), does not allow the creation of a holistic image of the complexity of the Chalcolithic dwelling, but the emergent advanced research in some areas [*http://map.cimec.ro/LocalizareExacta/mapserverEn.html*] gives hope that in the near future this deficiency will be overcome, and our knowledge of the relationship between settlement and landscape will be supplemented.

Landscape

In defining 'landscape', one faces the difficulty of working with a poloysemic concept. Since a landscape is a cultural (or social, see *Chapman 1997*) construct, structured in accordance with the purpose of the analysis, I choose from the multitude of definitions those which can be applied to the theme and method of the present paper, and describe landscape as a surface which shall be passed through.

In a diachronic perspective Stoddart and Zubrow (*1999*) perceive landscape as a palimpsest of cultural levels; the same viewpoint of a "*continued*" (*Bailey 1997.49*) "*surface over which people moved and within which they congregated*" is shared by Barrett (*1991.8*), and by all who see it as "*an arena for ritual or ceremonial activity*" (for an extended bibliography see *Knapp and Ashmore 1999*).

Tilley (*1994.25*) looks upon landscape as representing the "*physical and visual form of the earth as an environment and as a setting in which locales occur, and in dialectical relation to which meanings are created, reproduced and transformed*". He continues by saying that moving across a landscape is an art, especially approaching the cultural dominant locales from the "*right (socially prescribed) direction*" (*Tilley 1994.28*).

All the defintions mentioned insist on the cultural attributes of the landscape/s; consequently, I chose the syntagm 'cultural landscape' (first used by *Sauer*

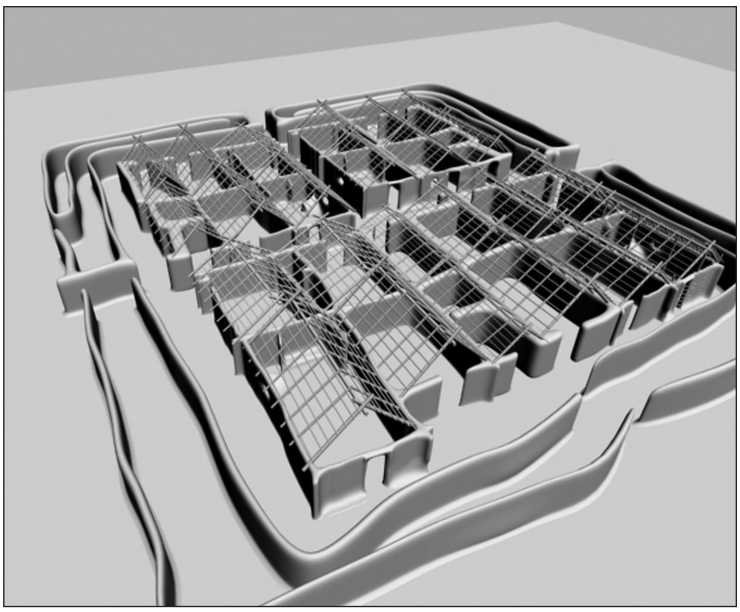


Fig. 2. Virtual reconstruction of Ovčarovo tell by Bogdan Dumitrescu (after* Todorova 1982*)

1925) to illustrate in the Lower Danube area the mix of geomorphology and cultural products such as tell settlements.

Tells

There are several definitions of tells (*Sherratt 1983; Chapman 1997; Kotsakis 1999*) and approaches (like the built /un-built space; *Chapman 1991a; 1991b*), social action (*Chapman 1997*) or visual relations (*Bailey 1997*) which depict them as a cultural and natural alluvium consisting of a cumulative, ordered and repetitive mode of dwelling in the same place. In my definitions, I asserted the character of separation from the rest of the environment by means of different architectural features (*Gheorghiu 2002a; 2003a; 2006a; 2006b*), or geomorphological elements, a trait which I will approach in the present paper from an experiential angle.

Fig. 3. A tell settlement surrounded by a ditch and palisade, Vadastra 2003.

A characteristic of the South Eastern Neolithic Europe dwelling is the fired levels of habitation which are supposed to have been intentional (see *Tringham 1992; Stefanović 1997; 2002; Chapman 1999*). Similar horizons of combustion are found in the Lower Danube area at the majority of tell settlements (see *Dumitrescu 1986; Nania 1967; Mihailescu and Ilie 2004.75*) (Fig.1).

Materials

When approaching tells from the perspective of site catchment, an aspect constantly neglected is the materiality of the built environment. The building of a tell implied the use of diverse basic materials whose presence in the landscape, and subsequently in the symbolism of the social group, had a significant cultural value. A tell was the result of the blending of clay with water, wood and processed vegetation (like chaff, cereal straws, reeds or twigs), being therefore a cultural landscape, since it was the result of a process of subtraction and re-composition of the materials from the natural landscape. In this perspective a tell acted like an attractor of the materials from the surrounding landscape and became a semiotic package of the materiality of the landscape, representing a re-ordered Nature, domesticated by means of cultural rules (*Gheorghiu in press a*). In time, ceramics, an artificial material resulting from the combustion of houses or palisades, were added to the list of natural materials.

Stages of separation

Gumelnita tells had good visibility – tell settlements were located 'to see and to be seen', (*Gheorghiu 2003b*), visually dominating the territory and being the dominant visual attractor of the territory; in other words, controlling the surrounding landscape from inside and outside the segregated built space.

There was a small number of types of location adopted for tell building: high terraces, anastomosed terraces and islands, determined not only by pragmatic factors like low flood risk, high sun exposure and low exposure to the prevailing winds, but also by the motivations of seclusion and visibility. Two main types of separation were identified (*Morinz 1962*): on one side, when positioned on protruding terraces; and around the built perimeter, when positioned on anastomosed terraces or islands. So the particular positioning of tells as interfaces between two kind of landscape, the dry land and the wetland, required a cultural and a natural separation depending on the geomorphology of the place chosen.

Being a sort of storehouse/wood shed/barn/dwelling, an architectural object designed mainly to store, an inference arises from the proportions of the built and un-built surface (*Chapman 1991a; 1991b*) (Fig. 2); tells probably represented a solution of economic adaptation to the cold season, but such a specialised way of dwelling required the existence of complementary ways of inhabiting. In this perspective, tells will be viewed not as the only way of dwelling in of Chalcolithic populations, but as a part of an extended mode of dwelling, comprised of seasonal open settlements (see *Nania 1967; Gheorghiu 2006a*) and necropoleis (for an extended bibliography see *Lazar and Parnic 2007*) which formed a holistic cultural landscape (see *Knapp and Ashmore 1999*).

Fig. 4. Foundation ditches for a wattle and daub house, Vadastra 2003.

For most of their part neglected by archaeological research, the open (*i.e.* non-separated) settlements and workshops subordinated to a tell (both as location and visibility) were probably seasonal places for processing the products of the wetland and dry land. This pattern emerges as early as the Early Chalcolithic in locations like Radovanu (*Comsa 1997*), Tangaru, Uzunu (all belonging to the late Boian tradition), Burdusani-Popina, Valea-Argovei-Vladiceasca (all belonging to the Gumelnita tradition), and supports the image of the tell as a packed place (*cf. Chapman 1991b*) and a temporary place of seclusion.

The cliffs of the terraces, as well as the marshes, the lakes or rivers which separated tells from the rest of the landscape were obstacles to the human body. In a similar way, the internal space of the tell offered a hierarchy of discontinuities because of the various boundaries created by its architecture (see *Hillier and Hanson 1984.144; Grahame 2000.11*). To have access to the inhabited space inside the tell, one had to pass through a series of footbridges, gates, and doors which underlined the rituality of passage from one space into another (*Gheorghiu 2003a*).

In this perspective it is reasonable to consider the archaeology of tells as being an archaeology of the rites of passage (separation being a rite in itself; *van Gennep 1960*) materialised in the archaeological record in the form of ditches and foundation trenches which delimited the dwelt an area separated both in a physical and symbolic way.

Fig. 5. The plaited structure of walls. Vadastra 2005.

The first stage of separation achieved by means of perimeter ditches and (sometimes) of palisades was between the inner dwelling space on the one hand, and the external (Fig. 3), cultural and wild spaces, like seasonal settlements, workshops, necropolis, cultivated lands and wilderness, on the other hand. Probably the act of separation of digging a ditch into the loess soil produced the clay and the container for the preparation of house daub (*Gheorghiu 2006b*). The separated, inhabited area of the tell was divided into several standardised rectangular enclosures (positioned in two rows in the simplest variant of the first phase of the dwelling, as seen at Radovanu; *Comsa 1997*), an architectural design which implies the existence of a predetermined plan (*cf. Todorova 1984* for Bulgarian tells), a tell settlement planned as a single architectural object, composed of a series of habitation units, built at the same time.

Fig. 6. The combustion of a wattle and daub house, Vadastra 2006.

Such an organisational decision suggests that social difference was not encoded in the dimensions of the houses, but probably in their position (within a back/front – left/right symbolism) within the master plan in relation to the main access of the ditch/palisade passage, and consequently, with the cultural landscape.

Not only was the process of construction structured according to rites of separation, but also the stages of the chaines-opératoires used to process the building materials had the role of separating them from their natural context and shapes. An example could be the removal of bark and shaping of tree trunks for use as beams or posts. Another rite of separation from their natural condition was performed when the processed materials were set in order according to two kinds of pattern: one natural (*i.e.* spatial orientation in relation to earth, sun, water and winds) and one cultural (*i.e.* the geometry of the built forms).

An additional rite of separation, this time within the community, was created when the foundation trenches of the houses were dug inside the secluded perimeter of the settlement (see *Todorova 1982.81, Fig. 41; Popovici and Railland 1996–1997.24; Marinescu-Bîlcu et al. 1997.68; Randoin et al. 1998–2000.231, Pl. V*) (Fig. 4). Ethnographic data from Vadastra village, as well as the experiments I carried out during the last few years, support the importance of the foundation trenches in the process of construction, because by filling the trench with soil pressed around the posts and the plaited twigs which formed the wattle and daub walls, the fastening of the vertical structure of the wall was improved.

One can imagine that the planting of the posts and of the plaited twigs was part of the process of designing a cultural landscape with a possible symbolic meaning representing a separate cultivated/domesticated/nature (Fig. 5).

Combustion was probably a final rite of separation when a building, or all the settlement were fired, and the crushed wattle and daub structures were transformed into ceramic layers, later levelled to create a new ground surface for a new dwelling. Ceramics became a material related to dwelling identity, an interface between two episodes of the inhabitation of a place.

Despite the discontinuities of inhabitation, tells can be seen as immobile places within a landscape in flux (see *Bailey 199.54; Andreescu et al. 2001*), where the next static cultural element was the necropolis.

Although a visual reciprocity existed between tell and necropolis (see *Bailey 1997.51; Lazar and Parnic 2007.137*), these two modes of social storage were separated by geomorphic elements. For example, at the Gumelnita eponymous site (*Dumitrescu 1996*) or Mariuca (*Lazar and Parnic 2007*), both situated in the microzone of Mostistea River, the tell and its necropolis were separated by a deep valley. At Cãscioarele-D'aia parte, the tell was positioned on an islet, separated by marshes cyclically flooded from the necropolis on the lake terrace (*Şerbãnescu and Şandric 1998*). To access the Gumelnita or Mariuta necropolis, one should walk off the terrace, cross a marshy valley and then walk up the terrace again; in other words, undergo the experience of a

Fig. 7. The fired house four months after the collapse of the walls. Vadastra 2006.

vantage of strong air turbulence; the functional openings in the walls and ceiling then create a draught to support the combustion of the fireproofed ligneous material (Fig. 6).

After the wooden interior structure of the walls was consumed by fire, their negative shape was transformed into a set of draught tubes which improved the combustion process of the daub (*Gheorghiu 2002b*). During the combustion process, the architectural element which played the most important role was the foundation trench, because it delimited the built perimeter after the collapse of the walls. After the ligneous material had been consumed, the walls could have been pushed to fall inside the built perimeter to douse the fire; generally, they fractured above the ground at variable heights, thus offering a visible image of the separation of the dwelt space (whose perimeter is therefore well preserved and visible above the ground) from the rest of the settlement space, in this fashion creating a post-habitation landscape (Fig. 7).

When perceived from this diachronic perspective as a palimpsest landscape formed as the result of ritual overlapping episodes of dwelling, combustion, abandon and return, in a kind of eternal return, tells reveal their pulsatory nature of attracting and transforming landscapes with fire.

rite of passage with three stages well defined visually and physically (see *Van Gennep 1960; Turner 1995*). Here, the valley separates the cultural landscape into two locales with different statuses.

A number of the necropolises were positioned west of the tell (at Căscioarele-D'aia parte, Vărăşti-Grădiştea Ulmilor, Sultana-Malu Roşu in the Lower Danube area, and at Durankulak, Goljamo Delcevo, Radingrad, Vinica in Bulgaria, see *Lazar and Parnic 2007. 140*), a spatial organisation that could have been the result of a symbolic decision related to rites of separation.

Firescapes as part of the cultural landscape

While many of the tell houses show signs of combustion, there are no regular patterns of occurrence, except for at Gumelnita final phase B, when almost all the Lower Danube tells were abandoned after being fired.

Chapman (*1999.122*) remarked that house combustion does not represent a unified phenomenon, and could have various causes, intentionality being one among many others. The experiments I conducted during the last few years support the idea that a wattle and daub dwelling was 'built to be fired' (*Gheorghiu in press b*) only after being filled with sufficient fuel, and after taking ad-

Fig. 8. The weathered walls of a wattle and daub house built in 2004. Vadastra 2007.

Other experiments on the decay of wattle and daub structures after the abandonment of a settlement without burning houses (by dissolution of the clay and by mechanical fracture due to human and animal action), revealed a similar pattern of deconstruction (Fig. 8), the process of decay of the wattle and daub walls being stopped at variable heights from the base of the walls by the mechanics of the foundation trenches, which produced a piling of the material along the perimeter of the trenches. We can infer that a post-habitation landscape shaped by the foundation trenches was perceived by Chalcolithic people as a landscape of abandonment, which preserved the coordinates of the previous plan of inhabitation.

Fig. 9. A perimeter ditch surrounding a palisade. Vadastra 2004.

Conclusion. Experiencing ancient mind and landscapes

In an attempt to understand the relationship between the minds and landscape of prehistoric populations, I employed a mix of experimental and experiential approaches, functioning as an instrument of thinking through the body. A whole cultural phenomenology (*Csordas 1999*) was therefore created through the crossing of valleys, slopes, ditches, footbridges or watching combustion processes, since they all subdued the body to an effort of control and awareness.

The passing through was revealed to be the process specific to experimenting on the cultural landscape of the tells: after a relatively exhausting crossing of the valleys, surrounding waters or marshes, the performer finally arrived in front of the tell; here, searching for the entrance his/her body was oriented according to the master plan of the dwelling, then followed the crossing of the temenos, the ditch (Fig. 9), then of the palisade, before reaching the true interior space, where narrow corridors between the household units reoriented and directed the body (but against the determinism of architectural structures on the human body, see *Brück 2001*).

As participants could experience, the technologies of building imposed bodily experience of the materiality of wild and cultural materials; the body treads and kneads the soft materials, and adjusts the solid ones, following geometric patterns. The firm geometry of the first levels of habitation in tells seems to have been a symbolic gesture of separation from the curved lines of the natural landscape.

When experimenting with the diverse techniques of acquisition and building, one could discover the remarkable analogies between plant cultivation and

Fig. 10. Watching the combustion of a wattle and daub house. Vadastra 2006.

their processing on the one hand, and the construction of the house on the other: the performer plants the posts and the wattle in the foundation trench in a way similar to the planting of trees; plaits the wattle of the wall like baskets and mats; and fixes the clay on the vegetal structure in rows like building a vase. An equivalent kinaesthesia controls the cultural landscape: cultivation, the making of objects and the building of houses are made in the same symbolic way, which implies a coherence of meaning in the creation of the landscape. Furthermore, symbolic correspondence could be found between the different firescapes: the farming fire cycles or deforestation, the combustion of tells, and the sunset over the westerly necropolises produced an analogous sight.

Firescapes were not only economic practices, but also commemorative. The intentional deconstruction through fire of the tell settlements could have had a ritual significance in constructing the social memory of the group, as well as strengthening the social body: during the first moments of the blaze which consumed a house, the group of observers behaved as a single individual due to a shared emotion[1] (Fig. 10).

One advantage of using a combination of science and phenomenological experience to understand tells in context was the opportunity to experiment with the analogies existing between separate realities such as the mind and landscape: I experienced how an ephemeral event like a firescape was fixed in the memory of the social body, how it was fixed in the memory of a ceramic deposit, and how it was fixed in the cultural landscape.

ACKNOWLEDGEMENTS

I want to thank Professor Mihael Budja for kind help during the conference, Dr. Romeo Dumitrescu for financing the experiment of building and firing the house, and M. Bogdan Capruciu for re-ordering the English text. Last, but not least, my gratitude goes to the team of experimenters who worked with me at the Vadastra site: Marius Stroe, Catalin Oancea, Dragos Manea, Adrian Serbanescu and Stefan Ungureanu, and to the village community who helped with people and materials. The experiments in 2005 and 2006 were financed by two CNCSIS grants (1612 & 945).

∴

REFERENCES

ANDREESCU R., MIREA P., APOPEI S. 2001. Valea Teleormanului, mediul si comunitatile umane in mileniul V a.Ch. In M. Neagu (ed.), *In Honorem Silvia Marinescu-Bilcu 70 de ani. Cultura si Civilizatie la Dunarea de Jos 22*. Calarasi: 141–150.

ARCHATLAS: Tellspotting on-line: http://www.archatlas.dept. shef.ac.uk/Tellspotting/TellsMain.php

BAILEY D. W. 1997. Impermanence and flux in the landscape of early agricultural South Eastern Europe. In Chapman J., Dolukhanov P. (eds.), *Landscapes in flux. Central and Eastern Europe*. Colloquia Pontica 3. Oxbow Books, Oxford: 41–58.

2000. *Balkan prehistory: Exclusion, incorporation and identity*. Routledge, London, New York.

BAILEY D. W., ANDREESCU R., HOWARD A. J, MACKLIN M. G., MILLS S. 2002. Alluvial landscapes in the temperate Balkan Neolithic: transition to tells. *Antiquity 76: 349–355*.

BARRETT J. 1991. The Archaeology of social reproduction. In Barrett J., Bradley R., Green M. (eds.), *Landscape, monuments and society: The prehistory of Cranborne Chase*. Cambridge University Press, Cambridge: 6–8.

BELL C. 1992. *Ritual theory, Ritual practice*. Oxford University Press, Oxford, New York.

BEM C. 2000–2001. Noi propuneri pentru o schita a eneoliticului romanesc. *Pontica XXXII – XXXIV: 25–120*.

1 It is obvious that the significance of the event recreated was completely different from that of the past, but one can infer that the process of a house consumed by fire was a special event in the past. For a contemporary person the experience of the combustion of the house is at the same time traumatic and fascinating, the whole process of combustion of the house could be regarded as a stage of separation which impressed the public. In spite of its ephemerality the event was fixed in the memory of the participants.

BRÜCK J. 2001. Monuments, power and personhood in the British Neolithic. *Journal of the Royal Anthropological Institute 7: 649–667*.

CAMPANA S., FORTE M. (eds.) 2006. *From Space to Place: 2nd International Conference on Remote Sensing in Archaeology*. Proceedings of the 2nd International Workshop, CNR, Rome, Italy, December 4–7, 2006 BAR IS 1568.

CAVULLI F., GHEORGHIU D. 2008. Looking for a methodology burning wattle and daub housing structures. A preliminary report on an archaeological experiment. *Journal of Experimental Pyrotechnologies 1: 37–43*.

CHAPMAN J. 1999. Deliberate house-burning in the prehistory of Central and Eastern Europe. In Gustafsson A., Karlsson H. (eds.), *Glyfer och arkeologiska rum – en vanbok till Jarl Nordbladh*. Gotarc Series A. Vol.3: 113–126.

1997. Places and timemarks –The Social construction of prehistoric landscapes in Eastern Hungary. In Nash G. (ed.), *Semiotics of Landscape: Archaeology of the Mind*. BAR 661: 147–178.

1991a. Social inequality on Bulgarian tells and the Varna problem. In Samson R. (ed.), *The Social Archaeology of houses*. Edinburgh University Press, Edinburgh: 49–92.

1991b. The Early Balkan village. In O. Grøn, E. Engelstad, I. Lindblom (eds.), *Social space. Human social behaviour in dwelling and settlements*. Odense University Press, Odense: 79–99.

CLIFFORD J. 1986. On ethnographic allegory. In Clifford J., Marcus G. E. (eds.), *Writing culture. The Poetics and politics of ethnography*. University of California Press, Berkeley: 98–121

COMSA E. 1997. Tipurile de asezari din epoca Neolitica din Muntenia. *Cultura si civilizatie la Dunarea de Jos XV: 144–164*.

1994. Asezarea Starčevo-Criş de la Dulceanca. *Analele Banatului SN III: 13 –17*.

1987. *Neoliticul pe teritoriul Romaniei*. Consideraţii. Editura Academiei. Bucharest.

COTEŢ P. V. 1976. *Campia Romana. Studiu de geomorfologie integrate*. Ceres. Bucharest.

CSORDAS T. 1999. Embodiment and cultural phenomenology. In Weiss G., Haber H. (eds.), *Perspectives on embodiment*. Routledge. New York: 143–162.

DAVISON K., DOLUKHANOV P. M., SARSON G. R., SHUKUROV. A. 2006. The role of waterways in the spread of the Neolithic. *Journal of Archaeological Science 33: 641–652*.

DRAGOMIR I. T. 1959. Sapaturile arheologice de la Largu. *Materiale VI: 499–503*.

DUMITRESCU V. 1996. Gumelniţa. In Preda C. (ed.), *Enciclopedia Arheologiei şi Istoriei Vechi a României II: 207–208*.

1986. Stratigrafia asezarii-tell de pe ostrovelul de la Cascioarele. *Cultura si civilizatie la Dunarea de Jos 2: 73–81*.

1966a. Principalele rezultate ale primelor doua campanii de sapaturi din asezarea neolitica tarzie de la Cascioarele. *Studii si Cercetari de Istorie Veche 16 : 215–237*.

1966b. Gumelnita. Sondajul stratigrafic din 1960. *Studii si Cercetari de Istorie Veche 17: 51–99*.

1965. Principalele rezultate ale primelor doua campanii de sapaturi din asezarea neolitica tarzie de la Cascioarele. *Studii si Cercetari de Istorie Veche 16: 215–237*.

EDMONDS M. 1999. *Ancestral geographies of the Neolithic. Landscapes, monuments and memory*. Routledge. London, New York.

FLEMING A. 2006. Post-processual landscape archaeology: a critique. *Archaeological Journal 16: 267–280*.

FORTE M. (ed.) 2005. *Archaeological landscapes through digital technologies*. Proceedings of the 2nd Italy-United States Workshop, Rome, Italy, November 3–5, 2003 Berkeley, USA, May 2005. BAR 1379.

FORTE M., RYAN WILLIAMS P., EL BAZ F., WISEMAN J. (eds.) 2003. *The Reconstruction of Archaeological Landscapes through Digital Technologies*. Italy-United States Workshop, Boston, Massachusetts, USA, November, 1–3, 2001. BAR 1151.

GHEORGHIU D. 2006a. The formation of tells in the Lower Danube wetlands in the Late Neolithic and Chalcolithic. *Journal of Wetland Archaeology 6: 3–18*.

2006b. Compactness and void: Addition and subtraction as fundamental operations in South East European Clay Cultures. In Frère-Sautot M-C. (ed.), *Des Trous. Structures en creux pre- et protohistoriques*. Monique Margoil, Dijon, Baume-les-Messieurs: 151–161.

2003a. Massive walls and decorated entrances: An archaeological approach to Modern architecture. In Malm G. (ed.), *Toward an Archaeology of Buildings. Contexts and concepts*. BAR 1186: 119–124.

2003b. Water, tells and textures: A multiscalar approach to Gumelnita hydrostrategies. In D. Gheorghiu (ed.), *Chalcolithic and Early Bronze Age Hydrostrategies*. BAR IS 1123.

2002a. On palisades, houses, vases and miniatures: The formative processes and metaphors of Chalcolithic tells. In Gibson A. (ed.), *Behind Wooden Walls: Neolithic palisaded enclosures in Europe*. BAR 1013: 93–117.

2002b. Fire and air draught: Experimenting the Chalcolithic pyroinstruments. In D. Gheorghiu (ed.), *Fire in archaeology*. BAR 1089: 83-94.

in press a. Prehistoric Mandalas: The Semiosis of landscape and the emergence of stratified society in the South-Eastern European Chalcolithic. In Nash G. (ed.), *The Semiotic of landscape*. BAR IS.

in press b. Built to be fired: The Building and combustion of Chalcolithic dwellings in the Lower Danube and East Carpathian areas. In Nikolova L., Marler, J., Merlini M., Comşa A. (eds.), Circumpontica in Prehistory: Western Pontic Studies. Global Gratitude to Eugen Comşa for His 85th Birth Anniversary. BAR International Series.

GRAHAME M. 2000. *Reading space: Social interaction and identity in the houses of Roman Pompeii. A syntactical approach to the analysis and interpretation of the built space*. BAR International Series 886. Archaeopress. Oxford.

HAMILAKIS Y., PLUCIENNIK M., TARLOW S. (eds.) 2001. *Thinking through the body: archaeologies of corporeality*. Kluwer Academic Press. London.

HAMILAKIS Y. et al. on-line http://ads.ahds.ac.uk/catalogue/adsdata/assemblage/html/index.html

HAMILTON S., WHITEHOUSE R., BROWN K., COMBES P., HERRING E., SEAGER THOMAS M. 2006. Phenomenology in Practice: Towards a Methodology for a 'Subjective' Approach. *European Journal of Archaeology 9: 31–71*.

HARTZUCHI N., DRAGOMIR I.T. 1957. Sapaturile arheologice de la Brailita, Raport preliminar. *Materiale III: 129*.

HILLIER B., HANSON J. 1984. *The Social logic of space*. Cambridge University Press. Cambridge.

HODDER I., HUTSON S. 2006. *Reading the past. Current approaches to interpretation in archeology*. Cambridge University Press. Cambridge.

BOURDIEU P. 1977. *Outline of a theory of practice*. Cambridge University Press. Cambridge.

HORNER D. S. 2001. Cyborgs and cyberspace: Personal identity and moral agency. In Munt S. R. (ed.), *Technospaces: Inside the new media*. Continuum. London: 71–84.

HURCOMBE L. 2007. A sense of materials and sensory perception in concepts of materiality. *World Archaeology 4: 532–545*.

JEFFREY D. on-line http://www.ucl.ac.uk/iams/jour_24

JOYCE R. 2005. Archaeology of the body. *Annual Review of Anthropology 34: 139–158*.

KELTERBORN P. 1987. Principles of experimental research in archaeology. *Bulletin of Experimental Archaeology 8: 11–14*.

KNAPP B. A., ASHMORE W. 1999. Archaeological landscapes: Constructed, conceptualized, ideational. In Ashmore W., Knapp A. B. (eds.), *Archaeologies of landscape: Contemporary perspectives*. Blackwell, Malden. Oxford: 1–32.

KOTSAKIS K. 1999. What tells can tell: Social space and settlement in Greek Neolithic. In Halstead P. (ed.), *Neolithic society in Greece*. Sheffield Academic Press, Sheffield: 66–76.

LAZAR C., PARNIC V. 2007. Date privind unele descoperiri funerare de la Măriuţa – La Movilă. *Studii de Preistorie 4: 135–158*.

LLOBERA M. 2001. Building Past Landscape Perception With GIS: Understanding Topographic Prominence. *Journal of Archaeological Science 28 (9): 1005–1014*.

MARINESCU BÎLCU S., POPOVICI D., TROHANI G., ANDREESCU R. 1997. Archaeological researches at Bordusani – Popina (1993–1994). *Cercetări Arheologice (10): 65–69*.

MATHIEU J. R. 2002. Introduction: Experimental archaeology. Replicating past objects, behaviors and processes. In Mathieu J. R. (ed.), *Experimental archaeology. Replicating past objects, behaviors and processes*. BAR IS 1035: 1–12.

MENZE B. H., UR J. A., SHERRATT A. G. 2006. Detection of Ancient Settlement Mounds: Archaeological Survey Based on the SRTM Terrain Model. *Photogrammetric Engineering & Remote Sensing 72 (3): 321–327*.

MIHAILESCU G., ILIE A. 2004. Tellul Gumelnitean de la Geangoiesti (Com Dragomiresti, Jud. Dambovita). *Ialomita 4: 71–80*.

MORINTZ S. 1962. Tipuri de asezari si sisteme de fortificatie si imprejurimi in cultura Gumelnita. *Studii si Cercetari de Istorie Veche 13 (2): 273–284*.

NANIA I. 1967. Locuitorii gumelniteni in lumina cercetarilor de la Teiu. *Studii si articole de istorie IX: 7–23*.

POPOVICI D., RAILLAND Y. 1996–1997. *Vivre au bord du Danube il y a 6500 ans*. [cat.] Saint Jean de la Ruelle.

RANDOIN B., POPOVICI D., RAILLAND Y. 1998–2000. Metoda de săpătură şi înregistrarea datelor stratigrafice într-un sit pluristratificat: Tellul neo-eneolitic de la Hârşova. *Cercetari arheologice X: 199–233*.

REYNOLDS P. J. 1999. The Nature of experiment in archaeology. In Harding A. F. (ed.), *Experiment and design. Archaeological studies in honour of John Coles*. Oxbow Books. Oxford: 156–162.

SAUER C. O. 1925. The morphology of landscapes. *University of California Publications in Geography 2: 19–54*.

ŞERBĀNESCU et al. on-line http://www.cimec.ro/ cronica/ cd/ index.htm

SHANKS M., PEARSON M. 2001. *Theatre/Archaeology*. Routledge. London.

SHERRATT A. 1983. The Eneolithic period in Bulgaria in its European context. In Poulter A. G. (ed.), *Ancient Bulgaria (Vol 1)*. Nottingham University. Nottingham: 188- 198.

STEVANOVIĆ M. 2000. Burned Houses in the Neolithic of South-eastern Europe. In Gheorghiu D. (ed.), *Fire in Archaeology*. BAR IS 1098: 55–62.

1997. The Age of clay. The Social dynamics of house construction. *Journal of Anthropological Archaeology 16: 334–395*.

STODDART S. K. F., ZUBROW E. 1999. Changing places. *Antiquity 73 (281): 686–688*.

TAMISARI F., WALLACE J. 1988. Towards an Experiential Archaeology of Place: From Location to Situation through the body. In Berndt R. M., Tonkinson R. (eds.), *Social anthropology and Australian Aboriginal studies: A Contemporary overview*. Aboriginal Studies Press. Canberra: 204–223.

THOMAS J. 2006. Phenomenology and material culture. In Tilley C., Keane W., Küchler S., Rowlands M., Spyer P. (eds.), *Handbook of Material Culture*. Sage. London: 43–59.

THOMAS J., BRÜCK J. 2001. Comment: Monuments, power and personhood in the British Neolithic. *Journal of the Royal Anthropological Institute 7 (4): 763–767*.

TILLEY C. 2004. *The materiality of stone. Explorations in landscape phenomenology*. Berg. Oxford.

1994. *A Phenomenology of landscape. Places, paths and monuments*. Berg. Oxford.

TODOROVA H. 1982. *Kupferzeitlische Siedlungen in Nordostbulgarien*. C. H. Beck. München.

TRINGHAM R. 1992. Households with faces: The Challenge of gender in prehistoric architectural remains. In Gero J., Conkey M. (eds.), *Engendering archaeology. Women in Prehistory*. Blackwell. Oxford, Cambridge: 93–131.

TURNER V. W. 1995. *The Ritual Process: Structure and Anti-Structure*. Aldine de Gruyter, New York.

1975. Ritual as communication and potency: A Ndembu case study. In Hill C. E. (ed.), *Symbols and society: Essays on belief system in action*. University of Georgia Press. Athens: 58–81.

TYLER S. A. 1985. Ethnography, intertextuality, and the end of description. *American Journal of Semiotics: 83–98*.

VAN GENNEP A. 1960. *Rites of Passage*. Routledge. London.

back to contents

UDK 903.2'12/'16(4-013+5)"633/634"

Documenta Praehistorica XXXV (2008)

Embodiment and visual reproduction in the Neolithic: the case of stamped symbols

Robin Skeates

Department of Archaeology, Durham University, UK

Robin.Skeates@durham.ac.uk

ABSTRACT – *This paper explores the cultural and conceptual dimensions of ceramic (and stone) stamps found at Neolithic and Copper Age sites in Western Asia and Southern Europe, dating to between the eighth and third millennia BC. Based upon a recent study of their archaeological deposition contexts, their surviving forms and regional variations in their style, they are discussed here in terms of their biographies, their reciprocal relations with people, and their embeddedness in cultural processes. More specifically, they are interpreted with reference to a pair of key cultural processes that characterise the material culture of Neolithic Eurasia: embodiment and visual reproduction.*

IZVLEČEK – *V članku raziskujemo kulturne in konceptualne vidike keramičnih (in kamnitih) pečatnikov iz neolitskih in bakrenodobnih najdišč zahodne Azije in južne Evrope iz časa med osmim in tretjim tisočletjem p.n.š. Na podlagi študija arheoloških kontekstov, kjer se pojavljajo, njihovih oblik in regionalnih stilističnih variant, razpravljamo o njihovih biografijah, njihovem medsebojnem razmerju z ljudmi in njihovem mestu v kulturnih procesih. Natančneje, interpretiramo jih v razmerju do dveh kulturnih procesov, ki zaznamujeta materialno kulturo neolitske Evrazije: poosebljanje (embodiment) in vizualne reprodukcije.*

KEY WORDS – *stamps; stamp seals; pintaderas; embodiment; visual reproduction*

Introduction

This paper is concerned with exploring the cultural and conceptual dimensions of one of the most visually striking categories of portable artefact found at Neolithic and Copper Age sites in Western Asia and Southern Europe, variously described as stamps, stamp-seals or 'pintaderas'. Previous studies of these objects have tended to focus on the typological classification and stylistic comparison of their decorative motifs, at the same time as speculating on their functional and social significance (*e.g. Buchanan 1967; Collon 1990; Cornaggia-Castiglioni 1956; Cornaggia-Castiglioni & Calegari 1978; Dzhanfezova 2003; Makkay 1984; 2005; Türkcan 2007*). It has been suggested, for example, that they were used as stamps to print or impress culturally significant patterns onto a range of materials (*e.g.* cloth, skin, bread and clay). It has also been claimed that their repeated application to certain kinds of people and property could have been used either in socio-economic transactions, to mark identity and ownership, or in ritual performances, to signify and enhance spiritual potency. I have recently published a revised account of these objects (*Skeates 2007*), in which I explored these artefacts' various biographies, their reciprocal relations with people, and their embeddedness in cultural processes, with particular reference to their archaeological deposition contexts, their surviving forms, and regional variations in their style (*c.f. Prijatelj 2007*). Here, I want to summarise some of my conclusions, at the same time as developing some of my interpretations with reference to the themes of embodiment and visual reproduction.

Frequency, distribution and resemblances

Stamps made of baked clay were widespread, but generally infrequent, material elements of Neolithic and Copper Age cultures in parts of Eurasia, which originated in the Near East and spread westwards via communicative human groups to South-East Europe, Greece, Italy and Corsica, between the eighth and third millennia BC. Both resemblances and differences are exhibited by these objects across this large span of space and time. For example, clear similarities have been noted between the material, shapes and decorative techniques of the stamp seals of Nea Nikomedeia in Greek Macedonia and earlier examples from Çatalhöyük in Central Turkey (*Rodden 1965*). On the other hand, rows of impressed points are an exclusively North Italian decorative element, which predominate in the Liguria region in North-West Italy.

Materials and production

Some of these stamps were made of stone. These included relatively highly valued, rare, durable and coloured stones, which were skilfully and laboriously carved, drilled and polished, particularly in Mesopotamia from the sixth millennium BC, but also occasionally as far away as Greece.

More commonly, however, they are made of unexceptional clays, which their makers probably obtained from relatively accessible local sources, and then worked, perhaps alongside the production of other commonplace and more unusual clay-based products such as daub, pottery vessels, clay tokens and ceramic figurines. Small numbers were quickly modelled by hand, a few quite roughly, and then smoothed. When dried to leather-hard, they were neatly engraved using a range of simple and familiar cutting tools and techniques, perhaps sometimes following the lines of preliminary markings. They were then converted into a solid state through firing, probably in simple hearths, ovens or bonfires, possibly together with other artefacts, with only loosely controlled oxidising and reducing conditions, which gave them variable, matt and earthy, surface colours. The general impression is, then, that these baked clay examples were made by people in a relatively unspecialised 'domestic mode of production', using readily available resources, with only limited investment in materials, time and skills.

Form

It is above all the forms of the stamps' bodies that set them apart as a distinctive category of artefact (Fig. 1). The key component is the flat or curving face, which serves as the well-proportioned platform for the visually striking engravings that cover it more-or-less completely. (Very occasionally, examples occur with two faces situated at opposite ends of a handle.) The primary importance of the face may seem self-evident, but is emphasised both by the evolution of cylinder seals which increased the surface area that could be engraved, and by the fact that on neither artefact type was the appearance of the engraved surface ever compromised by perforation. The second most important component of the artefact is the handle positioned centrally on the opposite side of the face(s), which is generally plain, with the exception of some 'figurine seals' from sites in Macedonia whose handles are incised with a human face (*Naumov, this volume*). In a minority of examples, the handle was perforated prior to firing.

Function

These features, combined with the relatively small size and light weight of the objects, indicate that they were primarily designed to be hand-held portable artefacts. More specifically, historic and ethnographic parallels and experimental reconstructions lend weight to the traditional archaeological assertion that these objects were primarily tools used by people as stamps used to print and impress decorative motifs.

They may have been made to last, given the fact that only small numbers appear to have been produced at most Neolithic sites, and in relatively durable materials, and the fact that some were intended by their makers to be suspended. Indeed, some appear to have been suspended from peoples' necks and wrists, to judge from their positioning in relation to a few articulated bodies in inhumation burials. From a strictly practical point-of-view, this would have helped people retain, carry around and look after these special artefacts, without having to hold them constantly in their hands, as they engaged in various activities. But I do not think that this explains fully why these examples were attached to the human body, and I shall say more about this below.

More specifically, the clay stamps may have been retained and repeatedly re-used by, and on, the same and different people and objects, even over generations. This process could have led to their becoming worn, clogged-up and damaged, either until their use was no longer required or until they were completely broken (either accidentally or intentionally). But the fact that they were never repaired, unlike some fineware pots, also indicates that they were replaceable, even disposable.

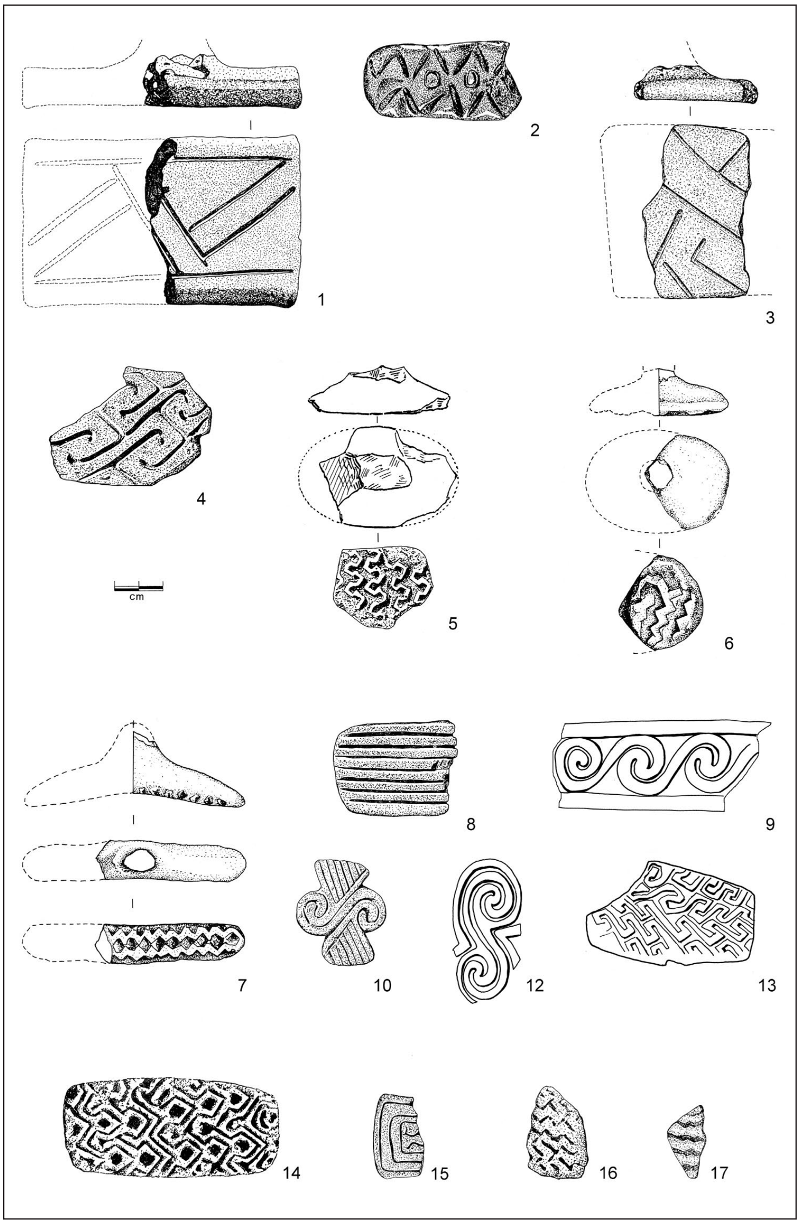


Fig. 1. 'Pintaderas' from the Puglia region, South-East Italy (after **Skeates 2007*). 1. Cala Tramontana, 2. Cala degli Inglesi, 3. Punta Vuccolo, 4. Grotta Scaloria, 4. Grotta Scaloria, 5. Pulo di Molfetta, 6. Grotta Santa Croce, 7. Cave Mastrodonato, 8–9. Grotta Sant'Angelo, 10. Caverna dell'Erba, 12–14. Grotta dei Cervi, 15–17. Grotta delle Veneri.***

They could then have been discarded or more formally deposited in or around the variety of places where they were used. According to the limited available details regarding their archaeological deposition contexts in Western Asia and Southern Europe, they ended up on the floors of houses, kitchens, workshops, storerooms and religious buildings, in settlement pits and refuse areas, in cave deposits, and in inhumation graves, during the course of an overlapping range of economic, social and ritual practices. They then undoubtedly sustained further post-depositional damage and wear, right up to the present day.

It is less clear what kinds of things would originally have been marked by the stamps, although it is safe to assume that stamping practices would have varied over space and time. Two alternative techniques can be distinguished.

On the one hand, stamps can be used to print coloured images (either monochrome or multi-coloured) onto materials such as human skin, leather, textiles and paper. This is done by coating or filling the image raised in relief or sunk in hollows with a sticky or dry pigment, and then transferring this in reverse to a dry or lightly oiled recipient surface by direct pressure. In Neolithic Romania, Macedonia and Italy, hints of this practice may be provided by the traces of pigments identified on the faces and in the grooves and holes of a few stamps.

On the other hand, stamps can also be used to impress their solid patterns in soft materials, such as clay, dough, butter and wax. In the Near East, they were certainly used in this way, to mark clay sealings, from as early as the sixth millennium BC.

Either way, the use of stamps results in the surface of other things becoming loaded with symbolic messages and cultural meanings, in varying degrees of permanence. The key significance of these tools, in other words, is not so much the archaeologically surviving artefacts but the symbols that they helped people to generate.

Symbols

On the stamps, relatively explicit, albeit stylised, figurative representations of animal, human and supernatural forms, as well as objects and scenes, were confined to the Near East and Anatolia, where they became increasingly standardised from the sixth millennium BC. With the exception of these, the engraved faces of the clay stamps exhibit a wide but culturally and technically constrained set of abstract patterns, based upon subtle permutations of repeated elements. These range from simple groups of lines and points to more visually and cognitively challenging geometric and curvilinear shapes, and combinations, including spirals, meanders and interlocking designs. These were carefully organised within, and framed by, the outline of the stamp's face, which was predominantly rectilinear, but also took other regular shapes and even figurative forms.

Embodiment

Abstract decorative designs such as these characteristically form bold, clear-cut shapes, and structured, repetitive and balanced patterns. A good example is provided by a broken specimen from the settlement site of Cala degli Inglesi in South-East Italy (*Zorzi 1949–50.228*). This has a rectangular outline with a curved end, which frames a simple and regular incised motif of a zigzag band containing circles (Fig. 1.2). Occasionally, however, one encounters other designs that are more visually unstable and confusing, and that can disturb the normal optical and cognitive functioning of the viewer. Two relevant examples, also from South-East Italy, are a pair of specimens from the ritual cave site of Grotta dei Cervi (*Lo Porto 1976.638*). Both have a simple rectilinear outline, but a complex maze-like pattern of interlocking rows of meander motifs (Fig. 1.13–14). More specifically, such examples can deliver a powerful graphic impact, particularly where rhythmic patterns, figure-ground tensions and slight asymmetries cause optical dynamism and ambiguity. In this way, they have the power to attract, captivate, even dazzle, the eye of the beholder.

Furthermore, in anthropologically-documented cases, noted, for example, by the late Alfred Gell, comparable visually powerful art-forms have sometimes been perceived in traditional societies as not only having a dazzling 'anaesthetic' effect on the senses, but also as being embodied by efficacious human-like social agency and even supernatural potency (*Gell 1992*). In other words, the visual disturbances caused by the decorative designs are sometimes interpreted as evidence of a magical superhuman power emanating from the object, and as evidence of the magical prowess of the craftsperson and owner. It is no coincidence, then, that they can be strategically exploited by various people, particularly when displayed during the course of social ceremonies or ritual performances.

I think this way of seeing might also be relevant to the prehistoric stamps and their patterns. In other words, I would like to suggest that they too may have been valued as pleasing and potent ancestral symbols that animated the Neolithic material world with human-like social agency and sacred power.

Meanings, reproduction and attachments

Abstract images depend upon agreed social conventions to encode and express meanings about the world or human life. These may be clear and overt, but they can, equally, be open, malleable and ambiguous. I do not, therefore, want to guess at any specific meanings that may or may not have been ascribed to these images by different people, in different places and times. Instead, I want to think a bit more about the reproduction and attachments of these images.

What sets stamps apart from other hand-held artistic tools, such as brushes, gouges and sharp points (which were also used in the Neolithic to produce similar images on a range of media), is their ability to reproduce – simply, quickly and manually – a large number of almost identical copies of an original graphic image, without significantly compromising the potency or 'aura' of the original (*Benjamin 1968*). This process of reproduction was also extended over long distances of time and space in the Neolithic, by the manufacture of new stamps with patterned designs that recalled and reproduced the style of other stamps, and well as, in some cases, also transforming this style.

Furthermore, the stamps and their motifs also echo (but do not precisely reflect or reproduce) the appearance of other contemporary, decoratively elaborated and culturally significant, products made of plaster, clay and coloured pigments. These include decorated house and cave walls, ceramic vessels, clay tokens, and anthropomorphic figurines, all of which sometimes occur in the same archaeological contexts as the stamps, but do not appear to have been decorated by them. Similarities may also have existed with archaeologically 'invisible' organic artefacts, including the products of weaving. Through the selective reproduction, transmission and transformation of a culturally-defined set of potent, memorable and communicative images, then, diverse elements of Neolithic material culture were ordered,

Fig. 2. 'Pintadera' fragment from the Final Neolithic inhumation cemetery at Cala Tramontana, San Domino island, South-East Italy. Zorzi collection, Museo Civico di Storia Naturale, Verona.

unified and perhaps also subtly differentiated, by patterns of resemblance and contrast established over long distances of time and space.

The same, of course, also applies to the diverse producers and consumers of these objects and images, who belonged to extended networks of communicative early farming communities in Western Asia and Southern Europe, (and even neighbouring hunter-gatherers, in the case of an example found recently in a Mesolithic context at the site of Basi in Corsica – *B. Weninger pers. comm. 2007*). Through this extensive process of visual reproduction of culturally significant information, people stamped order and significance onto their world. These powerful graphic signatures could have repeatedly attached, revealed and reproduced significant cultural concepts and relations across different people, their material world and the supernatural, during the course of the overlapping range of social, economic and ritual practices where they were produced and displayed. As the late Alfred Gell once stated, '*Decorative patterns applied to artefacts attach people to things, and to the social projects those things entail.*' (*Gell 1998.74*) In other words, these powerful cultural symbols could have repeatedly highlighted social and cultural relationships or attachments between various categories of object and people, in the variety of mundane situations and more overtly ritual performances where they were displayed to audiences. More specifically, they could have been used to express a range of culturally and personally significant concepts: of classification, identity, ownership, protection, potency, authenticity, and so on. The act of stamping, then, is likely to have been a highly significant cultural activity.

This process of attachment extended to the human body. It is quite possible that, in some cases at least, the stamps were used to mark people's bodies with potent cultural symbols. Connections with the body are also emphasised by the Macedonian 'figurine seals'. But we also know that some of the stamps themselves were attached to parts of the human body, via their perforated handles, including within symbolically significant mortuary deposits. This bodily attachment of the stamps suggests that at least some were valued as carefully curated, culturally meaningful, tools, intimately associated with the bodies of particular individuals, which could not be left behind, even in death. These examples might even have been used as personal amulets (*c.f. Skeates 1995*). In this way these stamps could, like the patterns they carried, also have been used as personal markers of protection, identity, and so on, which reinforced relations between different people, their material world and the supernatural.

The same could apply to the large and perhaps intentionally fragmented example from Cala Tramontana in South-East Italy (*Zorzi 1958*). One decorated half of this was placed in a grave (Fig. 2), the other decorated half perhaps having been retained in cultural circulation, possibly as a tangible and symbolic marker of ongoing links between the newly-dead and their surviving relatives (*c.f. Chapman 2001*).

Conclusion

By exploring the conceptual dimensions of stamps and their symbols, then, I hope to have contributed not only to the biography of a distinctive category of archaeological artefact, but also to our understanding of a pair of cultural processes – those of embodiment and visual reproduction – that characterise the material culture of Neolithic Eurasia.

ACKNOWLEDGEMENTS

I am very grateful to Professor Mihael Budja for inviting me to contribute this paper to the 14th Neolithic Seminar in Ljubljana, and to Agni Prijatelj and Goce Naumov for some stimulating discussions regarding stamps and stamping.

REFERENCES

BENJAMIN W. 1968. The work of art in the age of mechanical reproduction. In H. Arendt (ed.), *Illuminations: essays and reflections*. Schocken Books. New York: 217–251.

BUCHANAN B. 1967. The prehistoric stamp seal: a reconsideration of some old excavations. *Journal of the American Oriental Society 87: 265–279, 525–540*.

CHAPMAN J. 2001. Intentional fragmentation in the Neolithic and Copper Age of South East Europe: incised signs and pintaderas. In F. Draşovean (ed.), *Festschrift für Gheorghe Lazarovici zum 60 geburtstag*. Editura Mirton. Timişoara: 217–243.

COLLON D. 1990. *Near Eastern Seals*. British Museum Publications. London.

CORNAGGIA-CASTIGLIONI O. 1956. Origini e distribuzione delle pintaderas presitoriche 'euro-asiatiche': contributi alla conoscenza delle culture preistoriche della valle del Po. *Rivista di Scienze Preistoriche 11: 109–192*.

CORNAGGIA-CASTIGLIONI O., CALEGARI G. 1978. Corpus delle pintaderas preistoriche italiane: problematica, schede, iconografia. *Memorie della Società Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano 22: 7–30*.

DZHANFEZOVA T. 2003. Neolithic pintaderas in Bulgaria: typology and comments on their ornamentation. In L. Nikolova (ed.), *Early symbolic systems for communication in Southeast Europe. Volume 1*. British Archaeological Reports International Series 1139. Oxford: 97–108.

GELL A. 1992. The technology of enchantment and the enchantment of technology. In J. Coote and A. Sheldon (eds.), *Anthropology, art and aesthetics*. Clarendon Press. Oxford: 40–63.

1998. *Art and agency: an anthropological theory*. Clarendon Press. Oxford.

LO PORTO F. G. 1976. L'attività archeologica in Puglia. In *Atti del Quindicesimo Convegno di Studi sula Magna Grecia*. Taranto, 5–10 Ottobre 1975. Arte Tipografico. Napoli: 635–644.

MAKKAY J. 1984. *Early stamp seals in South-East Europe*. Akadémiai Kiadó. Budapest.

2005. *Supplement to the early stamp seals of South-East Europe*. J. Makkay. Budapest.

PRIJATELJ A. 2007. Digging the Neolithic stamp-seals of SE Europe from archaeological deposits: texts and mental constructs. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 231–256*.

RODDEN R. J. 1965. An Early Neolithic village in Greece. *Scientific American 212: 82–92*.

SKEATES R. 1995. Animate objects: a biography of prehistoric 'axe-amulets' in the Central Mediterranean region. *Proceedings of the Prehistoric Society 61: 279–301*.

2007. Neolithic stamps: cultural patterns, processes and potencies. *Cambridge Archaeological Journal 17: 183– 198*.

TÜRKCAN A. U. 2007. Is it goddess or bear? The role of Çatalhöyük animal seals in Neolithic symbolism. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34:* 257-266.

ZORZI F. 1949–50. Note paletnoligiche relative al promontorio Garganico e alle Isole Tremiti e raffronti con l'industria 'Campigniana' del Veronese. *Memorie del Museo Civico di Storia Naturale di Verona 2: 219–240*.

1958. Tremiti. *Rivista di Scienze Preistoriche 13: 208–209*.

back to contents

UDK 903.2'12/'16(497.17)"633/634"

Documenta Praehistorica XXXV (2008)

Imprints of the Neolithic mind – clay stamps from the Republic of Macedonia

Goce Naumov

Institute for History of Art and Archaeology, University of Skopje, Republic of Macedonia

gonaumov@mail.net.mk

ABSTRACT – *The presence and unusual structure of clay stamps found in Neolithic settlements often give rise to multiple interpretations to define their character. The small dimensions and specific shape of the stamps suggests that these portable objects were important in the social relations and visual communication between members within the same community and, possibly, more distant communities. The definite patterns distinguishe their function in maintaining the visual traditions of the populations inhabiting southeastern Europe. They had an important role in building the Neolithic image modularity, so that they fitted into the comprehensive decorative structure of Neolithic iconography, and the patterns present on the stamps are related to several aspects of Neolithic material culture from the Balkans and Anatolia. This homogeneity of patterns indicates that they were actively included in the transposition of cognition into visual metaphors.*

IZVLEČEK – *Glinasti pečatniki, ki jih najdemo v neolitskih naselbinah, in njihova nenavadna struktura so pogosto interpretirani na različne načine. Majhne dimenzije in značilne oblike kažejo, da so ti prenosljivi predmeti imeli pomembno vlogo v družbenih odnosih in vizualnih komunikacijah med člani iste skupine, morda pa tudi med bolj oddaljenimi skupnostmi. Njihovi očitni vzorci kažejo na njihovo pomembno vlogo pri oblikovanju neolitske vizualne kulture; njihovi vzorci so del neolitske ikonografije, ki se pojavlja v materialni kulturi od Anatolije do Balkana. Homogenost vzorcev kaže na njihovo aktivno vlogo pri oblikovanju vizualnih metafor.*

KEY WORDS – *Southeast Europe; Anatolia; Neolithic; stamp-seals; symbols; ethnographic implications*

Introduction

This paper presents both published and unpublished Neolithic stamps from the Republic of Macedonia, in an attempt to pose new interpretations as to their cognitive and social character across southeastern Europe. For that purpose, their decorative meaning will be of primary focus, as it allows us to discern the visual dynamics of the patterns and their communicative nature regarding their use with material culture. Furthermore, emphasizing the context and location of some of the stamps, the emphasis will be on the possibility of their role as objects used for imprinting patterns on certain media mediating relations between the inhabitants of one dwelling or settlement. Previous research on Neolithic stamps shows that these objects were always approached through several lines of observation, due to their unconventional appearance and form. Departing from solely function and meaning, the stamps were often interpreted as objects belonging in several categories depending on their utilitarian or ritual sociological context. Within the frameworks of these analyses and interpretations several important fundamentals have been reached in an effort to offer a basic definition of the characteristics of stamps from southeastern Europe and Anatolia (*Makkay 1984; Budja 2003; Dzhanfezova 2003; Naumov 2005a; 2006a; Türk-*

can 2006; 2007; Skeates 2007; Prijatelj 2007), thus pointing to their multifunctional character and their role in the visual culture of the Neolithic communities in these regions.

Between function and meaning

So far, the definite function of the stamps has not been determined. There are many hypotheses widening the functional boundaries which could encompass these objects, mostly emphasizing their socio-economic or ritual character. Regarding their most elementary feature – decoration – they were often related to the tattooing of the human skin, and thus the term *pintadera*, by which they have been referred to by some researchers (*Cornaggia-Castiglione 1956; Mellart 1967.220; Makkay 1984.91*). Two questions concerning Neolithic tattooing still remain open: was it necessary to create a tattoo using stamps, when this could be done with other tools more convenient for colouring the body, and considering the small dimensions of the stamps, how big a mark could they leave on the human body? The authors mentioned above point out that on a number of stamps, including several examples from Republic of Macedonia, the remains of colour are noticeable, so the possibility that they were used to decorate the human body is not excluded (see also *Prijatelj 2007. 242, Fig. 6*). In this case, the probable combination of several smaller patterns could leave remarkable traces on the skin. On the other hand, several authors treat the remains of colour on the stamps as indicative of their use as tools for colouring textile (*Mellart 1967.220; Makkay 1984.91; Perlès 2001.252; Budja 2003.119*). The use of the stamps for imprinting patterns on ceramics is still under discussion. Regarding southeastern Europe, and especially Republic of Macedonia, the association between the concrete patterns belonging to the stamps and the imprinted motifs on pottery and figurines are not yet confirmed. But in the Early Neolithic and Late Neolithic phases of the site at Tell Sabi Abyad (Syria), a large number of ceramic fragments bearing imprints from stamps were excavated (*Akkermans & Verhoeven 1995.21–25; Akkermans et al. 2006.131*). It is interesting that in one Late Neolithic dwelling, where numerous imprinted fragments were found, not one stamp appeared, thus highlighting the personal meaning of these 'tools'; that is, that they were taken by those who used them. It is assumed that the patterns denoted the origin, mode of distribution or the contents of the material preserved within the pots. In this way, the authors remark, a stylized symbolic intercession likely facilitated long-distance communication between two groups (*Akkermans & Verhoeven 1995.23*). By discussing ritual communication and identification through symbols, the distance between the recipients of these objects does not play a significant role, since the symbols directly addressed specific members of one or several communities. On the same site, a fragment of a vessel bearing an imprint in the form of a human body was discovered, and it is possible that this region was the place of origin for anthropomorphic stamps. Anthropomorphic stamps were supposed to represent the owners of the containers and the contents, or a mythical character who protected the goods.

The tradition of marking ceramic containers with stamps was maintained in the Balkans throughout the Bronze Age, but also over a wider area (*Dickinson 1994.189–193; Vasilakis 2001; Kircho 1989. 123–125; Joshi and Parpola 1987.XV*). Researchers do not exclude the possibility that these Bronze Age objects could also have had a magical or apotropaic character beside their use in the administrative control of products. The patterns and representations of the mythical characters, figures and ritual scenes on the stamps point towards their magical benefaction

Fig. 1. Position of the Republic of Macedonia in the Balkan Peninsula.

Fig. 2. Ceramic stamps from the Republic of Macedonia. 1, 4, 6 – Porodin; 2, 3 – Mala Tumba-Trn; 5 – Golema Tumba-Trn; 7 – Unknown site; 8 – Tumba Bara; 9 – Ustie na Drim; 10, 11 – Veluška Tumba. Photos by G. Naumov, courtesy of the Museum of Bitola and the Museum of Macedonia.

over the goods contained in the pots and bags, and perhaps they also functioned as talismans for the people who possessed them (*Dickinson 1994.189–192; Joshi and Parpola 1987.XV–XVII; Kerśak 2005.94*). Support for this idea comes from stamps discovered in Neolithic and Bronze Age grave inventories. Namely, at several Balkan sites and elsewhere, stamps have been discovered interred with both male and female individuals in equal numbers, and are often aggregated in relation to the head, the pectoral area and the pelvic girdle (*Mellart 1967.209; Türkcan 2006.46; Kircho 1989.123, 124; Baćvarov 2003.82, 220; Skeates 2007.186, 195*).

Besides the double function that could be attributed to Neolithic stamps, it is important that through these objects messages concerning some sociological relations could be sent, thus providing information on the mutual co-functioning of Neolithic groups and individuals. It is interesting that the largest number of stamps were discovered in, or around dwellings, thus pointing to their mediating function between members of individual households/families. But if we consider that a great number of the patterns used on stamps present, in part, the general 'decorative Neolithic alphabet', then we can confirm that they represented a medium through which some sort of interaction between the family and the community, or between the settlements in the surrounding environment was performed. This wide use of recombinant cognitive patterns points to developed communication between several settlements in a larger area in which they wanted to acclaim their origin and define their identity. The painted vessels from the Balkans and the similar patterns on the stamps confirm these ideas (*Naumov 2008*). In any case, they do not have to present signs of individual, but rather of a collective identity, of the whole community. It would be logical to expect that by using signs, connections between different communities were established (*Perlès 2001.289; Bailey 2000.110*). In this way, throughout the communication between Neolithic villages, stamps and other objects of the type 'assemblages' were used as mediators in various contracts, exchanges of goods, and even in marriages, when two families made 'exchanges' of younger members of the family (*Talalay 1993.46; Budja 2003.116*). So far, the imprinting of stamps on ceramics from the Macedonian Neolithic has not been confirmed and we cannot exclude the further possibility that on such occasions, imprints were also made on organic materials: leather, textile, dough, and even animals.

During the Copper and Bronze Age, clay bulls imprinted with the patterns of the stamps were made, and these have been discovered within dwelling contexts (*Kircho 1989.124*). This shows that by the later phase of the Neolithic a developed system of signs existed, through which an identification and recognition of the house 'inventory' was made. Furthermore, this system of meanings could move in several directions. For example, the analyses of the Vinča settlements show that objects with stamp signs were discovered in 79 of the houses, which surely implies their common use in household activities (*Starović 2005.258*). More generally, stamp 'signs' are not exclusive to a certain region or period, and similar patterns appear in social contexts across Anatolia, the Balkans, and into Hungary. Thus, the system of meanings and functions of these signs was developed in parallel to the Neolithisation process, and strengthened their role in the interaction between individuals, families and settlements. In this way, the stamps gradually created their interactive character, first dominating 'administrative' relations, but gradually finding their way into the ritual sphere. These two apparently different categories were probably not so differentiated during the Neolithic period, with the remnants of the practice continuing, as mentioned above, into the Bronze Age. Analogies can also be made through a comparison with ethnographic examples from Slavic populations in the Balkans, where the 'documentation' of the household inventory for ritual purposes is made, and is presented below.

Fig. 3. Ceramic stamps from the Republic of Macedonia. 1, 2 – Zelenikovo; 3 – Madjari; 4 – Gorobinci; 5, 6 – Govrlevo; 7 – Stenće; 8 – Gjumušica; 9 – Unknown site. Photos 2, 3, 5, 7 by M. Tutkovski and 1, 4, 6, 9 by G. Naumov; photo no. 8 by Aleksandar Mitkoski, courtesy of the Museum of Skopje, the Museum of Štip, the Museum of Prilep, the Museum of Macedonia.

Furthermore, the contexts in which the Neolithic stamps are found speak more of their dual function. They are very often found together in groups termed as *assemblages* or *caches*, *i.e.* where several different objects create a whole as a result of economic or ritual purpose (*Budja 2003.124; Prijatelj 2007.247, 248*). In one Syrian house, dated to 5900–5800 BC, ceramic fragments with imprints made by stamps were discovered together with approximately 1600 tokens, calculi, and figurines of animals and humans. It is supposed that all these objects represented part of an early administrative system where the tokens or calculi represented the goods and their quantity, while the figurines replaced the animals and the persons that were in the administrative relationship (*Akkermans et al. 2006.131, 132*). Other types of assemblages including stamps, however, are found at other Neolithic sites and suggest different interpretations. In the excavated houses from Nea Nikomedea, Rakitovo, Donja Branjevina, Divostin, Vashtemi and Podgorie, the stamps were almost always discovered together with female figurines, anthropomorphic vessels, vessels painted with white patterns, clay tablets, zoomorphic amulets, pins and female figurines with intentionally divided legs (*Budja 2003.124–126*). There is a question, however, regarding the discrete nature of these contexts, so that it cannot be asserted that the objects formed a mutually exclusive assemblage rather than being randomly arranged through the house, a situation very typical of Neolithic houses in the Balkans. In any case, the concentration of these types of object in one specific space points towards a mutual symbolic function probably related to the domestic rites. Regarding the stamps from the Republic of Macedonia, some of them can be denoted as belonging to assemblages, although the publications of the excavations do not always provide precise information regarding the context of discovery. In most of the published or partially published research on Neolithic dwellings where stamps were discovered, there is a concentration on, or bias towards, the other objects that formed these symbolic assemblages (white-painted vessels, female figurines, 'altars', anthropomorphic vessels, and even figurine house models). Until the consistent publication of excavations, it remains open as to whether stamps can be conclusively correlated to the symbolic functioning of surrounding objects,

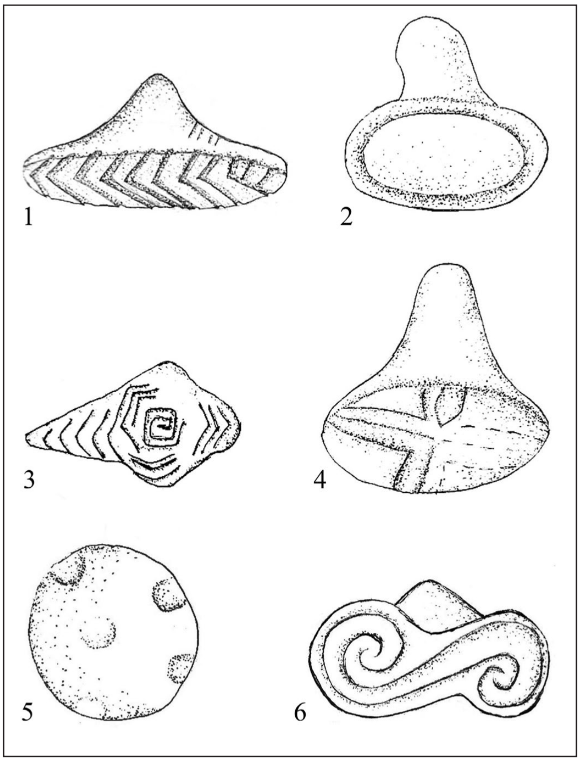


Fig. 4. Ceramic stamps from the Republic of Macedonia. 1 – Amzabegovo; 2 – Golema Tumba-Trn; 3 – Gorobinci; 4 – Nikuštak; 5 – Porodin; 9 – Dolno Trnovo. Drawings by G. Naumov.

or whether they function separately as objects with independent roles in domestic, utilitarian or ritual activities.

In one of the shrines in Çatal Höyük, four stamps together with seven figurines, fragments of vessels, tools and a grain-mill were discovered placed around a fireplace (*Türkcan 2006.45*). This constellation of objects and their context of deposition connect the stamps to domestic activities performed around the fireplace, most probably in the domain of activities relating to the preparation and decoration of bread.

All the above-mentioned interpretations of the stamps rely on several categories of evidence: the context of discovery, their visual analogies, and traces of their imprints. What is certainly missing from these categories is a belief in their singularity of function. On the contrary, it is likely that, despite the lack of visible traces, stamps could have been equally used in tactile and imaginary relationships between people, as well as in those between people and their numinous environment. In the following section, only the stamps from the Republic of Macedonia will be presented which, in many cases, belong to multi-layered engagements in the above-mentioned category of 'visual analogies'. This will certainly point to their multifunctional character, while the context of their position and ethnographic analogies with contemporary ritual stamps will enable yet another possibility for defining at least some of their functions.

Stamps from the Republic of Macedonia

In the course of the excavations of the Neolithic settlements in the Republic of Macedonia (Fig. 1), approximately 25 ceramic stamps belonging to all three phases of the period were discovered, although most of the stamps were dated to the Early and Late Neolithic.

In order to obtain more detailed knowledge about their character, data concerning their typological features, their stratigraphic determination and context of discovery was necessary. Unfortunately, this information is not always equally available for all accompanying stamps, since references from previous

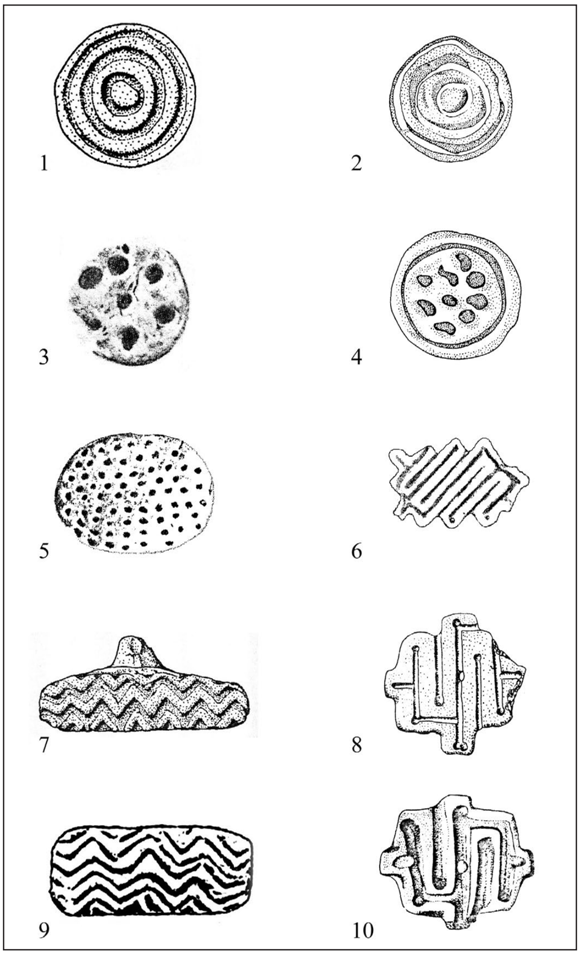


Fig. 5. Neolithic stamps from Greece. Nea Nikomedeia: 1, 5, 9 (**Budja 2003.Fig. 6*****); 3, 7 (*****Makkay 1984.Fig. VI. 4; Fig. X, 1*****); Sesklo: 2, 4; Achilleion: 6; Philia; Pyrasos (*****Makkay 1984.Figs. XII. 12; XIII, 8; XIII. 4; III. 4; III. 1*****).***

publications do not give clear details regarding the petrographic, chronological or contextual data, and, for many of the other excavated stamps, these details have not yet been published. Thus, this evaluation will focus mainly on the bases of the decoration and reflection within the socio-religious aspects of Neolithic life, while the part concerning the content of the clay from which the stamps are made and their precise contextual details will remain vague due to insufficient data.

Because of the variety of decoration, a complete typology has not been made, and has so far only included the range of stamps classified as *pintaderas*, such as those with rectangular, oval, circular, or amorphus bases (Figs. 2–4). Regarding the patterns inscribed on the stamps, it has been much more difficult to create a pattern-based typology. Although the patterns can be generically divided into two groups of geometrical patterns (rectangular and twisted), there is still a large number of patterns that are distinguishably unique. For this reason, it is almost impossible to create one general pattern-based typology since, considering almost all the inventory of stamps from Republic of Macedonia, most stamps have authentic and unique decoration. Regarding the geometrical rectangular patterns, the most common are flat lines, zigzags and triangular patterns, with examples on stamps found at sites at Djumušica, Amzabegovo, Gorobinci, Stenće, Golema Tumba-Trn, Velušina and Porodin[1]. Meandering types of stamp patterns appear at sites such as Ustie na Drim, Gorobinci, Madjari[2], and from two unidentified sites from the regions of Struga and Bitola[3]. Twisting stamp patterns are probably the most characteristic, and spiral motifs are the most common, followed by simple and concentric circle designs. Stamps with these patterns have been recovered from Mala Tumba-Trn, Golema Tumba-Trn, Porodin, and an unidentified site in the Ohrid region[4]. The remaining examples of stamp patterns are unique in their ornamentation, including amorphous and cross patterns, and bases with 'warty' patterns have been identified in

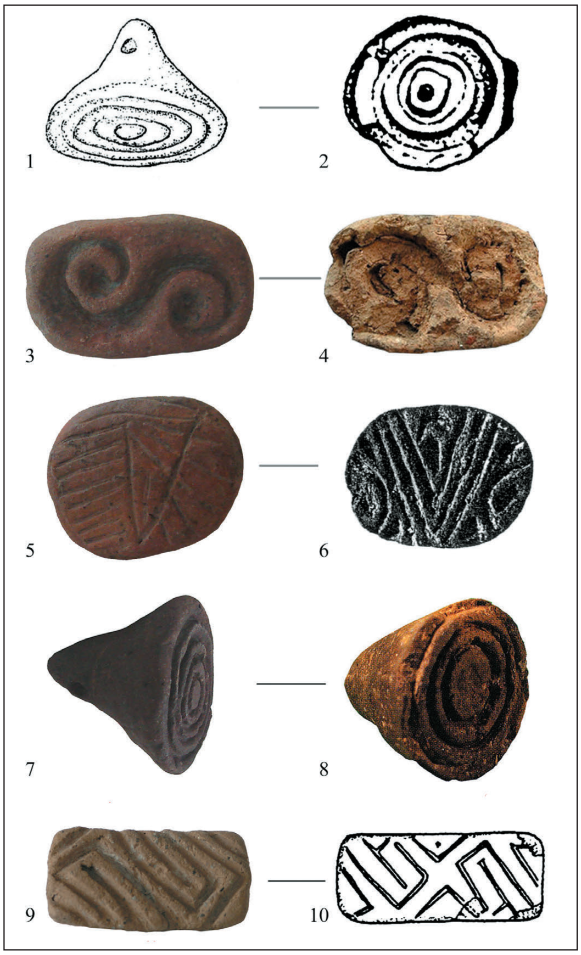


Fig. 6. Visual similarities between stamp patterns from the Republic of Macedonia and Anatolia. 1, 7: Porodin; 2: Çatal Höyük (*Budja 2003.Fig. 2*); 3: Mala Tumba-Trn; 4: Çatal Höyük (*Türkcan on line*); 5: Golema Tumba-Trn; 6: Çatal Höyük (*Mellart 1967.Fig. 121*); 8: Bademağaci (after* Özdoğan & Başgelen 1999.152, Fig. 39*); 9: Madjari; 10: Haçilar (*Budja 2003.Fig. 5*). 1, 3, 5, 7, 9 (Photos and drawing by G. Naumov, courtesy of the Museum of Bitola and the Museum of Macedonia).

Tumba Bara, Zelenikovo, Nikuštak, Mala Tumba-Trn and Porodin[5]. A stamp from Govrlevo, is unique, with a decorative pattern organized into several zones. This uniqueness is further accentuated by its but shape and modeling[6]. In a final consideration of de-

1 Basic data on these stamps: *Korošec and Korošec 1973.56, T. XIII: 17; Garašanin et al. 1971.43; Gimbutas 1976.Pl. 9; Zdravkovski 2006.193, c. 111; Simoska and Sanev 1976.32, 44, Fig. 2, 3, Fig. 153; Grbić et al. 1960.46, T. XXV: 1*. The find from Djumušica has not yet been published. Photo of this stamp used by kind permission of Aleksandar Mitkoski.

2 Basic data about these stamps: *Garašanin et al. 1971.48, c. 130; Sanev 1975. T. X: 4,5*. The example from Madjari is not yet published, so the data was taken from the exposition's glass-cases of the Museum of Macedonia.

3 One set of the exhibited stamps has not yet been published in the archaeological literature, so that their documentation was performed ad hoc through the exhibition's display cabinets. Due to the inappropriate noting of these and the finds, some of these objects have no information about the site or place of origin, or the information is inaccurate.

4 Basic data on these stamps: *Simoska and Sanev 1976.34, 44, 45, Fig. 51, Fig. 154, Fig.170*.

5 Basic data on these stamps: *Simoska and Sanev 1976.42, 45, Fig. 148, Fig. 171; Galović 1964. T. XII: 1, 2; Zdravkovski 1992.21, T. IV: 1; Grbić et al. 1960.46, T. XXV: 3, 4*.

6 Basic data on this stamp: *Bilbija 1986.36*.

coration it should be mentioned that numerous stamps from Republic of Macedonia have deeply inscribed patterns, which certainly leads to the conclusion that they were used for imprinting patterns on soft surfaces (Figs. 2–4). Stamp dimensions often vary, but most often the diameter of the base is wide, averaging approximately 3 or 4cm, although at the opposite end of the spectrum examples from Porodin and Velušina have base diameters closer to 8 or 9cm, which makes them some of the largest Neolithic stamps in southeast Europe. So far, the biggest stamp is from Zelenikovo, which has a base diameter of 12 cm (Fig. 3.1). It may be concluded that these specific stamps were applied to a media that did not have standard dimensions, or that their size had a secondary role in regard to the meaning of the pattern. It is interesting that stamp bases often have the remains of white, and very rarely red, coloration (Fig 2.6, 7, 11; Fig. 3.7). This points to the fact that these objects were slipped and painted over with white, a characteristic seen also on some figurines and clay models from the same region. The presence of colour could be a result of the use of these objects for making tattoos, but without further chemical analyses, this hypothesis cannot be confirmed. Regarding their features, the examples from Porodin, Gorobinci, Stenće and Madjari (Fig. 2.4, 7; Fig. 3.3, 4, 7), have small perforations on the handles, which suggests that they were hung or carried around the neck. Perforations like these are present on several Neolithic examples from other parts of southeast Europe (*Makkay 1984.Fig. I.6; Fig. IV.3, 9; Fig. V.7, 9, 10; Fig. VII.7; Fig. XII.12; Fig. XIII.2, 6, 8*; etc.), but also in Japan (*Kobayashi 2004.Fig. 7.3*). It can be confirmed that only certain personal or kinds of stamps were carried, as the larger percentage of stamps usually have modelled handles.

The relationship between Macedonian stamps and Balkan and Anatolian visual culture

Many of the stamps discovered in the Republic of Macedonia share similarities with, or are identical to those from neighbouring regions, and further afield to the north and southeast of Republic of Macedonia. Of great importance are the analogous examples discovered in Greece and Turkey. The chronology of these sites, in relation to those in the Republic of Macedonia, suggests the stamps may have been linked to the spread of the Neolithization. Generally, the similarities in decorative patterns are the main indication pointing towards cultural interaction, as the stamp patterns, in large part, recur across southeastern Europe (*Budja 2003.118, 121, 123; Perlès 2001. 288; Bailey 2000.109, 110*), making it difficult at times to point to primary connections between certain sites, that is denoting Neolithic cultural ties through engraved patterns. In such cases, only the reference sites from Greece and Turkey that have specific chronological and iconographic correlates to the stamps from the Neolithic settlements from Republic of Macedonia will be discussed. In this way, the accent will be on the eventual directions of the spread of Neolithisation, and of the further penetration of certain patterns into regions north of Republic of Macedonia. Regarding analogies from Neolithic settlement sites in the south of the Republic of Macedonia, it is notable that identical stamp patterns (zigzag, concentric circles, the applications of strings) present at the sites of Gorobinci, Amzabegovo, Djumušica, Govrlevo and Porodin have also been found at Nea Nikomedea and Sesklo, and this certainly points to cultural similarities and possible communication between these

Fig. 7. Visual similarities between stamp and vessel patterns from Republic of Macedonia and Anatolia. 1 – Amzabegovo (photo by G. Naumov, Courtesy of Museum of Štip); 2, 4 – Çatal Höyük (**Budja 2003. Fig. 2*****); Veluška Tumba (photo by G. Naumov, courtesy of the Museum of Bitola).***

regions (Fig. 2.1, 4; Fig. 3.4, 6, 8; Fig. 4.1, 5 compared to Fig. 5.1–5, 7, 9). Similarly, the labyrinth represented on the Middle Neolithic stamp from Madjari often appears in Thessaly at sites at Achilleion, Pyrasos, Tsangli, Nessonis, Philia and Sesklo (Fig. 5.6, 8, 10). Furthermore, aspects of stamp decoration from Republic of Macedonia were also present in the Anatolian examples. Four types of pattern from Republic of Macedonia (including concentric circles, spirals, meanders and triangles) were also found inscribed at Çatal Höyük (Fig. 6). Concentric circles, the labyrinth and parallel lines are also represented on stamps from Bademağaci and Haçilar, and even further into the Levant on stamps from the sites in Tell Halula and Mallaha. On the other hand, some of the stamp patterns from the Çatal Höyük appear on Early and Middle Neolithic painted vessels from Republic of Macedonia (Fig. 7), and a small percentage of the Macedonian examples seem to be closely related to the wall-painting decorations in the shrines at Çatal Höyük.

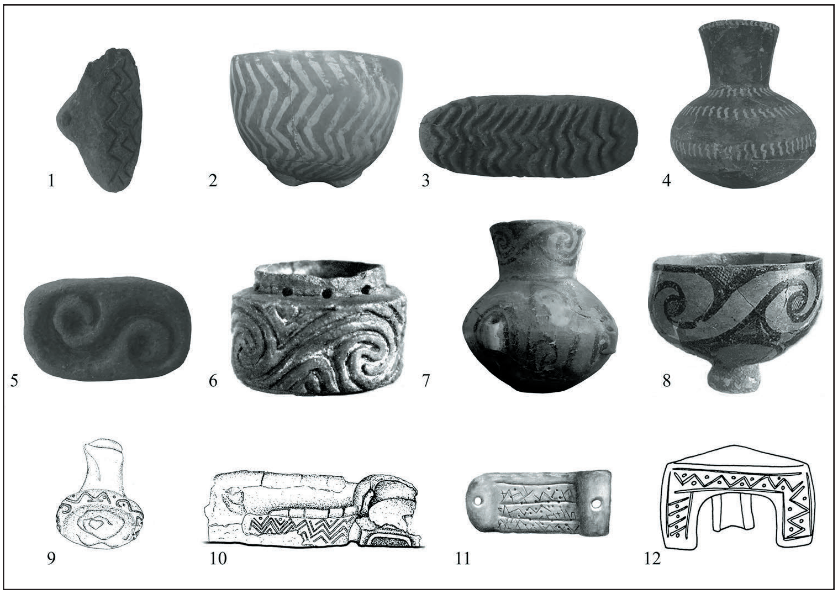


Fig. 8. Similar patterns represented on different types of material culture. 1 – Gorobinci; 2 – Amzabegovo; 3, 4 – Veluška Tumba; 5 – Mala Tumba-Trn; 6–8 – Madjari; 9 – Govrlevo; 10 – Zelenikovo (*Garašanin and Bilbija 1988.Pl. II*); Yannitsa (*Merlini 2005.Fig. 10*); 12 – Karanovo (*Todorova and Vajsov 1993.Fig. 208.9*). Photos 1–8 and drawing on 9 by G. Naumov, courtesy of the Museum of Štip, the Museum of Bitola and the Museum of Macedonia.

This wide distribution of identical decorative motifs points to the accepted hypothesis that the Neolithisation of the Balkans developed in close relation to Anatolia as the process moved up through Thessaly, and into the Macedonian region. The question remains open, however, at to whether the presence of similar or identical patterns from different sites indicates explicit communication between settlements, or whether the patterns were the result of local choices that developed independently of direct contact. It must be kept in mind that the geometrical motifs inscribed on the stamps are often simple and common across much of Europe, making it difficult to confirm a single reason for the appearance of identical patterns. Nevertheless, the chronological sequence of stamps at various sites supports this diffusionist hypothesis, as it is clear that the appearance of stamps and their inscribed patterns slowly moved into Europe from the southeast. The presence of the stamps is also synchronized with the appearance of pottery painting, particularly in white, in the Balkans (*Budja 2003.123*), which facilitates the detection of these patterns on material culture. Precise chronological analyses and the established contexts and stratigraphies for some stamps support the manner of their appearance, but it should also be noted that the distribution of these objects and their decorative motifs took place rapidly within the early phases of the Neolithic.

This is evidenced more generally when considering the full range of Neolithic material culture. In the early phases of occupation at Amzabegovo, the appearance of *triticum monococcum* and *triticum dicoccum*, the presence of specific kinds of goat and sheep, red and white wall painting, mud brick construction styles, and burial evidence suggesting individuals of Mediterranean descent, all resemble Anatolian traditions (*Hopf 1961; Sanev 2004.36; Gimbutas 1976.68; Baćvarov 2003.223–248; Naumov 2007a; Mellart 1975.99; Veljanovska 2000.45; 2006*). Furthermore, recent analyses of Y-chromosome haplotypes have confirmed some migration by the presence of 20–25% of the DNA lineages in southeastern Europe coming from the Near East and Anatolia (*King and Underhill 2002; Budja 2004. 237*). Nevertheless, despite the penetration of Anatolian and Near Eastern populations and their indirect manifestations, the Aegean influence should also be taken into consideration, especially regarding the

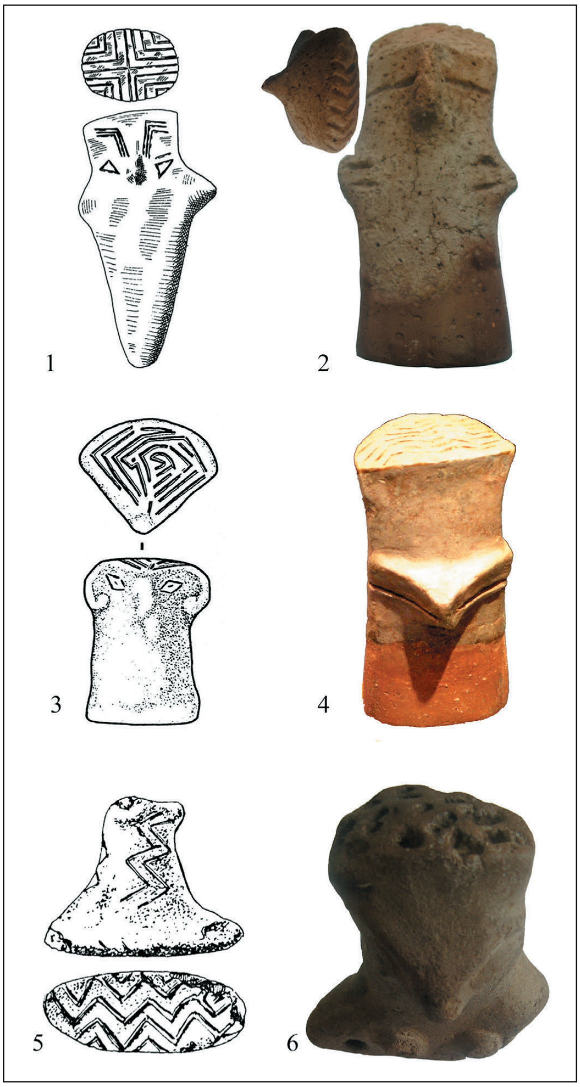


Fig. 9. Anthropomorphic and zoomorphic stamps and figurines: 1 – Medvednjak (**Gimbutas 1989. Fig. 21*****); 2 – Amzabegovo; 3 – Kurilo (*****Todorova and Vajsov 1993.Fig. 175.15*****); 4 – Zelenikovo; 5 – Szentes (*****Makkay 1984.Fig. XXX. 1*****); 6 – Gorobinci. Photos 2, 4, 6 by G. Naumov and 4 by M. Tutkovski, courtesy of the Museum of Štip and the Museum of Skopje.***

element of visual expression. In this context, it can be stressed that, considering the typological and chronological parallels, the process of a 'visual Neolithisation' reached Macedonia through Thessaly, but only in the stylistic pattern domain. At the compositional level, even in the earliest phases, authentic structures existed with no obvious parallels in the neighbouring regions of the Balkan Peninsula.

The often cited presence of the already mentioned patterns can be noticed on many stamps discovered in the region around the Republic of Macedonia, but also further north (*Makkay 1984.Figs. I–XXXI; Dzhanfezova 2003.Fig. 6*). The use of identical patterns in several regions points to strong communication links, which offers information beyond simply tracing the development of the Neolithisation process. Namely, these objects not only speak of the maintenance of traditions either through eventual colonization or indirect visual communication, but simultaneously they point to a tradition of preserving certain patterns which would incorporate further meanings for their manufacturers. The presence of the same patterns in the other spheres of pictorial expression only confirms the fundamental semantics of the patterns imprinted by stamps.

Stamp patterns and their analogies with decoration on other Neolithic objects

The repertoire of patterns imprinted on stamps is also present in other pictorial techniques and media, such as in the decoration of the utilitarian ceramic inventory. Aspects of these patterns are often painted or inscribed in different variations on vessels, figurines, ovens, clay tablets, and the walls of the some Neolithic dwellings or shrines. Objects utilizing these patterns were often of the highest degree of technical production, or were incorporated into particular domestic spheres. The repetition of the same patterns across several media may have represented a deeply engrained corpus of patterns used as a mode of symbolic expression, or it may have been more deliberately created as an insignia through which the local population recognized and differentiated itself from others.

The incised patterns found on the stamps are also common on Early and Middle Neolithic painted vessels from Republic of Macedonia. It is interesting that the stamp patterns and painted pottery also share certain compositional elements. Namely, the painted compositions consist of complex patterns of peculiar and combined permutations, visually segmenting the vessel into zones in some instances (*Naumov 2005b. 68–71; 2008*). Certain elements of the patterns inscribed on the Neolithic stamps were used, then, in the development of the pictorial compositions. What this shows is that these patterns were not independent or exceptions, but that they were actively employed in the visual expression of multiple media. Such visual dynamics were manifest in many relations and on several types of material culture present at Neolithic sites in Republic of Macedonia.

Several analogies between the patterns on stamps and vessels can be highlighted (Fig. 8.1–8). The zigzag motif inscribed on the stamps from Gorobinci

*Fig. 10. Stamps, wall paintings and reliefs from Çatal Höyük: 1, 7 (***Türkcan 2006.47, 48***); 2–5, 8 (***Mellart 1967.44, 87, 88, 200***); 6 (***Çatalhöyük 2006.196***); 9 (***Gimbutas 1989.Fig. 390.2***); 10: (***Budja 2003.Fig. 2***).*

and Djumušica was also found painted on an Early Neolithic vessel from Amzabegovo. The stamps and vessels from Velušina have identical twisted patterns. The painted pattern on Middle Neolithic vessels is also visible on a Pelagonian stamp from Trn. The inscribed spiral pattern on this stamp also appears in several variants on painted cups and amphorae belonging to the Middle Neolithic phases of the Amzabegovo-Vršnik group. The same motif is present on a small pot with inscribed decoration discovered in Madjari, although it is interesting that in this example there is a twisted swastika motif on the bottom of the vessel. This motif in particular belongs to the repertoire of patterns found on several Neolithic stamps in Albania, at Maliq (see *Makkay 1984.Fig. XVII. 5*). Nevertheless, it is the range of similarities and interactive relationships between the stamps from Anatolia and the painted vessels from Republic of Macedonia that should be noted, and these similarities in style and use continued throughout the Bronze Age (*Dickinson 1994.191; Kircho 1989.123*).

The decorative features of the Neolithic stamps from Republic of Macedonia are also visible, in part, in the architectural interior of some dwellings in Republic of Macedonia, Bulgaria, and Anatolia. Namely, there are similar decorative motifs on a stamp from Ustie na Drim (Fig. 2.9), inscribed on the lower parts of the walls of a house discovered in Azmak, and painted on some of the frescoes in the buildings at Çatal Höyük. The linear patterns on the stamp discovered in Amzabegovo are also present on the upper corner of the house model from Vršnik. What is highlighted in this last comparison is the pattern detail on the far right side which resembles the letter *E* (Fig. 4.1). This same pattern, independent or combined with other patterns, is inscribed on two fragments from the same stratigraphic layer at Amzabegovo from which the stamp was recovered (*Korošec and Korošec 1973.56*). The common reoccurrence of this pattern in two settlements so close to each other speaks to it having a particular meaning or as a certain type of communication shared between the communities in the region. While it would not be appropriate at this time to suggest it was part of some alphabetical system, its ideographic function should not be overlooked; all the examples bearing this same pattern belong to the Late Neolithic phases of the settlements, a period during which the so-called Danube alphabet was in formation (*Merlini 2005; 2007; Haarman 2005.228–231; Starović 2004.16–30; Winn 1981*).

In this context, the most interesting stamp is probably from Govrlevo – on its base border it has twisted and zigzagged ideograms separated by dots and whose pattern is partially inscribed on the 'oven/altar' from Zelenikovo. This pattern is also present on portable material, such as ceramic plates, and on walls in the neighbouring regions (Fig. 8.9–12). The unique patterning of this stamp suggests many possibilities for further semantic analyses of these ideograms and for defining the specific function of the stamps. The presence of dots may determine a numerical and spatial disposition. Its common correlation to zigzag lines may further point to the existence of prescribed principles structuring ideogram communication.

Stamp-figurines

The example from Govrlevo also belongs to another category of stamps which intersects with the sphere of anthropomorphic and zoomorphic sculpture, combining elements of both objects, and are referred to as stamps-figurines (Fig. 3.5; Fig. 9). The most remarkable example is the stamp from Govrlevo whose handle is actually a figurine. The base was incised in two zones with a connected line and independent ideograms, suggesting a symbolic function. It can be supposed that in the case of the figurines from Zelenikovo, Amzabegovo and Gorobinci, the inscribed patterns on top of their heads were used for imprinting, since their ornamentation is almost identical to that on the bases of some of the stamps (Fig. 9.2, 4, 6).

The pole-like figurines from the Balkans could be delineated as a different category, then, where the patterns visible on their heads are similar to the decoration of the stamps. The example from Medvednjak is excellent, and the context of its discovery provides insight into the function of these objects (Fig. 9.1). This object, which lacks a plain base so that it could be put on a plain surface, was discovered inside a silo which, according to the chemical analysis, was filled with grain (*Gimbutas 1989.14*). This information points to the figurine being used as an amulet protecting the grain, although it probably also functioned in activities related to the preparation and decoration of bread – a suggestion also supported by the decoration on its head. Identical decorative motifs are present on several Neolithic stamps discovered in Greece, Bulgaria and Hungary (*Makkay 1984.Figs. XIII, XXIII, XXVII*). It is difficult to say whether all the figurines bearing decoration on the tops functioned as stamps, but if we consider the depth of the inscribed patterns and make an analogy to the symbolic relation between human hair and grain in contemporary archaic cultures (*Chausidis 2005.234*), it can be supposed that some of them were used for imprinting patterns on soft dough.

A small subset of 'anthropomorphic' stamps belongs to a group made in the form of a foot or palm. Such examples have been discovered at Bikovo (Bulgaria), Çatal Höyük and Gura Vāii, although the earliest forms of these stamps were discovered at Byblos (*Makkay 1984.26, Türkcan 2007.261*). The last example resembles a bear foot, so the possibility that some of the figurine-stamps represented animals can-

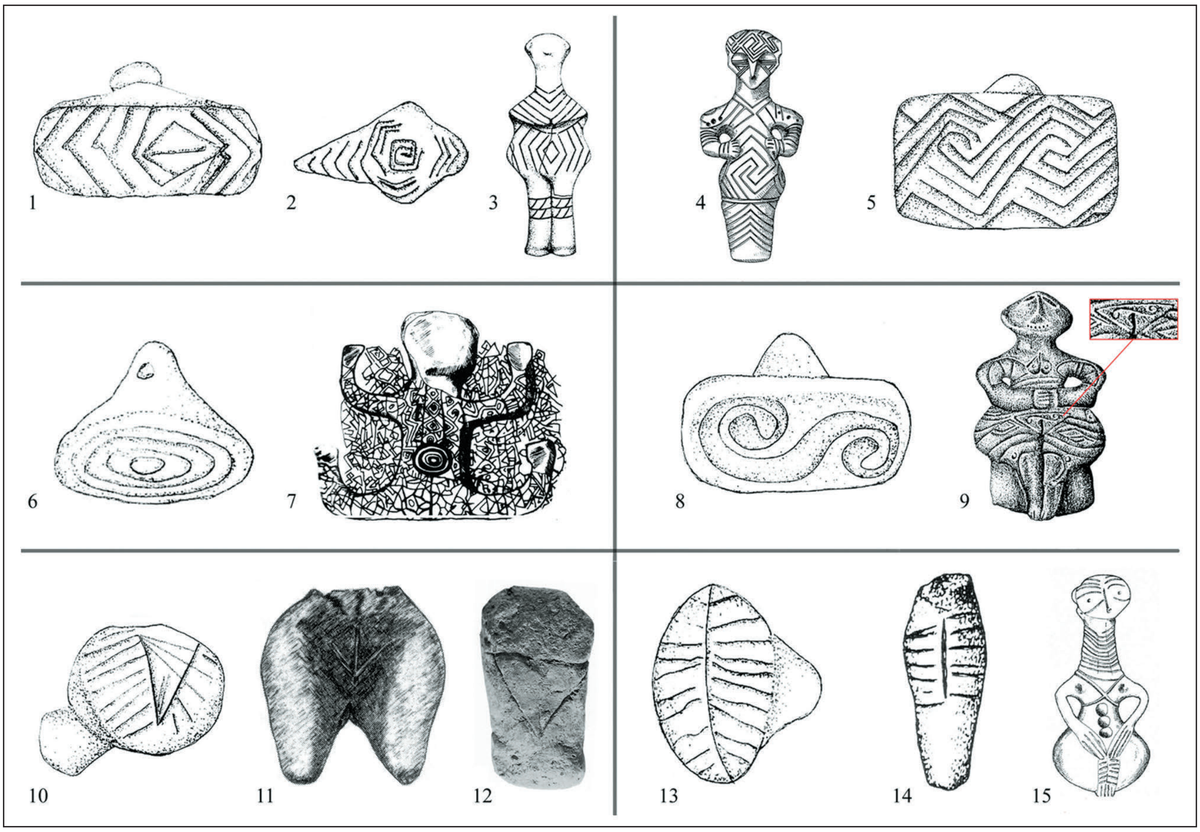


Fig. 11. Visual similarities between patterns on stamps and figurines: 1 – Stenće; Gorobinci; 3 – Balčik (**Chausidis 2005.Pl. B11. 18*****); 4 – Potporanj (*****Gimbutas 1989.Fig. 18*****); 5 – Ustie na Drim; 6 – Porodin; 7 – Çatal Höyük (*****Gimbutas 1989.Fig. 390.2*****); 8 – Mala Tumba-Trn; 9 – Pazardjik (*****Gimbutas 1989.Fig. 220*****); 10 – Golema Tumba-Trn; 11 – Čaška (*****Jovčevska 1993.T. II:7*****); 12 – Golema Tumba-Trn (*****Simoska and Sanev 1976.Fig. 165*****); 13 – Veluška Tumba; 14 – Yablona (*****Sorokin and Borziyak 1998.Fig. 5.5*****); 15 – Nudra (*****Gimbutas 1989.Fig. 148.1*****). 1, 2, 5, 6, 8, 10, 13 (Drawings by G. Naumov).***

not be excluded. Two stamps from Çatal Höyük in the forms of a bear and leopard suggest a further use of zoomoophic figurines as stamps (*Türkcan 2007*).

Stamps and animal imagery dynamics of Çatal Höyük

Over the years of excavations conducted first by Mellart and then Hodder, a dozen stamps strongly related to zoomorphic imagery dynamics were discovered (*Mellart 1967; Türkcan 2006; 2007*). The presence of stamps representing both bears and leopards correlates to the imagery traditions represented elsewhere in the settlement. These animals, in almost identical positions, were equally present in wall decorations, both as painted or sculpted images, and are, except for one example, absent from faunal remains (*Türkcan 2007.261*) (Fig. 10). Furthermore, some of the 'non-figurative' stamps are shaped or inscribed with patterns that are equally remarkable on the bodies of the painted and sculptured animals. Thus, the shape of the four-pointed stamp is often painted on the walls of buildings and, even more interesting, is painted on the head of some of the plastered leopards (Fig. 10.2–5). Surely this suggests that the four-pointed stamp is closely linked to representations of leopards, and it probably had the function of transporting some of the symbolic meaning or essence of the leopard through the image, and the leopard stamp itself was probably used for the further manifestation of these meanings onto the media where it should be imprinted. If we can imagine that the people painting on the walls were dressed in leopard skins (emphasized in a moment of a hunt, dance or trance), then we could suppose that these stamps concentrated the energy and skill of the leopard on the person decorated with or consuming products decorated with these suitable patterns. This will be discussed further below. In contrast, bear is also represented among the repertoire of animals on both stamps and wall decoration, but in a totally different context. While the positions in which these animals are represented are identical, there are distinguishing features in the patterns painted or inscribed on their bodies. In particular, the stomach area is often inscribed with patterns present on the 'non-figurative' stamps, regardless of whether the image is a stamp and on one of the reliefs (Fig. 10.7–10). This recurrent imagery leads to the conclusion that specific features of the animal bodies (especially the stomach) were deliberately isolated, and through the decoration of the stamp these characteristics could be transmitted to the new media. As will be pointed below, specific similarities between the patterns on the stamps and the animals' bellies will also be present in the corporeality of other figurines.

Semantic relations between patterns on stamps and other media

The decoration present on the stamps is also noticeable in different variations on figurines, cult tablets, ovens, cups, silos, wall reliefs, and paintings. It seems that the media and objects that entered the ritual sphere were decorated in order to symbolically protect, stimulate and multiply their contents. Since some of the patterns were precisely elaborated and repeated on different objects, it can be considered that they possessed concrete meanings which can be explored through semantic analyses. The repetition of these patterns suggests that in the Neolithic there was a defined repertoire of patterns which, depending on the object and its shape, were multiplied or placed in specific areas. In this context, the most interesting data comes from figurines and wall art, which were usually decorated by engraving or painting techniques. It was stressed above that some figurines, due to the deeply engraved patterns and decoration of their bases, belonged to the sphere of stamps utilized for imprinting decoration on other media. But in the Neolithic, figurines bearing the same patterns known for the stamps from Republic of Macedonia were inscribed on their stomach and genitalia. Re-

Fig. 12. House at Govrlevo (Photo by M. Biblija).

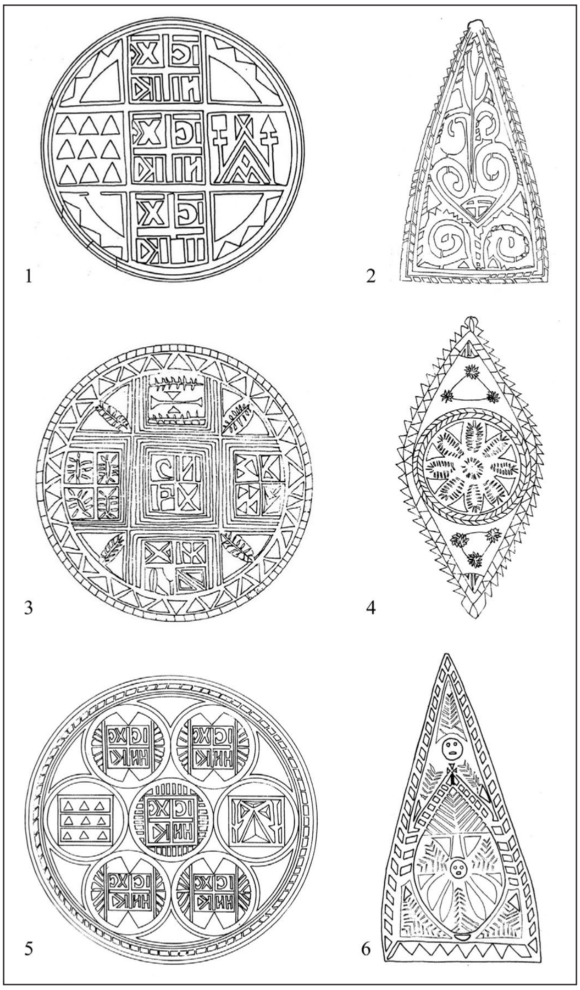


Fig. 13. Wooden stamps (*poskuri/šaralki*) from the Republic of Macedonia: 1 – Galičnik; 2 – Misleševo; 3 – Vevčani; 4 – Vevčani; 5 – Lazaropole; 6 – Vevčani (*Krstevska 2005.Figs. 3, 8, 13, 21*).

garding the patterns on the belly of these figurines, the most common patterns are pseudo-meanders, bordered lozenges and concentric circles. Analogous patterns and motifs are found on stamps from Ustie na Drim, Stenće, Gorobinci and Porodin (Fig. 11.1–7). Concerning the patterns represented on the genitalia, most are composed of long spirals, cut triangles or vertical lines with thick oblique or horizontal crossing lines. Such examples can be seen on the stamps discovered in Mala Tumba-Trn, Velušina, Golema Tumba-Trn and two unknown sites in the regions of Ohrid and Struga (Fig. 11. 8–15). Finally, with the last example, a detailed study of on the authentic stamp was made, and it is interesting to point out certain technical characteristics in the manufacture of its decoration (Fig. 11.10; Fig. 2. 5). During the engraving of the lines, the craftsmen intended to produce a motif identical to the one from Velušina (Fig. 11.13; Fig. 2.10), but for unknown reasons, changed the method of engraving and, while the clay was still wet, a triangle with a line that cuts through its middle over the original set of lines was engraved.

What is interesting about these motifs is that both variations were often used to represent female genitalia on figurines. This stamp may be the best example of stamps being used to impress patterns denoting the vulva, with all its symbolic meaning (*Chausidis 1996.60*). It remains an open question as to what type of context this pattern would have been imprinted in, but considering that the engraved pattern on the stamp from Trn is very shallow, it can be supposed that it was meant to be imprinted on a soft surface, or to be worn simply as an amulet, serving to symbolically transpose the meanings of the vulva to the new media or to its owner. Rudimentary representations of female genitalia are also present on other examples from Republic of Macedonia and the Balkans; and are identical to representations of genitalia on some of Neolithic figurines from southeastern Europe.

The question concerning the relationship between the patterns on stamps and those engraved on the sex of female figurines remains open for further elaboration and would surely provide greater insight into the function of the stamps. Therefore, it would be interesting to explore the media on which these patterns were imprinted and whether these media had a symbolic relationship to the characteristics of the female abdomen. Along these lines, the use of analogies and the context of deposition of some stamps, linking them to the character of the objects decorated with stamps, could be explained. In the recent excavations of building A1 at Çatal Höyük, four stamps along with seven figurines, a grinding stone and tools for processing cereals were discovered together (*Türckan 2006.45*). The stamp-figurine from Govrlevo had a very similar depositional context (Fig. 3.5), being recovered next to a large ceramic structure, and arranged with several grinding stones, models of loaves and the remains of a significant amount of ash (Fig. 12)[7]. Close to this area, one more stamp was discovered (Fig. 3.6), and on the same site the remains of figurine-house models were discovered. On one of them the female representation has a navel and a stomach in a state of preg-

7 Information about the context of this stamp and the clay construction were acquired courtesy of the researcher of Govrlevo, Miloš Bilbija.

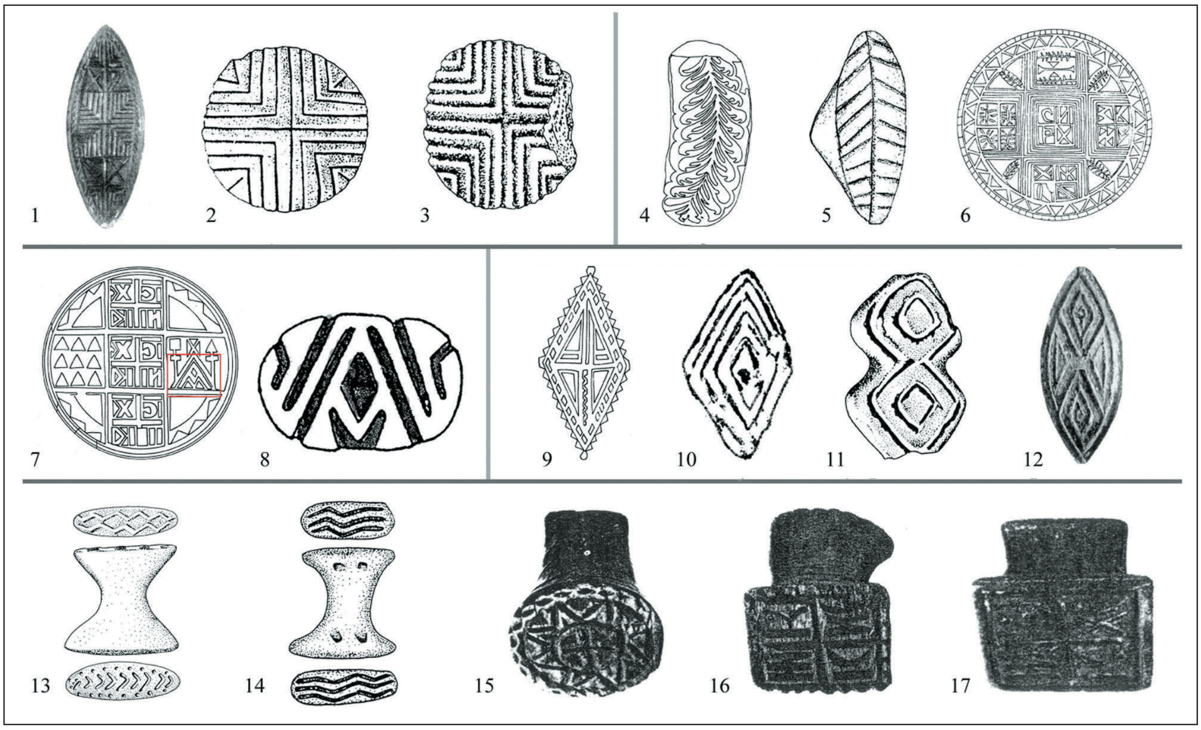


*Fig. 14. Visual similarities between patterns on Neolithic and contemporary stamps: 1 – Markovac (*Kostić 1967.Pl. II. 1*); 2 – Prague (*Makkay 1984.Fig. XXIII. 2*); 3 – Ruse (*Makkay 1984.Fig. XXIII. 4*); 4 – Struga (*Krstevska 2005.Fig. 20*); 5 – Unknown site (Drawing by G. Naumov); 6 – Vevčani (*Krstevska 2005.Fig. 3*); 7 – Galičnik (*Krstevska 2005.Fig. 21*); 8 – Çatal Höyük (*Budja 2003.Fig. 2*); 9 – Volino (*Krstevska 2005.Fig. 16*); 10 – Szakály (*Makkay 1984.Fig. XV. 2*); 11 – Eutresis (*Makkay 1984.Fig. XIII. 3*); 12 – Markovac (*Kostić 1967.Pl. II. 4*); 13 – Slatina-Sofia (Makkay 1984.Fig. VIII. 8); 14 – Slatina-Sofia (*Baćvarov 2003.Fig. 2. 26*); 15 – Lika (*Kostić 1967.Pl. V. 4*); 16 – Ljubižda (*Kostić 1967.Pl. V. 2*); 17 – Strmosten (*Kostić 1967.Pl. V. 3*).*

nancy represented identically to the loaf discovered near the construction. According to Bilbija, this structure was used in the preparation and baking of bread. It is interesting that the ideograms engraved on the stamp-figurine from this dwelling correspond to those engraved on another structure/oven, located in a dwelling at Zelenikovo, a settlement near Govrlevo (Fig. 8.9, 10). This scenario, along with the depositional context of the stamp-figurine from Medvednjak discovered in a silo with grain, clearly demonstrates that Neolithic stamps were, in part, related to the preparation of bread. Using both the Neolithic models of loaves and ethnographic data, it is likely that some stamps were thus used for decorating unleavened cakes, bread and loaves prepared in some dwellings.

Neolithic stamps and their ethnographic implications

Many ethnographic reports from the Balkans in the 19th and 20th centuries note that bread was used in many ceremonies and rituals and, for these purposes, it was often decorated with imprinted or applied patterns. During the regular process of decorating the bread, the woman prepared the soft dough by adding patterns (domestic animals, people, tools etc.) using small leftovers of dough (*Svetieva 1997.168*). But during the ritual process, always performed early in the morning before dawn, the women usually decorated the bread using strictly defined patterns, and used specially prepared sheep bones or, very often, wooden and ceramic stamps (Fig. 13). These stamps are known variously across the Balkan populations as *proskurnik, poskurnik, šaralka, svaća, guguška, panagijće, pisalnik, slovo, krušno slovo, kruće* etc. (*Krstevska 2005; Kostić 1967*). Linguistically, some of these terms (*poskurnik* and *proskurnik*) originate from the Greek '*prosfora*' which means ritual bread or offering. Researchers have defined two types of stamp – *poskurnik* and *šaralka* (decorating tool) – which have independent roles in the process of decorating the bread. First, the *šaralki* are always used for imprinting patterns on bread that is for living members of the community and rituals concerning birth, baptism, engagement, and weddings. In contrast, the *proskurnici* are always included in rituals related to deceased individuals and ancestors, funerals, commemorations, domestic and village celebrations, and *zadušnica* (day of the dead). According to the researchers' typology, the *šaralki* more commonly have circular or oval shapes, while the *proskurnici* have rectangular bases with engraved inscriptions (*i.e.* ИС ХС NI КА (IS HS NI KA) 'Jesus Christ the Triumphant') (*Krstevska 2005. 17, 20; Kostić 1967.99*). In the context of this research, the relationship between shape, decoration and function of the Neolithic and contemporary stamps for bread is important, and has previously been accentuated by several researchers (*Chausidis 2005.98, 128; Antonova 1984.30; Naumov 2006a*). It is interesting that some of the *šaralki*, besides being made of wood, were also made of ceramics, with engraved patterns almost identical to those on Neolithic stamps (Fig. 14). Interestingly, part of the pattern, seen on one of the stamps from Çatal Höyük (Fig. 14.7, 8), is almost always present on the *proskurnici* and represents the Virgin Mary[8]. As was stressed above, some of the patterns on the Neolithic stamps are related to female genitalia, so

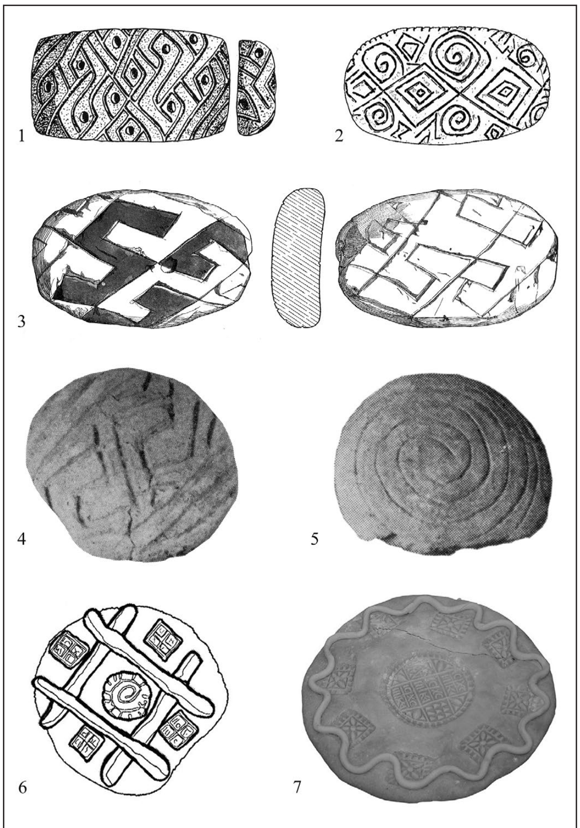


Fig. 15. Models of bread loaves: 1 – Çatal Höyük (*Gimbutas 1989.Fig. 222. 3*); 2 – Potporanj (*Gimbutas 1989.Fig. 227*); 3 – Vinča (*Vasić 1936.Fig. 72a*); 4 – Nova Zagora (*Kančeva 1992.Pl. VII. 5*); 5 – Nova Zagora (*Kančeva 1992.Pl. VII. 2*); 6 – Kozar Belene (*Chausidis 2005.Pl. B32. 6*); 7 – Unknown site (photo by D. Karasarlidis).

that the reminiscence of this conception, as presented on the Balkan *proskurnici*, becomes more than suggestive, and is an avenue for further research. Regarding shape, it is important to highlight yet another similarity between the archaeological and the ethnographic material. Several Neolithic stamps discovered in the Balkans have bases for decorating on both sides of the handle. Stamps with the same shape were used in Serbia in the 20th century and were known as *šaralki* with *proskurnik* (objects which had, on one side an oval stamp, a *šaralka*, while on the other side they had a rectangular stamp, a *proskurnik*) (Fig. 14.13–17). Depending on whether the ritual was performed for the living or the deceased, a suitable stamp was used (*Kostić 1967.99, T. V*). These stamps were exclusively used for decorating ritual breads, and it remains open at to whether these similar Neolithic stamps were used in the same way. In addition to the decorative and typological similarities between stamps, there are also the so-called models of loaves discovered at sites in Anatolia and the Balkans. At Çatal Höyük, Mellart excavated two models of loaves bearing identical patterns to the stamps discovered in the settlement (Fig. 15.1; Fig. 10.8). Dynamic relationships between artifact categories have been argued for, and objects like miniatures, wall paintings and reliefs strengthen the possibility of interpreting these stamps as tools for decorating bread. As an example, models of loaves suggestive of local varieties, were discovered at Neolithic sites in Serbia, Romania and Bulgaria, and bore decorative patterns identical to those of stamps discovered in the Balkans (Fig. 15.2–5). These stamp patterns, considering their small dimensions, could have been imprinted on bread in combination with several other patterns, just as in the case of contemporary ritual loaves (Fig. 15.6, 7). Still, as some ethnographic data indicate, it cannot be excluded that one stamp was used to imprint a single loaf. If we consider the dimensions of the larger Neolithic stamps from Republic of Macedonia and Bulgaria (those with a diameter between 9–12cm), and the dimensions of the models of loaves discovered in Govrlevo (Fig. 16) whose size was probably comparable to an actual loaf, we can suppose that one stamp was sufficient to imprint a large part of the bread.

In the Delčevo region, funeral rituals include small ritual loaves, called dolls which are decorated with the smaller stamp on the handle of the poskurnik (*Krstevska 2005.17*). In relation to the female sym-

8 On the meaning of this pattern in the Christian liturgy, see *Mesnil and Popova 2002.107. Fig. 1.*

bolism, the terms used for the *šaralki* and the ritual loaves can be explicit. In examples from Republic of Macedonia and Serbia, some *šaralki* were named *sister-in-law*, while the ceremonial breads were called *grandmother* (*Petrović 1996; Krstevska 2005. 21, Fig. 17*). It is certain that these terms related back to those who prepared the bread, usually the older women in the family, although we should not exclude a deeper symbolic significance related to the presence of these individuals in ritual performance, and also in the frameworks of the material culture, ethnographic as well as archaeological (*Naumov 2006b.81; 2007b*).

It is important to mention that a model of bread identical to the *grandmother* loaf has been discovered in a Neolithic house in Govrlevo including the same context with the previously mentioned construction, grinding stones, cereals, and ash (Fig. 16. 3). Across the settlement, the number of these models is much greater. The *grandmothers*, as well as the model from Govrlevo, were all made in small dimensions, with a hole for salt in the middle and prepared in hot ash and glowing embers (*Petrović 1996.26, 30*). The similarities between the model, the Neolithic artefacts and the *grandmother* bread continue on the level of ritual functions. At the end of the ritual, the *grandmother* bread was split or 'butchered' and parts given to those present (*Petrović 1996.23, 25*). This practice of splitting is similar to the situation of the models of bread in Govrlevo, but also to the Neolithic figurines from the Balkans. On a large part of the figurines discovered in the settlements, the legs are deliberately split, and usually one leg is not in the close surrounding of the figurine. Part of them has hips made of small slice of 'reinforcements', or clay slices, so that, if the occasion required it, the legs could be easily removed or reattached (*Naumov 2007b*). This fragmentation of both figurines and breads/loaves relates to their mediation in different processes of exchange and social relationships, such as during rites of passage, where fragmentation represents a temporal or spatial border (*Svetieva 1997.172; Talalay 1993.45; Gheorghiu 2001.76, 83; Bailey 2005.102; Chapman 2000; Budja 2003.124, 126; Skeates 2007.195; Naumov 2007b*). The active use of bread in rituals (as a mediator between the living and the dead, praying for rain, fortune telling etc.) clearly points to its overlapping with several social, economic and ritual spheres. The required decoration or marking of the loaves with 'images and signs' links these spheres directly. On the other hand, in the context of these rituals, the bread itself represents the property and its owners. Even the *grandmother* bread, which until its division at the end of the three-day ceremony, is constantly exposed on a table and symbolizes the property of those who serve the table (*Petrović 1996.31*). With other ritual breads, it is very common that dough figurines were prepared and applied to the loaves during bread-making and included representations of the owner, landlord, ploughman, plough, cereals, vessels, shepherd, the shepherd's pall, stable, threshing-floor, and domestic animals. Some of the breads used in domestic rituals were actually referred to as *threshing-floor* or *stable* (Fig. 17), so that the bread symbolically represented the landlord, the landlord's possessions, and their agrarian or economic activities (*Svetieva 1997.169, 173; Chausidis 2008*). As the figurines used to decorate the bread are made of dough, it is likely that the *šaralki* pattern used for imprinting also had a purpose, probably affording symbolic protection to the land and security for the family's continued existence. Even the *proskurnici*, which are the only ones with Christian funeral connotations, have the identical function of guarding or protecting the deceased. Although the *proskurnici* have far more complex symbolic meanings, especially regarding the inscription IS HS NI KA (Jesus Christ the Triumphant) and the protective intercession by the mythical through the bread, the nature of these objects as markers of certain cultural identities should also be pointed out. For example, in the Balkans, where during and after the Ottoman Empire a diverse ethnic map emerged, it was necessary for certain populations to manifest

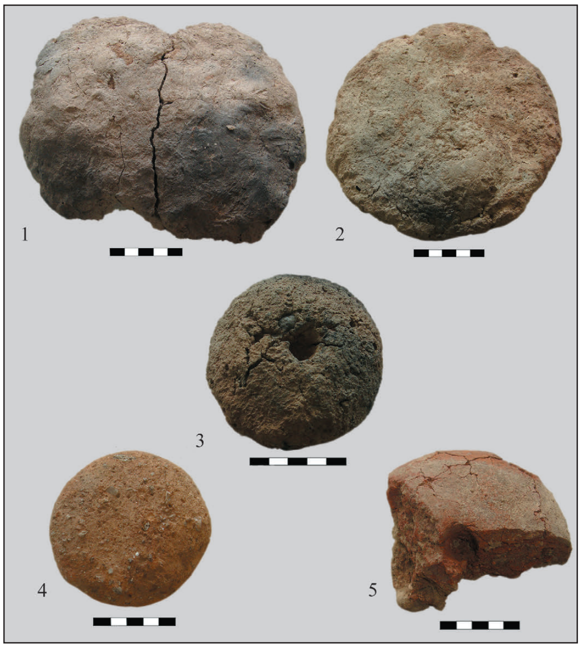


Fig. 16. Neolithic clay model loaves from Govrlevo (Photos by G. Naumov).

*Fig. 17. Ritual loaves from Bulgaria: 1, 6 – Gorni Lom (*Yaneva 1989.81*); 2 – Trnovsko (*Yaneva 1989. 83*); 3 – Gabrovsko (*Chausidis 2008.Pl. VI. 7*); 4 – Maraški Trstenik (*Chausidis 2008.Pl. VI. 12*); 5 – Mihailovgradsko (*Yaneva 1989.82*).*

their cultural identity through rituals and religions, such as through the use of Christian iconography. Later, at the end of the First World War and the rise of the Serbian kingdom, in regions such as Šumadija, Kosovo and Republic of Macedonia (but not further north) *šaralki* bearing two-headed eagles were produced (*Kostić 1967.92–94*), with the explicit goal of marking the newly constructed identity of the populations in these territories. After the Second World War, Serbian *šaralki* bearing a five-pointed star were manufactured (*Kostić 1967.96*), accentuating the new ideas and identities by which these populations recognized self and others in this period. The situation concerning the *šaralki* and the *proskurnici* shows that within the domain of ritual activities, one or several populations used the patterns on these objects as an element in their own identification. In this way, it can be perceived that, even in the 20th century, the categories of sacred and everyday secularity were not divided, but on the contrary, intertwined. This situation of parallel interaction between the insignia of cultural identity and religious behaviour is also noticeable today in the numerous rites of passage and initiation celebrations in Republic of Macedonia.

Imprinted mind

The function of Neolithic stamps still remains questionable and might never be fully answered. In an attempt to demystify their function, several interesting and logical interpretations have been presented which offer different kinds of answer. On the one hand, it was noticed that stamps from different regions have been discovered in different contexts, so it can be supposed that they had different uses. On the other hand, some stamps, although discovered in settlements separated by great distances, were of similar shape, decoration and context in relation to other finds, and were thus probably used for similar purposes. The position commonly held by many researchers suggests that these distributional differences support the interpretation that the stamps were multifunctional. Their role as imprinters of signs of identity, property and protection of the bread adds to this complex function. According to the ethnographic examples, we were able to suggest that bread, and its context-dependent pattern was a mediating element between members of one or several communities; the patterned loaves were convenient objects facilitating interaction, especially in rites of passage. The decorative nature of Neolithic stamps, suggests they may have been used in similar rituals, and the visual effect of the imprinted surface should be accentuated. Some stamps have a very shallow engraved pattern, so if they had been imprinted on surfaces with a compact thickness (such as a textile, skin, or ceramic), it is questionable how long the pattern would have been distinguishable. If they were to be imprinted on dough, however, during the rising and baking phases the patterns would enlarge. Thus, lacking the remains of color, dough becomes a suitable media for making these patterns visible. As an active medium in ritual, patterned bread would have a strong visual communication role for participants in both domestic and village rituals.

From this we can conclude that the stamps, and especially their patterns, possessed potent symbolic significance. Their durable nature facilitated their continued and repeated reproduction on soft media, such as dough. In this way, they became completely enmeshed with the cognitive aspects of the community and were reproduced as culturally specific symbols. While Lewis-Williams and Pearce argue that, in the case of the stamps, the engraved patterns represent entopts, or neuro-psychological phenomenon which were the result of altered states of consciousness (*Lewis-Williams and Pearce 2005.46–59*), we would disagree. On the contrary, the patterns on the stamps were used over a long period, gradually being integrated into the general compositional repertoire including on painted ceramics, other decorated artefacts and construction elements. The deployment of patterns on several media, their similar context, and their similar presentation on artefacts and constructions indicates that substantial interaction, resulting in a reinforced or concrete meaning becoming established in the domain of the most essential religious concepts. In this way, the stamp patterns became completely embedded in the perception and the symbolic expression of Neolithic populations, which used these symbols in multiple spheres of visual culture. It can be considered that the Balkan Neolithic, even in its early stages, had developed a strongly defined cognitive symbolism as represented in the stamp patterns which could have been engraved, painted or applied, and was repeated over the millennia. It is difficult to treat the patterns as a result of an altered state of mind when they were used across much of southeast Europe and Anatolia. Certainly, in the earliest phases, these patterns were closely related to a shared cognitive repertoire and perception of human existence. Over time, these patterns gradually turned into signs of identity, and maintained a dual function. Thus the body and the patterns on the stamps were incorporated in the dynamics of social mediation and, through multiple avenues, they mediated the symbolic complexity of human cognition.

ACKNOWLEDGEMENTS

Acknowledgements: I would like to thank Professor Nikos Chausidis for his useful suggestions and engaging discussions. I am also grateful to Miloš Bilbija for sharing the Govrlevo excavation data with me and allowing me to use unpublished data and photos from the same site. Many thanks to Marija Atanasoska and Irena Kolištrkovska-Nasteva, who assisted me during the documentation of the stamps from the Museum of Macedonia, to Miško Tutkovski and Darko Karasarlidis for helping me with some of the photos, and to Aleksandar Mitkoski for providing the information and photo of the stamp from Djumušica. My endless gratitude to Orhideja Zorova for the translation of the text, and especially to Sheila E. Kohring for editing and improving the English version. Finally, I thank Professor Mihael Budja for inviting me to the 14th Neolithic Seminar and giving us the opportunity to share our ideas.

∴

REFERENCES

AKKERMANS M. M. G. P. & VERHOEVEN M. 1995. An Image of Complexity: The Burnt Village at Late Neolithic Sabi Abyad, Syria. *American Journal of Archaeology 99: 5–32*.

AKKERMANS M. M. G. P. et al. 2006. Investigating the Early Pottery Neolithic in Northern Syria: New Evidence from Tell Sabi Abyad. *American Journal of Archaeology 110: 123–156*.

ANTONOVA E. B. 1984. K probleme funkcii pečatei rannih zemledelcev vostoka. *Sovetskaja Arheologija 4: 26–34*.

BAĆVAROV K. 2003. *Neolitni pogrebalni obredi*. Bard. Sofia.

BAILEY D. 2000. *Balkan Prehistory: Exclusion, incorporation and identity*. Routledge. London.

BILBIJA M. 1986. Cerje – neolitsko naselje. *Arheološki pregled 1985: 35–36*.

BUDJA M. 2003. Seals, Contracts and Tokens in the Balkans Early Neolithic. In M. Budja (ed.), *10th Neolithic Studies. Documenta Praehistorica 30: 115–130*.

2004. The transition to farming and the 'revolution' of symbols in the Balkans. From ornament to entoptic and external symbolic storage. In M. Budja (ed.), *11th Neolithic Studies. Documenta Praehistorica 31: 59–81*.

CHAPMAN J. 2000. *Fragmentation in Archaeology: People, places and broken objects in the prehistoru of southeastern Europe*. Routledge. London.

CORNAGIA-CASTIGLIONE O. 1956. Origini e distribuzione delle pintaderas preistoriche "euro–asiatiche". *Rivista di Scienze Preistoriche 11: 123–153*.

CHAUSIDIS N. 1996. Rombičnite ornamenti kako sredstvo za transponiranje na plodnosta. *Kulturen život 1: 58–66*.

2005. *Cosmological Images: symbolisation and mythologisation of the cosmos in the pictorial medium*. Čausidis. Skopje.

2008 (in print). *Mitologiziranoto gumno vo slovenskata tradicionalna kultura – II*. Studia Mythologica Slavica 11.

ÇATALHÖYÜK 2006. Çatalhöyük: From Earth to Eternity (catalogue). Haydaroğlu M. (ed.). Yapi ve Kredi Bankasi. Istanbul.

DICKINSON O. 1994. *The Aegean Bronze Age*. Cambridge University Press. Cambridge.

DZHANFEZOVA T. 2003. Neolithic Pintaderas in Bulgaria. In Nikolova L. (ed.), *Early Symbolic Systems for Communication in Southeast Europe Vol. 1*. BAR International Series 1139. John and Erica Hedges Ltd. Oxford: 97–108.

GALOVIĆ R. 1964. Zelenikovo – neolitsko naselje. *Zbornik Narodnog Muzeja 5: 127–167*.

GARAŠANIN M. and BILBIJA M. 1988. Kuća 1 vo Zelenikovo. *Macedonia Acta Archaeologica 9: 31–41*.

GARAŠANIN M., SANEV V., SIMOSKA D., KITANOSKI B. 1971. *Predistoriskite kulturi vo Makedonija*. Štip: Naroden Muzej – Štip.

GHEORGHIU D. 2001. The Cult of Ancestors in the East European Chalcolitic. A Holographic Approach. In P. Biehl et al. (eds.), *The Archaeology of Cult and Religion*. Archaeolingua. Budapest: 73–88.

GIMBUTAS M. 1976. *Neolithic Macedonia*. The Regents of the University of California. Los Angeles.

1989. *The Language of the Goddess*. Thames and Hudson. London.

GRBIĆ M., MAČKIĆ P., ŠANDOR N., SIMOSKA D., STALIO D. 1960. *Porodin: kasno-neolitsko naselje na Tumbi kod Bitolja*. Narodni muzej Bitolj i Arheološki institut – Beograd. Bitolj.

HAARMAN H. 2005. The chalenge of the abstract mind: symbols, signs and notational systems in European prehistory. In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 221–232*.

HOPF M. 1961. Uhtersuchugsbericht Über Kornefunde aus Vršnik. *Zbornik na Štipskiot naroden muzej 2: 41–50*.

JOSHI J. P. & PARPOLA A. 1987. *Corpus of Indus Seals and Inscriptions*. Suomalainen Tiedeakatemia. Helsinki.

JOVČEVSKA T. 1993. Kućata od horizont I vo neolitskata naselba „Mramor" kaj Čaška. *Macedonia Acta Archaeologica 13: 31–41*.

KANČEVA T. 1992. Spätneolithische Kunstwerke im Museum von Nova Zagora. *Studia Praehistorica 11–12: 74–86*.

KERŚAK E. 2005. *Drevne seobe*. Školska knjiga. Zagreb.

KING R. & UNDERHILL P. A. 2002. Neolithic painted pottery and ceramic figurines with Y-chromosome lineages. *Antiquity 76: 707–714*.

KIRCHO L. B. 1989. Seals and their imprints in the early agriculture assemblages (New materials from southern Turkmenia). *Varia Archaeologica Hungarica 2: 123–130*.

KOBAYASHI T. 2004. *Jomon Reflections: Forager life and culture in prehistoric Japanese archipelago*. Oxbow Books. Oxford.

KOROŠEC P. & KOROŠEC J. 1973. *Predistoriska naselba Barutnica*. Arheološko društvo na Makedonija. Prilep.

KOSTIĆ P. 1967. Zbirka šaralica za obredne hlebove u etnografskom muzeju u Beogradu. *Zbornik etnografskog muzeja u Beogradu 30: 91–111*.

KRSTEVSKA M. 2005. Kolekcijata na šaralki za obredni lebovi vo Muzejot na Makedonija. *Zbornik na Muzejot na Makedonija – Etnologija 3: 15–29*.

LEWIS-WILLIAMS D. & PEARCE D. 2005. *Inside the Neolithic Mind*. Thames and Hudson. London.

MAKKAY J. 1984. *Early Stamp Seals in South-East Europe*. Akademiai Kiado. Budapest.

MELLART J. 1967. *Çatal Hüyük: A Neolithic Town in Anatolia*. Thames and Hudson. London.

1975. *The Neolithic of the Near East*. Thames and Hudson. London.

MERLINI M. 2005. Semiotic aproach to the features of the "Danube Script". In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 233–251*.

2007. A Semiotic Matrix to Distinguish Between Decorations and Signs of Writing Employed by the Danube Civilization. *Acta Terrae Septemcastrensis 6: 73–130*.

MESNIL M. & POPOVA A. 2002. L'offrande céréalière dans les rituels funéraires du sud-est européen. In K. Fechner and M. Mesnil (eds.), *Bread, oven and hearths of the past*. Université Libre de Bruxelles. Bruxelles: 101–117.

NAUMOV G. 2005a. Neolitski pintaderi: pečati ili amuleti? Pintadera I, on-line: http://www.axios.org.mk

2005b. Neolitski slikani ornamenti. *Kulturen život 3: 66–77*.

2006a. *Neolithic stamp seals from Macedonia*. Paper presented at the symposium of the Macedonian Association of Archaeologists, Delchevo.

2006b. Sadot, pećkata i kukjata vo simbolićka relacija so matkata i ženata (neolitski predloški i etnografski implikacii). *Studia Mythologica Slavica 9: 59–95*.

2007a. Housing the Dead: Burials inside houses and vessels from Neolithic Balkans. In C. Malone & D. Barowclough (eds.), *Cult in Context*. Oxbow Books. Oxford: 255–265.

2007b. *Small breasts – big buttocks: Gender determination of the Neolithic figurines from Macedonia and the Balkans*. Paper presented on the 13th annual conference of the European Association of Archaeologists, Zadar.

2008. (in print) Painted White: Stylistic diffusion of the white painted decoration and development of Early Neolithic local identities on the territory of The Republic of Macedonia. *European Journal of Archaeology*.

ÖZDOĞAN M. & BAŞGELEN N. 1999. *Neolithic in Turkey (plates)*. Arkeoloji ve sanat Yayinlari. Istanbul.

PERLÈS C. 2001. *The Early Neolithic in Greece. The first farming communities in Europe*. Cambridge University Press. Cambridge.

PETROVIĆ S. 1996. Magijsko-mitološki smisao slavskog hleba "baba" u Istočnoj Srbiji. *Glasnike etnografskog instituta SANU 45: 19–36*.

PRIJATELJ A. 2007. Digging the Neolithic stamp-seals of SE Europe from archaeological deposits, texts and mental constructs. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 231–256*.

SANEV V. 1975. Neolitskata naselba Rug Bair kaj s. Gorobinci. *Zbornik na štipskiot naroden muzej 4–5: 203–245*.

2004. Some characteristics of the Amzabegovo-Vršnik cultural group in Macedonia. In S. Perić (ed.), *The Central Pomoravje in Neolithization of South East Europe*. Archeological Institute. Belgrade: 35–47.

SVETIEVA A. 1997. Obrednite lebovi za Badnik – voved vo sakralnoto. *Etnolog 7–8: 167–174*.

SIMOSKA D. & SANEV V. 1976. *Praistorija vo Centralna Pelagonija*. Naroden Muzej. Bitola.

SKEATES R. 2007. Neolithic Stamps: Cultural Patterns, Processes and Potencies. *Cambridge Archaeological Journal 17(2): 183–198*.

SOROKIN V. Y. and BORZIYAK I. A. 1998. Antropomorfnaya plastika tripolskogo poseleniya Yablona I. In M. Stefanović, H. Todorova, H. Hauptmann (eds.), *James Harvey Gaul: In Memoriam. The James Harvey Gaul Foundation*. Sofia: 161–181.

STAROVIĆ A. 2004. Knowledge Owner's Marks. In Starović A. (ed.), *Signs of Civilization*. SANU – branch in Novi Sad and Institute for Archaeomythology. Novi sad: 16–32.

2005. If the Vinča script once really existed who would have written or read it? In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 253–260*.

TALALAY E. T.1993. Deities, Dolls and Devices, Neolithic Figurines form Franchthi Cave. In T. W. Jacobsen (ed.). *Excavation in Franchthi Cave, Greece, Fascicle 9*. Indiana University Press. Indianapolis.

TODOROVA H. & VAISOV I. 1993. *Novo-kamennata epoha v Blgarija*. Nauka i Izkustvo. Sofia.

TÜRKCAN A. U. 2005. Clay Stamp Seals. In Çatalhöyük 2005 Archive Report. on-line http:/www.catalhoyuk.com/archive_reports/2005/ar05_30.html

2006. Çatalhöyük Stamp Seals. In M. Haydaroğlu (ed.), *Çatalhöyük: From Earth to Eternity*. Yapi ve Kredi Bankasi. Istanbul: 45–49.

2007. Is it goddess or bear? The role of Çatalhöyük animal seals in Neolithic symbolism. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 257–266*.

VASIĆ M. 1936. *Preistoriska Vinča II*. Državne štamparije Kraljevine Jugoslavije. Beograd.

VASILAKIS A. 2001. *Minoan Crete: From Myth to History*. Adam Editions. Athens.

VELJANOVSKA F. 2000. *Antropološki karakteristiki na naselenieto na Makedonija od neolit do Sreden Vek*. Republički zavod za zaštita na spomenicite na kulturata. Skopje.

2006. Neolitski skeletni naodi od Pista-Novo Selo. *Macedoniae Acta Archaeologica 17: 341–350*.

WINN S. M. M. 1981. *Pre-writing in Southeastern Europe: The sign system of the Vinča culture ca. 4000 B.C.* Western Publishers. Calgary, Alberta.

YANEVA S. 1989. *Blgarski obredni hlyabove*. Izdatelstvo na Blgarskata akademiya na naukite. Sofia.

ZDRAVKOVSKI D. 1992. Neolitska naselba "Čibuk Češma" – s. Nikuštak, Kumanovo. *Macedoniae Acta Archaeologica 13: 19–30*.

2006. *Geneza i razvoj na Anzabegovo-vršničkata kulturna grupa*. Unpublished PhD dissertation. University of Skopje. Skopje.

UDK 903.2(520)"633/634":2-536.7
Documenta Praehistorica XXXV (2008)

Feasting and inter-village networks

Takamune Kawashima
Graduate School of Humanities and Social Sciences, University of Tsukuba, Japan
k_takamune@hotmail.com

ABSTRACT – *While the exchange of material goods and techniques is thought to be the main reason for the existence of exotic materials at Jomon sites, it is not clear what kind of exchange occurred. I propose that feasting could be one of the reasons for the diffusion of material goods and even techniques. As feasting is connected to activities such as exchange and ritual, feasting remains could be an indicator of exchange. This paper uses exotic materials and feasting remains to analyze the distribution of goods, using ethnographic data related to ritualized exchange and feasting.*

IZVLEČEK – *Čeprav pojav eksotičnih dobrin na Jomonskih najdiščih pogosto razumemo kot posledico menjave, ne vemo za kašne vrste menjavo je šlo. Gostije so lahko eden poglavitnih medijev širitve dobrin in tehnik. Če torej gostije lahko povežemo z rituali in z menjavo, potem so ostanki gostij lahko poglavitni vir za preučevanje menjav. V članku analiziram distribucijo dobrin s pomočjo etnografskih primerov ritualizirane menjave in gostij ter ostankov gostij in eksotičnih predmetov.*

KEY WORDS – *Jomon; Japan; exchange; ritual; feasting*

Introduction

Exchange is thought to be the main reason for the existence of exotic materials from the Jomon, the Japanese prehistoric period (Tab. 1). Some archaeologists assert that trading as subsistence must have existed in the Early and Middle Jomon period because exotic materials like jade and obsidian were widely distributed (*Daikuhara 2002; Kosugi 2003*). From the perspective of ethnography, however, most hunter-gatherers were not involved in trading for subsistence. Hunter-gatherers do not follow the strategies of a capitalistic market economy to earn profit by exchange (*Teshigawara 2007*). Therefore, it is difficult to support the existence of traders throughout Jomon society. The subsistence of Jomon society is principally based on hunting, fishing and gathering. However, it has been pointed out that the natural environment and subsistence of the eastern Jomon culture is similar to the pacific coast of North America, in which ranked society existed in spite of a hunting-gathering economy (*Anzai 2002; Watanabe 1990*). The ethnography of tribes on the pacific coast of North America implies that hunter-gatherers in a particular situation can possess a hereditary ranked society without agriculture. Although it is not clear whether a hereditary ranked society existed in the Jomon period (*Yamada 2003; Pearson 2007*), it is thought that Late and Final Jomon society was a transegalitarian society (*Hayden 1995; Takahashi 2001*), which is the middle stage between egalitarian societies and chiefdoms.

In order to investigate the exchange system during the Jomon period, an example of exchange from a transegalitarian society should be used for comparison, as social development and exchange are correlated. For example, in the Kula exchange system in Melanesia, leaders made great efforts to collect valuables such as necklaces and bracelets for exchange (*Malinowski 1922*). It is apparent that this kind of exchange needs inter-village networks and

	14C-date(year BP)	year cal BC	Duration
Final Jomon	3000–(2400)	1260/1230/1220–(410)	(*c.* 810–850)
Late Jomon	4050–3000	2580/2510–1260/1230/1220	*c.* 1250–1360
Middle Jomon	4800–4050	3630/3550–2580/2510	*c.* 970–1120
Early Jomon	6300–4800	5300–3630/3550	*c.* 1670–1750
Earliest Jomon	9800–6300	9250–5300	*c.* 3950
Incipient Jomon	13 000–9800	13 680–9250	*c.* 4430

Tab. 1. Radiocarbon dates of the Jomon period (after* Taniguchi 2001. Tab. 1*).

leaders to maintain this type of relationship. Although some rituals may have been held to maintain inter-village relationships in the Jomon period, it is difficult to recognize such relationships by their material remains. In order to solve this problem, it is helpful to consider the rituals and feasts involved in the exchange process. Evidence of the rituals and feasts which were part of exchange activities would have been left at the sites. Therefore, feasting could be an indicator of exchange. In larger scale feasting, usually guests from other villages are invited (*Hayden 2001*). According to the ethnography of the potlatch on the Northwest coast of North America, valuables such as gifts and food were prepared for guests from different villages (*Birket-Smith 1967; Hayden 1995; Kan 1989*). After that, the guests had to repay such gifts at another potlatch. Repeating such ceremonies, gifts could be distributed within the area. Although the aim of potlatch is not exchange, this case may explain how the patterns of pottery and exotic goods were diffused over a broader area. As feasting is one of the aspects of the potlatch, it could represent the foundation of inter-community relationships, as well as intra-community socio-political organization.

In this paper, I will argue that feasting could be another cause for the diffusion of material goods and even techniques. At archaeological sites, it is difficult to recognize each ritual, but there could be an accumulation of ritual and feasting remains, because feasting requires more food than is usually consumed. Evidence of feasting is recognized by food processing facilities, special hearths, charcoal, animal bones, botanical remains and so on (*Hayden 2001. Tab. 2.1; Kawashima 2007*). Although these features are reported from sites in the Late and Final Jomon period, they have not been recognized as evidence of feasting. I will look for the remains of ritual and feasting in Jomon sites and try to investigate the exchange system, focusing on the Late to Final Jomon period (Fig. 1).

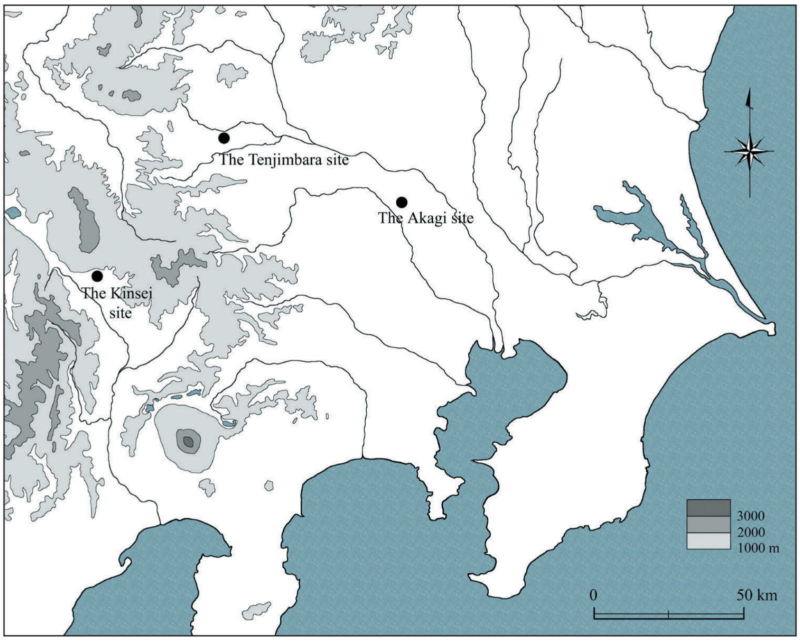


Fig. 1. Location of sites mentioned in the paper.

The social function of feasting

Jomon society could be categorized as a transegalitarian society. The social function of feasting in transegalitarian societies is described by Hayden (*1995*). He classified transegalitarian society into three types: despot communities, reciprocator communities, and entrepreneur communities. In despot communities, the scale of feasting is small, and the food is mainly served as wealth. Although this case does not show individual contributions, feasting already functions as a tool for mobilizing surpluses (*ibid. 38–39*). Feasts in reciprocator communities can mobilize more surpluses and expect more benefit (*ibid. 47*). Entrepreneur communities perform competitive feasts, such as the potlatch on the Northwest coast of North America (*ibid. 51*). The types and function of feasting are thought to increase with its extent and development (*Hayden 2001*). Feasting has various purposes and functions. It can be also seen as a tool for the manipulation of wealth based on surpluses and prestige goods. While there is competition for power within a community, large scale feasting includes guests from other communities. Apart from exchange, funerals and weddings are good examples of large scale feasting, where we can expect archaeological remains and the transportation of gifts such as prestige goods and food. As a result, goods must have been transferred, even if exchange itself was not the main purpose.

The mechanism of Kula exchange

A brief explanation of Kula exchange based on Malinowski is described as follows (*Malinowski 1922*). Kula exchange was observed in the eastern part of New Guinea, and is known as ritualized inter-tribal exchange. In this area, social structure is recognized as one of the most stratified in Melanesia. Especially in the Trobriand Islands, leaders have influence over some villages. Generally, high ranking people participate in Kula exchange, and the partnership of Kula between two men lasts for a lifetime. The main treasures of Kula exchange are *mwali* (bracelet) and *soulava* (necklace), which are transported in opposite directions. *Soulava* always moves clockwise, and *mwali* rotates counterclockwise among the villages. There is no direct exchange of *mwali* and *soulava* at the same time in a village, so two expeditions are needed for one set. In order to obtain honour, the Kula members may not keep these treasures for a long period. The transfer of *mwali* and *soulava* is in the focus when the Kula exchange is described, but in fact various goods are simultaneously transferred as gifts. In addition, during the expeditions, visitors acquire shells for making beads by themselves. It is notable that many kinds of goods were circulated through or along the Kula exchange network.

The whole process of Kula contains various rituals, which include exchange, gift giving, feasting, and so on. Once a Kula expedition is proposed, all the canoes must be repaired or rebuilt instead of using the old canoes. This is recognized as the first part of a Kula. In the canoe building stage, feasting can be observed at events such as the felling and moving of trees to a village (*ibid. 129*), launching (*ibid. 147*), and the trial run of new canoes, which is combined with a preliminary exchange of Kula (*ibid. 164–165*). Most of these activities are held within a village, but neighbouring villages give gifts for the trial run. Even before the expeditions, there are some opportunities for exchange. During the expeditions, treasures and food are given to the visitors. In the case of the Trobriand natives, who due to prohibition, do not eat food from the Dobuans, their Kula partner, but Dobuans can obtain food in the Trobriand Islands. Besides the exchange, a funeral is one of the most important events for a Kula partner. The host invites the partners to the funeral where there is feasting and food distribution. This shows that the

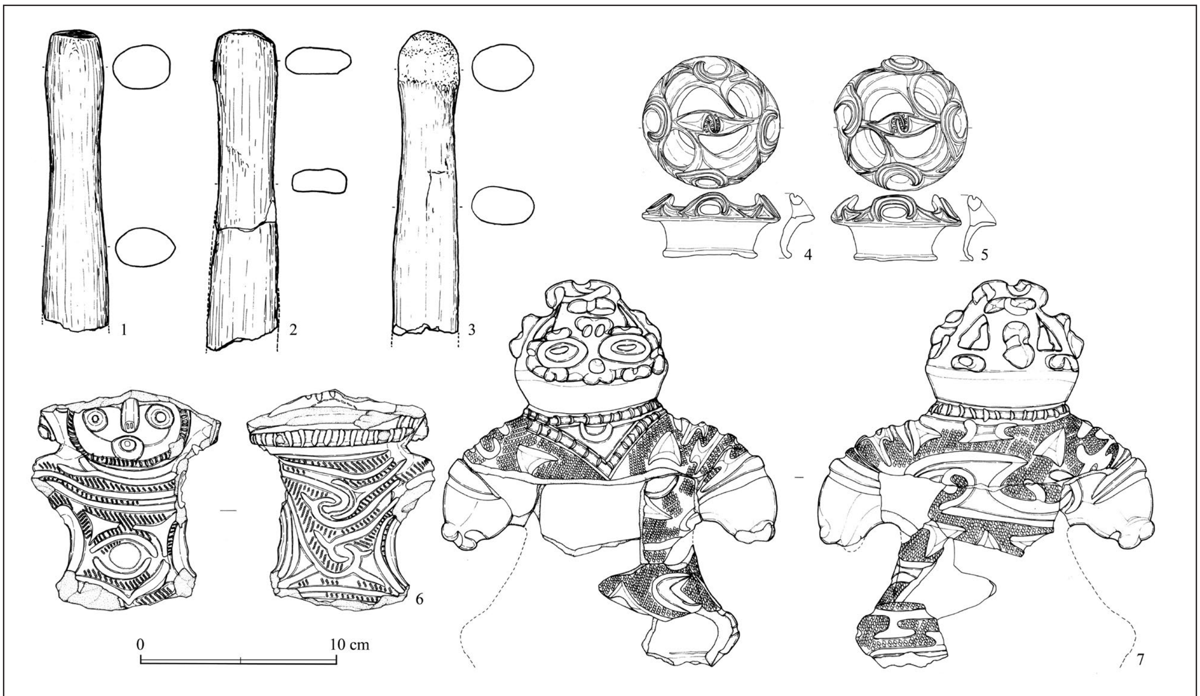


Fig. 2. Ritual artefacts from the Akagi site (1–3 stone rods:* After Araya et al. 1988.Fig. 348; 4–5 clay ear-rings; ibid.Fig. 316; 6 owl-faced figurine; ibid.Fig. 333; 7 snow-glassed figurine; ibid.Fig. 339*).

Kula partners are not merely exchange partners, but have important social relationships beyond exchange.

The food for feasting is based on the cultivation of yam, which is the staple in this area. The harvest is usually greater than the amount consumed, which is apparent because of there is yam storage and an indication that people could not consume all the preserved yams (*ibid. 169–170*). Pigs are also important for ritual and feasting.

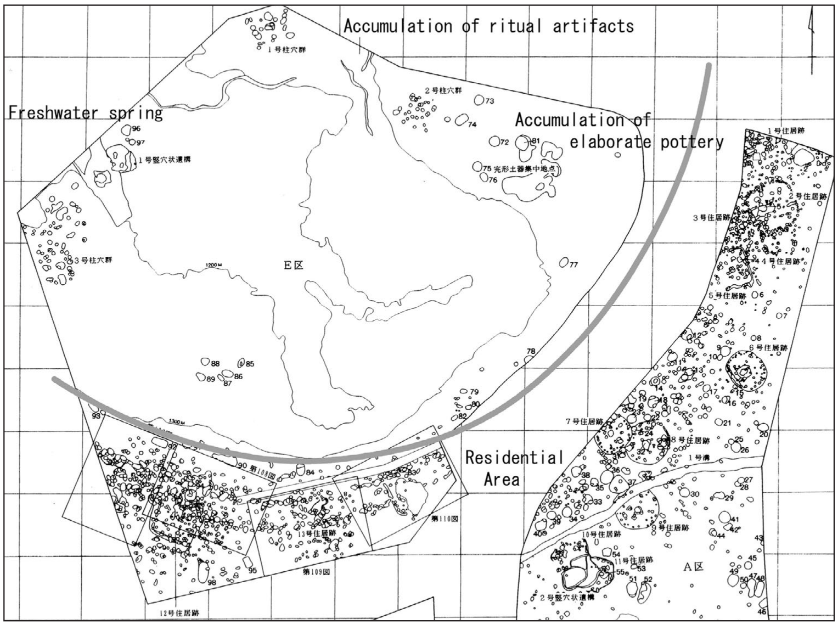


Fig. 3. Site Plan of the Akagi site (after **Araya et al. 1988.Fig. 91***).*

Ritual and feasting in the Jomon

I will outline the evidence of ritual and feasting from the Akagi site, the Kinsei site, and the Tenjimbara site, which are located in Kanto district (Fig. 1). At these sites, ritual objects such as clay figurines, clay earrings, and stone rods were found (Fig. 2). On the other hand, most other sites rarely yield ritual objects. It seems that in Jomon society, archaeological sites can be divided into at least two types, according to ritual activity. As a large number of figurines were uncovered from Jomon sites, and figurine types were sensitive to influence from other cultures, they are suitable for use in the analysis of feasting and exchange activities. Stone rods must have been involved in exchange, as material for stone rods was limited. Stone rods were widely distributed in the Kanto district, even in areas where stone objects were not produced. Finished stone rods could be produced near a quarry, and then transferred. Geographical conditions influence the number of stone rods which accumulated at a site, but I suggest that human activity was important in the diffusion of such ritual objects.

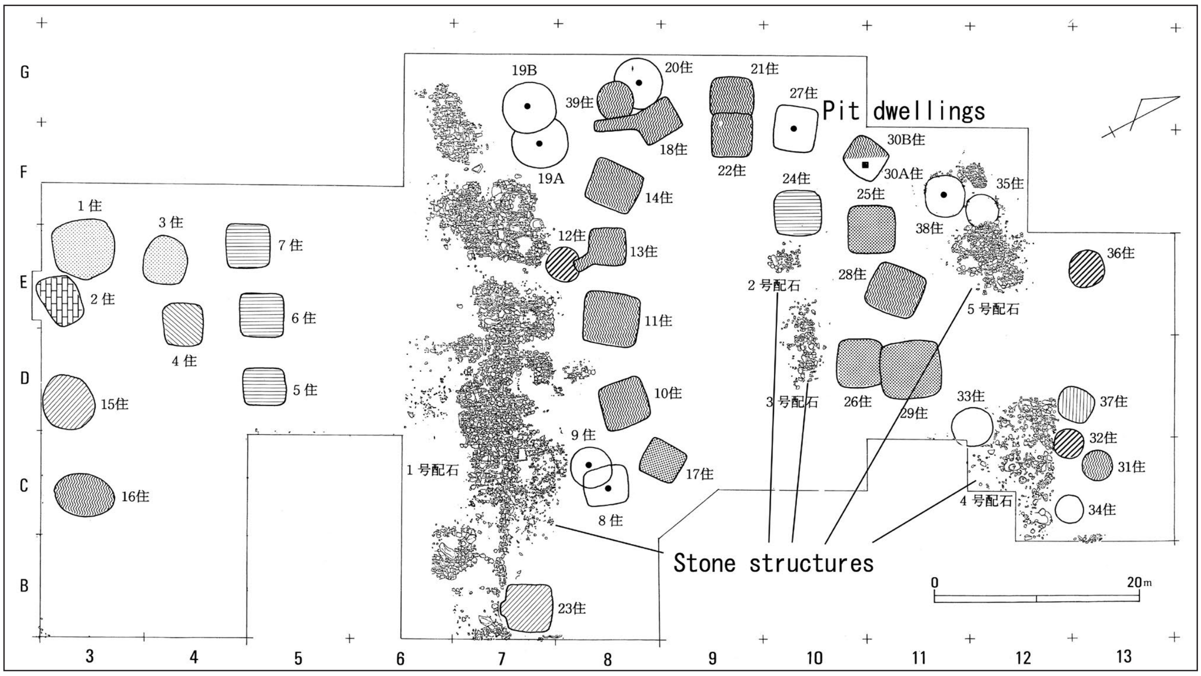


Fig. 4. Site Plan of the Kinsei site (after **Niitsu et al. 1989.Fig. 158***).*

The Akagi site

The Akagi site is located on the northwest of the Omiya tableland (*Araya et al. 1988*) (Fig. 1), at approximately 14m above sea level. This site can be divided into different areas, such as the residential area, ritual area and central space (Fig. 3). Most of the ritual artefacts were found accumulated in one place, which is approximately 3m in diameter, and consisted of pebbles and boulders (Tab. 2). This could be recognized as a place connected with ritual activity. Near this accumulation, the distribution of almost intact elaborate pottery was concentrated in an area approximately 15m in diameter. It is apparent that the number of ritual artefacts is concentrated in this accumulation.

	figurine	stone rod	earring
accumulation of ritual artefacts	48	18	11
accumulation of elaborate pottery	1	1	8
total number	86	36	57

Tab. 2. The number of ritual artefacts from the Akagi site.

The Kinsei site

Pit dwellings of the Late and Final Jomon were uncovered at the Kinsei site, where 233 figurines, 560 earrings, 133 stone rods were uncovered (*Niitsu et al. 1989*) (Fig. 4). This site is located in the mountains, approximately 760 to 780m above sea level. The site is close to the source of materials which were used for stone artefacts and stone structures. It is also remarkable that a number of clay earrings were found. This site is located in mountains where stone was quarried. Stone objects including rods and clay figurines were discovered. While some of the stone structures are related to graves which were constructed during the Late Jomon, others are recognized to be connected to rituals. A figurine which is influenced by northern culture was found with stone rods at a stone structure which belongs to the Final Jomon. Stone structures for ritual were used in the Final Jomon and possibly in the Late Jomon. A large number of artefacts were connected to the area of stone structure 1, which is over 60m long, where 41 figurines, 91 earrings, and 22 stone rods were discovered. As stone structure 1 can be considered a complex of structures, these artefacts must have accumulated over a long period. As at the Akagi site, compared to neighboring sites, the Kinsei site yields more clay figurines (Fig. 5). Not only figurines, but other ritual artefacts were apparently abundant at this site.

The Tenjimbara site

At the Tenjimbara site (Fig. 6), 40 clay figurines and 40 clay earrings, and 61 stone rods were uncovered, and 74 stones which resemble stone rods were also found (*Daikuhara et al. 1994a; 1994b*). The combination of ritual artefacts is almost the same as at the Akagi and Kinsei sites, but stone rods are dominant. There are stone graves which belong to the Late Jomon, and stone structures which were constructed mainly in the Final Jomon. In the Final Jomon, stone structures were grouped close together, surrounded by a shallow ditch and a bank. As some stone structures were connected to surrounding post holes, it is possible to imagine a superstructure covering the stone structures. These ritual structures could have been used repeatedly and for multivarious purposes.

Feasting

After the Late Jomon period, food processing facilities were constructed near freshwater springs to leach

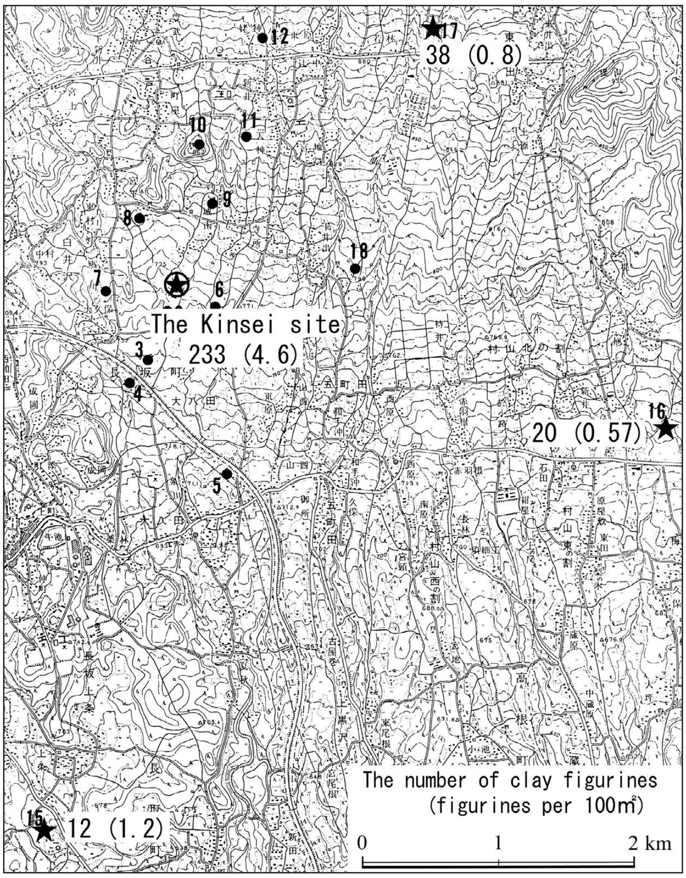


Fig. 5. The distribution of clay figurines around the Kinsei site (after* Niitsu et al. 1989.Fig. 3*).

horse chestnuts, where an accumulation of nut shells is often found. In the Akagi site, in the lowest point of the excavated area, a part of the food processing facility which extends to the lowland area was located at the freshwater spring. In the spring, wooden parts and small amounts of nut shell were uncovered. In this site, the area of concentration of elaborate vessels can be recognized as a place related to rituals, and these vessels may have been used for serving food.

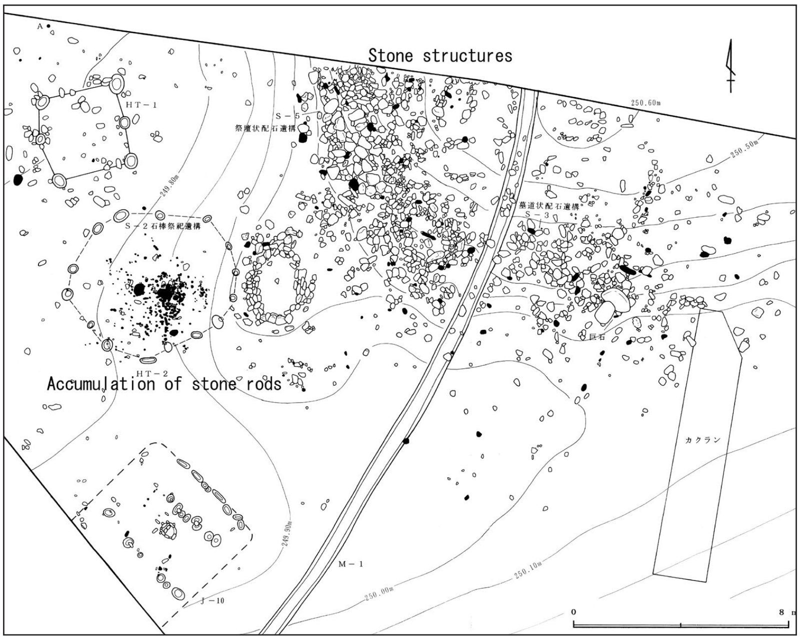


Fig. 6. Stone structures at the Tenjimbara site (after **Daikuhara et al. 1994b***).*

At the Kinsei site, it is noteworthy that a pit was found from which the jawbones of 138 individual wild boar, mostly yearlings, were recovered (*Kaneko 1989*). As there were some layers of dark soil in this pit, not all the boar were consumed at the same time. This is an extreme example, but it is generally reported that the soil of the Final Jomon period contains small fragmented bones, besides burned soil and charcoal. These features, which were not observed before the Late Jomon, imply an increase in food production for special occasions, which supports an increase in feasting (*Kawashima 2007*).

The correlation between ritualized exchange and feasting in the Jomon

As mentioned elsewhere, the distribution of clay figurines at different sites in the same period was not even (*Kawashima 2005*). Sites with and without clay figurines co-existed in the same period. In the Omiya tableland, which is approximately 35km long and 20km wide, at least 280 figurines from the Angyo period were uncovered from 25 out of 76 sites. In the area around the Akagi site, not only the number of figurines, but also the quality was found to be uneven. The Akagi site yielded the largest number, and at the same time yielded examples which were influenced by northern Japan. Such figurines are larger than the indigenous ones and have a hollow structure. Compared to those found at other sites, those from the Akagi site are more elaborate and closer to the original shape of this type. The percentage of exotic examples at the Akagi site is much higher than at other sites which yielded figurines in this area. The figurines themselves may not have been exchange objects, but information about making them would have been gained through exchange networks.

Comparing the Utaya site and the Sasara site (Fig. 7, Tab. 3), which yielded a relatively large number of clay figurines, the Akagi site contains more, and the ratio of Snow-glassed figurines is higher. The Snow-glassed figurines uncovered from the Omiya tableland were thought to have been made in the Kanto region, because the pattern and decoration are different from the original ones (*Kaneko 1993*). Therefore, information on the structure and pattern for copying this type must have been transmitted to particular settlements.

As well as clay figurines, stone rods should also be examined, as they were transported from production sites. The distribution of stone rods is as uneven as the distribution of clay figurines. At each of the three sites, six to seven kinds of material were found. Chlorite schist was the most common mate-

	Total number of figurines	Total number of exotic figurines	Percentage of exotic figurines
Akagi	86	28	32.6
Sasara	43	2	4.7
Utaya	42	1	2.4

Tab. 3. The ratio of exotic (Snow-glassed) figurines of the three sites.

rial for stone rods, but the percentage varies (Tab. 4). The Akagi site is located closer to a quarry, which is 40km to the west. Because it is not far between the Akagi site and the other two sites, they shared the custom of using stone rods and there must have been various exchange routes.

	Total number of stone rods	Total number of chlorite schist	Percentage of chlorite schist
Akagi	36	30	83.3
Sasara	47	23	48.9
Utaya	37	16	43.2

Tab. 4. The ratio of chlorite schist at the three sites.

Earrings are usually found in the mountainous regions, rather than on the plain where the Omiya tableland is located. While the Akagi site is closer to the mountainous region, approximately 100 fragments of earrings were uncovered from the Sasara and Utaya sites (Tab. 5). It is uncertain whether the earrings were brought to the sites through exchange, but even if they were made at the sites, the design must have been acquired from other sites. A type of decorative earring may have been brought from other settlements. At the concentration of the pottery at the Akagi site, these kinds of earring were uncovered in pairs (Fig 2: 4–5).

The distribution of artefacts shows a tendency of some settlements to have more power to collect particular artefacts both quantitatively and qualitatively. On the other hand, as a small number of ritual artefacts are distributed at the other sites, there must have been a relationship between the two kinds of sites. Although the exchange system was not completely the same as the Kula, it appears that settlements were uneven in terms of access to prestige goods. We can see only a part of the result of activity in the past, but it is possible to assume the existence of inter-village networks and exchanges which were connected to feasting and based on personal connections between leaders.

	figurine	stone rod	earring
Akagi	84	36	57
Sasara	43	47	100
Utaya	42	37	95

Tab. 5. Number of artefacts from the three sites.

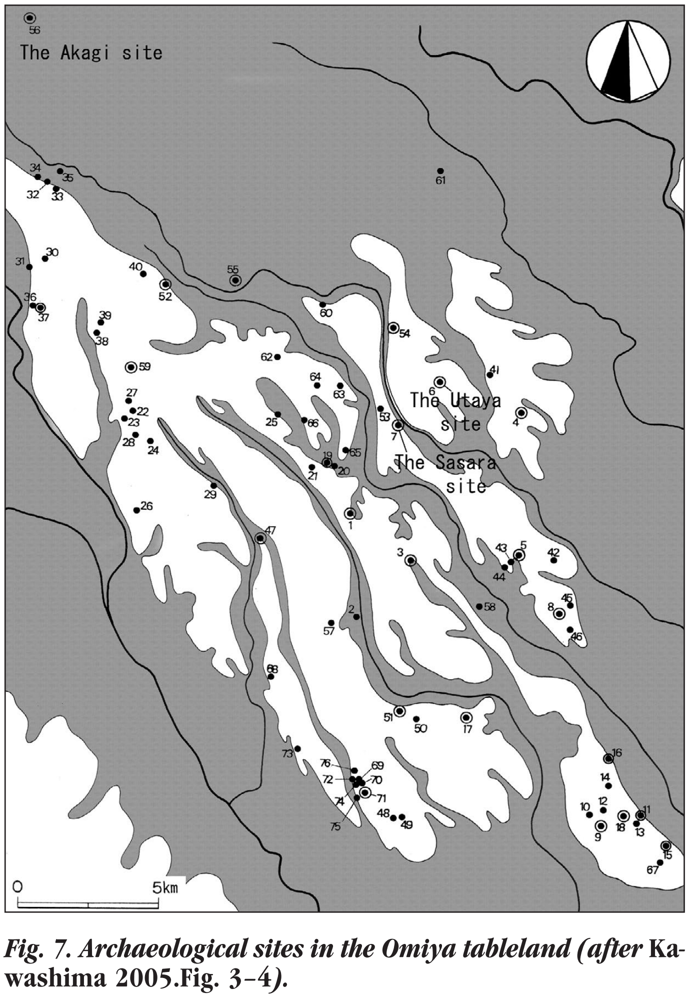


Fig. 7. Archaeological sites in the Omiya tableland (after **Kawashima 2005.Fig. 3–4*).***

As I mentioned above, because feasting is strongly connected to ritual, it is possible to assume that rituals with guests from other settlements were held, and that networks were constructed on such occasions. According to the evidence of ritual activity and feasting, a ritualized exchange system could have developed in the Late to Final Jomon period, which was still at the stage of reciprocity. The argument in this article is based on the hypothesis that feasting is observed universally in various societies and that the development of feasting and social complexity are correlated. The Kula exchange shows that exchange activity includes rituals and feasting. In the Late and Final Jomon period, ritual activities were not carried out in all but in particular settlements. The goods and the information would have been accumulated once in the 'core' settlement, such as Akagi site, and then exchanged in the region. This does not mean 'redistribution', because there is no evidence for the existence of chiefs and associated power in the whole exchange process. Stone rods and a particular type of earring would have been exchanged, and the technique and design of figurines could have been transferred through the 'core' settlements. As the increase of the size and frequency of exchange could be evaluated by ritual and feasting, I propose the evidence of ritual and feasting from the Jomon sites. The emergence of food processing facilities in the Late Jomon is not necessarily correlated to population growth, because the number of pit dwellings decreased in this period. Therefore, food processing facilities are not used only for the minimum usual consumption of food, but also used for atypical consumption, and the amount of animal bones uncovered from the Late and Final Jomon sites increased, which is observed not only at the sites located in the mountains, but also those on the plain. Pits containing animal bones, like those at the Kinsei site, were found, and small fragments of animal bones were observed in the dark soil. These characteristics of the Late and Final Jomon could be recognized as contributing to feasting activities.

Conclusion

My suggestions in this paper do not mean that the exchange system in Jomon society was same as the Kula exchange, but I consider that there could be similarities. The treatment of ritual and feasting which are observed in the various societies could be an indicator of inter-village relationship during the Jomon period. In fact, stone rods, a particular type of earring, and the design of Snow-glassed figurines were brought from other settlements and accumulated at a site in the Omiya tableland. Like Kula exchange, commodities also could have been distributed through networks mediated by ritual and feasting in the Late and Final Jomon. It has not been clarified that Jomon society achieved social complexity at the same level as Kula communities, but the evidence of feasting in the Jomon implies the development of social complexity to some extent. Exchange in transegalitarian societies is a candidate for comparison with the Jomon. It is necessary to consider ritualized exchange in order to investigate the exchange system in Late and Final Jomon period.

ACKNOWLEDGEMENTS

I thank Professor Budja for kindly inviting me to the 14th Neolithic Seminar and for giving me advice. I also thank Associate Professor Hudson and Dr. Haggis for help with corrections to the text. This research was partly supported by the Sasakawa Scientific Research Grant from The Japan Science Society.

REFERENCES

ANZAI M. 2002. Hoppō shuryōsaishōmin no shakai: kōki no hokkaidō (The northern hunter-gatherer society of the Late Jomon in Hokkaido) (in Japanese). In M. Anzai (ed.), *Jōmon shakai ron (ge) (Jomon Society Studies vol. 2)*. Dōseisha. Tokyo: 51–102.

ARAYA M. et al. 1988. *Akagi iseki (The Akagi Site)* (in Japanese). Saitama-ken Maizōbunkazai Chvsa Jigyōdan. Kumagaya.

BIRKET-SMITH K. 1967. *Studies in Circumpacific Culture Relations I. Potlatch and Feasts of Merit.* Det Kongelige Danske Videnskabernes Selskab Historisk-filosofiske Meddelelser 42.3. Munksgraard. København.

DAIKUHARA Y. et al. 1994a. *Nakanoya chiku isekigun: Honbun hen (The Sites in Nakanoya Area I)* (in Japanese). Annaka-shi Kyōiku Iinkai. Annaka.

1994b. *Nakanoya chiku isekigun (The Sites in Nakanoya Area II)* (in Japanese). Annaka-shi Kyōiku Iinkai. Annaka.

DAIKUHARA Y. 2002. Kokuyōseki no ryūtsū wo meguru shakai: Zenki no Kitakantō Chūbu chiiki (The exchange of obsidian in Kanto and Chubu district), In M. Anzai (ed.), *Jōmon shakai ron (jō) (Jomon Society Studies vol. 1)*. Dōseisha. Tokyo: 67–131 (in Japanese).

HASHIMOTO T. et al. 1985. *Sasara II* (in Japanese). Saitama-ken Maizōbunkazai Chōsa Jigyōdan. Kumagaya.

1990. *Utaya iseki (The Utaya Site)* (in Japanese). Saitama-ken Maizōbunkazai Chvsa Jigyōdan. Kumagaya.

HAYDEN B. 2001. Fabulous Feasts: A Prolegomenon to the Importance of Feasting. In M. Dietler and B. Hayden (eds.), *Feasts: Archaeological and Ethnographic Perspectives*. Smithsonian Institution. Washington, DC: 23–64.

2003. Were Luxury Foods the First Domesticates? Ethnoarchaeological Perspectives from Southeast Asia, *World Archaeology 34.3: 458–469*.

KAN S. 1989. *Symbolic immortality. The Tlingit potlatch of the nineteenth century*. Smithsonian Institution Press. Washington, DC.

KANEKO A. 1993. Kantō chihō no shakōki dogū: Tōhoku chihō no shakōki dogū to no idō (The differences of Snow-glassed figurines between Kanto district and Tohoku district) (in Japanese). *Saitama kōko (Saitama Archaeology) 30: 139–171*.

KANEKO H. 1989. Kinsei iseki shutsudo no jūkotsu (Animal bones uncovered from the Kinsei site) (in Japanese). In K. Niitsu (ed.), *Kinsei II: Jōmon*. Yamanashi-ken kyōikuiinkai. Kōfu: 222–242.

KAWASHIMA T. 2005. Another aspect of figurine function. In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 177–185*.

2007. Heisambō kaizuka sokuryō hōkoku: Kanjō moritsuchi ikō kenshutsu no jissen to kadai (Survey of the Heisambo shell midden site) (in Japanese). *Tsukuba daigaku senshigaku kōkogaku kenkyū (Tsukuba Archaeological Studies) 18: 53–67*.

KOSUGI Y. 2003. Seigyō toshite no kōeki katsudō (Reevaluation of the exchange of goods in the Jomon period as a subsistence activity) (in Japanese). *Kōkogaku kenkyū (Quarterly of Archaeological Studies) 50.2: 10–27*.

MALINOWSKI B. 1922. *Argonauts of the Western Pacific*. Routledge and Kegan Paul. London.

NAKAMURA O. 1999. Bosei kara yomu jōmon shakai no kaisōka (Stratification of Jomon society from the view of funeral system) (in Japanese). In T. Kobayashi (ed.), *Saishin jōmon gaku no sekai (The Latest data of Jomon Studies)*. Asahi Shimbunsha. Tokyo: 48–60.

NIITSU K. et al. 1989. *Kinsei II: Jōmon*. Yamanashi-ken Kyōiku Iinkai. Kōfu.

PEARSON R. 2007. Debating Jomon Social Complexity. *Asian Perspectives 46.2: 361–388*.

TAKAHASHI R. 2001. Sōron: Sonraku to shakai no kōkogaku (General remarks: The archaeology of settlements and societies) (in Japanese). In R. Takahashi (ed.), *Sonraku to shakai no kōkogaku (The Archaeology of Settlements and Societies)*. Asakura Shoten. Tokyo: 1–93.

TANIGUCHI Y. 2001. Jōmon jidai no iseki no nendai (Chronology of sites in the Jomon period) (in Japanese). *Kikan Kōkogaku (Archaeology Quarterly) 77: 17–21*.

TESHIGAWARA A. 2007. Jōmon jidai no bungyō no tokushitsu (The characteristics of division of labor in the Jomon) (in Japanese). In *Ogasawara Yoshihiko sensei tainin kinen ronshū kankōkai (ed.), Kōkogaku ronkyū: Ogasawara Yoshihiko sensei tainin kinen ronshū (Essays contributed to Professor Yoshihiko Ogasawara)*. Shinyōsha. Kyoto: 1–24.

WATANABE H. 1990. *Jōmon shiki kaisōka shakai (Jomon-Type Stratified Society)* (in Japanese). Rokkō Shuppan. Tokyo.

YAMADA Y. 2003. Kodomo he no tōshi ni kansuru kisoteki kenkyū: Jōmon kaisō shakai no sompi wo megutte (A Fundamental Study of Investment for Children Concerning the Existence of Jomon Stratified Society) (in Japanese). In Kansai jōmon bunka kenkyūkai (ed.), *Kansai jōmon jidai no shūraku bochi to seigyō (Settlements, Graves and Subsistence of Jomon period in Western Japan)*. Rokuichi Shobō. Tokyo: 125–139.

back to contents

UDK 903.02.08'1(5'012)"631/634"

Documenta Praehistorica XXXV (2008)

Spiral patterns on the Neolithic pottery of East Asia and the Far East

Irina Zhushchikhovskaya[1], Olga Danilova[2]

1 Institute of History, Archaeology and Ethnology of Peoples of the Far East, Russian Academy of Sciences, Russia, irinazh@mail.primorye.ru

2 Vladivostok State University of Economics and Services, Russia

ABSTRACT – *The paper focuses on the investigation of East Asian and Far East Neolithic spiral patterns, with the application of some mathematical principles. The basis of the research is published data on pottery assemblages from Japan, Eastern China, and the Amur River basin from the 6th to the beginning of the 1st mil. BC. We suggest a descriptive order of spiral patterns based on the typology of spiral figures used in geometry. This approach permits us to see the regional and cultural diversity of Neolithic spiral patterns within the research area.*

IZVLEČEK – *V članku se ukvarjamo z matematičnimi principi vzhodnoazijskih in daljnevzhodnih spiralnih vzorcev. Raziskava temelji na objavljenih zbirih lončenine iz Japonske, vzhodne Kitajske in območja reke Amur od 6. do 1. tisočletja p.n.š. V članku predlagamo opis in razvrščanje spiralnih vzorcev na podlagi tipologije spiral v geometriji. Skozi ta pristop lahko opazujemo regionalno in kulturno raznovrstnost neolitskih spiralnih vzorcev na študijskem območju.*

KEY WORDS – *East Asia and Far East; the Neolithic; pottery; spiral patterns; spiral as geometric figure*

Introduction

In many regions, the Neolithic and Bronze Age saw the flourishing of curvilinear ornamentation in decorative art – in particular, in pottery decoration. One of most widespread motifs was the spiral, which in its various techniques, configurations and compositional derivations, appeared on ceramic vessels in Central and Mediterranean Europe (*Bogucki 1995; Manson 1995*), Northern Africa (*Spenser 1997*), East Asia and Far East (*Chen Chunhe et al. 1995; Kobayashi 2004; Okladnikov 1981; 1984*).

In publications considering prehistoric, ancient and traditional decorative arts, the description and systematization of spiral patterns are usually suggested in general and approximate terms. Usually, spiral figures are identified as certain visual images and symbols, such as 'S-shaped figure', 'C-shaped figure', '8-shaped figure', 'ε-shaped figure', 'running wave pattern', 'volute pattern', 'weather horns pattern', and 'scroll design' (*Ivanov 1962.347, 349, 353; Kahsina 1977.138–140; Kyzlasov and Korol 1990.22, 49, 53; Kobayashi 2004.43, 48; Myl'nikova 1999.61; Shepard 1985.255–305; Simonov 1995.32–34*). In terms of semantics, the spiral pattern is associated with ideas of movement, dynamics, change (*Malyavin 2001.484; Rybakov 1994.51, 195; Shepard 1985. 302–304*). In some cases the spiral is interpreted as a solar symbol (*Yablan 2006.56*).

This paper continues the subject of spiral motifs in prehistoric decorative art, and considers ornamental patterns in terms of geometry. Mathematical approaches to the characteristics and study of ornamental forms – in particular, past and traditional ones – conducted since the 1920s and 30s are restricted mostly by the application of the laws of symmetry as one of the basic properties of organic and non-organic nature (*Birkhoff 1933; Shepard 1948; 1985.259–305;*

Sturrok 2003; Yablan 2006). In cases of curvilinear ornamentation, it seems to be productive to use some principles of the graphic construction, description and systematization of curvilinear figures used in geometry and algebra (*Pedoe 1979*). The paper presents the results of applying these principles to the study of the spiral as a particular case of a curvilinear figure, and spiral patterns on the Neolithic pottery of East Asia and the Russian Far East.

Fig. 1. Map of the research area: 1 – Japanese archipelago; 2 – East China, Huanghe River basin; 3 – Lower Amur River basin.

The archaeological framework of our research includes the Jomon culture of the Japanese archipelago, the Yangshao cultural community in East China, and the Neolithic cultures of the Lower Amur River basin in the Russian Far East (Fig. 1). The research database is comprised of publications consisting of drawings and photographs of ceramic vessels decorated with spiral patterns (*Aikens and Higuchi 1982; Catalogue... 1999; Chen Chunhe et al. 1995; Chzhang 1984; Fukuda 2007; Kashina 1977; Kobayashi 2004; Okladnikov 1981; 1984; Pearson 1992; Skarpari 2003; Yamanouchi 1964*). The instrumental supplement of computer graphic processing (Adobe Photoshop and CorelDraw programs) was applied for the correct processing of the published data and presentation of the images of spiral figures.

The spiral as a geometrical figure

Spirals (from Lat. *spiro* – coil) are lines curved around a certain fixed point on a plane or a certain axis in space. Plane spirals are geometrical figures formed by rotating and moving any point. The direction of the movement is a basic characteristic of the spiral. Four mathematical, or algebraic, types of plane spiral figure are recognized. They are the Archimedes spiral, the logarithmic spiral, the clothoid spiral, and the spiral formed by the connection of semi-circular arcs (like the Chinese yin-yang symbol). Each type is bound by certain geometrical rules and has a distinctive appearance (Fig. 2).

The Archimedes spiral was described by Archimedes in the 3rd century BC. Its algebraic formula given in polar coordinates is:

$$p = a\varphi$$

A spiral of this type looks like a coiled line turning away from or towards a certain point on the plane. The distance between the spiral's coils is constant (Fig. 2.1).

The logarithmic spiral was described Decart and Bernulli in the 17th century. Its algebraic equation formula given in polar coordinates is:

$$p = ae^{k\varphi}$$

A spiral of this type is constructed by regularly increasing the distance between coils (Fig. 2.2).

Logarithmic and Archimedes spirals are similar to the structures of some animal and plant forms. For instance, the logarithmic spiral's configuration is characteristic of the shell structure of certain kinds of cephalopod and gastropod mollusks (*Hadorn and Wehner 1986*). The configuration of the Archimedes spiral looks very like the coiled pattern of the upper part of a fern shoot (*Atlas 1980.333*). The idea that certain natural forms might have been models for the construction of ornamental patterns in the Paleolithic and Neolithic has been advanced by some

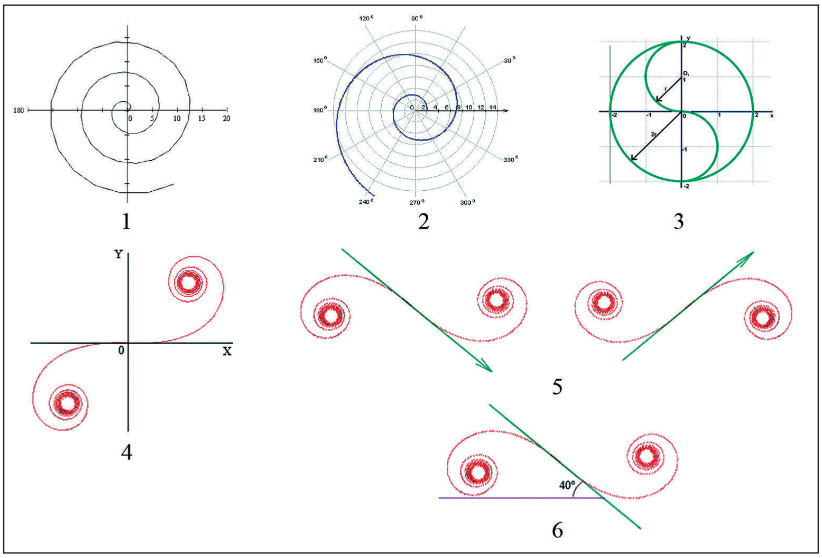


Fig. 2. Mathematical types of spiral figures: 1 – Archimedes spiral; 2 – logarithmic spiral; 3 – spiral formed by the connection of semi-circled arcs (yin-yang symbol); 4 – clothoid spiral; 5 – descending clothoid spiral (left); ascending clothoid spiral (right); 6 – determinaiton of direction and inclination angle of tangent line in clothoid spiral.

researchers (*Yablan 2006.52–179*). In respect of direction, we distinguish right-oriented and left-oriented Archimedes and logarithmic spirals. After turning a spiral figure through 180°, the direction remains the same.

A clothoid spiral figure represents the plastic connection of two symmetrical branches directed opposed (Fig. 2.4). The configuration of branches corresponds to the Archimedes or logarithmic spiral. The term clothoid was introduced in 20th century by the Italian mathematician Chezzaro as an analogy to the Ancient Greek mythological character Clotho – the goddess of fate, winding the thread of human life around a spindle (information from www.liceotosi.va.it/matehelp/sportello). The clothoid spiral corresponds to the image of the well-known ornamental 'running wave' pattern. The parametric equations for a clothoid spiral are:

$$x = a\int_0^a \cos\frac{\pi u^2}{2}\,du \qquad y = a\int_0^a \sin\frac{\pi u^2}{2}\,du$$

Considering the clothoid figure as an ornamental motif, we suggest establishing two descriptive characteristics. The first is the direction of movement indicated by the line which is tangential to both branches passing through the connecting stretch. The direction from left to right corresponds to the ascending clothoid; the opposite direction corresponds to a descending clothoid. Another characteristic is the angle of tangent inclination relative to the conventional horizontal axis of the clothoid. The angle depends on the distance between the clothoid's branches.

A spiral formed by the connection of semi-circular arcs described by Albrecht Dürer in 16th century differs from other spiral figures types by its method of formation (*Pedoe 1979.35–36*). This spiral has to be constructed in an instrumental-mechanical, or circular way, but not by means of a mathematical formula. Certain variants of this spiral are determined by the length of semi-circular arcs (Fig. 2.3). This figure is an analogue of the well-known yin-yang symbol, in Chinese the *t'ai chi*, or ultimate (*Williams 2003.385*). These mathematical types of plane spirals are applied to the systematization of the variety of spiral patterns on Neolithic pottery in East Asia and the Far East.

Spiral motifs on Neolithic pottery in Japan

The Neolithic Jomon culture existed in Japan from 13 600 to 900 BC, according to the most recent data. It is divided into six periods, which are defined in great measure in terms of changes in pottery decoration and patterns (*Kobayashi 2004*). Even quite archaic pots from the Incipient Jomon period (13 600–9200 BC) are in some cases designed with the simplest ornamental compositions, while the most intensive development of vessel decoration began in the Early Jomon (5300–3500 BC). The potteries of the Early, Middle, Late and Final periods are decorated by quite variegated compositions, including straight lines and curvilinear elements and motifs. Pottery decoration was done by cord-impression, incising, grooving, relief application, some kinds of stamping, and carving. Each period produced its specific combination of techniques, while cord-impressing remained the main technique from the beginning to the end of Jomon culture.

The spiral motif on Early Jomon pottery

It seems likely that the spiral motif first appeared in Jomon pottery decoration in the Early period. In some cases we can see only amorphous spiral-like elements (Fig. 3.3). In other cases, the completed spiral figures are presented in a vessel's decoration (Fig. 3.1–2). The type of figure is usually like an Archimedes spiral. The technical means of spiral decoration are mainly cord-impression and sometimes incision. The flexibility of cords was appropriate for producing spiral patterns. According to published records, spiral figures form horizontal band compositions. Two kinds of Archimedes spiral type are distinguished – right-oriented and left-oriented. There are spirals formed by 1.5–2 coils and by 5–7 coils. An interesting case of multi-coiled spiral ornamentation is presented on a ceramic vessel of Moroiso style from Tenjin, in Yamanashi Prefecture (*Kobayashi 2004.38, Fig. 3.13*). The upper part of the vessel has a wide horizontal band as the dominant, which is formed by joining two left-oriented Archimedes spirals. The way the spiral combine produces the illusion of mirroring. The technique of ornamentation is cord-impression (Fig. 3.1). Another case is a horizontal band formed by alternating left-oriented and right-oriented Archmedes spirals – this pattern is on a vessel from a site near Fukuoka, Saitama Prefecture (*Yamanouchi 1964.Pl. 43*).

Certain Early Jomon pottery samples present two linked Archimedes spirals joined by a curved plastic line similar to a clothoid spiral figure (Fig. 3. 2). For instance, the horizontal band composition formed by these figures is found on a ceramic vessel from a site near Yudza, in Yamagata Prefecture (*Yamanouchi 1964.Pl.42*).

The spiral motif on Middle Jomon pottery

Spiral motifs developed further during the Middle Jomon period (3500–2500 BC) in local pottery styles called Kasory E, Kaen (Flame-like), Atamadai, Middle Daigi and others (*Aikens and Higuchi 1982.137–156; Kobayashi 2004.42–49; Yamanouchi 1964.Pl. 78, 79, 82–85*). In general, these styles demonstrate great variability in decorative composition and technique. The decoration or ornamentation, including spiral motifs, were mainly produced by appliqué relief over a background of cord impressions. There are spirals of several types: Archimedes, logarithmic, and clothoid (Figs. 4 and 5). Given the data from publications, we can suppose that the Archimedes spiral occurs in pottery more frequently than other types (Fig. 4. 3, 4). A logarithmic spiral is identified clearly in some cases only (Fig. 4. 1). The series of pottery samples shows a figure which appears to be intermediate between Archimedes and logarithmic spirals, especially when the spiral is formed by 1.5–

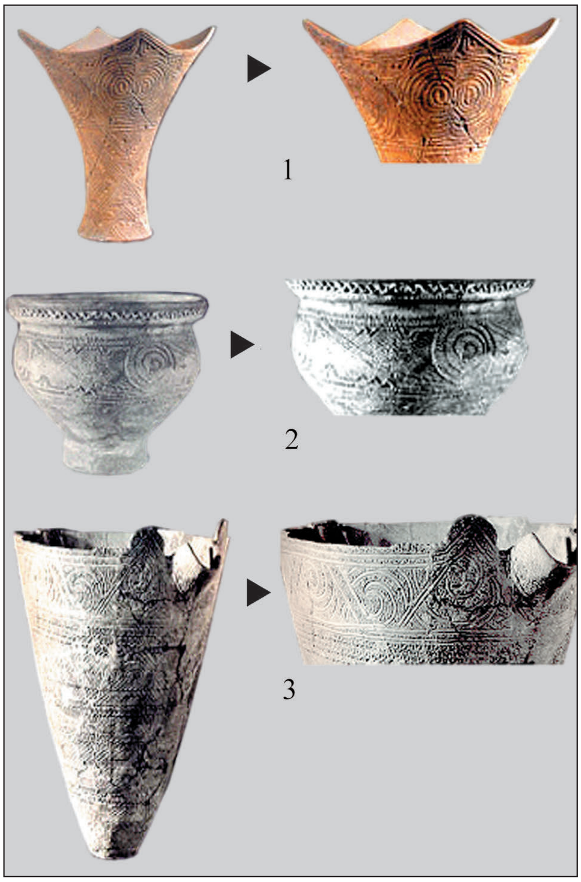


Fig. 3. Spiral patterns on Early Jomon pottery, Japanese archipelago (1 –* Kobayashi 2004.38*; 2, 3 –* Yamanouchi 1964. Pl. 42, 43*).

2 coils (Fig. 4. 5, 7). Combining different spiral types in the same composition is common (Fig. 4. 1, 2, 6).

The figure of an Archimedes or logarithmic spiral may be used as a basic motif in ornamental composition (Fig. 4. 1–6), or as additional, or accenting one, if the composition includes other more representational motifs (Fig. 4.7). In first case, the figures of Archimedes or logarithmic spirals form motifs of band type ornament. Ornamental bands usually have a horizontal orientation and are located in the upper part of the vessel. The composition may be organized by a simple parallel transition, or replication of a spiral figure along the horizontal axes (*Yamanouchi 1964.Pl. 82, 107*), or alternating left-oriented and right-oriented spirals similar to the principle of mirroring (*Yamanouchi 1964.Pl. 109, 144*). Spiral figures forming horizontal bands are sometimes linked together by a direct horizontal or slightly inclined line that gives the effect of a permanent pattern (*Yamanouchi 1964.Pl. 82, 84, 107, 109*). In some cases, ornamental band compositions consisting of Archimedes or logarithmic spirals are vertical (Fig. 4.1). It may be noted that the principle of the vertical dis-

Fig. 4. Spiral patterns on Middle Jomon pottery, Japanese archipelago (1, 2 – from **Kobayashi 2004.44, 46***; 3, 4, 5 –* **Catalogue 1999.11***; 6, 7 –* **Yamanouchi 1964.Pl. 122, 112***).*

position of ornamental motifs and elements was known in the pottery-making tradition of the Early Jomon period. For instance, ceramic vessels of Ento type were designed with vertical zones filled in cord impressions of various kinds (*Yamanouchi 1964.Pl. 32, 33*). Obviously, the manner of orienting ornamental patterns vertically survived during the Middle Jomon period, but in another decorative context. Interesting cases are the compositions formed by combining large and small Archimedes or logarithmic spiral figures (Fig. 4. 1, 2).

The clothoid spiral type seems to be an infrequent motif on Jomon pottery of the Middle period. In particular, the pottery of Kasori E style shows some samples of clothoid spiral motif (*Kobayashi 2004.43, Fig. 3.16*). Spiral figures produced in relief appliqué technique have a horizontal orientation forming the band composition. The specific feature of the clothoid spiral is that its branches are separated one from another by some interval or distance. The angle of tangent inclination is around 20–40°. This gives the impression of a 'fluent', long-drawn spiral (Fig. 5).

The spiral motif on Late and Final Jomon pottery

The late (2500–1200 BC) and Final (1200–900 BC) Jomon periods are characterized by significant changes in pottery-making standards. The pottery assemblages from Late and Final Jomon sites provide evidence of improving techniques and technology, increasing diversity of shapes, and new tendencies in ceramic vessel decoration. Ornamental motifs and compositions marked by esthetic perfection correlate finely with the vessel's shape. Ornamentation techniques include incising and grooving, low relief application, carving, and cord-impressing (*Aikens and Higuchi 1982. 164–182; Kobayashi 2004.40, 42–49; Pearson 1992. 73–75*).

Fig. 5. Spiral patterns on Middle Jomon pottery, Japanese archipelago (1, 3 – from **Kobayashi 2004.43***; 2 –* **Yamanouchi 1964.Pl. 139***).*

Curvilinear ornamentation appears on the pottery of local types: Horinouchi, Final Angyo, Kamegaoka, and others (*Aikens and Higuchi 1982.164–179; Fukuda 2007.25–71; Kobayashi 2004.40; Yamanouchi 1964.Pl. 15–264*). Published records show a series of curvilinear figures which are associated with Archimedes and logarithmic spirals or their intermediate forms. The configuration and compositional pattern of spiral motifs share characteristics with the same spiral types of the Middle Jomon (Fig. 6). The 2–2.5-coiled spiral figure predominates, while in certain cases the spiral may be formed of 5 to 6 coils (*Catalogue...1999.47, Fig. 1; Yamanouchi 1964.Pl. 164, 178, 181, 191*). Archimedes and logarithmic spiral figures form horizontal or, more rarely, vertical band compositions by parallel transition or mirroring (*Catalogue...1999.29, Fig. 3, 31, Fig. 1; Yamanouchi 1964.Pl. 178, 181*) (Fig. 6. 1–3). Sometimes the spirals may be combined with other elements and motifs to forming an ornamental composition (*Pearson 1992.97, Fig. 47, 99; Yamanouchi 1964. Pl. 164*) or in some cases may be used as an additional accenting motif (*Aikens and Higuchi 1982.144, Fig. 3.26; Yamanouchi 1964.Pl. 112*) (Fig. 6. 4).

The clothoid spiral as an ornamental motif saw significant development during the Late to Final Jomon (Fig. 7). In most of cases, the configuration of clothoid figures is close to the clothoid of the Middle Jomon in its fluent, long-drawn line. The angle of tangent inclination to the horizontal axes of clothoid figures varies from 15° to 35°. In a few cases a compact, or 'expressive' clothoid, where the small distance between the branches may be noted. According to published records, there are several compositional variants of the clothoid spiral pattern. The first is a band of running wave type spirals combined to produce an effect of permanent movement. Usually the ornamental band is oriented horizontally (Fig. 7.2 ,3, 4). For instance, ceramic bowl from the site at Kainohana, Final Jomon period, is decorated with a wide band of incised, descending clothoid spirals (*Catalogue... 1999.33, Fig.4*). An ornamental band composition formed of incised ascending clothoid figures is located in the mouth of a footed bowl from the Korekawa site, Final Jomon (*Pearson 1992. 107*). There are some similar cases (*Yamanouchi 1964.Pl. 209, 250, 252*). One kind of ornamental composition has a horizontal band of separate clothoid spiral figures located at an angle to band's axes. This decoration was produced by incision, or incision in combination with carving (Fig. 7.5, 6). In rare cases, one can fix the vertical disposition of the clothoid spiral pattern on the vessel body (Fig. 7. 1).

The clothoid spiral was sometimes an accentuating element in an ornamental composition. Thus, the teapot-shaped vessel from Final Jomon site near Edosaki, in Ibaraki Prefecture, is decorated with a wide zone of incised meanders. The finest incised clothoid spiral figures are included in a total composition as 'enlivening' details. (*Yamanouchi 1964. Pl. 185*).

Spiral motifs on Neolithic pottery in eastern China

The Yangshao culture was discovered in the Huanghe River basin in the 1920s. The investigation of archaeological sites abundant in various cultural remains provided information of great value for understanding the Neolithic of East and Central China. The pottery was recognized as the most remarkable feature of Yangshao culture. A developed technology, significant morphological diversity and surprisingly colorful and complicated decoration are distinctive features of Yangshao ceramic vessels (*Chen Chunhe et al. 1995.25–35; Kashina 1977*).

Fig. 6. Spiral patterns on Late and Final Jomon pottery, Japanese archipelago (1, 2, 3 – from* Catalogue 1999.29, 31, 47*; 4 –* Yamanouchi 1964. Pl. 202*).

After the discovery of Yangshao culture, a series of closely related Neolithic cultures in a general chronological framework from the end of the 5th to the end of 3rd mil. BC was recognized within the vast area of the Huanghe basin. These are the Machayao and Daven'kou cultures, and some others (*Chzhang 1984; Kuchera 1977; Scarpari 2005.154, 155, 215*). Neolithic pottery was decorated with polychrome and monochrome painting on polished walls. Black, brown, white, and green colors were produced from mineral pigments. Ornamental traditions are characterized by a great diversity of elements, motifs, and compositional schemes. Curvilinear motifs – spirals, in particular – were widespread.

According to the data of published illustrations, the spiral configurations generally correspond to the clothoid type (Figs. 8 and 9). Probably among the earliest evidence of clothoid spiral patterns are the compositions on ceramic vessels from the Myaodigou site of the Yangshao culture, 3280 ± 100 BC. In some cases, ornamental horizontal band compositions are formed of clothoid-like elements (*Kuchera 1977.Pl. 2, 3*) (Fig. 8.1, 2). In other cases the compositions represent completed clothoid spirals. For instance, ures of ascending clothoids are combined to form a wide horizontal band surrounding the vessel body. The decoration is produced by multiple repetitions of a spiral figure in paint of various colors (*Kashina 1977.114, Fig. 51–3*). Similar ornamental compositions are characteristic of the pottery from the Yangshao culture site at Bangshan, while here the spiral figures correspond to descending clothoids (Fig. 8 – 3, 4). It is interesting to note that the ceramic vessels designed with this ornamentation are interpreted as funerary urns (*Kashina 1977.124–140*). The decoration of pottery from the site at Machang demonstrates cases of ascending and descending clothoid spiral figures composing horizontal bands. Sometimes the spiral pattern serves as the structural frame for stylized zoomorphic images of frogs and others (*Kashina 1977.132, Fig. 64 –1, 5*).

The ceramic vessels of the Machayao culture are decorated with wide polychromic horizontal bands constructed of combined clothoid spirals of ascending and descending type (Fig. 9.1–4). An interesting case is the ornamental band formed by four descending clothoid figures combined with stylized frog images (*Kashina 1977.117, Fig. 53 –9a, 9b*). In some cases, one can note a net-structured pattern of circles and ascending clothoid spirals (Fig. 9. 5) (*Kashina 1977.113, Fig. 50–1*). A specific feature of clothoid spiral patterns on Machayao and Yangshao pottery is that in certain cases the concentric circles or round figures enter inside the clothoid's branches (Fig. 9. 1, 5). In the pottery of Daven'kou culture there are cases of spiral patterns close to Yangshao ornamentation – a wide horizontal band of ascending and descending clothoid spirals (Fig. 9. 6) (*Kuchera 1977.Pl. 11; Chzhang 1984.94, Fig. 26*).

Fig. 7. Spiral patterns on Late and Final Jomon pottery, Japanese archipelago (1, 2, 3, 5, 7 – from* Yamanouchi 1964.Pl. 181, 209, 235, 244, 250*; 4 –* Catalogue 1999.33*; 6 –* Kobayashi 2004.40*).

Sometimes curvilinear patterns were constructed using the Archimedes spiral. For instance, in Bangshan pottery there are cases of horizontal ornamental bands formed by the parallel transportation of a right Archimedes spiral figure (*Kashina 1977.134, Fig. 66–5*). The same principle of ornamentals band

Fig. 8. Spiral patterns on Yangshao pottery, East China (1, 2 – from* Kuchera 1977.Pl. 2, 3; *3, 4 – from (http:/www. bibliotekar. ru/china1/3.htm).

formed with left-oriented Archimedes spirals is found on the pottery of Machayao culture (*Skarpari 2003. 155*).

Spiral decoration on Neolithic pottery from the Lower Amur River region

The Neolithic of the Lower Amur River region in the southern region of the Russian Far East is presented in archaeological assemblages of the Malyshevo, Kondon, Voznesenovka cultures. These cultures, probably connected by close relationships, form a chronological sequence within the limits of the 6th–mid-2nd mil. BC. Pottery is the most representative category of artifacts at these Neolithic sites. Ceramic vessel decoration is very diverse as to motifs, compositions, and techniques (*Derevyanko and Medvedev 2006; Medvedev 2003; Okladnikov 1981; 1984*).

Pottery assemblages of Malyshevo culture and Voznesenovka culture give the series of spiral pattern samples. Malyshevo culture pottery dated to the 6th–mid-4th millennium. BC has examples of Archimedes and clothoid spirals used as the basic motifs of horizontal band compositions. Spiral decoration was produced by imprinting with a toothed roller tool (Fig. 10). The Archimedes spiral is formed of 4–6 coils. In certain instance there are right and left oriented Archimedes spirals within same composition (*Derevyanko and Medvedev 2006.136, Fig. 7.10 – 3*). In the cases of clothoid spiral patterns, the opposing branches of the curvilinear figure are formed with multi-coiled Archimedes spirals (Fig. 10. 1). Sometimes, horizontal band composition is formed with curvilinear figures looking like uncompleted, or 'broken', clothoid spirals (*Derevyanko and Medvedev 2006.136, Fig. 7.10 – 4*).

The pure flourishing of spiral patterns is connected with the pottery-making tradition of the late Neolithic Voznesenovka culture in the mid-3rd–mid-2nd mil BC. Ceramic vessels excavated at the sites at Voznesenovka, Kondon, Takhta, Suchu have horizontal band-like compositions formed with motifs of Archimedes and logarithmic spirals, clothoid spirals, and the yin-yang type, or a type of 'T'ai Chi figure' (Fig.

Fig. 9. Spiral patterns on Machayao (1–5) and Davenkou (6) pottery, East China (1, 3 – from* Kuchera 1977.Pl. 4, 7*; 2, 4, 5 – from* http:/www. bibliotekar. ru/china 1/3.htm*; 6 – from* Kuchera 1977.Pl. 11*).

11). The decorative technique was standard – incised or grooved spiral patterns over a vertical zigzag pattern impressed by a small-toothed comb and covering most of the vessel's walls. So, the spiral pattern played the main role in a vessel's decoration. In many cases the composition represents the combining of different spiral types – for instance, Archimedes or logarithmic spirals and clothoid spirals (Fig. 11.4, 8), or clothoid and yin-yang spirals (Fig. 11.2). The spiral figure formed by the connection of semi-circular arcs and looking like a yin-yang symbol occurs in ornamental compositions in several cases – this motif is specific to the Late Neolithic pottery of Lower Amur, as against Jomon culture and Yangshao pottery (Fig. 11.1–3).

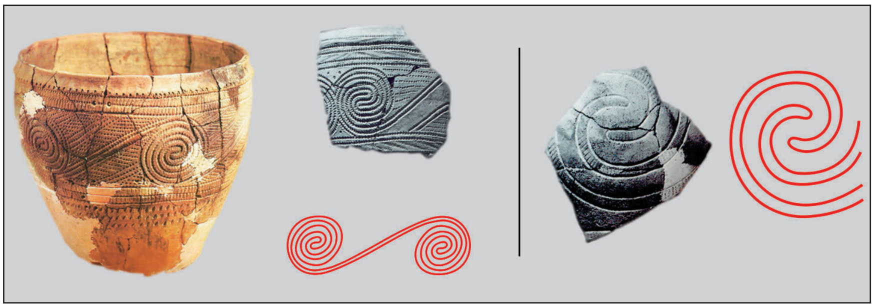


Fig. 10. Spiral patterns on Malyshevo culture pottery, Lower Amur region (from* Okladnikov 1981.Pl. 62, 85, 89*).

The pottery of Voznesenovka culture is quite interesting in some samples decorated with curvilinear anthropomorphic images. Fragments of such vessels were discovered at Voznesenovka (Fig. 12). An important element of this decoration is a spiral figure of yin-yang type. The decoration is produced by grooving and fine comb-impressing on a red painted and polished background. Researchers interpret these splendid vessels as containers for non-utilitarian, probably festive, purposes (*Derevyanko and Medvedev 2006.148*).

Conclusion

The materials considered here provide a basis for some conclusions concerning spiral patterns on the Neolithic pottery of East Asia and the Russian Far East.

❶ The current mathematical typology of the plane spiral as a geometric figure may be applied to the description and systematization of curvilinear de-

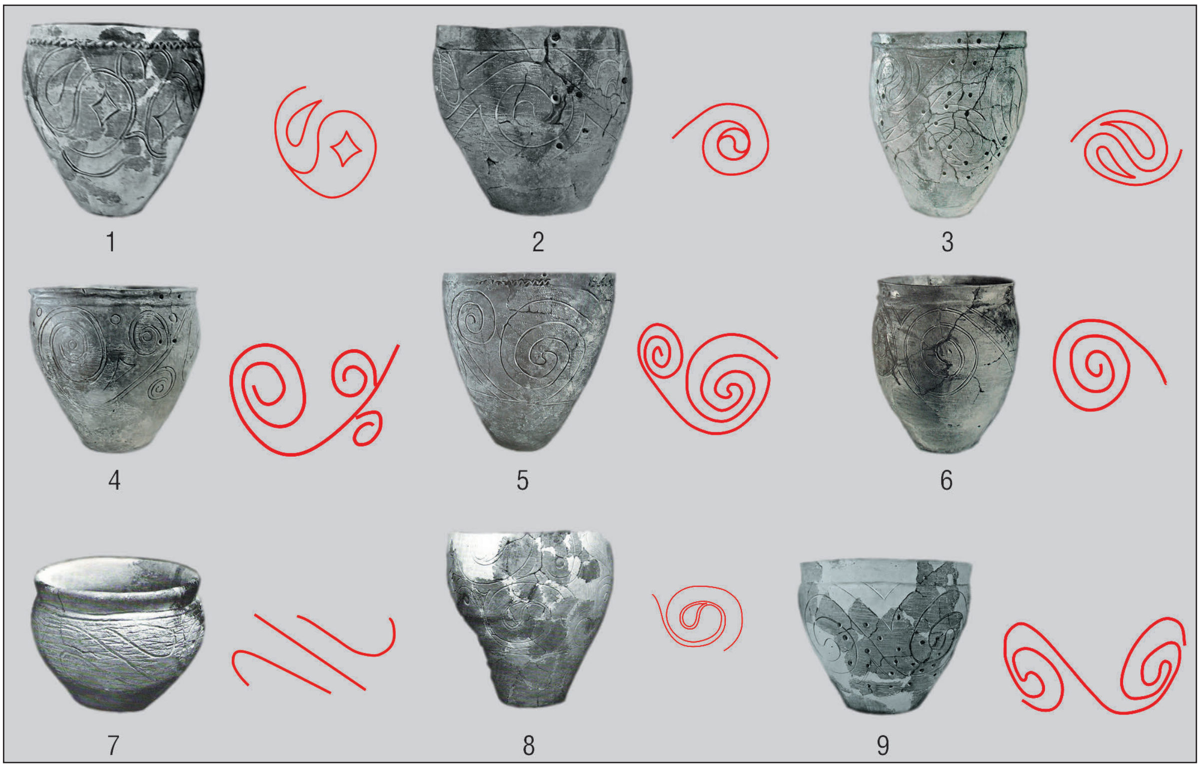


Fig. 11. Spiral patterns on Voznesenovka culture pottery, Lower Amur region (1–6, 8, 9 – from* Okladnikov 1984.Tabl. XV, XIX, XX, XXI, XXII, XLV, XLVI, LVII*; 7 – from* Okladnikov 1981.Pl. 91*)

coration on prehistoric pottery. This approach helps to make our research more correct and logical, and provides new possibilities and perspectives in the study of archaeological records.

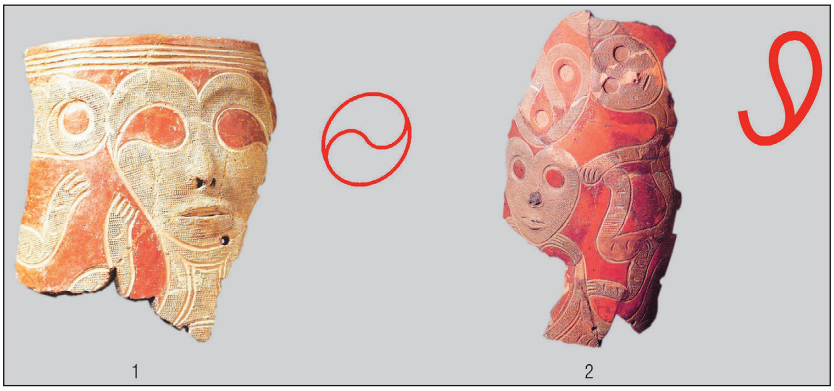


Fig. 12. Spiral patterns on pottery with anthropomorphic images from the Voznesenovka site, Voznesenovka culture, Lower Amur region (from **Okladnikov 1981.Pl. 18, 19***).*

❷ The pottery decoration of Neolithic cultures of Eastern Asia and the Russian Far East presents cases of spiral motif configurations corresponding to all the basic types of plane spiral figure. These are the Archimedes, logarithmic, clothoid spirals, and the spiral of yin-yang type, or t'ai chi figure. It may be considered as evidence that the spiral was one of the main and most developed geometrical concepts of the Neolithic population in this part of the world.

❸ The spiral decoration of Neolithic East Asian and Far Eastern pottery demonstrates certain regional and cultural variability. The pottery-making tradition of Jomon culture from the Early to the Final period shows a gradual development of spiral motifs and compositions including them. Spiral motifs are formed with Archimedes, logarithmic, and clothoid spirals. Archimedes and logarithmic spiral types reaches the peak of development in the Middle Jomon period, while the clothoid type flourished during the Late-Final periods. The clothoid spirals on Jomon pottery are characterized mostly by fluent, long-drawn configurations. In general, they show great compositional diversity.

A distinctive feature of spiral decoration on eastern Chinese pottery is the predominance of spiral motifs corresponding to clothoid figures. The compositional structure of the ornamental pattern is standard in most cases – clothoid spiral figures are combined to form a horizontal band around the vessel's belly. It is a classic type of running wave pattern. The clothoid figure is characterized by the short distance between its branches, creating the effect of an expressive, compact spiral. This style differs obviously from the clothoid spirals on Jomon pottery. Archimedes spiral figures were used in Neolithic Chinese pottery spiral decoration more rarely than clothoids.

Curve-lined decoration on the pottery of Lower Amur region became most developed in the late Neolithic stage, the mid 3rd–mid 2nd millennium. BC, which was close to the Late Jomon of the Japanese archipelago and some assemblages of the Yangshao cultural circle in East China. Ornamental compositions tend to be combinations of various spiral types, rather than patterns of single spirals. The most interesting feature of spiral ornamentation on Lower Amur pottery is the presence of a motif corresponding to a curvilinear figure formed by the connection of semi-circular arcs, or the yin-yang symbol.

In general, it seems likely that regional variability in spiral decoration reflects cultural differences in prehistoric esthetic conceptions and traditions. The common idea of spiral figures was adopted in different forms in various Neolithic entities of East Asia and the Far East.

REFERENCES

AIKENS M., HIGUCHI T. 1982. *Prehistory of Japan*. Academic Press. New York – London – Toronto.

ATLAS 1980. *Atlas arealov i resursov lekarstvennyh rastenii SSSR [Atlas of the areas and resources of medicinal plants of the USSR]*. Botanical Institute of the Academy of Sciences, Moscow (in Russian).

BIRKHOFF G. D. 1933. *Aesthetic Measure*. Cambridge.

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

CATALOGUE 1999 *Catalogue of Special Exhibition-Studying of Shellmound*. Matsudo Museum Press. Matsudo (in Japanese and English).

CHEN CHUNHE, TIANG YUSHAN et al. 1995. *Zhongguo Lidai Yishu [Chinese Art in the Dynasties]*. Taiwan, E. B. Books Co., Ltd. Taibei (in Chinese).

CHZHANG YATZIN 1984. *Keramika neoliticheskih kul'tur Vostochnogo Kitaya [The Pottery of East China Neolithic Cultures]*. Nauka. Novosibirsk (in Russian).

DEREVYANKO A. P., MEDVEDEV V. E. 2006. Neolithic of the Nizhnee Priamurye (Lower Amur River Basin). In S. M. Nelson, A. P. Derevyanko, Y. V. Kuzmin, R. L. Bland (eds.), *Archaeology of the Russian Far East: Essays in Stone Age Prehistory*. BAR International Series 1540. Archaeopress. Oxford.

FUKUDA M. 2007. *Hokkaido and the Prehistoric Cultures of Russian Far East: Archaeology of the 1st millennium B.C.*

HADORN E., WEHNER R. 1986. *Allgemaine Zoologie*. Georg Thieme Verlag. Stuttgart.

IVANOV S. V. 1962. *Ornament narodov Sibiri kak istoricheskii istochnik [The Ornamental Art of Siberian Peoples as a Historical Source]*. Nauka. Moscow – Leningrad (in Russian).

KASHINA T. 1977. *Keramika kul'tury Yangshao [Yangshao Culture Pottery]*. Nauka. Novosibirsk (in Russian).

KOBAYASHI T. 2004. *Jomon Reflections*. Oxbow Books. Oxford.

KUCHERA S. 1977. *Kitaiskaya arkheologiya [Chinese Archaeology]*. Nauka. Moscow (in Russian).

KYZLASOV L. R., KOROL G. G. 1990. *Dekorativnoe iskusstvo srednevekovykh hakasov kak istoricheskii istochnik [Decorative Art of Medieval Hakas Peoples]*. Nauka. Moscow (in Russian).

MANSON J. L. 1995. Starčevo Pottery and Neolithic Development in the Central Balkans. In W. K. Barnett and J. W. Hoopes (eds.), *The Emergence of Pottery: Technology and Innovation in Ancient Societies*. Smithsonian Institute Press. Washington – London: 65–78.

MALYAVIN V. V. 2001. *Kitaiskaya tsivilizatsiya [Chinese Civilization]*. Moscow (in Russian).

MEDVEDEV V. E. 2003. Academik A. P. Okladnikov i neolit Nizhnego Amura: razvitie idei [The Academician A. P. Okladnikov and the Neolithic of the Lower Amur Region: the Evolution of Concepts. In *Problemy arkheologii I paleoecologii Severnoi, Vostochnoi i Tsentral'noi Azii*. Institute of Archaeology and Ethnology, Siberian Division of the Russian Academy of Sciences. Novosibirsk: 164–171 (in Russian).

MYL'NIKOVA L. N. 1999. *Goncharstvo neoliticheskih plemen nizhnego Amura [The Pottery-Making of the Lower Amur Region]*. Institute of Archaeology and Ethnology, Siberian Division of the Russian Academy of Sciences. Novosibirsk (in Russian).

OKLADNIKOV A. P. 1981. *Ancient Art of the Amur Region*. Aurora Art Publishers. Leningrad (in English and Russian).

1984. *Keramika drevnego poseleniya Kondon (Priamurie) [The Pottery of the Prehistoric Site at Kondon (Priamurye)]*. Nauka. Novosibirsk (in Russian).

PEARSON R. (ed.) 1992. *Ancient Japan*. Smithsonian Institute Press. Washington, D.C.

PEDOE D. 1979. *Geometriya I iskusstvo [Geometry and Art]*. Translated from English. Mir-press. Moscow (in Russian).

RYBAKOV B. A. 1994. *Yazychestvo drevnikh slavyan [The Paganism of Ancient Slavic Peoples]*. Nauka. Moscow (in Russian).

SHEPARD A. O. 1948. *The Symmetry of Abstract Design, with Special Reference to Ceramic Decoration*. Carnegie Institute Press. Contribution 47. Washington, D.C.

1985. *Ceramics for the Archaeologist*. Carnegie Institute Press. Washington, D.C.

SIMONOV M. D. 1995. Osnovnye elementy udaegeiskogo ornamenta [Basic Elements of Udaege Ornamental Art]. In *Ornamental'nor iskusstvo narodov Dal'nego Vostoka*. Komsomolsk – na-Amure: 32–34 (in Russian).

SKARPARI M. 2003. *Drevnii Kitai. Kitaiskaya tsivilizatsiya ot neolita do epohi Tan [Ancient China. Chinese Civilization from the Neolithic to the Tang Dynasty]*. Astrel Press. Moscow (in Russian).

SPENSER A. J. 1997. Pottery in Pre-dynastic Egypt. In I. Freestone, D. Gaimster (eds.), *Pottery in the Making: World Ceramic Traditions*. British Museum Press. London: 44–49.

STURROK S. 2003. *Celtic Spirals Handbook*. Guild of Master Craftsman Publications Ltd. Lewes.

WILLIAMS C. A. S. 2003. *Chinese Symbolism and Art Motifs*. Tuttle Publishing. Boston.

YABLAN S. 2006. *Simmetriya, ornamenty i modulyarnost [Symmetry, Ornamental Forms and Modality]*. Institute of Computer Technologies. Moscow (in Russian).

YAMANOUCHI S. (ed.) 1964. *Primitive Arts of Japan. Vol. 1. Jomon Pottery*. Kodansha Press. Tokyo.

back to contents

UDK 903.08'1"631/634":7.031.1
Documenta Praehistorica XXXV (2008)

Colour, form, animals and deception in the ice age

Simona Petru
Department of Archaeology, Ljubljana University, SI
simona.petru@ff.uni-lj.si

ABSTRACT – *Vision is the main sense through which we observe and recognise the outside world. Humans are among the few mammals with trichromatic vision, which is important for food procurement and evading predators. For better hunting success, ice age people camouflaged themselves as animals. It is possible that without such an ability for deception, symbolic thought would never have evolved. Because vision is so important to humans, visual forms of the transmission of information emerged early in the history of modern humans, and today we call them Palaeolithic art. Colour and form are the principal elements of this art, but because of the lost context, we are unable to understand completely what they meant to ice age artists.*

IZVLEČEK – *Vid je glavno čutilo, s katerim opazujemo in spoznavamo svet okrog nas. Ljudje smo med redkimi sesalci, ki imajo trikromatski vid, ki je koristen tako pri pridobivanju hrane, kot pri izogibanju plenilcem. Da so si izboljšali možnosti pri lovu, so se ledenodobni lovci preoblekli v živali. Morda se brez takšnih sposobnosti zavajanja ne bi nikoli razvilo simbolično mišljenje. Ker je vid za človeka tako pomemben, je že zgodaj v svoji zgodovini izumil vizualne sisteme prenosa informacij, ki jih danes imenujemo paleolitska umetnost. Barva in oblika sta bistvena elementa te umetnosti, vendar zaradi izgubljenega konteksta ne moremo povsem razumeti, kaj sta pomenili ledenodobnim umetnikom.*

KEY WORDS – *Palaeolithic; Palaeolithic art; colour vision; form, animals*

Introduction

For most people, vision is the main sense through which they perceive the outside world. We see the form, colour and size of objects and we perceive their distance and movement. Through vision it is also possible to detect the facial and body expressions of other people and, to some degree, experience what they are feeling. For ice age hunter-gatherers, vision was important in obtaining food. Together with good memory and an advanced capacity for problem solving, excellent vision was also important for detecting predators camouflaged with spots and lines to blend with the background (*Hodgson & Helvenston 2006*).

Colour vision

Humans have trichromatic vision, which means that three protein pigments in the retina, called opsins, absorb different wavelengths of light. Accepted information is then processed in the brain and a colour picture appears. Trichromatic colour vision is rare among mammals, occurring only in humans, apes and some species of monkey. It enables them to detect coloured food items such as fruit and fresh leaves against the foliage of the forest (*Rowe 2002; Caine & Mundy 2000*). The human ability to see and identify colours and forms evolved because it ensured advantage for survival. For humans, some colours might be subconsciously connected with certain foods, which is why we find them pleasing. Since food is essential for our survival, everything related to nutrition has a strong emotional impact and is connected symbolically to life. These subconscious feelings might have been even stronger in the Palaeolithic, when food procurement was the main occupation in life, and vision was the most important instrument for obtaining it. The colours of food such as red, orange, yellow and green please us and give us satisfaction. They are symbols of life, while dark brown and black, which in nature are colours of decay, arouse negative feelings and are symbols of sickness and for death. This is also reflected in the colours of traditional shamanistic healing, which are red and black (*Rudnick 2004.165*) and might be seen as symbols of the battle between life and death which takes place during sickness. In the Palaeolithic, red and black pigments are known from many sites, so these two colours probably had some sort of symbolic meaning. For example, in Sungir, a pendant of a red horse with black spots was found in the cultural layer (Fig. 1), and some of the body decorations in the burials of the man and two children from this famous Russian site were also painted in red and black (*White 1993; 2003*).

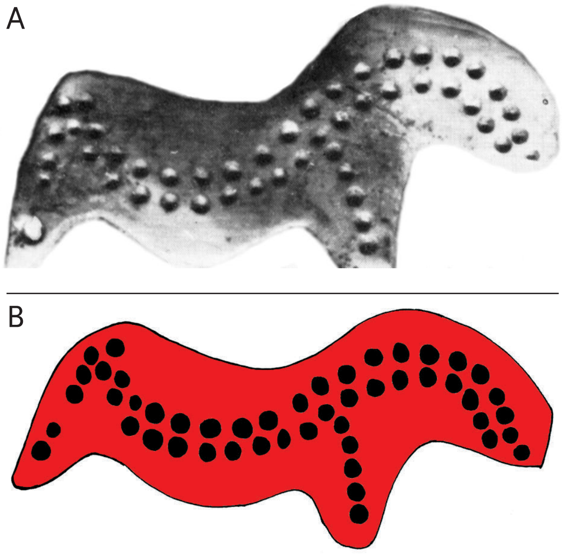


Fig. 1. A. Pendant in the form of a horse. Sungir (after* Abramova 1967.Fig. 23*). B. Colour reconstruction of the pendant.

Trichromatic vision is important in detecting more than one colour, but in some cases dichromatic vision may also have advantages, like improved spatial vision and a better ability to detect colour camouflage. When objects are camouflaged with large, irregular patches of colour, someone with trichromatic vision may fail to detect it, since the overall contours of the object are lost in a confusion of patches. Dichromats (people with red-green colour blindness) are less sensitive to the profusion of colours and are more likely to detect such objects. They may also have an improved ability to detect edges and contours in coloured objects (*Regan et al. with ref., 2001*). For this reason, dichromats can detect colour-camouflaged objects much better than trichromats. This is an important advantage when hunting colour camouflaged prey (*Morgan et al. 1992; Yokoyama & Takenaka 2005; Regan et al. 2001*). A group of foragers is more efficient, if it is composed by individuals with a wide range of gathering skills. If dichromats are able to penetrate some kinds of camouflage more effectively than trichromats, their presence in the group would be an advantage (*Morgan et al. 1992*). In the Palaeolithic, there were two ways to obtain food – gathering and hunting. Trichromatic vision would be more suitable for gathering, while for hunting it may be even better for the group if dichromats were included.

Human dependence on vision is also the reason, that visual forms of communication and information storage emerged early in the history of modern humans. Today, in western culture, the written word is omnipresent, and there are few members of western society unable to read. But at the beginning of our history pictures were created to tell stories and to transmit information to future generations. During the ice age, pictures, and sculptures as their three-dimensional counterparts, were a source of information which was transmitted through space and time

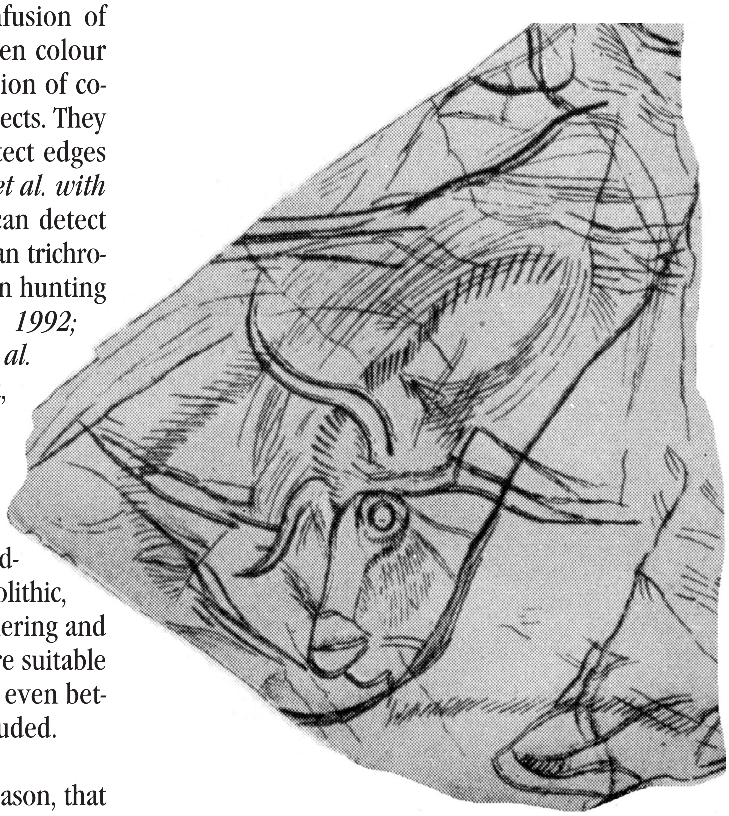


Fig. 2. Engraved image of a bison. Is this merely mundane, utilitarian information about the animal, or does it have a symbolic meaning? Or both? Mas d'Azil (after* Graziosi 1956.Fig. 78*).

and at different levels of cognition. Even today there are examples of story-telling with pictures, like the 'storyboards' from the island of Palau in the Micronesian archipelago, where myths, historical events and other stories are carved on wood boards (*Bendure & Friary 1995. 216*).

Fig. 3. Animal camouflage – unconscious deception.

From animals and deception to form and symbolism

Animals are the main subjects of Palaeolithic art, which is one of its most distinctive characteristic (Figs. 1, 2, 9, 10, 11). This is a reflection of the profound human interest in animals and their behaviour, which is still present today. Many people travel to distant places to join safaris or take their children to the zoo to observe different animals.

It was essential for ice age hunters to understand animal behaviour, since animals were not only a source of food, but also a considerable threat. Those individuals who knew animals and their behaviour well and were able to efficiently identify different sorts of animals had more chance of surviving (*Hodgson and Helvenston 2006*). For this reason, it was important for ice age hunters to study and imitate animals, and learning these skills probably started in early childhood. Experience and knowledge were not only shared orally, but also visually, with play and images, because visual memory was also important, and through play and pictures some characteristics of animals and their behaviour could be better expressed than through stories.

Animals can deceive hunters or prey with colour and form (colour camouflage, mimicry), but this is not conscious deception (Fig. 3), while humans developed various intentional and conscious techniques for deceiving animals by observing them and contemplating their behaviour.

Before hunting, Palaeolithic hunters might cover their bodies with animal hide, and sometimes even with antlers, to change their form, and they might use animal droppings to mask their odour. To imitate animal sounds and attract prey, they probably used bone whistles or other instruments, and by decorating their bodies with ochre and other pigments, they camouflaged themselves with colour (Figs. 4, 5).

Intensive colours, like those of predators or poisonous animals and plants, might also be used for body painting to give hunters a feeling of power and

Fig. 4. Human camouflage – conscious deception (after **Buschan 1922.Fig. 444***).*

to frighten intruders away from their territory. It is possible that body decoration developed from hunting camouflage (Figs. 4, 6).

Gradually, hunters may start to believe that by imitating different animals, they symbolically acquire their power and skills. Successful hunters were able to quickly recognise the forms of different animals, but they also knew animal behaviour, like present-day hunters in indigenous societies who, in their minds, become one with the hunted animal, which enables them to predict how the animal will react.

There is a biological basis for this sort of behaviour. Apes and humans have developed 'mirror neurons', which enable us by observing another individual's actions to 'resonate' with those actions. This is why we can experience empathy, and have an improved understanding of others, and can communicate so well (*Hodgson & Helvenston 2006*).

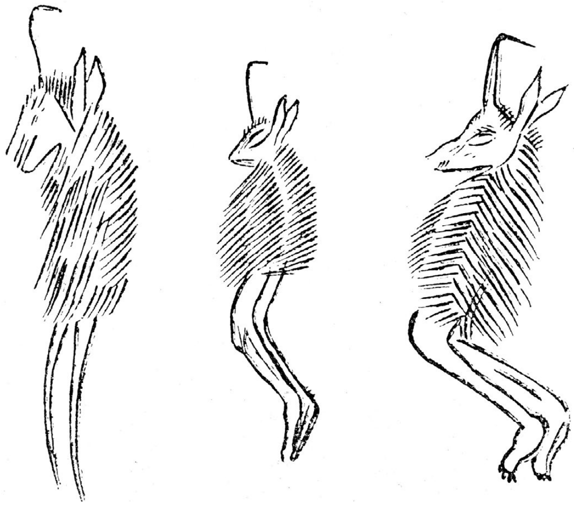


Fig. 5. Dancing 'little devils', from l'abri Mège (Grottes de la Mairie–Teyat). Engraving of animals with human postures – probably people dressed to represent animals (drawn by Breuil, in* Macalister 1921.Fig. 136*).

People who were able to deceive animals and were able to hunt them more efficiently than others may have been perceived as more powerful and may have had a special position in the group. Besides their own, they also incarnated the power of the chosen animal and impersonated the 'soul' of the animal to which they were connected by wearing its pelt. This is reflected in representations of so-called 'composites' (part human, part animal) in rock art (Fig. 7).

Fig. 6. Body decoration, Melanesia (after Buschan 1922).

Today, shamanism in various indigenous societies is the closest reflection of the probable idea behind composites in Palaeolithic art (Fig 8). It is impossible to know the beliefs of Palaeolithic painters, but there are indicators that they were able to experience altered states of consciousness or trance, which is also characteristic of modern shamans (*Lewis-Williams & Dowson 1988; Clottes & Lewis Williams 1998; Lewis-Williams 2002*). Shamanism and animism are ideal forms of belief for hunter-gatherers, since they are reflections of the close connection between humans and animals in hunter-gatherer societies. Trance can be stimulated (besides other methods) by hunger or prolonged isolation (*Lewis-Williams 2002.124*). Such stressful situations can occur during a prolonged hunt or during periods of food shortage, which probably quite often appear in societies with few reserves. For hunters it was important to have an explanation for states of altered consciousness and to understand or even control them. They induced such states artificially, often with the aid of hal-

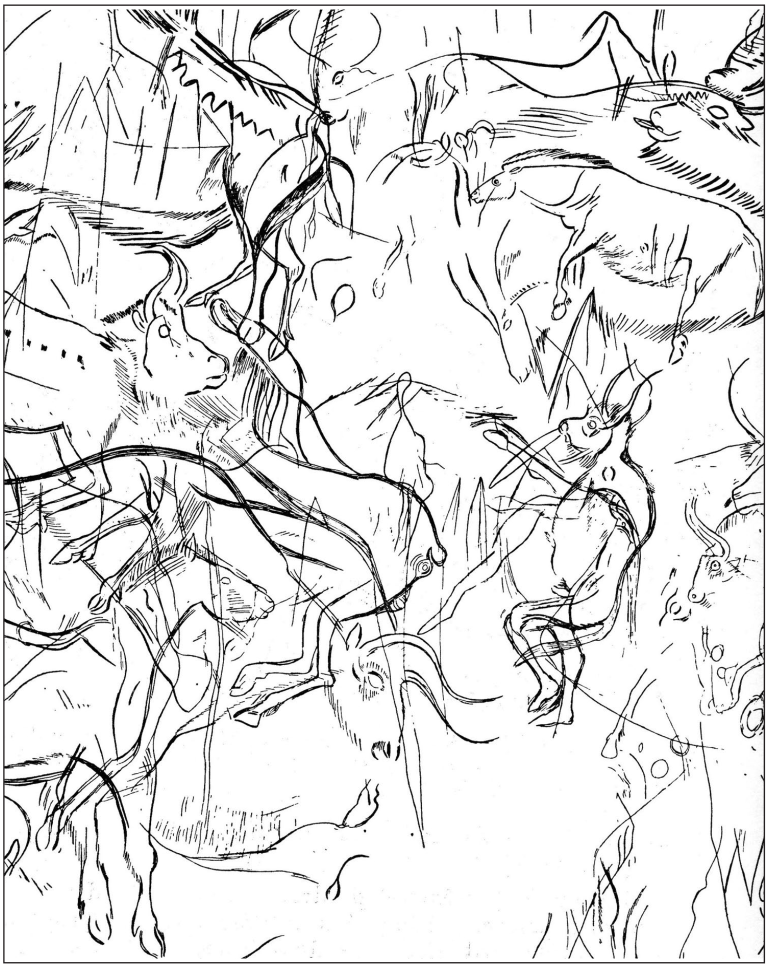


Fig. 7. The so-called 'Bison man' from Les Trois Frères cave, who plays musical bow. He has human and animal characteristics and is surrounded by animals (after* Bégouën & Breuil 1958.Figs. 61–63*).

lucinogens, to get used to them in the safe environment, so they were prepared if trance occurred unintentionally because of physical stress.

A second characteristic of shamanism is the close relation of shaman and animal during a trance. Animals are the shaman's spirit guides, and identification with them is even more intense during states of altered consciousness then normally. An individual who experiences trance is transformed into an animal and can feel complete anatomical changes (*Clottes & Lewis Williams 1998.17*). A shaman in a trance is not human, but has changed psychologically into an animal. In this state, the form, colour, characteristics and behaviour of the animal are further imprinted in the subconscious and enable the person to even better understand animals when in a normal state of mind.

Ice age people learnt to deceive animals in order to catch them more easily, but deception may also be the reason for the origin of symbolic thought. When deceiving, different meanings are given to things and to words. Reality is not what is perceived, but something totally different. So real things obtain different meanings and become symbols for something else. It is possible that without the ability for deception, humans would never have been capable of inventing and understanding symbols. When things are perceived as they are, there is no space for symbolic thought.

The changing of the real forms into symbols later in history enabled the formation of picture writing (pictography). Colour was an insignificant part of pictograms, because it is form which gives us more information about the perceived object. Outlines are sometimes more effective than full colour pictures, which have more information. This extra information can in some cases distract attention from the defining attributes of the object we are observing (*Ramachandran & Hirstein 1999.24*). Like everything else, the perception of colours and forms has to be learnt. Blind people who regain their sight after an operation do not recognize objects. They see something, but they do not know what it is. It is possible for them to recognise objects by touching them, but they can not recognise the same objects

Fig. 8. 'Modern' Siberian shaman. A trance is achieved by rhythmic drumming (after **Buschan 1922. Fig. 308***).*

by sight. The process of learning is slow; they learn to recognise movement and colour first, size and distance after that, and form at the end of the process. In the visual field, a fundamental differentiation is to distinguish form from the background. Form is unbroken and organised, while background is indefinite and unorganised (*Pečjak 2006.50, 51*). So, form is the most complicated visual effect to learn, but it also contains most of the information about the objects around us. People with normal sight perceive objects as a mixture of form and colour. But it is easier to transmit information by means of form than colour. Rhinoceros and elephants are more or less the same colour, especially when seen from a distance, but the form of the two animals is different for an observer even if they are far away. Form defines the object, while colour fills it with energy. Form is more durable than colour, if it is manufactured in an appropriate manner and in an appropriate material. In the Palaeolithic, representations were sculpted (Figs. 1, 9), engraved (Fig. 2), painted (Fig. 11) and sometimes even shaped in clay (Fig. 10).

Colour symbolism is different from the symbolism of form, since many objects share the same colour, while form defines only one type of object. In colour symbolism, several objects are presented as the same. Blue means sky, sea and river. All three are connected with water. So blue is an appropriate symbol for water, and includes all forms of water and the sky. On the other hand, the same object is sometimes symbolically represented by different forms. On the portable Palaeolithic art from Russia, the symbolic patterns for water are different: fish-scales, bands, ladders, zigzag lines... (*Marshack 1979*). Colour was probably never part of water symbolism in the Palaeolithic, since blue pigments were not obtainable (*Couraud 1983.107; 1988.20*).

Interpreting the images

In Palaeolithic art, an image is a composition of form and colour and its primary role is to transmit information. Aesthetics is only of secondary importance, and means that the information we get from an image is for some reason close to us, comforts us and gives us a feeling of satisfaction (Fig. 11).

An image can also be an object of worship if it gives us emotional satisfaction, which is why it could be a very powerful agent of manipulation. The creator of an image imposes certain information on the observer, which could be tied to time and space, but could

Fig. 9. Sculpture of feline. Isturitz (after Graziosi 1956.Fig. 46).

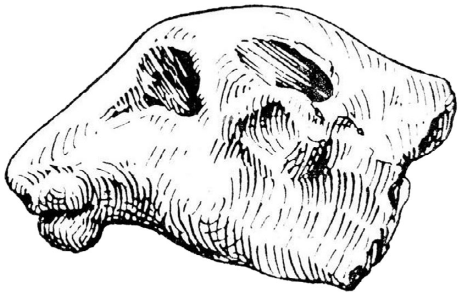


Fig. 10. Clay animal head. Dolni Vestonice (after **Zotz 1951.Fig. 18***).*

invitation to a meeting in her wigwam. The girl is a member of the bear clan, which is represented by an image of a bear (B). She and her two friends are drawn as three crosses (A, E, F) and they live in two wigwams (triangles C, G), placed near two lakes (J and K). From the second wigwam the footpath leads to the main road (H). From main road, another footpath branches off to her lover's wigwam (I), who is a member of the fish clan (D). The small figurine in the left triangle (C) marks the meeting point of the lovers.

also exceed those limitations and address a viewer who is distant temporally or spatially from the person who created it. The problem is that the information which was transferred by the picture 20 000 years ago is not the same that a viewer in 21st century will take from it. To understand the picture properly, the creator and viewer must be the part of the same cultural circle; otherwise, the meaning of the picture will be quite different for each of them. This can be demonstrated with images made by North American Indians in historic times (*Kulundžić 1951*). The picture (Fig. 12) appears packed with symbols and symbolic animal forms, but in reality it is just a love letter from an Indian girl to her lover and an

This demonstrates how difficult it is to interpret the meaning of a picture if the viewer does not share the cultural environment with the creator of the image. So the picture is in a way a foreign language to someone who does not understand it. It can contain intimate information intended for one person only, as in the case of the enamoured Indian girl, selected information interesting for a chosen group of people, or general information for anyone who is part of a group with the same cultural values and is able to understand the information.

There have been various interpretations of Palaeolithic art, from first ideas that it was mere decoration

Fig. 11. Horses, cattle and reindeer from the Lascaux cave. Does this painting please us because of its deep symbolic meaning, because of our innate feeling for aesthetics, or simply because it subconsciously reminds us of food? (after **Graziosi 1956.Fig. 171***).*

or a reflection of sympathetic magic, to structuralist and shamanistic theories (*Clottes and Lewis Williams 1998; Bahn & Vertut 1999*). Some ideas were quickly forgotten, others lasted for longer periods, but all of them largely mirrored the time in which they originated and the knowledge and values of that time (*Bahn & Vertut 1999.207, 208*), but what the art meant to ice age people remains a mystery.

Conclusion

In Palaeolithic art a lot of information about its creators is hidden, but the communication channels through the millennia are not clear, so we are left to our imaginations and the fact that we are descendants of ice age painters, to overcome obstacles that obstruct our understanding of the first artists. Cultural and artistic values have developed in the course of time, but we are still the same species that decorated Altamira and Lascaux. Just like them, we try to understand the world around us and the different influences that affect our lives. Because of our close kinship, we try to find a connection between the behaviour and beliefs of Palaeolithic people and our own, which is why colour and form combined by distant artists to create an image is a constant challenge to our imagination.

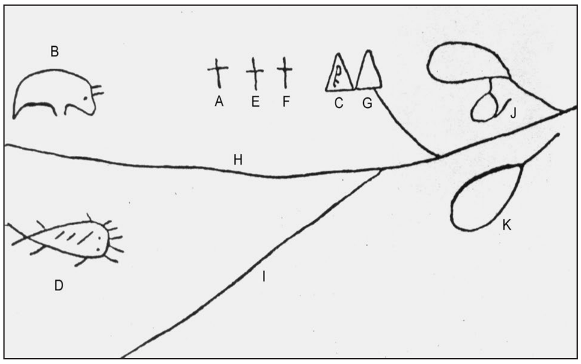


Fig. 12. Indian 'love letter' (transformed after* Kulundžić 1951.Fig. 31*).

∴

REFERENCES

ABRAMOVA Z. A. 1967. L'art mobilier paléolithique en URSS. *Quartär 18: 99–126*.

BAHN P. G., VERTUT J. 1999. *Journey Through the Ice Age*. Seven Dials. London.

BÉGOUËN H., BREUIL H. 1958. *Les Cavernes du Volp: Trois Frères – Tuc d'Audoubert*. Arts et Métiers Graphiques. Paris.

BENDURE G., FRIARY N. 1995. *Micronesia*. Lonely Planet Publications. Hawthorn.

BUSCHAN G. 1922. *Die Sitten der Völker 1–4*. Union Deutsche Verlagsgesellschaft. Stuttgart, Berlin, Leipzig.

CAINE N.G., MUNDY N. I. 2000. Demonstration of a foraging advantage for trichromatic marmosets (Callithrix geoffroyi) dependent on food colour. *Proceedings of the Royal Society: Biological Sciences 267: 439–444*.

CLOTTES J. and LEWIS-WILLIAMS J. D. 1998. *The Shamans of Prehistory: Trance and Magic in the painted caves*. Harry N. Abrams, Inc. New York.

COURAUD C. 1988. Pigments utilisés en préhistoire. Provenance, préparation, mode d'utilisation. *L'Anthropologie 92(1): 17–28*.

GRAZIOSI P. 1956. *L'Arte dell'antica eta della pietra*. Sansoni. Firenze.

HODGSON D., HELVENSTON P. A. 2006. The emergence of the representation of animals in paleoart: Insights from evolution and the cognitive, limbic and visual systems of the human brain. *Rock Art Research 23(1): 3–40*.

KULUNDŽIĆ Z. 1951. *Knjiga o knjizi*. Školska knjiga. Zagreb.

LEWIS-WILLIAMS J. D. 2002. *The mind in the cave: consciousness and the origins of art*. Thames and Hudson. London.

LEWIS-WILLIAMS J. D. and DOWSON T. A. 1988. Signs of all times: entoptic phenomena in Upper Palaeolithic art. *Current Anthropology, 29(2): 201–245*.

MACALISTER R. A. S. 1921. *A Text-Book of European Archaeology, Vol. 1: the Palaeolithic period*. Cambridge University Press. Cambridge.

MARSHACK A. 1979. Upper Paleolithic Symbol Systems of the Russian Plain: Cognitive and Comparative Analysis. *Current Anthropology 20(2): 271–311*.

MORGAN M. J., ADAM A., MOLLON J. D. 1992. Dichromats Detect Colour-Camouflaged Objects that are not Detected by Trichromats. *Proceedings of the Royal Society: Biological Sciences 248 (1323): 291–295*.

PEČJAK V. 2006. *Psihološka podlaga vizualne umetnosti*. Debora. Ljubljana.

RAMACHANDRAN V. S., HIRSTEIN W. 1999. The science of Art. A Neurological Theory of Aesthetic Experience. *Journal of Consciousness Studies 6, No. 6–7: 15–51*.

REGAN B. C., JULLIOT C., SIMMEN B., VIÉNOT F., CHARLES-DOMINIQUE P., MOLLON J. D. 2001. Fruits, foliage and the evolution of primate colour vision. *The Philosophical Transactions of the Royal Society London 356: 229–283*.

ROWE M. H. 2002. Trichromatic Color Vision in Primates. *News in Physiological Science 17: 93–98*.

RUDNICK H. 2004. The links between western psychotherapy and traditional healing. Thesis, University of Johannesburg (http://etd.rau.ac.za/theses/available/etd-05052004-113647/)

WHITE R. 1993. Technological and Social Dimensions of »Aurignacian-Age« Body Ornaments across Europe. In H. Knecht, A. Pike-Tay, R. White (eds.), *Before Lascaux: Complex Record of the Early Upper Paleolithic*. CRC Press. Boca Raton.

2003. *Prehistoric art: the symbolic journey of humankind*. Harry N. Abrams, Inc. New York.

ZOTZ L. F. 1951. *Altsteinzeitkunde Mitteleuropas*. Ferdinand Enke Verlag Stuttgart. Stuttgart.

YOKOYAMA S., TAKENAKA N. 2005. Statistical and Molecular Analyses of Evolutionary Significance of Red-Green Color Vision and Color Blindness in Vertebrates. *Molecular Biology and Evolution 22(4): 968–975*.

back to contents

UDK 902.03:902.6(497.4)"631/634"
Documenta Praehistorica XXXV (2008)

Reassessing the Mesolithic/Neolithic 'gap' in Southeast European cave sequences

Dimitrij Mlekuž[1], Mihael Budja[1], Robert Payton[2], Clive Bonsall[3], Andreja Žibrat Gašparič[1]
1 *Department of archaeology, Faculty of Arts Ljubljana University, SI*
2 *School of Agriculture, Food and Rural Development, University of Newcastle, Newcastle upon Tyne, UK*
3 *School of Arts, Culture and Environment, University of Edinburgh, Edinburgh, UK*
dimitrij.mlekuz@ff.uni-lj.si

ABSTRACT – *Radiocarbon sequences from some northern Mediterranean cave sites show a temporal gap between Mesolithic and Neolithic occupations. Some authors regard this as a regional phenomenon and have sought to explain it in terms of a general population decline in the late Mesolithic, which facilitated the replacement of indigenous foragers by immigrant farmers. New evidence from the rockshelter site of Mala Triglavca, in Slovenia, leads us to question this view. The results of AMS radiocarbon dating of samples recovered in excavations in the 1980s and associated soil/sediment analyses reveal evidence of substantial postdepositional disturbance of the cave sediments by human agency and geomorphological processes, which have created 'temporal gaps' and 'inversions' in the radiocarbon sequence and secondary deposits with residual finds.*

IZVLEČEK – *Zaporedja ^{14}C datumov iz nekaterih jamskih najdišč severnega Sredozemlja kažejo časovno vrzel med mezolitsko in neolitsko poselitvijo. Nekateri avtorji to vrzel razumejo kot regionalni pojav in ga razlagajo z zmanjšanjem mezolitskih populacij, kar naj bi olajšalo zamenjavo domorodnih lovcev-nabiralcev s kmetovalskimi prišleki. Novi dokazi iz spodmola Mala Triglavca to hipotezo spodbijajo. Rezultati neposrednega AMS ^{14}C datiranja vzorcev izkopavanj v 80. letih in sedimentne analize so pokazali na možne postdepozicijske spremembe depozitov, ki so ustvarile časovne vrzeli in inverzije v sekvenci ^{14}C datumov in sekundarne depozite z rezidualnimi najdbami.*

KEY WORDS – *Mesolithic, Neolithic, cave sequences, radiocarbon dating, Mala Triglavca*

Introduction

It is often assumed that Mesolithic-Neolithic continuity or discontinuity of settlement relates to the processes involved in the transition to farming, and can be recognized and read directly in the depositional sequences of archaeological sites and their associated artefact assemblages. This view derives from the conceptual conversion of geological into cultural stratigraphy and the acceptance of lineal radiocarbon sequences as representing sequential accumulations of deposits through anthropogenic activities. Lineal series of radiocarbon dates from individual sites tend to be interpreted as a direct record of habitation, with any discontinuity being seen as a gap in occupation and, by extension, in local or even regional Mesolithic-Neolithic cultural trajectories. Thus the neolithization of southeast Europe, and the Adriatic basin in particular, has become instrumentalised by 'comparative stratigraphy' that links Anatolia (Çatal Höyük, Suberde and Beldiba) with the Peloponnese and southern Balkans (Franchthi, Argissa, Sesklo, Vlush, and Drenovac) and the Adriatic (Škarin Samograd) (*Parzinger 1993.53, 65–78, 190, 254*). Recently, attention has focused on cave deposits, with several authors arguing for well-defined breaks between the Mesolithic and Neolithic. In this paper, we discuss the evidence from the rockshelter site of Mala Triglavca, in Slovenia, which has a critical bearing on the issue.

Continuity or gap?

Mark Pluciennik (*1997*) noted a hiatus of several centuries to a millennium or more between Mesolithic and Neolithic occupations in radiocarbon sequences from northern Mediterranean sites. Rather than accepting the gap as real, Pluciennik used it to highlight a number of conceptual issues relating to the transition to farming. The gap was seen as symptomatic of the periodization of the archaeological record into Mesolithic and Neolithic and the treatment of the Neolithic as radically different from the Mesolithic. He proposed several possible explanations for the phenomenon, ranging from taphonomic and methodological problems connected with archaeological visibility, to changes in settlement pattern.

However, the evidence of discontinuous occupations of individual sites was translated into regional cultural or demographic phenomena. Based on two well-studied sites with clear evidence of the gap, Theopetra (*Karkanas 1999; 2001*) and Franchthi (*Farrand 2000; 2003*), Laurens Thissen suggested there was "a stratigraphic discontinuity between the Latest (or Final) Mesolithic and the onset of the Neolithic both in Thessaly (at Theopetra) and in Southern Greece at Franchthi" (*Thissen 2005.35*). Others maintain that the gap is a wider regional phenomenon, using it to argue for radical change between the Mesolithic and the Neolithic. Biagi and Spataro (*2001*) reviewed the radiocarbon dates from selected cave sites in the central Mediterranean, and found evidence of a hiatus between the latest Mesolithic and earliest Neolithic occupations in every case. From this, it was suggested that the late Mesolithic (Castelnovian) was a period of population decline, with the hunter-gatherers disappearing altogether soon after the arrival of farming. This in turn was seen as evidence that neolithization of the circum-Adriatic region had proceeded largely by 'demic diffusion' (*Biagi and Starnini 1999.12; Biagi 2003. 148–150*).

In this paper we argue that the interpretation of the gap in terms of a widespread demographic decline of hunter-gatherers is problematic. There could be a number of different, and quite complex, processes behind the phenomenon, unconnected with demographic trends. In some cases a gap may simply be a function of 'sampling bias', caused by too few dated samples and/or inconsistent stratigraphic or spatial sampling. Cave excavations in the region are typically small in scale (sondages), which means that our interpretations are invariably based on only a very small sample of the deposits. A lack of proper stratigraphic control in excavations has often compounded the problem.

In any case, Mesolithic settlement patterns should not be interpreted in a reductionist manner. A Mesolithic settlement pattern is not just a distribution of points in space, to be studied in isolation without reference to the wider context. Rather, it is a remnant of wider economic, demographic and social structures. The long-term reproduction – social and demographic – of such structures is reflected in a stable settlement system. In this perspective the Mesolithic record becomes a densely or loosely connected network spanning large areas (*Wobst 1974; Chapman 1990*). Hunter-gatherer settlement patterns and associated structures are dynamic and flexible, and this is another factor that potentially can affect the occupational sequences of individual sites. Thus 'gaps' in the radiocarbon sequence of a particular site do not necessarily reflect demographic breaks and depopulations, but equally could be the result of factors such as altered mobility patterns or site use.

Moreover, other evidence argues against the idea that the transition to farming in the region relates to demic diffusion of immigrant farmers and the demographic extinction of the indigenous hunter-gatherers. The European genetic landscape was reshaped recently by the identification of subclades I1a, I1b*, I1b2, and I1c of I Y chromosomes. Haplogroup I is the only autochthonous haplogroup that is almost entirely restricted to the European continent where it shows frequency peaks in two areas, Scandinavia and southeast Europe (*Semino et al. 2000.1155–1159; Rootsi et al. 2004.129–134; 2006*). The I1b* subclade reaches maximum frequencies in southeast Europe including the Balkan peninsula, suggesting strong Mesolithic-Neolithic demographic continuity in the region (*Barać et al. 2003*).

It should also be noted that in some sites the existence of a gap is by no means certain, because the 2-sigma calibrated age ranges of the radiocarbon dates for the latest Mesolithic and earliest Neolithic occupations overlap. This is the case, for example, at Sidari on Corfu (*Sordinas 1969*), Konispol in Albania (*Russell 1998; Schuldenrein 1998*), Odmut in Montenegro, (*Srejović 1974; Kozłowski et al. 1994*), and Vela Spila in Croatia (*Čečuk and Radić 2005*). However, considering the circum-Adriatic region as a whole, it is noticeable that there are significantly fewer radiocarbon dates for the period 6600–6000 cal BC compared to the six centuries immediately before or after; this requires explanation, but it is beyond the scope of the present paper, except to observe that this period contained two key events, one climatic (the '8.2 ka event') and the other cultural (the spread of agriculture through the Balkan and Italian peninsulas), which probably impacted significantly on demography, settlement pattern, and the use of caves and rockshelters (*e.g. Bonsall et al. 2002; Weninger et al. 2006; Budja 2007*).

Mlekuž (*2005*) and Forenbaher and Miracle (*2005; 2006*) considered the evidence from the northern Adriatic in some detail. They acknowledged that the individual ^{14}C sequences from cave and rockshelter sites on the Triestine karst and in Istria (*e.g.* Benussi/Pejca na Sedlu, Edera/Stenašca, and Pupićina) show a temporal gap between the latest Mesolithic and earliest Neolithic occupations. However, they observed that the gap varied in duration and was not synchronous among the sites, that the latest date for a Mesolithic context at Benussi is similar to the earliest dates for 'Neolithic' contexts at Edera (layer 3a), Podmol pri Kastelcu (layer 13), and Pupićina in Istria, and that there are still a number of sites with undated Late Mesolithic-Early Neolithic sequences. From this they concluded that, in spite of the existence of temporal gaps in individual sites, there was no reason to assume a general hiatus in settlement across the region as a whole. Rather, it was suggested that the lack of radiocarbon evidence and hence the existence of gaps at individual sites could reflect complex economic and social processes occurring in the region at the time, either pioneer colonization of farmers and subsequent interactions with indigenous populations in the hinterland (*Forenbaher and Miracle 2006*) or internal transformations of Mesolithic groups (*Mlekuž 2005*).

Current distributions of Mesolithic sites have been distorted by sea level rise during the early- to mid-Holocene, and the Mesolithic settlement pattern is biased in favour of upland caves throughout the Dinarides, while there is a selective field survey bias in favour of lowland, open-air Neolithic sites (*Chapman 1994*). The dated archaeological record for the Mesolithic-Neolithic transition is thus an obviously biased sample, based mainly on cave stratigraphies (*cf.* Biagi and Spataro's [*2001*] sample, which consists of caves only).

Caves are sediment traps in which archaeological deposits can accumulate over long periods of time. This characteristic has made them invaluable for recording long-term patterns of social and demographic processes. However, as geoarchaeological and taphonomic studies have accumulated, it has become increasingly apparent that the interpretation of the archaeological record from these contexts is often problematic.

An important topic which has to be considered in the discussion of Mesolithic-Neolithic continuity is the evidence of sedimentary hiatuses or erosional surfaces between Neolithic and Mesolithic layers. Well-documented examples have been reported from Franchthi Cave (*Farrand 1993; 2000; 2003*) and Theopetra Cave (*Karkanas 1999; 2001*) in Greece, and linked to climate change (*Karkanas 2001*). They have been noted also at many sites on the northern Adriatic karst, including Edera, Caterina, Azzura, Zingari and Lonza (*Boschian and Montagnari Kokelj 2000*). In Grotta Azzura intact Mesolithic layers were found in a test trench in the front of the cave; the test trench inside the cave contained only traces of Castelnovian layers (*Cremonesi et al. 1984*). In the Pupićina Cave the Middle Neolithic strata are deposited directly on an early Mesolithic surface, which was compacted through trampling (*Miracle and Forenbaher 2006*). While climate change may have been a contributory factor, these erosional surfaces and sedimentary hiatuses may largely reflect intensive anthropogenic modifications of the cave interiors, which happened at least once, at the beginning of the Neolithic, destroying evidence of late Mesolithic occupation. Reworking of older deposits appears to have been a primary process in the formation of the Neolithic layers in Edera (*Boschian and Montagnari Kokelj 2000*). This discontinuity also marks a completely different use of caves: from gatherings of people in the Mesolithic, to animal shelters or sheep pens in the Neolithic, which is a well-known pattern in caves and rockshelters throughout the Mediterranean (*Brochier et al. 1992*; see also *Boschian and Montagnari Kokelj 2000*). This could explain the presence of Late Mesolithic Castelnovian microliths in Neolithic deposits in the Triestine karst caves (*Montagnari Kokelj 1993*) and the presence of anomalous radiocarbon dates and inversions in radiocarbon sequences.

Mala Triglavca case study

Mala Triglavca (45°40' N, 13°58' E) is a rockshelter site on the Dinaric Karst of southwestern Slovenia, 15 km from the northern Adriatic coast (Fig. 1). The rockshelter opens in the side of minor doline, its north-facing entrance lying at *c.* 435m above sea level. It was formed in the bedded rudist limestone and is a remnant of the ancient cave system of the river Reka (Fig. 2).

Mala Triglavca was first described by France Leben on the basis of excavations undertaken between 1979 and 1985 (*Leben 1988*). Leben excavated the deposits in the western half of the rockshelter to a depth of *c.* 4 m below the cave floor. Excavation and recording were based on a grid of 2m squares, and the deposits removed in horizontal units (spits) of up to 20cm thickness. No sieving or flotation was undertaken. Though never fully published, Leben's excavation showed the site to have a rich archaeological inventory (see *Leben 1988; Turk and Turk 2004*) and a long occupation sequence extending back to the early stages of the Mesolithic at least.

Following site reconnaissance in the summer of 2001, new excavations were started in 2002 as a joint venture between the universities of Ljubljana and Edinburgh, with the parallel aims of clarifying the results of Leben's excavation and establishing a benchmark archaeological sequence for the local region.

Here we provide a description of the deposits within the rockshelter and discuss the results of AMS radiocarbon dating of animal bones and bone artifacts from Leben's excavation. We also highlight problems connected with the conversion of stratigraphic sequences into cultural and periodic sequences.

Cave soils and sediments

Leben described the cave sediments in a paper written several years after his excavation (*Leben 1988*). The paper records 5 stratigraphic layers but these are not easy to relate to the layers shown in the published diagram (*Leben 1988.Fig. 9*). That diagram shows the sequence of deposits between the entrance and the back wall of the cave. The position of the section line in relation to Leben's excavation grid is shown in Figure 4. In the central part of the cave, Leben's field drawing appears to show 7 main layers, which we have labelled I–VII in Figure 3. It is not entirely clear how these correspond with the 5 layers described in his 1988 paper, but we suggest the correlation shown in Table 1.

The lowermost layer (VII = 5) was described by Leben (*1988*) as "autochthonous red clay with rubble". Archaeologically sterile, it was interpreted as Pleistocene in age. The overlying layers were attributed by Leben to the Holocene. Leben's (*1988*) lithological descriptions are incomplete, and the accounts in his field notes give little further information. The distinctions between layers III–VI appear to have been based mainly on small differences in colour and stoniness. Horizontal ash lenses occurred throughout this part of the sequence.

He noted lateral changes in the composition of the sediments. Thus he describes the deposits at the cave entrance as a "*unified layer of compact red/brown clayey soil with rubble and stones*" and notes that the deposits at the rear of the cave are more stony with occasional pockets of dark soil. According to the field drawing, layer boundaries became uncertain in the rear half of cave, but occasional stone lines are shown which could relate to palaeosurfaces.

In his 1988 paper Leben simplified this part of sequence into 2 layers (3 and 4) based mainly on archaeological content. Layer 4 (VI in Fig. 3) was assigned to the Mesolithic based on the presence of microliths and an absence of pottery. This layer also contained bone artefacts (including mattocks and piercers) and fragmentary remains of wild animals (mainly deer). Layer 3 contained Neolithic pottery as well as stone and bone tools. The faunal assemblage from this layer was dominated by the bones of wild animals, but approximately one-third were those of domesticated animals including cattle, sheep, goats, and dog. At the upper boundary of layer 3, Leben (*1988*) reported finding Eneolithic and EBA pottery.

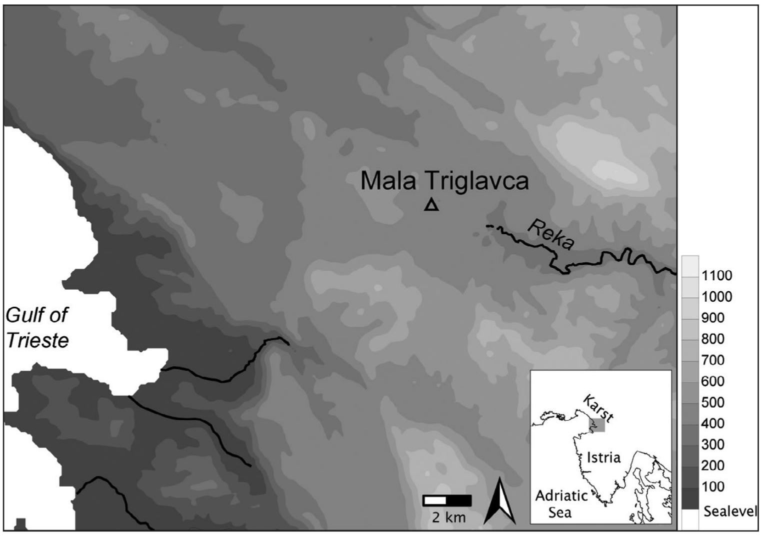


Fig. 1. Mala Triglavca location map.

Fig. 2. Mala Triglavca.

Layers 1 and 2 (I–II) at the top of the sequence were described in Leben's field notes as consisting of "rubble and humus", with layer 2 reported as having a greater stone content. Pottery recovered from these layers was interpreted as belonging to various periods from LBA to modern.

In 2001, as a preliminary to the current series of excavations in Mala Triglavca, the section corresponding to the S wall of Leben's trench – which was 2–3m east of Leben's main axial section – was examined and recorded after cleaning. However, the lowermost layer encountered by Leben had been obscured by debris fall and was not re-examined at that time. Detailed description of the cave deposits was confined to the central portion of the exposed face, between the 92 and 94m grid lines, although observations on the deposits at the rear of the cave and toward the entrance were also made.

Initial observations showed that the cave deposits had been extensively modified by soil forming processes, including biotic disturbance and soil structure development. Therefore, it was decided to adopt a pedological (as opposed to sedimentological) approach to the description of the section, using internationally accepted methods described in Hodgson (*1976*). This recognizes layers as soil horizons, but does differentiate lithologically distinct layers through the use of numerical prefixes (Tab. 1, Fig. 5). Soil pH was measured on soil samples collected from the main horizons recognized. This was done using a pH meter with combined electrode on soil suspensions with a soil:distilled water ratio of 2:5 (*Avery and Bascomb 1982*). Calcium carbonate content was estimated by the dilute hydrochloric acid field test using the criteria defined by Hodgson (*1976*).

Starting from the cave floor, we distinguished seven horizons/layers. Broadly, these correspond to layers I–VI in Figure 3 (Leben's [*1988*] layers 1–4).

Table 1 shows that the materials have similar texture (particle size distribution) and reaction throughout, being a calcareous loam with average pH in the range 8.0–8.5. All horizons other than 6Bk show strong evidence of organic matter incorporation giving dark colours and clear evidence of biotic structure development, hence the granular structure observed throughout. These properties, together with the low porosity and packing density observed in all horizons other than 6Bk, indicate biotic disturbance of the cave sediments and their transformation into mull humus typical of soil surface horizons (*Babel 1975; Duchaufour 1982*). Living plant roots extend through all horizons, but are most abundant in the first three (Ah, 2AB, 3AB), including both fibrous and woody tree roots. These originate mainly from forest trees growing outside the cave. Rooting effects, including organic matter addition from dead roots, together with mixing by soil-ingesting invertebrates, are the main processes that have altered the sediments forming granular structured soil material.

The lithological differences between the soil horizons relate mainly to the frequency of stones and boulders, and the occurrence of extremely calcareous horizontal lenses. The latter occur throughout the 2AB, 3AB and 4AB horizons. In the main, these features correspond to the 'ash lenses' described by Leben. They are paler coloured and friable bodies up to 8cm thick and 40cm across in the section described. The strong concentration of $CaCO_3$ in these lenses, indicated by a very strong reaction with dilute HCl and high pH, suggests that if these are ash lenses, then some recalcification has occurred. At present it is difficult to estimate the contribution of dissolved calcium percolating through the developing soil horizons, which may have an external source, for example, calcium dissolved from the cave roof rather than from the cave sediments.

A. PRESENT STUDY		B. Leben's study (Leben 1988, and field documentation)		
Layer	**Description**	**Layer (Leben 1988)**	**Layer (field drawing, cf. Fig. 2)**	**Description**
Ah	0–10/36cm.Very dark greyish brown (10YR 3/2), very calcareous loam; pH 8.45; many very small and small angular, (tabular to equant form) limestone stones; strongly developed medium to fine granular biotically-derived soil structure; many medium and coarse woody roots; common to many fine fibrous roots proliferate in some areas; sharp irregular lower boundary; variable horizon thickness of 10 to 30cm.	1	I	Up to 30cm thick layer of rubble and humus; many roots.
2AB	10/36–68/84cm. Same colour, texture, soil structure, root frequency as the overlying Ah horizon; pH 8.45; stones increase abruptly to extremely abundant very large and large angular (tabular to equant form) limestone stones, some with subrounded elements on one side; this horizon becomes much thicker near the back wall of cave; occasional paler coloured greyish brown (10YR 5/2) to light brown (10YR 6/3) extremely calcareous, friable, horizontally-aligned lensoid bodies 2–3cm thick and 20-30cm long; clear irregular lower boundary. The increased frequency of large angular/tabular limestone with one edge smoothed and subrounded indicates solution weathering and rockfall from the cave roof, which is most likely due to frost weathering.	2	II	Layer of cave humus with angular rubble, with many larger stones (collapsed cave ceiling). It varies in thickness from 20-30cm (in the central partof the cave) to up to 120cm (near the southern and western cave wall, whereat this depth loose black soil with stones start to appear). Boundary with layers 1 and 3 is not clear.
3AB	68/84–160/170cm. Same colour, and texture as 2AB; pH 8.20; strongly developed fine granular to fine subangular blocky biotically-derived soil structure; far fewer stones; woody roots still common as above, but the frequency of fibrous roots decreases to common; occasional faint, extremely calcareous brownish grey (10YR 5/2) to light brown (10YR 6/3) friable, horizontally-aligned lensoid bodies; an angular stoneline occurs at 106-118cm. The observed lithological discontinuity in stone content indicates in washing or blowing in of soil material.	3	III–IV	'Horizon 3a' Black, humose, loose deposit with less rubble than layer 2. Contains many features: ash lenses and patches of burnt clay. Thickness 100–120cm. Pottery.
4AB	160/170–194–204cm. Same colour, texture, root frequency as 2AB; pH 8.34; abundant large angular (tabular to platy form) limestone stones of no particular alignment; strongly developed, biotiically-derived, medium to fine granular soil structure; abrupt, irregular boundary. This horizon thickens toward back wall of cave and the lower boundary plunges. The lithological distinctness of this more stony layer indicates a major rockfall from the cave roof.			
5bAh	186–204cm. A discontinuous buried horizon (paelosurface) of black (7.5YR 2/0) humose, calcareous loam, pH 8.16. Less stony than 4AB with common to many large angular (tabular to platy form) limestones stones. Strongly developed medium to fine biotically-derived granular structure. Common burnt and unburnt bones. Abrupt, smooth boundary. The higher organic matter content of this horizon could be due to addition of organic material by human agency.	3b	V	'Horizon 3b' Darker sandy and burnt soil with small rubble (or no rubble). No pottery.
6Bk	204–240/250cm . Light grey (10YR 7/1 to 7/2) to light brownish grey (10YR 6/2), extremely calcareous, horizontally-aligned lensoid body of loose to massive silt loam; stones decrease to common, i.e. fewer stones than in 5bAh; pH 8.45; locally common small nodules of $CaCO_3$; black inclusion similar to 5bAh lens; few woody roots. The less stony character, lensoid form and black inclusion of this discontinuous horizon suggests a pit infill.	4	VI	Black, darker layer of rubble, with features of decomposed rubble and two remains of hearths.
7bAh	240/250–280cm (base of section). Black to very dark brown (10YR 2/1 to 2/2) humose very calcareous loam; pH 8.07; abundant medium and large angular limestone stones; strongly developed medium to ine to medium granular biotically-derived soil structure; occasional fine woody roots; common animal bones often concentrated in less stony pockets suggests a midden; few snail shells; lower boundary not seen;. The high frequency of animal bones agrees with Leben's description of his Layer 4, regarded as Mesolithic in age. Large organic matter content may relate to the decay of midden material and bones transformed by biotic soil forming processes.			
	Not seen	5	VII	Autochthonous red clay ('cave earth') with rubble. Pleistocene deposit.

Tab. 1. Characteristics of soils and sediments in Mala Triglavca rockshelter: a) present study; b) Leben's study.

At a depth of 186cm, a much darker humose layer was encountered (5bAh). This was black (7.5YR2/0) in colour, and is interpreted as a buried surface with a larger organic carbon content, possibly with finely divided charcoal. The colour suggests the addition of organic material by human agency. This layer also contained common burned and unburned bone fragments.

In one place in the central part of the section, this dark layer rested directly on lighter greyish, extremely calcareous material, which took the form of a lenticular body *c.* 115cm long and 40–50cm thick (6Bk). This very porous but massive material compressed easily and was non-sticky, indicating a high carbonate or ash content. In places, firmer and denser areas coincided with the presence of small nodules of calcium carbonate. It also contained black, humose inclusions similar in composition to the 5bAh horizon. The much less stony character of this feature suggests some kind of pit infill. The other pedological features indicate solution of calcium derived from the ash and/or limestone fragments and re-precipitation of secondary calcium carbonate as intercalary crystals or nodules. Although the black colour of this horizon might suggest finely divided charcoal, no other evidence of burning in the form of larger charcoal fragments or burned stones was recorded.

Toward the base of the section, at approximately 240cm, another black to very dark brown humose horizon was recorded (7bAh). This was also interpreted as a buried surface. As with the overlying horizons, this was a very calcareous loam, and contained abundant medium and large angular limestone stones. Bones were also common, concentrated in less stony pockets, together with a few landsnail shells.

The variability in stone content throughout the section can in part be attributed to rockfalls from the roof and walls of the cave, most probably due to frost shattering. In the 2AB horizon stones were very large and extremely abundant, consisting of angular limestone, but with subrounded elements on one side. This juxtaposition of form can be attributed to solution weathering on the cave roof, thus proving the origin of this stony material. This is further proven by the thickening of this extremely stony layer towards the rear wall of the rockshelter where stones are tabular or platy with a distinct horizontal alignment indicating a recent fall from the roof with little disturbance of horizontal bedding.

In parts of the underlying horizons, stone lines were apparent. In the 3AB horizon at 106cm an alignment of medium to large angular stones may also represent a minor rockfall from the cave roof, or an arti-

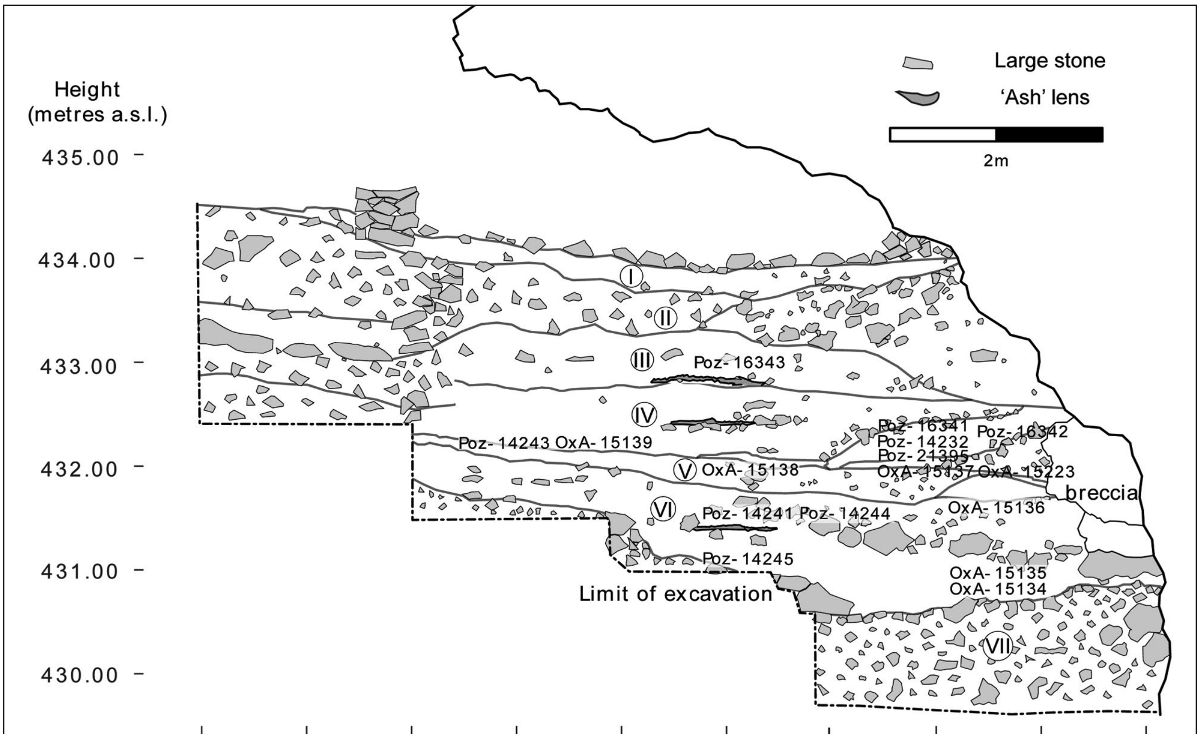


Fig. 3. Leben's main axial section drawing with position of samples for radiocarbon dating (Tab. 2).

ficial stone pavement. However, much of the 3AB horizon was much less stony than the overlying or underlying horizons.

Generally, the variation in frequency of stones in the different horizons could relate to variations in the intensity of rockfalls, inwashing or wind deposition of stoneless sediment, or indeed, preferential removal of stones by human agency. The horizons recognized in the central part of the section became difficult to trace toward the rear of the rockshelter. The more chaotic arrangement of stones and boulders and subhorizontal alignment along what appear in some cases to be shear planes, suggests that disturbance through rotational slumping of the materials has occurred. This was confirmed in 2006, after several seasons of excavation, when pottery from different periods (Middle Neolithic/Vlaška culture and Eneolithic/Ljubljana culture) was found on either side of a distinct shear plane. Moreover, the horizontal alignment of the recent rockfall described earlier is nowhere seen in these lower layers to the rear of the rockshelter. Possible explanations include slumping of super-saturated cave sediments after overloading by rainwater running into the cave, and movements triggered by seismic activity. There is a significant slope leading into the rockshelter and the amount of surface water which runs in during storms can be high. Solution weathering at the rear of the cave may periodically have destabilized the adjacent deposits, facilitating movement.

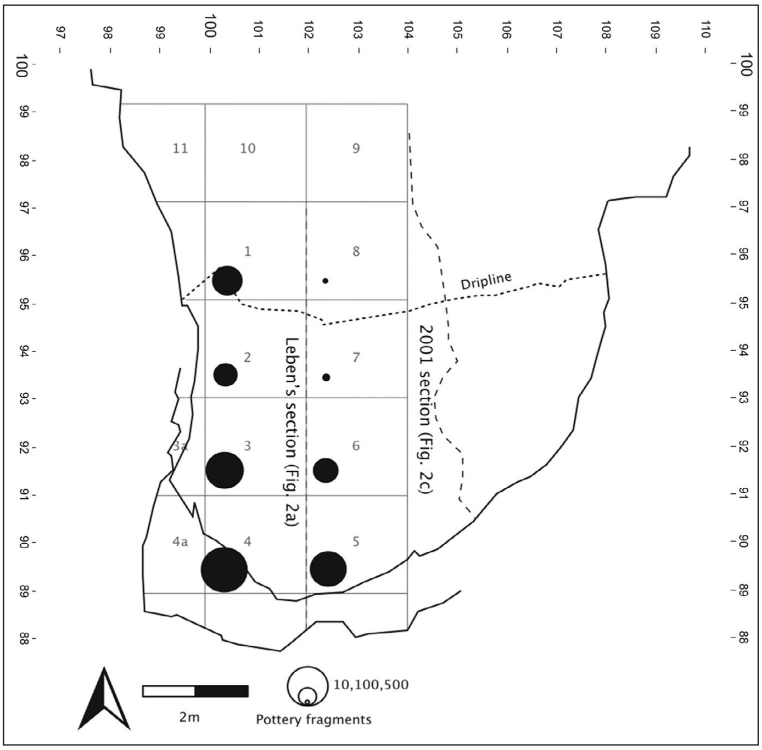


Fig. 4. Leben's excavation grid with density of pottery sherds per grid square.

Radiocarbon Dating

Samples of terrestrial mammal bone from Leben's excavation were selected for AMS ^{14}C dating, together with an additional pottery sample. The objectives were to establish the ages of the different layers, and to test the stratigraphic integrity of the sequence.

All the dated materials show evidence of anthropogenic modification, either in the form of manufacturing traces (bone tools) or fragmentation (animal bones).

Eight samples from bones of large mammals were submitted to the Poznan lab. A further 12 samples were taken from individual antler and bone artefacts using high-speed steel drills, and submitted to the Oxford Radiocarbon Accelerator Unit. The samples submitted to Oxford weighed between 200mg and 620mg, while those submitted to Poznan were fragments weighing between 300mg and 1200mg. Collagen extractions were performed using each laboratory's standard procedure. The Oxford procedure included an ultrafiltration step. This usually produces collagen of improved quality (for details, see *Bronk Ramsay et al. 2004; Higham et al. 2006. 556*). Collagen quality and chemical integrity are assessed using the atomic ratio of carbon to nitrogen (C:N atomic ratio), the percentage of collagen extracted compared with the starting weight of bone (wt% collagen), and the carbon yield of the collagen on combustion. Problem bones may be screened on the basis of these parameters. Bone is considered acceptable if measured C:N ratios of collagen fall between 2.9 and 3.5. In addition, bone that is composed of less than 1wt% collagen is not dated. Collagen yield in five of the samples submitted to Oxford fell below this threshold value, and so only 7 of the 12 samples submitted were actually dated. One pottery sherd was submitted to the Poznan laboratory, where organic residues on the pottery were extracted and dated. The 16 radiocarbon dates obtained from the Oxford and Poznan labs are presented in Table 2.

The radiocarbon sequence documents frequent use of the cave from 8400 BP to at least 3700 BP. The dates fall into three distinct clusters (8400–7900, 7600–7200 and 6600–6000 BP) with some outliers. However, the clusters as well as the gaps in the sequence (7900–7600 BP, 7200–6600 BP) could be the result of the sampling.

A consideration of the relation between depth/stratigraphic context and age reveals some obvious inversions in the sequence. However, the inversions can be observed only in the sequence from grid squares 4 and 5 in the rear of the cave, close to the cave wall, where horizon boundaries became uncertain, evidence for rockfalls increases (Tab. 1) and the presence of shear planes was noted.

The dates from the central part of the cave (grid squares 2, 3, 6, 7), where horizons could be clearly defined, show no obvious inversions. Here, a long gap of 1770 ^{14}C years can be observed between OxA-15139: 6451 ± 36 BP) and OxA-15138: 8225 ± 40 BP. The dates come from successive spits. The boundary between these spits at 3.05m depth corresponds to the boundary between Leben's horizons 3a and 3b (4AB and 5bAh, Tab. 1). According to the excavator, the main difference between the two layers was the presence of pottery and bones of domesticated animals in layer 3a and their absence from layer 3b (*Leben 1983*).

Therefore, the gap of 1770 radiocarbon years probably corresponds to a sedimentary hiatus or erosional surface, separating Mesolithic and Neolithic deposits in the central part of the cave. The recorded morphology of the 5bAh horizon supports this feature as a paleosurface (Tab. 1). The 'missing' dates corresponding to this temporal gap (OxA-15136: 7255 ± 40 BP, Poz-14232: 7630 ± 50 BP, Poz-16341: 7950 ± 50 BP) occur in the deposits at the rear of the cave, in grid squares 4 and 5. Occasional stone lines inclined upward toward the back of the cave suggest that the deposits in this part of the cave were formed in a different way from those in the central area of the cave. These deposits could be the result of movement of material from the central part of the cave due to human agency, combined with natural processes operating at the back of the cave, redepositing rockfall as scree, which was subsequently buried by finer sediment to produce inclined stonelines. Therefore, it may be suggested that at some time before 6400 BP, sediments originally deposited

Sample	Grid	Level	Lab ID	^{14}C age yr B.P.	Error	$\delta^{13}C$	Cal yr BC age range (2σ)	Median probability of cal yr BC age range
red deer mandible	4	2.70	Poz–14232	7630	50		6591–6420	6477
large ungulate humerus	5–6	3.50–3.70	Poz–14241	8210	50		7446–7070	7226
large ungulate scapula	7	2.90–3.05	Poz–14243	5980	40		4988–4750	4869
Bos *seu* Bison *skull*	5–6	3.50–3.70	Poz–14244	8020	50		7075–6710	6932
Sus scrofa *maxilla*	3A	"directly above Pleistocene layer"	Poz–14245	8070	50		7180–6820	7046
red deer antler	4	2.50–2.70	Poz–16341	7950	50		7041–6691	6867
human skull	4	2.50 "above breccia deposit"	Poz–16342	5120	40		4031–3798	3893
Capra *horn core*	3	1.90	Poz–15343	3690	40		2198–1959	2081
pottery fragment	4	2.70–3.00	Poz–21395	6320	40		5460–5214	5301
antler, red deer ("beam chisel")	5	4.10	OxA–15134	6602	37	–20.4	5617–5485	5546
antler, red deer ("beam chisel")	4	4.05	OxA–15135	8430	45	–20.8	7582–7367	7514
antler, red deer ("beam chisel")	5–6	3.60–3.75	OxA–15136	7255	40	–21.9	6221–6034	6133
bone, large ungulate ("splinter")	4	3.70–3.90	OxA–15137	7229	38	–18.7	6211–6020	6090
bone, roe deer ("fine 1/2 point")	6	3.05–3.25	OxA–15138	8225	40	–21.1	7446–7081	7242
bone, roe deer ("tip of medium point")	7	2.90–3.05	OxA–15139	6451	36	–19.2	5481–5343	5418
bone, red deer ("fine point")	4	3.70–3.90	OxA–15223	6647	37	–19.3	5635–5511	5579

Tab. 2. AMS ^{14}C ages and associated contextual data for mammalian bone pottery samples from Leben's excavation in Mala Triglavca rockshelter. Calibration performed with CALIB 5.0.2 (*Stuiver & Reimer 1993; Stuiver et al. 2005*) using the IntCal04 curve (*Reimer et al. 2004*).

between 8200 and 6400 BP in the central part of the cave were moved toward the rear of the cave and redeposited against the cave wall. One date (OxA-15136: 7255 ± 40 BP) is on a bone tool (red deer antler beam "chisel"), while others (Poz-14232: 7630 ± 50 BP, Poz-16341: 7950 ± 50 BP) are on fragmented animal bones and antlers (Tab. 2). Thus, in our opinion all three dates, which correspond to the hiatus in the central part of the cave, indicate human use of the cave during this period. The deposits at the rear of the cave contain large quantities of cultural material, including lithics, bone tools, pottery, and fragmented animal bones. The spatial distribution of pottery, with concentrations of pottery sherds near the cave walls (Fig. 4), suggests that movement and redeposition of material at the cave walls (possibly associated with living floor maintenance) continued after 6400 BP. A pottery fragment from grid square 4, dated to 6320 ± 40 BP (Poz-2139) further supports this hypothesis.

However, there appears to have been another process that altered the positions of deposits within the cave. Three dates, Poz-2139: 6320 ± 40 BP., OxA-15223: 6647 ± 37 BP and OxA-15137: 7229 ± 38 BP from the rear of the cave (grid squares 4 and 5) create a depth/age inversion with the dates above them (Poz-14232: 7630 ± 50 BP, Poz-16341: 7950 ± 50 BP, OxA-15136: 7255 ± 40 BP). They relate to a level corresponding to Leben's Mesolithic layer 4 (equivalent to 7bAh in Table 1). This suggests that there were postdepositional processes, which led to vertical displacement of material. It seems likely that this movement is connected with the curved shear/erosional planes discovered in 2006 (see above), most likely caused by periodic slumping of cave sediments after overloading by rainwater running into the cave. These rotational slumps (*Selby 1993*) were probably localized and connected with the presence of cavities or conduits penetrating the bedrock at the back of the cave, which provided a further destabilizing factor. Unfortunately, the low resolution of Leben's contextual information for the dated material does not allow us to localize those processes.

The evidence presented for disturbance of the cave sediments by soil formation, in particular bioturbation (Tab. 1), is not regarded by the present authors to have significantly affected the stratigraphic sequence of the sediments in the central parts of the cave. The finer fractions of the sediments have certainly been substantially transformed into soil materials with the form of mull humus, however, larger clasts (stones and boulders) and larger archaeologi-

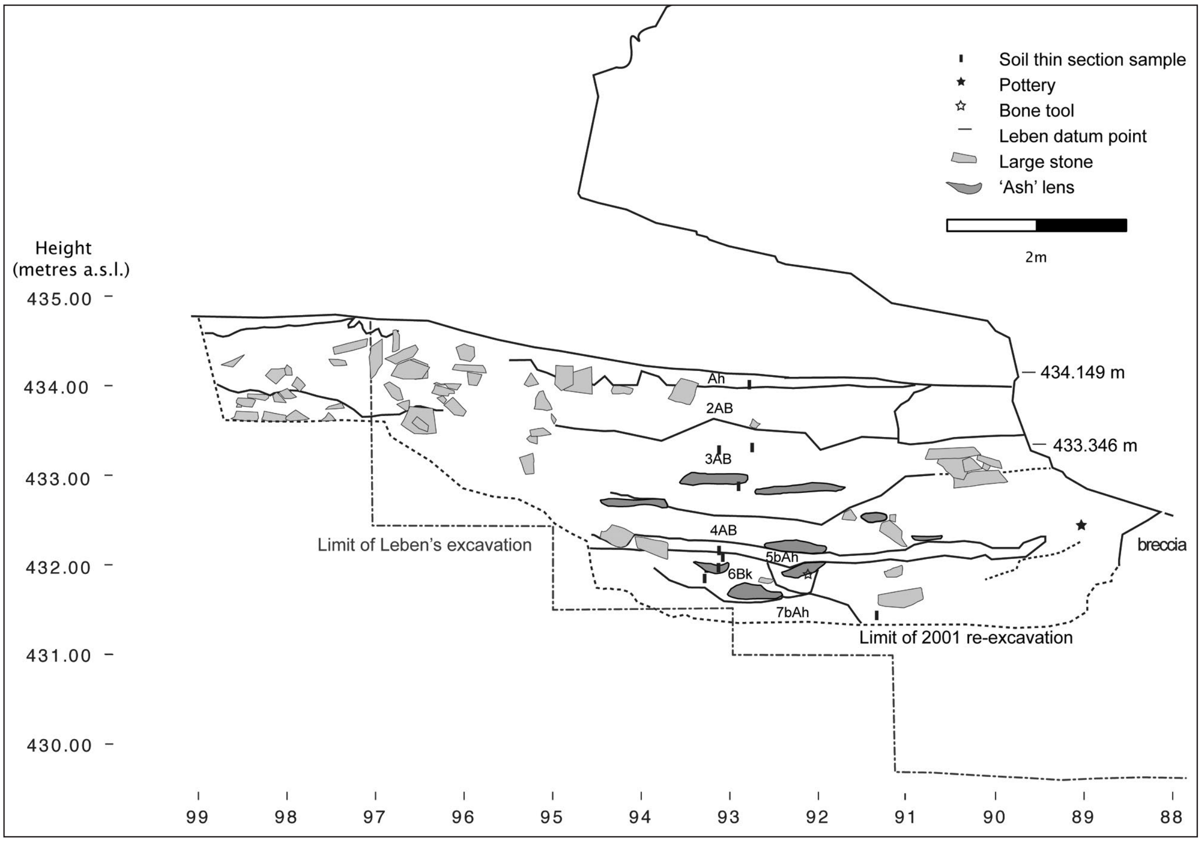


Fig. 5. Section corresponding to W wall of Leben's trench, recorded in 2001.

cal objects, including those used for dating, have probably remained more or less in situ, providing lithologically distinct layers. However, smaller, undated animal bones and bone tools could indeed have been translocated by soil forming processes.

Pottery

Leben's layer 3 contains Neolithic and Eneolithic pottery. The assemblage is modest in size; 690 pottery fragments could be attributed to this layer. The ceramic material is very fragmented and only 29 whole vessels could be reconstructed. The assemblage was investigated for its technological and typological properties on a macroscopic level, and subsequently archaeometrical analyses of pottery samples from the site were also conducted (*Žibrat Gašparič 2004. 206–209; 2008.44–64*). The material includes some ceramic vessels that are typical of the Neolithic period in this region, including bowls ornamented with triangles, tulip shaped cups, and a rhyton fragment (Fig. 6: MT22/00, MT 24/03; *Žibrat Gašparič 2004. Fig. 2, 1–3*).

Three main groups of ceramic matrixes were identified at the macroscopic level. The group with calcium carbonate is by far the most abundant; 78.3% of all the samples from Leben's layer 3 belong to this group. The group with calcium carbonate and quartz constituted 18.9%, and the group with quartz made up only 2.7% of the total assemblage. Calcium carbonate in the form of the mineral calcite was added as temper to the clay, as shown by the mineralogical analysis of the material (*Žibrat Gašparič 2004.215–216*).

The distribution of the pottery sherds in the cave shows distinctive patterning, with pottery concentrations in the grid squares adjacent to the cave walls, where average potsherd weight is also higher than in the grid squares in the central part of the cave (Fig 4). This evidence supports the hypothesis that material in the cave was moved and deposited, or redeposited, near the cave wall. Grid square 4, located at the back of the cave, contains most of the pottery from Leben's layer 3 (232 fragments or 33 % of the ceramic material from the layer). This material is mixed; it includes artefacts that can be securely attributed to the Neolithic and Eneolithic periods on the basis of typological characteristics. One potsherd from grid square 4 was dated by the AMS ^{14}C method. The result (Poz–21395: 6320 ± 40 BP) places the potsherd firmly in the Neolithic (*Žibrat Gašparič 2008.48, Fig. 4.2*).

In an effort to determine the provenance of the pottery from Mala Triglavca, clay samples were taken mostly in a 5km radius around cave, as proposed by Arnold (*1985.32–34*) for prehistoric sites. Samples were taken from the Mala Triglavca rockshelter, from the nearby archaeological site of Trhlovca, from local caves or denuded caves in the vicinity (*e.g.* from Divaška jama, dolina Radvanj, Lipove doline), as well as from some more distant locations on the Karst plateau (Tomaj), from Vremsko polje, and from the Slovene coastal area near the open-air Neolithic site of Sermin near Koper (*Žibrat Gašparič 2008.89–96*).

The analyses revealed the clay samples from cave sites and the samples from Vremsko polje to have a mineralogical composition similar to the natural clay matrix of the Neolithic pottery from Mala Triglavca, from which it is inferred that the pottery was produced locally. Only the clay samples from the Slovene coastal region (*e.g.* from Sermin and Rižana near Koper) could not be linked to the Neolithic pottery production of Mala Triglavca, mainly because they contained calcareous molluscs (not present at Mala Triglavca) but also a lower concentration of the mineral haematite (*Žibrat Gašparič 2008.97–100*). Trace element analysis revealed similarities between the Mala Triglavca ceramic assemblage and the clays from the Divača Karst region (*i.e.* from the locations of Divaška jama, Trhlovca, dolina Radvanj and Lipove doline) and from the nearby Vremsko polje (*Žibrat Gašparič 2004.Tab. 5; 2008.100–107.Fig. 4.32*).

As part of a functional study of the pottery, 36 samples from layer 3 were analyzed for the presence of organic residues or lipids using the GC-C-IRMS me-

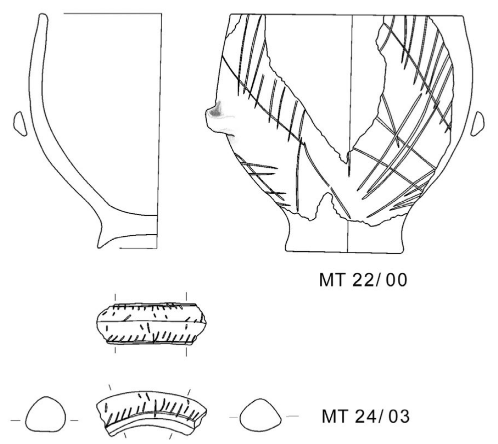


Fig. 6. Typical middle Neolithic bowl ornamented with triangles, from Leben's layer 3 with evidence of milk lipids (MT 22/00) and a rhyton fragment (MT 24/03).

thod. Lipids were present within the pottery fabric in 28% of the samples. Milk residues could be identified in 6 (16.7%) of the pottery samples analyzed from Mala Triglavca (*Šoberl et al. this volume*); these were detected in 3 bowls and 1 cup, one of which is a typical middle Neolithic bowl ornamented with triangles, from Leben's layer 3. (Fig. 6: MT 22/00). These results provide direct evidence of Neolithic dairying practices, and this line of research could lead to a new understanding of the function and social meaning of Neolithic pottery in the Caput Adriae region.

Conclusions

The evidence from the current excavations and associated soil/sediment analyses at Mala Triglavca show that in the central part of the cave a well-defined stratigraphic sequence can be established, despite postdepositional modification by soil forming processes. There is, however, also evidence for postdepositional disturbance of the cave sediments by human agency and geological/geomorphological processes. Leben's description of the cave sediments assumed a straightforward stratigraphic sequence, failing to recognize the significance of postdepositional modifications. Where controls can be established, some postdepositional disturbances – for example, those resulting from soil forming processes such as bioturbation – do not significantly alter the superpositioning of larger components within sequential layers/horizons, as in the sequence described in Table 1. However, the current study has found substantial evidence for other postdepositional processes of greater magnitude including: rotational slumps and possible anthropogenic removal and transport of soil material. In places, such processes have transformed the stratigraphic sequence in Mala Triglavca rockshelter, altering original stratigraphic relationships, thus effectively creating a series of secondary deposits with residual finds.

The relatively large set of radiocarbon dates obtained on bone samples from Leben's excavation now enables some of the processes to be identified. Vertical displacement of material has created 'temporal gaps' and 'inversions' in the radiocarbon sequence. Two separate processes are indicated. One accounts for the radiocarbon gap detected in the sequence from the middle of the cave, which can be explained by late Mesolithic deposits having been removed from this area and redeposited against the rear wall of the cave – a process that was probably linked to human activity – and subsequently modified by natural processes resulting in inclined stonelines. Another postdepositional process resulted in the movement of material deeper into the cave, possibly due to rotational slumps, as evidenced by the presence of distinct shear planes. The precise nature of these anthropogenic and natural processes, and the relationship between them, is uncertain, but may be resolved through ongoing excavation of the site.

The work at Mala Triglavca underlines the fact that any stratigraphic or radiocarbon sequence may be a complex palimpsest, created and recreated through a series of interlinked processes. On the one hand, 'gaps' in the radiocarbon sequence do not necessarily represent periods of abandonment of a cave, but may reflect episodes of postdepositional disturbance and intensive modification and transformation of the cave sediments. They may also be created by having too few radiocarbon samples and by the selectivity of the sampling. Small scale excavation (typical for cave sites), failure to appreciate the effects of postdepositional processes, direct translation of series of radiocarbon dates into cultural sequences, and interpretative models that see the Neolithic as radically different from the Mesolithic, have all contributed to the creation of such gaps. The gaps detected by some researchers in the radiocarbon sequences of caves in southeast Europe around the time of the Mesolithic-Neolithic transition are perhaps symptoms of our approach toward the transition, rather than a reflection of radical cultural or demographic change associated with the displacement of Mesolithic foragers by immigrant farmers.

ACKNOWLEDGEMENTS

This research was partly supported by the Slovenian Research Agency, Research Programme Arheologija P6–247 and ALPIne NETwork for Archaeological Sciences – EU "Culture 2000" Programme (Mihael Budja). Dimitrij Mlekuž's and Andreja Žibrat Gašparič's contributions was carried out within the Junior Researcher Program, funded by the Ministry of Higher Education, Science and Technology of Slovenia. Clive Bonsall wishes to thank the British Academy, the Carnegie Trust for the Universities of Scotland, and the Munro Fund, Hayter Fund, and Development Trust Research Fund of the University of Edinburgh for the award of research grants to support the work at Mala Triglavca.

REFERENCES

ARNOLD D. E. 1985. *Ceramic Theory and Cultural Process*. Cambridge University Press, Cambridge.

AVERY B. W. and BASCOMB C. L. 1982. *Soil Survey laboratory methods*. Soil Survey technical monograph no.6. Soil Survey of England and Wales, Harpenden.

BABEL U. 1975. Micromorphology of soil organic matter. In J. E. Geiseking (ed.), *Soil Components. Volume 1, organic components*. Springer Verlag, New York: 369–473.

BARAĆ L., PERIČIĆ M., MARTINOVIĆ KLARIĆ I., ROOTSI S., JANIČIJEVIĆ B., KIVISILD T, PARIK J., RUDAN I., VILLEMS R. and RUDAN P. 2003. Y chromosomal heritage of Croatian population and its island isolates. *European Journal of Human Genetics 11: 535–542*.

BIAGI P. 2003. A review of the late Mesolithic in Italy and its implications for the Neolithic transition. In A. J. Ammerman and P. Biagi (eds.), *The widening harvest: the Neolithic transition in Europe: looking back, looking forward*. Archaeological Institute of America, Boston: 133–155.

BIAGI P. and SPATARO M. 2001. Plotting the evidence: some aspects of radiocarbon chronology of the Mesolithic-Neolithic transition in the Mediterranean basin. *Atti della Società per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 12: 15–54*.

BIAGI P. and STARNINI E. 1999. Some aspects of the neolithization of the Adriatic region. *Atti della Società per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 11: 7–17*.

BONSALL C., MACKLIN M. G., PAYTON R. W. and BORONEANŢ A. 2002. Climate, floods and river gods: environmental change and the Meso-Neolithic transition in southeast Europe. *Before Farming: the archaeology of Old World hunter-gatherers 3–4(2): 1–15*.

BOSCHIAN G. and MONTAGNARI KOKELJ E. 2000. Prehistoric shepherds and caves in the Trieste Karst (northeastern Italy). *Geoarchaeology: An International Journal 15: 331–371*.

BROCHIER J., VILLA P., GIACOMARRA M. and TAGLIACOZZO A. 1992. Shepherds and sediments: geo-ethnoarchaeology of pastoral sites. *Journal of Anthropological Archaeology 11: 47–102*.

BRONK RAMSEY C., HIGHAM T. F. G., BOWLES A. and HEDGES R. E. M. 2004. Improvements to the pre-treatment of bone at Oxford. In N. Beavan Athfield and R. J. Sparks (eds.), Proceedings of the 18th International Radiocarbon Conference, Wellington. *Radiocarbon 46(1): 155–163*.

BUDJA M. 2007. The 8200 cal BP 'climate event' and the process of neolithisation in south-eastern Europe. In M. Budja (ed.) *14th Neolihic Studies. Documenta Praehistorica 34: 191–201*.

CHAPMAN J. 1990. Demographic trends in Neothermal south-east Europe. In C. Bonsall (ed.), *The Mesolithic in Europe*. Papers presented at the Third International Symposium, Edinburgh 1985. John Donald, Edinburgh: 500–515.

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

CREMONESI G., MELUZZI C., PITTI C. and WILKENS B. 1984. Grotta Azzura: Scavi 1982 (nota preliminare). *Il Mesolitico sul carso Triestino. Società per la Preistoria e Protoistoria della Regione Friuli-Venezia Giulia, Quaderno 5: 65–108*.

ČEČUK B. and RADIĆ D. 2005. *Vela Spila. A stratified prehistoric site Vela Luka – island of Korčula (Croatia)*. Centar za kulturu "Vela Luka", Vela Luka.

DUCHAUFOUR P. 1982. *Pedology, 2nd edition*. Allen & Unwin, London.

FARRAND W. R. 1993. Discontinuity in the stratigraphic record: snapshots from Franchthi Cave. In P. Goldberg, D. T. Nash and M. D. Petraglia (eds.), *Formation Processes in Archaeological Context*. Monographs in World Archaeology No. 17. Prehistory Press, Madison: 85–96.

2000. *Depositional History of Franchthi Cave – Sediments, Stratigraphy, and Chronology*. Indiana University Press, Bloomington.

2003. Depositional environments and site formation during the Mesolithic occupations of Franchthi Cave, Peloponnesos, Greece. In N. Galanidou and C. Perlès (eds.), *The Greek Mesolithic: problems and perspectives*. British School at Athens, London: 69–78.

FORENBAHER S. and MIRACLE, P. 2005. The spread of farming in the Eastern Adriatic. *Antiquity 79: 514–528*.

2006. Pupićina Cave and the spread of farming in the eastern Adriatic. In P. Miracle and S. Forenbaher (eds.), *Prehistoric Herders of Northern Istria: the archaeology of Pupićina Cave*. Volume 1. Arheološki muzej Istre, Pula: 483–523.

HIGHAM T., BRONK RAMSEY C., I., SMITH F. H. and TRINKAUS E. 2006. Revised direct radiocarbon dating of the Vindija G1 Upper Paleolithic Neandertals. *Proceedings of the National Academy of Sciences of the USA 103(3): 553–557*.

HODGSON J. M. 1976. *Soil Survey Field Handbook*. Soil Survey technical monograph no. 5. Soil Survey of England and Wales, Harpenden.

KARKANAS P. 1999. Lithostratigraphy and micromorphology of Theopetra cave deposits, Greece: some preliminary results. In G. N. Bailey, E. Adam, E. Panagopoulou, C. Perlès and K. Zachos (eds.), *The Palaeolithic Archaeology of Greece and Adjacent Areas*. Proceedings of the ICOPAG Conference, Studies 3. British School at Athens, Athens: 240– 251.

2001. Site formation processes in Theopetra Cave: a record of climatic change during the Late Pleistocene and Early Holocene in Thessaly, Greece. *Geoarchaeology: An International Journal 16: 373–399*.

KOZŁOWSKI J. K., KOZŁOWSKI S. and RADOVANOVIĆ I. 1994. *Meso- and Neolithic Sequence from the Odmut Cave (Montenegro)*. Wydawnictwa Uniwersytetu Warszawskiego, Warszawa.

LEBEN F. 1983. Mala Triglavca. Elaborat: izkop 1983. Manuscript at the Archive of the Institute of Archaeology at ZRC-SAZU (No. 175). ZRC-SAZU, Institute of Archaeology, Ljubljana.

1988. Novoodkrite prazgodovinske plasti v jamah na Krasu. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 16: 65–76*.

MIRACLE P. and FORENBAHER S. 2006. Changing activities and environments at Pupičina cave. In P. Miracle and S. Forenbaher (eds.), *Prehistoric Herders of Northern Istria: the archaeology of Pupićina Cave. Vol. 1*. Monografije i katalozi, 14. Arheološki muzej Istre, Pula: 455–481.

MLEKUŽ D. 2005. The ethnography of the Cyclops: Neolithic pastoralists in the eastern Adriatic. In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica 32: 15–51*.

MONTAGNARI KOKELJ E. 1993. The transition from Mesolithic to Neolithic in the Trieste Karst. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 21: 69–84*.

PARZINGER H. 1993. *Studien zur Chronologie und Kulturgeschichte der Jungstein-, Kupfer- und Frühbronzezeit zwischen Karpaten und Mittlerem Taurus*. Römisch-Germanische Forschungen, 52. Philipp von Zabern, Frankfurt am Main.

PLUCIENNIK M. 1997. Radiocarbon determinations and the Mesolithic-Neolithic transition in southern Italy. *Journal of Mediterranean Archaeology 10(2): 115–150*.

REIMER P. J., BAILLIE M. G. L., BARD E., BAYLISS A., BECK J. W., BERTRAND C. J. H., BLACKWELL P. G., BUCK C. E., BURR G., CUTLER K. B., DAMON P. E., EDWARDS R. L., FAIRBANKS R. G., FRIEDRICH M., GUILDERSON T. P., HOGG A. G., HUGHEN K. A., KROMER B., MCCORMAC F. G., MANNING S., BRONK RAMSEY C., REIMER R. W., REMMELE S., SOUTHON J. R., STUIVER M., TALAMO S., TAYLOR F. W., VAN DER PLICHT J. and WEYHENMEYER C. E. 2004. INTCAL04 terrestrial radiocarbon age calibration, 0–26 kyr BP. *Radiocarbon 46(3): 1029–1058*.

ROOTSI S. 2006. Y-Chromosome haplogroup I prehistoric gene flow in Europe. In M. Budja (ed.), *13th Neolithic Studies. Documenta Praehistorica 33: 17–20*.

ROOTSI S., MAGRI C., KIVISILD T., BENUZZI G., HELP H., BERMISHEVA M., KUTUEV I., BARAĆ L., PERIČIĆ M., BALANOVSKY O., PSHENICHNOV A., DION D., GROBEI M., ZHIVOTOVSKY L. A., BATTAGLIA V., ACHILLI A., AL-ZAHERY N., PARIK J., KING R., CINNIOGLU C., KHUSNUTDINOVA E., RUDAN P., BALANOVSKA E., SCHEFFRAHN W., SIMONESCU M., BREHM A., GONCALVES R., ROSA A., MOISAN J., CHAVENTRE A., FERAK V., FUREDI S., OEFNER P. J., SHEN P., BECKMAN L., MIKEREZI I., TERZIC R., PRIMORAC D., CAMBON- THOMSEN A., KRUMINA A., TORRONI A., UNDERHILL P. A., SANTACHIARA-BENERECETTI A. S., VILLEMS R. and SEMINO O. 2004. Phylogeography of Y-chromosome haplogroup I reveals distinct domains of prehistoric gene flow in Europe. *American Journal of Human Genetics 75(1): 128–137*.

RUSSELL N. 1998. The Mesolithic-Neolithic transition in the faunal assemblage from Konispol Cave, Albania. In H. Buitenhuis, L. Bartosiewicz and A. Choyke (eds.), *Archaeozoology of the Near East III*. University of Groningen, Institute of Archaeology, Groningen: 145–199.

SCHULDENREIN J. 1998. Konispol Cave, southern Albania, and correlations with other Aegean caves occupied in the Late Quaternary. *Geoarchaeology: An International Journal 13: 501–526*.

SELBY M.J. 1993. *Hillslope Materials and Processes. 2nd edition*. Oxford University Press, Oxford.

SEMINO O., PASSARINO G., OEFNER P. J., LIN A. A., ARBUZOVA S., BECKMAN L. E., DE BENEDICTIS G., FRANCALACCI P., KOUVATSI A., LIMBORSKA M., MIKA A., MIKA B., PRIMORAC D., SANTACHIARA-BENERECETTI A. S., CAVALLI-SFORZA L. L. and UNDERHILL P. A. 2000. The genetic legacy of Paleolithic Homo sapiens sapiens in extant Europeans: a Y chromosome perspective. *Science 290: 1155–1159*.

SORDINAS A. 1969. Investigation of the prehistory of Corfu during 1964–1966. *Balkan Studies 10(2): 392–424*.

STUIVER M. and REIMER P. J. 1993. Extended ^{14}C data base and revised CALIB 3.0 ^{14}C age calibration program. *Radiocarbon 35(1): 215–230*.

STUIVER M., REIMER P. J. and REIMER R. 2005. CALIB Radiocarbon Calibration (rev. 5.0.2): On-line Manual. http://radiocarbon.pa.qub.ac.uk/calib/manual/

ŠOBERL L., ŽIBRAT GAŠPARIČ A., BUDJA M. and EVERSHED R. P. 2008. Early herding practices revealed through organic residue analysis of pottery from the early Neolithic rock shelter of Mala Triglavca, Slovenia. In M. Budja (ed.), *15th Neolithic Studies. Documenta Praehistorica 35: this volume*.

THISSEN L. 2005. Coming to grips with the Aegean in prehistory: an outline of the temporal framework, 10.000–5500 cal BC. In C. Lichter (ed.), *How Did Farming Reach Europe? Anatolian-European relations from the second half of the 7th through the first half of the 6th millennium cal BC*. Byzas 2. Yayinlari, Istanbul: 29–40.

TURK M. and TURK I. 2004. Archaeological finds. In I. Turk (ed.), *Viktorjev spodmol and Mala Triglavca: Contributions to understanding the Mesolithic period in Slovenia*. Opera Instituti Archaeologici Sloveniae, 9. ZRC-SAZU, Ljubljana: 176–196.

WENINGER B., ALRAM-STERN E., BAUER E., CLARE L., DANZEGLOCKE U., JÖRIS O., KUBATZKI C., ROLLEFSON G., TODOROVA H. and VAN ANDEL T. 2006. Climate forcing due to the 8200 cal yr BP event observed at Early Neolithic sites in the eastern Mediterranean. *Quaternary Research 66: 401–420*.

WOBST H. M. 1974. Boundary conditions for Paleolithic social systems: a simulation approach. *American Antiquity 39(2): 174–178*.

ŽIBRAT GAŠPARIČ A. 2004. Archaeometrical analysis of Neolithic pottery from the Divača region, Slovenia. In M. Budja (ed.), *11th Neolithic Studies. Documenta Praehistorica 31: 205–220*.

2008. *Strukturna analiza neolitske keramike in lončarske tehnologije*. Unpublished PhD dissertation. Department of Archaeology, University of Ljubljana.

back to contents

UDK 903'12/'15(4/5)"633/634":575.17; 903'12/'15(4/5)"633/634":574.91
Documenta Praehistorica XXXV (2008)

Early herding practices revealed through organic residue analysis of pottery from the early Neolithic rock shelter of Mala Triglavca, Slovenia

Lucija Šoberl[1], Andreja Žibrat Gašparič[2], Mihael Budja[2] and Richard P. Evershed[1]*
1 *Organic Geochemistry Unit, School of Chemistry, University of Bristol, Bristol, UK*
2 *Department of Archaeology, Faculty of Arts, University of Ljubljana, Ljubljana, SI*
**author for correspondence:* r.p.evershed@bristol.ac.uk

ABSTRACT – *A collection of pottery from the early Neolithic site of Mala Triglavca was analysed with the aim of obtaining insights into vessel use and early animal domestication and husbandry practices in the Adriatic region. Total lipid extracts were submitted to gas chromatography (GC), GC-mass spectrometry (GC-MS) and GC-combustion-isotope ratio MS (GC-C-IRMS) in order to obtain molecular and stable carbon isotope signatures as the basis for determining the nature and origins of the residues. The extracts were dominated by degraded animal fats. The majority (70%) of the total lipid extracts displayed intact triacylglycerol distributions attributable to ruminant adipose and dairy fats, which were subsequently confirmed through* $C_{16:0}$ *and* $C_{18:0}$ *fatty acid* $\delta^{13}C$ *values.*

IZVLEČEK – *Izbor keramičnih vzorcev iz zgodnje neolitskega najdišča Mala Triglavca je bil analiziran z namenom, da bi pridobili dodatne informacije o uporabi keramičnih posod ter značaju zgodnje živinoreje na Jadranskem prostoru. Lipidne ekstrakte vzorcev smo analizirali s pomočjo plinske kromatografije (GC), plinske kromatografije sklopljene z masno spektrometrijo (GC/MS) in plinske kromatografije sklopljene s sežigno masno spektrometrijo razmerij izotopov (GC-C-IRMS). V lipidnih ekstraktih so prevladovale živalske maščobe. V večini (70%) lipidnih ekstraktov so bile prisotne nespremenjene trigliceridne distribucije, ki jih lahko pripišemo tolščnim ter mlečnim maščobam prežvekovalcev. Lipidni izvor je bil nadalje potrjen z* $\delta^{13}C$ *vrednostmi prostih maščobnih kislin* $C_{16:0}$ *in* $C_{18:0}$.

KEY WORDS – *Neolithic, Adriatic, organic residues, fatty acyl lipids,* $\delta^{13}C$ *values*

Introduction

Organic residues survive in two principal forms in association with archaeological pottery, namely as: (i) surface residues appearing as visible residues on the exterior or interior of vessels, and (ii) as absorbed residues preserved within the vessel wall; invisible to the naked eye. The first class of residues, occurs on the exterior surfaces of and correspond to either sooting derived from heating on a fire or seemingly rather rare instances of applied decorations (*Urem-Kotsou et al. 2002; Connan et al. 2004*). Together with exterior sooting, the interior surface residues are probably the group of residues most familiar to pottery analysts. These are often carbonised, and presumed to be residues of 'cooking' failures, while post-firing treatments are also seen, particularly as copious linings associated with Roman amphorae (*Beck et al. 1989*). Absorbed residues are by far the most common in pottery and probably the most widely occurring residue type. Analyses performed to date suggest that absorbed organic residues survive in >80% of domestic cooking pottery assemblages worldwide.

Lipids residues of cooking and the processing of other organic commodities have been found to survive in archaeological pottery vessels as components of surface and absorbed residues for several millennia. The most successful analytical approaches involve solvent extraction, then using a combination of instrumental analytical techniques, including: high temperature-gas chromatography (HTGC), GC/mass spectrometry (GC/MS; *Evershed et al. 1990*) and GC-combustion-isotope ratio MS (GC-C-IRMS; *Evershed et al. 1994*), to identify and quantify the components of the lipid extracts of such residues. Characterisation of lipid extracts to commodity type is only possible through detailed knowledge of diagnostic compounds and their associated degradation products formed during vessel use and/or burial. An increasing range of commodities is being detected in pottery vessels, including animals products (*e.g. Evershed et al. 1992; Copley et al. 2003*), leafy vegetables (*Evershed et al. 1991; Evershed et al. 1994*), specific plant oils (*Condamin et al. 1976; Copley et al. 2005a*) and beeswax (*Heron et al. 1994; Evershed et al. 1997; Regert et al. 2001*).

Animal fats are by far the most common residue identified from archaeological pottery, characterised by high abundances of free fatty acids, particularly palmitic ($C_{16:0}$) and stearic acid ($C_{18:0}$). Triacylglycerols (TAGs) are the major constituents of modern animal fats, however, they are degraded to diacylglycerols (DAGs), monoacylglycerols (MAGs) and free fatty acids during vessel use and burial, such that in archaeological pottery the free fatty acids tend to predominate. This has been observed in numerous pottery vessels (*Evershed et al. 2001*) and verified through laboratory degradation experiments (*e.g. Charters et al. 1997; Dudd and Evershed 1998; Evershed 2008*). Precise assigning of the origins of animal fats is only possible through the use of compound-specific stable carbon isotope analysis. GC-C-IRMS allows the carbon stable isotope ($\delta^{13}C$) values of individual compounds (within a mixture) to be determined. It has been previously observed that the $\delta^{13}C$ values for the principal fatty acids ($C_{16:0}$ and $C_{18:0}$) are crucial in distinguishing between different animal fats, *e.g.* ruminant and non-ruminant adipose fats and dairy fats (*Evershed et al. 1997a, Dudd and Evershed 1998*), as well as in the identification of the mixing of commodities (*Evershed et al. 1999; Copley et al. 2001*). Recently it has been demonstrated that dairy products were important commodities in Early Neolithic at various archaeological sites throughout Europe and Near East, as illustrated through the persistence of dairy fats in archaeological pottery vessels (*Copley et al. 2003; 2005b; Evershed et al. 2008*).

The aim of this investigation was to apply organic residue analysis to prehistoric pottery from the Neolithic rock shelter Mala Triglavca in order to determine the nature and origin of preserved lipids and thereby provide new insights into food preparation and consumption of the inhabitants. As a consequence of the wider interest in the use of rock shelters in the early Neolithic, the organic analysis of the pottery from this site offers an important opportunity to explore aspects of animal husbandry, particularly dairying.

Sites and samples

The Neolithic rock shelter site of Mala Triglavca is situated in the Dinaric karst in south-western Slovenia. There is evidence that the site has been continuously occupied from the Mesolithic until the Middle ages. Rock shelter sites in the region have mostly been interpreted in two different ways: (i) as seasonal camps for hunters/shepherds, or (ii) as places for long-term settlement. Archaeozoological remains discovered on the site mainly belong to domesticated animals (cattle, sheep, goat, dog) as well as wild animals (wild boar, red deer, roe deer). A total of 36 potsherds were selected for analysis from earliest Neolithic phase.

Materials and methods

Lipid analyses were performed using established protocols which are described in detail in earlier publications (*Evershed et al. 1990; Charters et al. 1993b*). Briefly, analyses proceeded as follows:

Solvent extraction of lipid residues

Lipid analyses of potsherds involved taking *c.* 2g samples from area of the the sherd that had been surface-cleaned using a modelling drill to remove any exogenous lipids (*e.g.* soil or finger lipids due to handling). The sub-samples were then ground to a fine powder, accurately weighed and a known amount (20µg) of internal standard (*n*-tetratriacontane) added, to enable determination of the lipid concentration. The lipids were extracted with a mixture of chloroform and methanol (2:1 v/v). Following separation from the ground potsherd the solvent was evaporated under a gentle stream of nitrogen to obtain the total lipid extract (TLE). Portions (generally one third aliquots) of the extracts were then trimethylsilylated and submitted directly to analysis by HTGC. Where necessary combined GC/MS analyses were also performed on trimethylsilylated aliquots of the lipid extracts to enable the elucidation of structures of components not identifiable on the basis of HTGC retention time alone.

Preparation of trimethylsilyl derivatives
Portions of the total lipid extracts were derivatised using *N,O*-bis(trimethylsilyl)trifluoroacetamide (40µl; 70°C; 60 min; Sigma-Aldrich Company Ltd., Gillingham, UK) and analysed by HTGC and GC-MS.

Saponification of total lipid extracts
Methanolic sodium hydroxide (5% v/v) was added to the TLE and heated at 70°C for 1 h. Following neutralisation, lipids were extracted into chloroform and the solvent reduced under gentle stream of nitrogen.

Preparation of methyl ester derivatives (FAMEs)
FAMEs were prepared by reaction with BF_3-methanol (14% w/v; 100µl; Sigma-Aldrich, Gillingham, UK) at 70°C for 1 h. The methyl ester derivatives were extracted with chloroform and the solvent removed under nitrogen. FAMEs were re-dissolved in hexane for analysis by GC and GC-C-IRMS.

Results

The HTGC and GC/MS analyses serve to quantify and identify compounds in the TLE, revealing the possible presence of: (i) animal fat or plant oil, and/or (ii) plant epicuticular waxes, and/or (iii) beeswax or other sealants, and/or (iv) mid-chain ketones that indicate that the vessel has been heated (*Evershed et al. 1995; Raven et al. 1997*). Further analyses by GC-C-IRMS analyses can distinguish between ruminant and non-ruminant adipose fats and dairy fats by investigating the $\delta^{13}C_{16:0}$ and $\delta^{13}C_{18:0}$ values. Table 1 lists the sample designations, the concentrations of lipids detected and the assignments of the broad commodity groups present in individual sherds based on the molecular and isotopic compositions of the components of the TLEs. Ten of the sherds (28%) yielded significant concentrations of lipid (*i.e.* >5µgg^{-1}) sufficient for further analysis by GC-MS and GC-C-IRMS.

Figure 1 shows a typical partial gas chromatogram for the TLE of sample 08MT, revealing the presence of free fatty acids, with high abundances of $C_{16:0}$ and $C_{18:0}$ components, mono-, di- and triacylglycerols (MAGs, DAGs, TAGs). The chromatogram also shows presence of odd carbon number saturated fatty acids, iso- and anteiso-branched odd carbon number fatty acids ($C_{15:0br}$, $C_{17:0br}$), which may indicate a ruminant source (*Mottram et al. 1999; Evershed et al. 2001*). Traces of wax esters were also present eluting in the region of the TAGs.

MAGs, DAGs and TAGs, which are indicative of degraded animal fat were detected in 7 of the TLEs together with relatively high abundances of the palmitic ($C_{16:0}$) and stearic ($C_{18:0}$) free fatty acids, which as discussed above, are the terminal products of TAG hydrolysis. Previous work has shown that the TAG distributions can be linked to different sources, thereby allowing preliminary differentiation of fats of the two major classes of domestic animals (ruminant and non-ruminant) and ruminant dairy fats.

However, laboratory experiments have shown that TAG distributions can be skewed by degradation; the wide TAG distribution characteristic of fresh ruminant dairy fat is considerably narrowed, and thus comes to resemble the narrower distribution seen in ruminant adipose fat (*Dudd et al. 1998; Dudd and Evershed 1998*). Therefore conclusions drawn from TAG distributions have to be made with caution. The TAG distributions preserved in the extracts from the Mala Triglavca sherds are shown in Figure 3.

The total lipid extracts (TLEs) of samples 08MT, 18MT, 78MT, 79MT and 159MT displayed relatively broad TAG distributions with acyl carbon number range of C_{44} to C_{54}, maximising at C_{50}/C_{52}. Such distributions are characteristic of reference ruminant adipose fat, or degraded milk fat. In contrast, the extract of 13MT displayed quite a narrow TAG distribu-

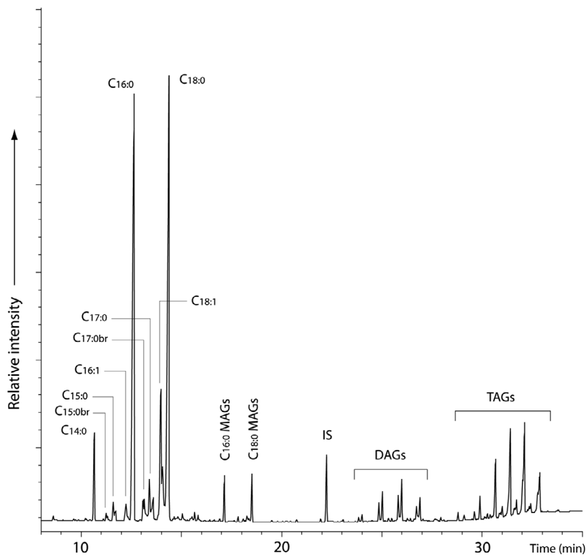


Fig. 1. Partial HTGC profile of the trimethylsilylated total lipid extract from sample 08MT, showing the distribution of components characteristic of degraded animal fat. Key: $C_{X:0}$ are saturated free fatty acids of carbon length x, br stand for branched fatty acids, IS is the internal standard (C_{34} n-alkane). MAGs are monoacylglycerols; DAGs are diacylglycerols; TAGs are triacylglycerols.

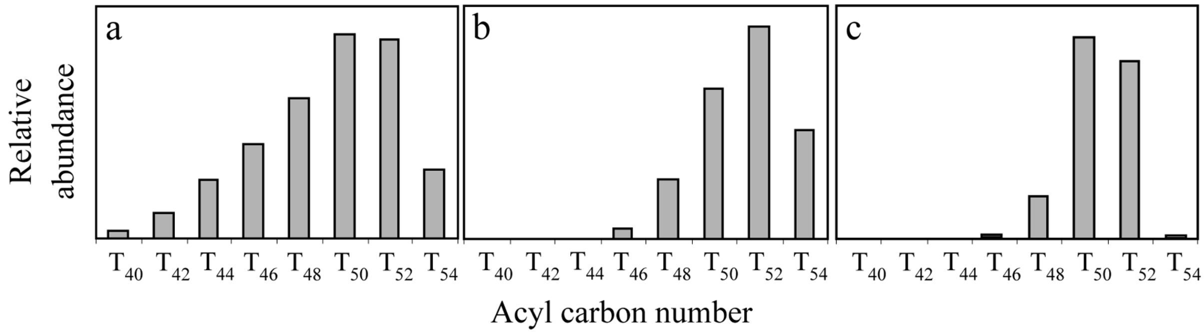


Fig. 2. Histograms showing the typical acyl carbon number distributions expected for triacylglycerols deriving from degraded lipid residues obtained from: (a) ruminant dairy fat, (b) ruminant adipose, and (c) pig adipose (*Berstan 2002*).

tion, with an acyl carbon number range of C_{50} to C_{54}, maximising at C_{52}, which is identical to reference ruminant adipose fats (Fig. 2).

The 8 TLEs that yielded appreciable lipid concentrations analysed further by GC-C-IRMS to determine the $\delta^{13}C$ values for the major fatty acids ($C_{16:0}$ and $C_{18:0}$); these values are plotted in Figure 4. The $\delta^{13}C$ values obtained for modern reference animal fats from the major domesticated animals exploited in prehistory are grouped within confidence ellipses, onto which the values from archaeological pottery are plotted. The $\delta^{13}C$ values for the $C_{18:0}$ fatty acid are more depleted in milk fats than in ruminant adipose fats, thus enabling distinctions to be drawn between milk and adipose fats from ruminant animals (*Dudd and Evershed 1998*). This is witnessed in the *c.* 2.5 ‰ shift between centroids of the reference ruminant adipose fat and ruminant dairy fat ellipses. The less depleted $\delta^{13}C$ values seen for the fatty acids in non-ruminant fats compared to equivalent components in ruminant fat are to be due to differences in diet and in the metabolic and biochemical processes involved in the formation of body fats in ruminant and non-ruminant animals.

The $\delta^{13}C$ values for the $C_{16:0}$ and $C_{18:0}$ fatty acids from 18MT, 79MT, 87MT, 88MT and 161MT plot within or adjacent to the dairy fat reference confidence ellipse, while that from 75MT plots within the ruminant adipose reference fat ellipse. Values from 08MT and 13MT plot between the porcine adipose fat and ruminant adipose fat ellipses. These $\delta^{13}C$ values are most likely indicative of mixing of commodities in the vessels, which may have occurred through multiple use of the vessel or through the contemporaneous mixing of animal products.

The modern fats used to construct the reference isotope plot were reared on a strict C_3 diet of fodders and cereals. The slight displacement of some of the $\delta^{13}C$ values to the right of the mixing curves may be

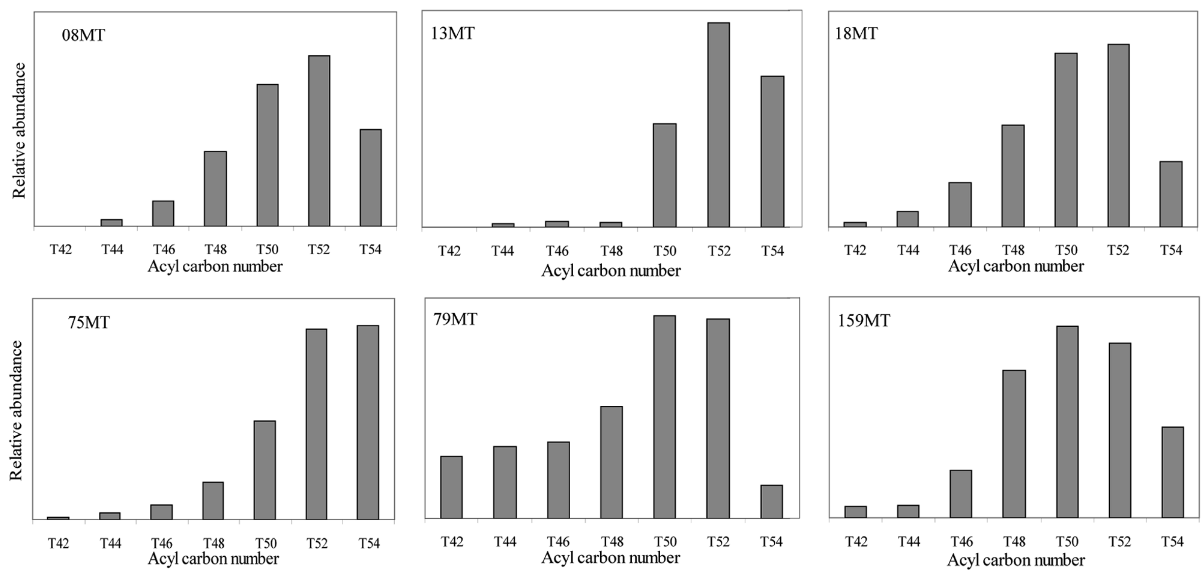


Fig. 3. The distributions of TAGs detected in the Mala Triglavca total lipid extracts.

Lab. sample no.	Lipid concentration $(\mu g\ g^{-1})$	Lipids detected	$\delta^{13}C_{16:0}$ ± 0.3 (‰)	$\delta^{13}C_{18:0}$ ± 0.3 (‰)	Predominant commodity type
08MT	173.35	FA (16<18; 14, 15, 15br,17, 17br, 19, 20), MAG, DAG, TAG, WE	–26.5	–29.9	mixture of animal fats
09MT	1.90	n/a	n/a	n/a	n/a
11MT	0.81	n/a	n/a	n/a	n/a
12MT	0.42	n/a	n/a	n/a	n/a
13MT	11.56	FA (16<18), MAG, A, OH, DAG, WE, TAG	–26.7	–28.8	ruminant adipose fat
14MT	0.24	n/a	n/a	n/a	n/a
15MT	0.00	n/a	n/a	n/a	n/a
16MT	0.00	n/a	n/a	n/a	n/a
17MT	1.01	n/a	n/a	n/a	n/a
18MT	88.09	FA (16<18; 14, 15, 15br,17, 17br, 18:1, 19, 20, 21, 22, 23, 24), MAG, DAG, TAG	–27.7	–33.3	dairy fat
75MT	90.54	FA (16<18; 14, 15, 15br,17, 17br, 18:1, 19, 20), MAG, DAG, TAG	–29.0	–31.5	ruminant adipose fat
76MT	2.92	n/a	n/a	n/a	n/a
77MT	0.00	n/a	n/a	n/a	n/a
78MT	2.58	n/a	n/a	n/a	n/a
79MT	27.23	FA (16>18; 14,17, 17br, 18:1, 19, 20), MAG, OH, A, DAG, TAG, P	–27.8	–32.9	dairy fat
80MT	3.45	n/a	n/a	n/a	n/a
81MT	1.34	n/a	n/a	n/a	n/a
82MT	0.00	n/a	n/a	n/a	n/a
83MT	3.12	n/a	n/a	n/a	n/a
84MT	1.10	n/a	n/a	n/a	n/a
85MT	1.34	n/a	n/a	n/a	n/a
86MT	1.38	n/a	n/a	n/a	n/a
87MT	21.93	FA (16>18; 14,17, 17br, 18:1, 19, 20), OH, A, P	–27.3	–32.2	dairy fat
88MT	9.93	FA (16>18; 14, 20), P	–27.0	–31.9	dairy fat
89MT	0.00	n/a	n/a	n/a	n/a
156MT	10.06	FA (16>18; 18:1), P	n/a	n/a	?
157MT	4.06	n/a	n/a	n/a	n/a
158MT	0.98	n/a	n/a	n/a	n/a
159MT	12.65	FA (16>18), MAG, DAG, TAG, P	n/a	n/a	dairy fat ?
160MT	5.53	n/a	n/a	n/a	n/a
161MT	43.81	FA (16<18), MAG, DAG	–29.5	–34.1	dairy fat
162MT	2.77	n/a	n/a	n/a	n/a
163MT	4.02	n/a	n/a	n/a	n/a
164MT	2.47	n/a	n/a	n/a	n/a
165MT	1.53	n/a	n/a	n/a	n/a
166MT	4.67	n/a	n/a	n/a	n/a

Tab. 1. Summary of the results of the organic residue analyses of Mala Triglavca early Neolithic potsherds.
Key: FA refers to free fatty acids, MAG to monoacylglycerols; DAG to diacylglycerols; TAG to triacylglycerols; A are n-alkanes, K are mid chain ketones, WE are wax esters, P are plasticizers and nd = none detected. Annotation 18:1 refers to the level of unsaturation and 17br to branched free fatty acids.

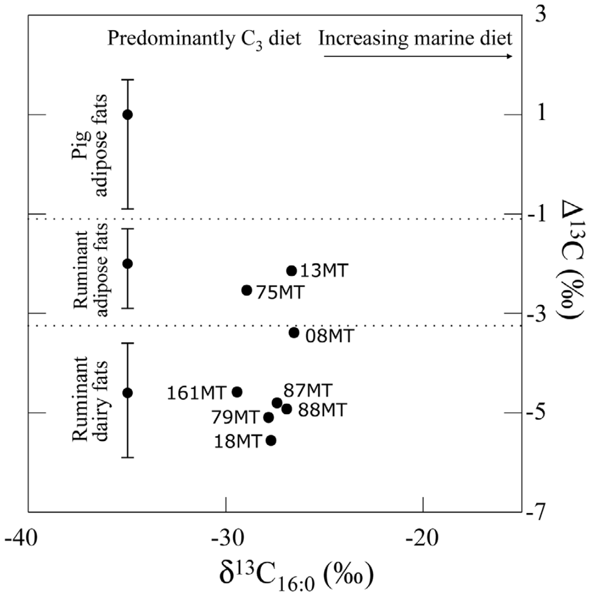


Fig. 5. A plot showing the difference between $\Delta^{13}C$ values ($\delta^{13}C_{18:0}$ – $\delta^{13}C_{16:0}$) and $\delta^{13}C$ values obtained from the $C_{16:0}$ fatty acids extracted from the Mala Triglavca potsherds. The ranges for the modern reference fats are plotted to the left of the diagram.

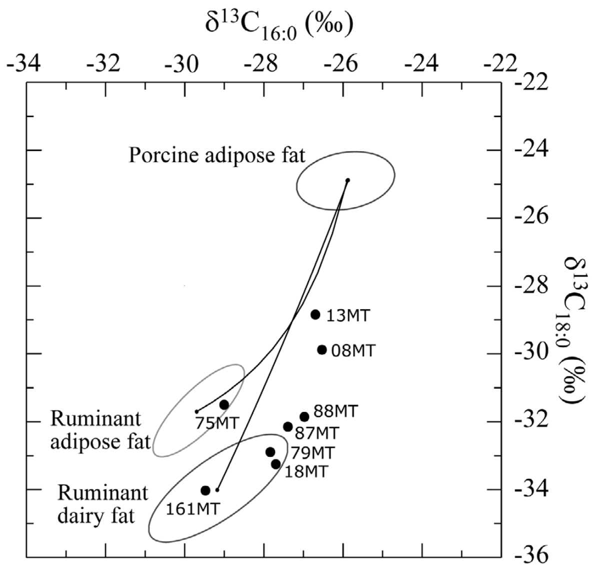


Fig. 4. Scatter plot showing the $\delta^{13}C$ values of $C_{16:0}$ and $C_{18:0}$ fatty acids prepared from total lipid extracts of Mala Triglavca potsherds. The values of modern reference fats are represented by confidence ellipses (1 standard deviation). Lines connecting the ellipses represent theoretical $\delta^{13}C$ values obtained through the mixing of these fats.

due to the fact that the animals in prehistory were reared on diets, which varied in $\delta^{13}C$ values compared to today's values today environmental influences. $\Delta^{13}C$ values ($\delta^{13}C_{16:0}$ – $\delta^{13}C_{18:0}$) are also a useful indicator of lipid origin where such variations exist. Figure 5 displays the $\Delta^{13}C$ values plotted against $\delta^{13}C_{16:0}$ values for the Mala Triglavca potsherd fatty acids. The ranges on the left side of the graph are from the modern reference fats.

Using Figure 5, it was possible to more securely attribute the Mala Triglavca residues to their potential lipid sources. Sample 13MT, which was plotted on Figure 4 in between the ruminant dairy and adipose reference ellipse, can now be more accurately attributed to the latter, together with 75MT. Unfortunately, the same could not be achieved for TLE of sample 08MT, which remains plotted on the boarder of two ranges and most likely the consequence of mixing of different types of fat during the pottery use.

Discussion

The lipid components of the organic residues preserved in the early Neolithic vessels from Mala Triglavca displayed reasonable preservation given their age, with appreciable TLEs being detected in 28% of the sherds analysed. The high degree of preservation overall was also reflected in the survival of acylglycerol components (MAGs, DAGs and TAGs) in a significant proportion (70%) of TLEs. Although somewhat later age the lipid residues from Mala Triglavca show similar rate of recovery and mean concentrations to those observed in early

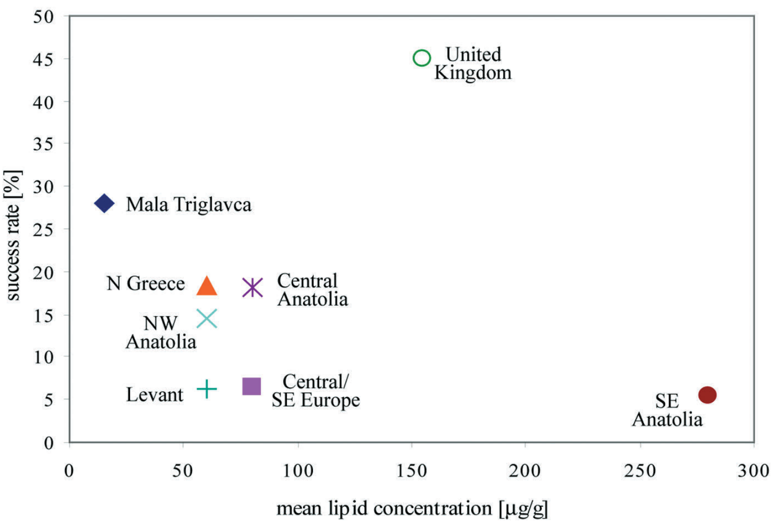


Fig. 6. A plot showing the correlation between success rate (which is number of TLEs with appreciable lipid concentration divided by total number of samples analysed) and mean lipid concentration for Mala Triglavca and other regions with evidences for early Neolithic milk use.

Neolithic pottery from SE Europe, Turkey and Near East (Fig. 6; *Evershed et al. 2008*). Interestingly, dairy fats dominate the preserved lipids at Mala Triglavca, and display a mean lipid concentration of 15μgg-1, which is comparable to the concentration seen in pottery from the other regions where early Neolithic milk use has been demonstrated. The concentrations and rate of recovery of lipid from British Neolithic pottery are both significantly higher than the more southerly located sites and likely reflect preservational differences related to climate and age (*Copley et al. 2005b*).

Returning to the Mala Triglavca residues there is also a good correlation between the triacylglycerol distributions preserved and interpretations of ruminant dairy and adipose fats in pottery based upon stable carbon isotope values. None of the total lipid extracts contained porcine adipose fat, which agrees with the low percentages of pigs in faunal assemblage from the site, which is dominated by small cattle and sheep/goat. The latter clearly correlates with the fat type detected in the pottery, although the fats from the different species cannot be separated. Interestingly, Mlekuž has recently managed to partially reconstruct herd structures using faunal remains from early Neolithic sites on the Adriatic coast. The earliest animal domestication and husbandry appears to have involved exploitation of both animal meat as well as dairy products (*Mlekuž 2006*). Analyses of absorbed lipid residues of pottery from Mala Triglavca confirm this interpretation – the Neolithic inhabitants of the site were using diverse domesticated animal products in every day food preparation and consumption. Since no mid-chain ketones were present in any of the extracts it appears that the vessels were not heated to high temperatures (>300° C) during use (*Raven et al. 1997*).

In summary, the results obtained from lipid analyses of the Mala Triglavca pottery is consistent with on-going debate concerning the integration of animal domestication into early farming as part of the Neolithisation process along the Adriatic coast. The results concur with recent findings from organic residue analyses of Neolithic pottery from the SE Europe and Near East, where it has been shown that the early use of dairy products dates back at least to the 7th millennium BC and rather than being a fixed package, likely developed in different ways and in different geographical regions (*Evershed et al. 2008; Mlekuž et al. 2008*).

ACKNOWLEDGEMENTS

This research was undertaken while LS was in receipt of a EU Leonardo da Vinci Scholarship. Drs R. Berstan and I. D. Bull are thanked for technical support. The NERC are thanked for mass spectrometry facilities. The UK Joint Higher Education Funding Council for England and Office of Science and Technology Science Research Investment Fund (SRIF), and the University of Bristol are thanked for infrastructure funding.

∴

REFERENCES

BECK C. W., SMART C. and OSSENKOP D. 1989. Residues and Linings in Ancient Mediterranean Transport Amphoras. *Archaeological Chemistry 4: 69–380*.

BERSTAN R. 2002. *Compound-Specific δ13C and 14C Determinations of Archaeological Animal fats* (Doctoral thesis defended at University of Bristol).

CHARTERS S., EVERSHED R. P., GOAD L. J., LEYDEN A., BLINKHORN P. W. and DENHAM V. 1993. Quantification and distribution of lipid in archaeological ceramics: implications for sampling potsherds for organic residue analysis and the classification of vessel use. *Archaeometry 35: 211–223*.

CHARTERS S., EVERSHED R. P., BLINKHORN P. W. and DENHAM V. 1995. Evidence for the mixing of fats and waxes in archaeological ceramics. *Archaeometry 37: 113–127*.

CHARTERS S., EVERSHED R. P., QUYE A., BLINKHORN P. W. and REEVES V. 1997. Simulation experiments for determining the use of ancient pottery vessels: The behaviour of epicuticular leaf wax during boiling of a leafy vegetable. *Journal of Archaeological Science 24: 1–7*.

CONDAMIN J., FORMENTI F., METAIS M. O., MICHEL M. and BLOND P. 1976. The application of gas chromatography to the tracing of oil in ancient amphorae. *Archaeometry 18: 195–201*.

CONNAN J., NIEUWENHUYSE O. P., VAN AS A. and JACOBS L. 2004. Bitumen in early ceramic art: bitumen-painted ceramics from Late Neolithic Tell Sabi Abyad (Syria). *Archaeometry 46: 115–124*.

COPLEY M. S., BERSTAN R., DUDD S. N., DOCHERTY G., MUKHERJEE A. J., STRAKER V., PAYNE S. and EVERSHED R. P. 2003. Direct chemical evidence for widespread dairying in prehistoric Britain. *Proceedings of the National Academy of Sciences 100: 1524–1529*.

COPLEY M. S., BLAND H. A., ROSE P., HORTON M. and EVERSHED R. P. 2005a. Gas chromatographic, mass spectrometric and stable carbon isotopic investigations of organic residues of plant oils and animal fats employed as illuminants in archaeological lamps from Egypt. *Analyst 130: 860–871*.

COPLEY M. S., BERSTAN R., DUDD S. N., AILLAUD S., MUKHERJEE A. J., STRAKER V., PAYNE S. and EVERSHED R. P. 2005b. Processing of milk products in pottery vessels through British prehistory. *Antiquity 79: 895–908*.

DUDD S. N. and EVERSHED R. P. 1998. Direct demonstration of milk as an element of archaeological economies. *Science 282: 1478–1481*.

EVERSHED R. P. 1993. Biomolecular archaeology and lipids. *World Archaeology 25: 74–93*.

2008. Experimental approaches to the interpretation of absorbed organic residues in archaeological ceramics. *World Archaeology 40: 26–47*.

EVERSHED R. P., HERON C. and GOAD L. J. 1990. Analysis of organic residues of archaeological origin by high-temperature gas-chromatography and gas-chromatography mass- spectrometry. *Analyst 115: 1339–1342*.

1991. Epicuticular wax components preserved in potsherds as chemical indicators of leafy vegetables in ancient diets. *Antiquity 65: 540–544*.

EVERSHED R. P., HERON C., CHARTERS S. and GOAD L. J. 1992. In A. M. Pollard (ed.), *New Developments in Archaeological Science*. Oxford University Press, Oxford: 187–208.

EVERSHED R. P., ARNOT K. I., COLLISTER J., EGLINTON G. and CHARTERS S. 1994. Application of isotope ratio monitoring gas-chromatography mass-spectrometry to the analysis of organic residues of archaeological origin. *Analyst 119: 909–914*.

EVERSHED R. P., VAUGHAN S. J., DUDD S. N. and SOLES J. S. 1997. Fuel for thought? Beeswax in lamps and conical cups from the late Minoan Crete. *Antiquity 71: 979–985*.

EVERSHED R. P., DUDD S. N., CHARTERS S., MOTTRAM H., STOTT A. W., RAVEN A., VAN BERGEN P. F. and BLAND H. A. 1999. Lipids as carriers of anthropogenic signals from prehistory. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences 354: 19–31*.

EVERSHED R. P., DUDD S. N., COPLEY M. S., BERSTAN R., STOTT A. W., MOTTRAM H. R., BUCKLEY S. A. and CROSSMAN Z. 2001. Chemistry of archaeological animal fats. *Accounts of chemical research 35: 660–668*.

EVERSHED R. P., PAYNE S., SHERRATT A. G., COPLEY M. S., COOLIDGE J., UREM-KOTSOU D., KOTSAKIS K., ÖZDOĞAN M., ÖZDOĞAN A. E., NIEUWENHUYSE O., AKKERMANS P. M. M. G., BAILEY D., ANDEESCU R. R., CAMPBELL S., FARID S., HODDER I., YALMAN N., ÖZBAŞARAN M., BIÇAKCI E., GARFINKEL Y., LEVY T. and BURTON M. M. 2008. Earliest date for milk use in The Near East and southeastern Europe linked to cattle herding. *Nature 455: 528–531*.

HERON C., NEMCEK N. and BONFIELD K. M. 1994. The chemistry of Neolithic beeswax. *Naturwissenschaften 81: 266–269*.

MLEKUŽ D. 2006. *Meat or milk? Neolithic economies of Caput Adriae. Preistoria dell'Italia settentrionale*. Studi in ricordo di Bernardino Bagolini, Atti del Convegno, Udine settembre 2005, 453- 458.

MLEKUŽ D., BUDJA M., PAYTON R. and BONSALL C. 2008. "Mind the Gap": Caves, Radiocarbon Sequences, and the Mesolithic-Neolithic Transition in Europe – Lessons from the Mala Triglavca Rockshelter Site. *Geoarchaeology: An International Journal 23: 398–416*.

MOTTRAM H. R., DUDD S. N., LAWRENCE G. J., STOTT A. W. and EVERSHED R. P. 1999. New chromatographic, mass spectrometric and stable isotope approaches to the classification of degraded animal fats preserved in archaeological pottery. *Journal of Chromatography A. 833: 209–221*.

RAVEN A. M., VAN BERGEN P. F., STOTT A. W., DUDD S. N. and EVERSHED R. P. 1997. Formation of long chain ketones in archaeological pottery by pyrolysis of acyl lipids. *Journal of Analytical and Applied Pyrolysis 40/41: 267–285*.

REGERT M., COLINART S., DEGRAND L. and DECAVALLAS O. 2001. Chemical alteration and use of beeswax through time: accelerated ageing tests and analysis of archaeological samples from various environmental contexts. *Archaeometry 43: 549–569*.

UREM-KOTSOU D., STERN B., HERON C. and KOTSAKIS K. 2002. Birch-bark tar at Neolithic Makriyalos, Greece. *Antiquity 76: 962–967*.

back to contents

UDK 903'12/'15(497.11)"633/634":314.17
Documenta Praehistorica XXXV (2008)

Vlasac revisited: formation processes, stratigraphy and dating

Dušan Borić[1], Charles French[1], Vesna Dimitrijević[2]
1 *Department of Archaeology, University of Cambridge, Cambridge, UK*
2 *Department of Archaeology, Belgrade University, Belgrade, Serbia*

ABSTRACT – *Since 2006, new excavations of the Mesolithic-Neolithic site of Vlasac in the Danube Gorges of the north-central Balkans have been under way. Excavations made across the surviving preserved portion of the site provide a unique opportunity for a re-evaluation of previous conclusions about the stratigraphy, chronology and the character of occupation at this classic site of the Lepenski Vir culture. Our revision work is contributing to new knowledge about formation processes at the site, its absolute dating, complex interplay of different mortuary practices and the nature of Mesolithic-Neolithic transformation in the region as a whole. Some aspects of these research efforts are presented in the paper.*

IZVLEČEK – *Od leta 2006 potekajo nova izkopavanja na mezolitsko-neolitskem najdišču Vlasac v donavski soteski v severnem delu centralnega Balkana. Izkopavanja, omejena so na ohranjeni del najdišča, omogočajo ponovno presojo in reinterpretacijo stratigrafije, kronologije in poselitve klasičnega naselja kulture Lepenskega Vira. Naše delo omogoča nove pojasnitve procesov formiranja naselja, njegovo absolutno datiranje ter predstavitev kompleksnosti pogrebnih praks v kontekstu mezolitsko-neolitske transformacije v regiji. V članku predstavljamo nekatere vidike in zaključke raziskovalnega dela.*

KEY WORDS – *Vlasac; Mesolithic; Danube; Lepenski Vir; geoarchaeology; chronology*

Introduction

A series of settlements along the narrows of the Danube River on the Serbian-Romanian border provide a rich settlement and intramural mortuary dataset. The archaeological record indicates largely unbroken continuity of occupation during the Mesolithic and Early/Middle Neolithic periods (*c.* 10 000–5500 cal BC) (*e.g. Borić 2002a; Borić and Dimitrijević 2007 in press; Borić and Miracle 2004; Radovanović 1996; Srejović 1972;* but *cf. Bonsall et al. 2002*). This long continuity is marked by important changes throughout the sequence, the most important one being the transition from the Mesolithic to the Neolithic from around 6200 to 5900 cal BC. Early Neolithic pottery appears in the central Balkans around 6300 cal BC (*Whittle et al. 2002; 2005*). Significantly, this dating seems to coincide with architectural changes in the Danube Gorges: the transition from the use of rectangular open-air stone hearths to the construction of elaborate trapezoidal buildings with limestone floors. At the type-site of Lepenski Vir this new form of architecture is most elaborately expressed. However, it seems that these features in their basic form, including trapezoidal floor outline with central rectangular hearths and red limestone flooring, appear already in the Mesolithic sequence at the neighbouring site of Vlasac for the first time (*Borić 2007a; Srejović and Letica 1978*). Moreover, at Lepenski Vir, there seems to exist a gap between the Early Mesolithic occupation and the later phase with trapezoidal buildings. This gap coincides with the duration of the regional Late Mesolithic, *c.* 7300–6200 cal BC. In contrast, at Vlasac, this period saw the most intense activity on the basis of existing radiometric evidence (see below). Hence these two neighbouring sites provide complementary sequences for studying diachronic changes among the Danube Gorges fisher-foragers.

In this paper, we revisit the dating, stratigraphy and phasing of the site of Vlasac. Such a discussion is partly facilitated with the results of new fieldwork at this site (*Borić 2006; 2007b*) that enabled a re-examination of formation processes, among other things. In addition, a series of new AMS dates from Vlasac, most of which are published here for the first time, encompass samples from both the 1970s excavations as well as the most recent excavations and help us ground our observations about site's stratigraphy in the temporal framework. These new results are then compared with and discussed in relation to observations made by the first excavators of the site.

Geological setting

The Danube Gorges region of eastern Serbia/western Romania (Fig. 1) is a complicated but well studied region geologically (*Banu 1972; Grubić 1972; Marković-Marjanović 1978; Rabrenović and Vasić 1997; Stevanović 1997*). By the late glacial period there was a very large meandering and fast flowing river confined within the limestone/granitic/sedimentary rock dominated gorge, with narrows, cataracts and terrace remnants on the floodplain edge. These often occurred as promontories on the valley floor, composed of riverine sand, wind-blown loessic silt and/or scree off the adjacent steep slopes, often re-cut and re-carved by channel avulsion processes. It was on these 'tongues' of land projecting at near right angles to the adjacent valley slopes that the Mesolithic peoples established themselves with settlement and burial sites, with Lepenski Vir on finely laminated riverine sands, and Vlasac on granitic and limestone derived scree. These floodplain edge 'terrace remnants' could be seen as more accessible – just above the river's influence and not being covered to the same extent with the thick and developing woodland that gradually blanketed the adjacent slopes in the early Holocene.

Previous research at Vlasac

The first excavations at Vlasac (44° 32' N, 22° 02' E; *c.* 62–78 m asl) were made in 1970 and 1971 across the area of 640m² (*Srejović and Letica 1978*) (Fig. 2). The site was excavated along the riverbank section that would be submerged and only selected areas of the river terrace were excavated. There were five dwelling structures with floors and 26 possible open-air (?) hearths as well as 17 stone constructions of different shapes and extent whose function remains undetermined. There are also 87 graves containing either 119 individuals (*Nemeskéri 1978*) or 164 individuals (*Roksandić 1999; 2000*). The excavation area was divided into three sectors: western (176m² excavated), central (224m² excavated) and eastern (240m² excavated) sectors. It was suggested that one could separate three main cultural horizons across the site: Vlasac I with subphases a and b, Vlasac II and Vlasac III. The excavators described the sequence at each of these sectors separately. The cultural and physical characteristics of these layers are mixed in these descriptions that come from Srejović and Letica (*1978.11–14*) and we shall later try to connect these first observations about the stratigraphy of the site with our own observations about the stratigraphic sequence at the southernmost extent of its spread investigated in the course of renewed work in 2006 to 2008 (see below). Stratigraphic descriptions of each sector follow.

Fig. 1. Vlasac – location map (1 : 25 000).

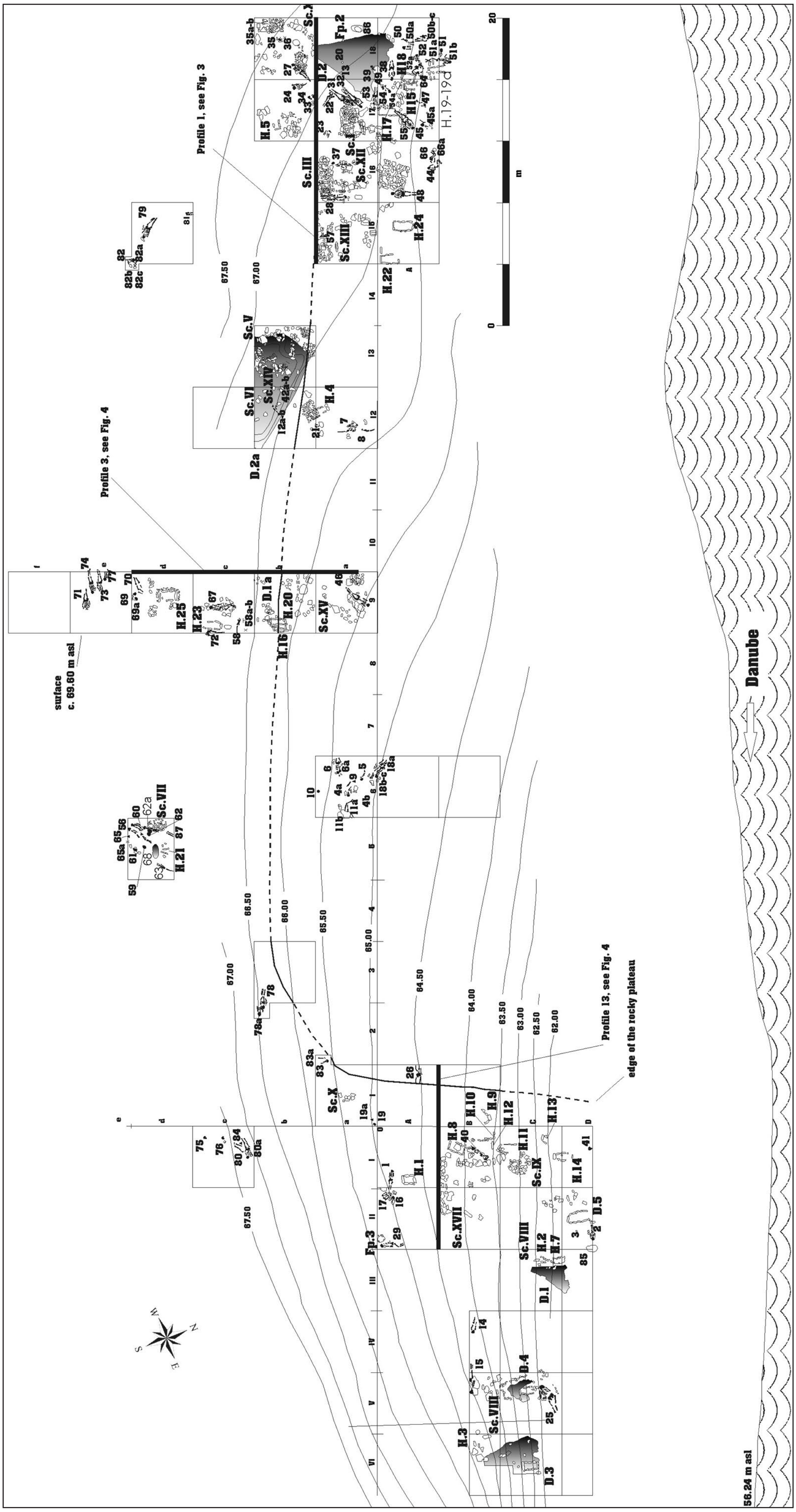


Fig. 2. Areas excavated in 1970–1971 at Vlasac with the location of some section drawings marked (adopted after Srejović and Letica 1979).

Western sector

At this sector the terrain slopes gently from the SW to the NE (approximately 50cm over a distance of 8m). The most representative section of the stratigraphic sequence at this sector and possibly the whole site, as stressed by Srejović and Letica (*1978.11*), is reproduced in Fig. 3. The stratigraphic sequence at this sector as seen by the excavators is as follows:

- Humus (20 to 25cm);
- Younger scree (15 to 30cm);
- Older scree (30 to 60cm);
- Eneolithic layer only in square a/18 (10cm);
- Vlasac III (40 to 80cm): brown to black soil containing gravels and large stones;
- Vlasac II (30 to 100cm): brown soil with large quantities of smaller scree;
- Vlasac Ib (10 to 60cm): dark yellow soil with larger gravels;
- Vlasac Ia (20 to 60cm): only in squares a/17, a/18, A/17 and A/18): a large number of fish bones, gravels and clay-like soil;
- Natural: clay-like soil, culturally sterile, with brown soil and gravels (virgin soil I) or the oldest yellow scree with smaller gravels (virgin soil II).

Central sector

The surface at this sector slopes from the S to the N relatively more abruptly than at the western sector (approximately 1.5m over a distance of 16m). Interestingly, at this sector the bedrock slopes in the opposite direction: from N to S, by 1.8m. Due to the specifics of the terrain in this part of the site, in square B/6 under the level of humus, the bedrock was hit with no cultural levels, while in squares A/6 and a/6, a homogenous cultural level was only 60cm thick, with burial remains only and rare finds of animal bones and other materials. This is due to the existence of an elevated rocky plateau (bedrock formed of large stones) that was forming a half-circle in the central part of the terrace (see Fig. 2; *Radovanović 1996.Fig. 4.7*). This feature must be a relict of the Danube's palaeo-channel, which in the past had cut through less resistant sediments behind the rocky plateau, which remained unaffected. The first inhabitants of Vlasac appropriated the depression left here for their first settlements (*Srejović and Letica 1978.10*). This feature of the site topography is important for understanding both the specificity of formation processes in certain areas of the site as well as for the organization of the initial settlement activities as reflected in the settlement layout. This feature can best be observed on the published sections that run from point d9 to x9 or c12 to x12 (*Srejović and Letica 1978.profiles 3, 7*). Similarly, at the eastern sector, this is observable on sections that run through points ay to a1 and from point AII to A1 with the rocky base dipping from the NW to

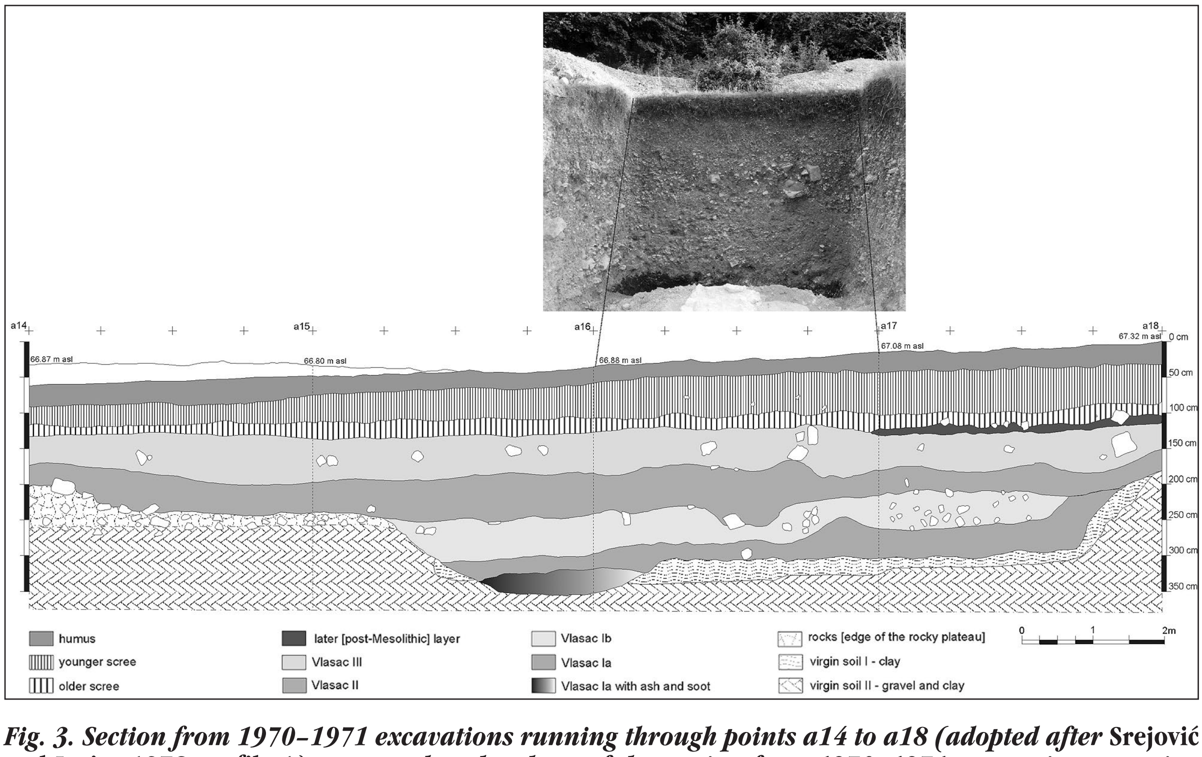


Fig. 3. Section from 1970–1971 excavations running through points a14 to a18 (adopted after* Srejović and Letica 1978.profile 1*) compared to the photo of the section from 1970–1971 excavations running through points a16 to a17 in the background and parts of squares A/17 and a/17 with Hearth 17 (at 64.55 m asl) in the foreground (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

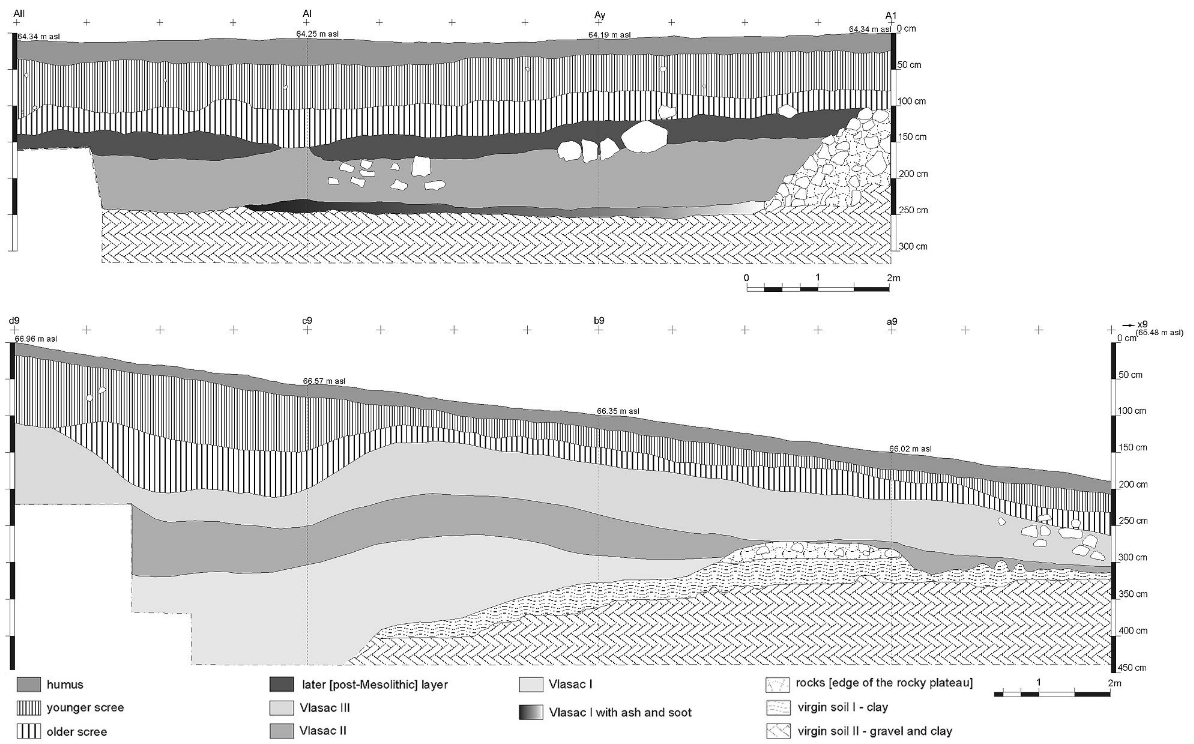


Fig. 4. Cross-sections of the stratigraphy of the Vlasac terrace with the rocky plateau indicated on the basis of published sections (a) d/9 to x/9 and (b) A/II to A/1 (adopted from **Srejović and Letica 1978.profile 3, profile 13*).***

the SE. At these latter sections one catches the limit of this rocky, elevated plateau on the eastern side of the Vlasac terrace (*Srejović and Letica 1978.profile 10*). In Fig. 4a–b, we reproduce published cross-sections of the terrace showing the rocky plateau as documented on the central and eastern sectors. The limit of the rocky plateau in the central sector can also be established in square b/3 where the bedrock is reached below 20cm of surface humus. The bedrock here also slopes from the NW to the SE.

In the central sector the thickness of identified layers is somewhat different from the western sector:

- Humus (20cm);
- Scree (30 to 180cm);
- Vlasac III (40 to 100cm);
- Vlasac II (average thickness 50cm; present in squares d/9 and c/9 only);
- Vlasac I (150cm; present in squares d/9 and c/d only with a sudden dip of layers behind the zone of the rocky plateau);
- Natural.

Eastern sector

The observed stratigraphic sequence behind the rocky plateau (see Fig. 4b) is divided in two zones: Western zone in squares A/1, A/I, B/1, B/I, B/II, C/I, C/II, C/III, D/I, D/II and D/III):

- Humus (25cm);
- Younger scree (average thickness 20cm);
- Older scree (average thickness 40cm);
- Early/Middle Neolithic horizon (80cm, only in squares C/III, C/II and C/I).
- Vlasac III (average thickness 50cm; in square A/1, only 20cm due to the intrusion of an Early/Middle Neolithic pit, or completely damaged in squares A/I, B/I and C/I);
- Vlasac II (average thickness 40 to 90cm);
- Vlasac Ib (30 to 180cm, only in squares C/III, C/II and C/I);
- Vlasac Ia (10 to 40cm, only in squares C/III, C/II and C/I);
- Natural.

According to the excavators, the eastern zone of the eastern sector in squares B/IV, B/V, B/VI, C/IV, C/V and C/VI differs from the rest of the site both on the basis of layers' physical characteristics (consistency, inclusions, colour) as well as in terms of their archaeological content. The excavators observe that the pre-Neolithic levels are rather homogenous, largely containing clays and smaller pebbles (*Srejović and*

Letica 1978.13). The terrain here also is rather steep with the inclination the S–N and the height difference is 2m at the distance of 4m. The base of the sequence also has an abrupt dip from the SE to the NW at point BV (*Srejović and Letica 1978.profile 16*) forming a deeply buried sequence in squares B/V, B/IV, C/V and C/IV.

- Humus (30cm);
- Homogenous layer of scree (average thickness 80cm);
- Vlasac III (40 to 70cm);
- Vlasac II (50 to 140cm);
- Vlasac Ib (20 to 100cm over a small area);
- Vlasac Ia (average thickness 30cm over a small area);
- Natural.

The observations at this sector are added with the mention of test square c/I (see Fig. 1), where the base of the sequence has an abrupt dip from the SE to the NW, which forms a deeply stratified sequence in the NW corner of this square. This is probably similar to the situation in the central sector (see above) with the existence of a deep natural 'gully' behind the rocky plateau, before the base starts to rise again toward the south. In square c/I one observes the following stratification:

- Humus;
- Homogenous layer of scree (100cm);
- Younger cultural levels (70cm): yellow-brown soil containing large stones and charcoal;
- Older cultural levels (60cm): reddish-brown deposit with lots of charcoal and ash at its bottom;
- Natural.

Summary and discussion

Above given detailed descriptions provide very illuminating insights about the original topography of Vlasac and point out significant variations of archaeological deposits across the site. For the adequate understanding of formation processes at this site, it is important to comprehend the existence of the central rocky plateau that approximately forms a half-circle with a natural 'gully' behind this rocky plateau where one seems to find the most deeply stratified zone. Also, here, the excavators observed the existence of the earliest levels, which they attribute to their phase Ia–b. However, their descriptions of the physical characteristics of all three main horizons (phases Vlasac I–III) are limited to the western sector and are not very detailed. These observations are then assumed for other areas of the site. The excavators seem to take for granted the existence of layers that possess the same physical characteristics and the same type of cultural material at approximately the same level across the site. Yet, it is obvious from their descriptions of the site's topography that this sloping terrace has a fairly complex sequence and that it is unlikely that the cultural levels would be formed continuously across the site as is often the case when cultural layers are laid on a flat terrain, for instance, in tell type of archaeological sites. Hence the excavators' basic assumption that at the complex erosive-accumulative terrace such as Vlasac, with varying inclinations of slopes, one could distinguish and recognize Holocene layers of the same date, with the same physical characteristics (consistency, colour, etc.), at approximately the same level, was problematic. Moreover, Srejović and Letica's phases Vlasac I–III, marked on published section drawings as separate entities, lack detailed descriptions of their physical characteristics.

By comparing one of these published sections with a previously unpublished photo of a part of the same section (Fig. 3), one could check the decisions made by the excavators to attribute a particular zone to a particular level. In this example, the humus layer is clearly distinguished, while it is more difficult to make a distinction between the so-called 'younger' and 'older' scree as marked by the excavators. On this photograph, instead, one notices a homogenous zone beneath surface humus that contains smaller scree. This likely represents the subhumic level and the archaeologically sterile hillwash (see below). Larger stones and significant amounts of gravel can be distinguished as layer Vlasac III, which seems clearly defined on the photograph, particularly in comparison to the layer below it. A difference between layers marked as Vlasac II and Ib on the published section is less recognizable on the photograph although one may notice differences in the concentration and size of gravels in particular zones of this rather homogenous deposit. On the photograph, one can also notice an intense dark layer at the bottom of the stratigraphic sequence that would correspond to layer Vlasac Ib as drawn on the published section. This markedly different colour on the section may partly be due to a different degree of moisture in this part of the section in comparison to the rest of the exposed section as its bottom portion must have been excavated last, but could perhaps also relate to a concentration of charcoal in this particular layer as indicated on this part of the published section (see Fig. 3). We are missing the base of the section on the

Fig. 5. North-facing section in Trench 3/2006 before the start of excavation works in 2006 (© D. Borić).

photo and cannot compare the cultural layers with the sterile layer beneath that the excavators on the section drawing distinguish into two different zones: a thin layer of clay virgin soil directly beneath cultural levels and gravel and clay deposits that mark the base of the whole terrace.

In the following section, we will describe the stratigraphic sequence as seen through our renewed work at the upper portion of the terrace, trying to make connections between what we can observe and the characteristics of the stratigraphic sequence described by the excavators in the 1970s at the lower portion of the Vlasac terrace.

Geoarchaeology and the stratigraphic sequence at Vlasac in 2006–2008

A large part of Vlasac closer to the original river terrace was excavated during the 1970 and 1971 rescue excavation campaigns (see above) while unexcavated parts were submerged under waters of the modern Danube. For over 35 years since the end of the first excavations at Vlasac, the Danube at this location was slowly eroding away sediments, creating a new riverbank section (Fig. 5). During the 2005 field season in the Danube Gorges hinterlands[1], there were reports from local fishermen about washed out bones at this place. Checking these reports at the start of the 2006 field season, it was confirmed that certain portions of this site were still preserved and accessible for research (*Borić 2006; 2007b*).

At the break of slope just above the water's edge, which fluctuates depending on the accumulation of water in the artificial lake (*i.e.* the Danube in this part of its course in front of the hydroelectric dam), there is a *c.* 10m wide linear zone of Holocene archaeological survival (Figs. 6–7) associated with a complicated erosion sequence. From the field observation of the open section profiles and some selected micromorphological analyses, the aims were to investigate the nature of any buried land surfaces present and the colluvial sequence, and any potential structural surfaces.

The composite hillslope sequence of deposits as seen on the north-facing, exposed riverbank section

Fig. 6. Excavated areas at Vlasac in 2007 seen from the Danube (© D. Borić).

1 New fieldwork in the Danube Gorges started in 2004 as part of a collaborative project entitled "*Prehistory of north-east Serbia*" between the Department of Archaeology of the University of Belgrade, Serbia, and the Department of Archaeology, University of Cambridge, UK, and with Miloš Jevtić and Dušan Borić as principal investigators. A part of this wider project relating to the Stone Ages has been designed to test the notion of the Mesolithic-Neolithic frontier as a general model as well as its applicability in this regional example by reference to known Mesolithic settlements on the Danube and largely uninvestigated hinterland areas on the Serbian side of the Danube.

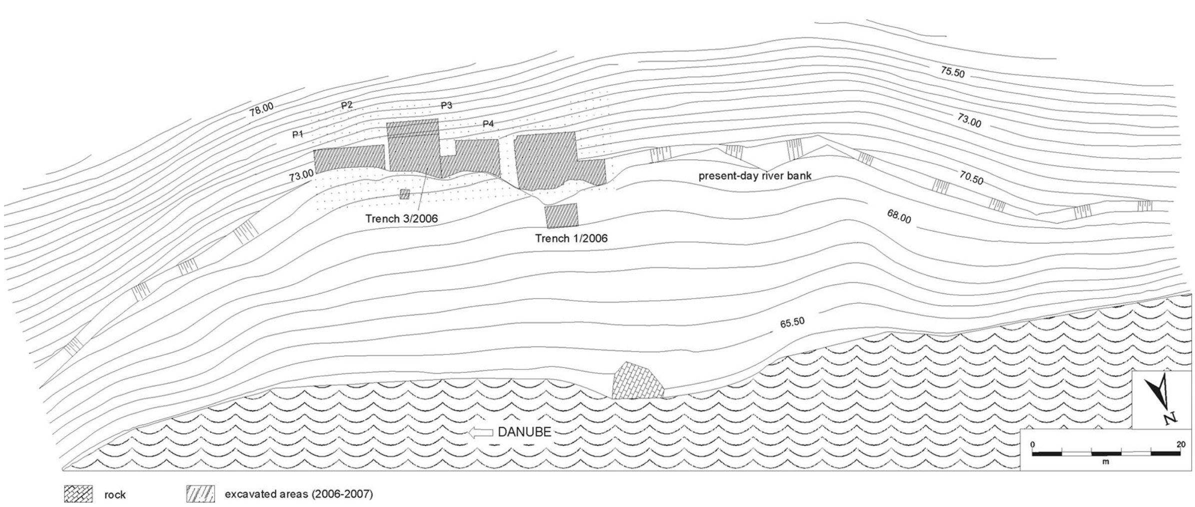


Fig. 7. Excavated areas at Vlasac in the course of 2006–2007 excavation campaigns (© D. Borić).

of Trench 3/2006 at Vlasac (Figs. 8–11) is described as follows.

Above the bedrock at the base of the slope is a 20+ cm thick gray limestone scree deposit, which is probably a solifluction type of deposit of the late glacial period (*cf. Marković-Marjanović 1978*).

It has a slightly undulating boundary with a *c.* 15–40cm thick, reddish brown, calcitic clay with common to occasional fine (<3cm), angular to sub-rounded limestone fragments. From the micromorphological analysis (*French 2008*), this horizon exhibits some pedogenic features, notably a well defined, fine (<5mm), sub-angular blocky ped structure, some bioturbation through soil faunal action and evidence of a once greater organic content in the form of fragmentary amorphous iron-replaced plant tissues. This horizon undoubtedly represents a soil with some degree of soil formation and stability, but which is probably also influenced by additions of hillwash-type material in the form of calcium carbonate and fine limestone pebbles. The upper organic A horizon has been truncated, presumably through subsequent slope erosion processes. But this palaeosol contains no evidence of any loessic component, contrary to initial impressions in the field (*French 2007*).

The early Holocene buried soil is present by at least the Late Mesolithic, from *c.* 7300 cal BC. It is certainly possible that there was a substantial degree of woodland cover immediately upslope from the occupation and burial site at this time which allowed relative stability at the base of the slope where the current excavations are taking place, and therefore the formation of this soil. The longevity of this soil is impossible to ascertain on soil features alone, but as there is now a suite of radiocarbon dates indicating the continuous use of this site throughout the late Mesolithic for at least several centuries (see below), indicating by implication that the soil is of a similar age range.

Importantly in the upper half of the palaeosol (contexts 145 and 149) and immediately associated with a possible trapezoidal structure, there is a distinct line of horizontally oriented small limestone frag-

Fig. 8. North-facing section in Trench 3/2006 through burial sequence and possible dwelling floor after initial cleaning (© D. Borić).

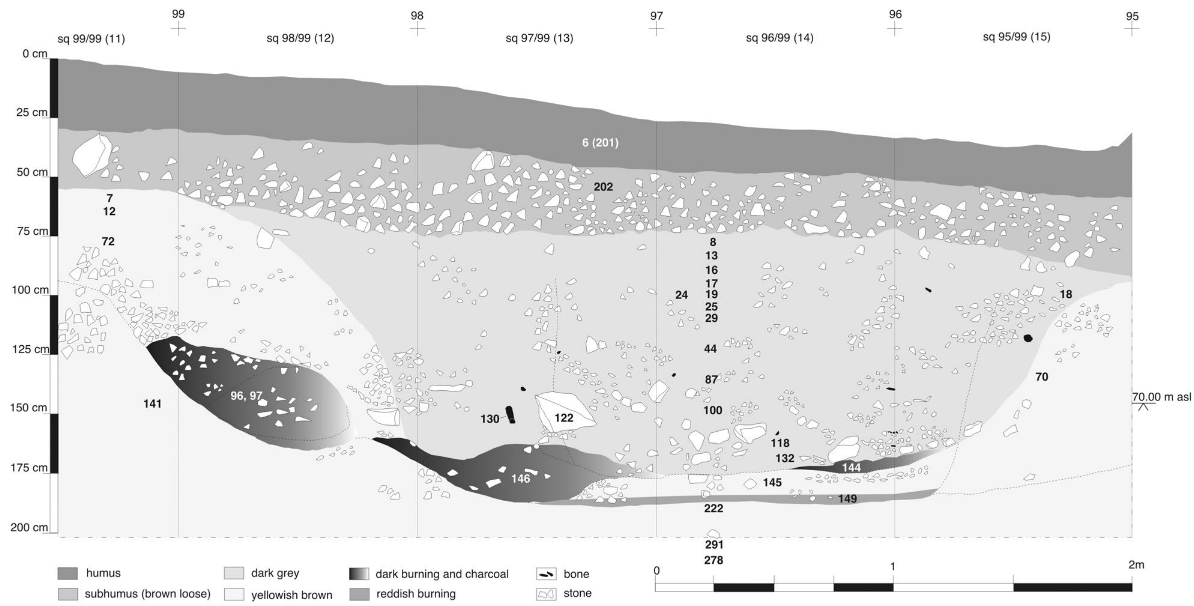


Fig. 9. Drawing of the north-facing section in Trench 3/2006 through burial sequence and possible dwelling floor after initial cleaning (© D. Borić).

ments which strongly suggest that this is a surface (Fig. 12). It is probably not a prepared surface *per se*, but it has either been truncated at this level, or trampled and compacted through human use. On balance, it is suggested that this level represents an exposed surface, and this is corroborated by the few fragmentary anthropogenic inclusions of fish bone, both burnt and unburnt, bone and charcoal with much amorphous iron impregnation (Fig. 13). This reflects anthropogenic activity during the Mesolithic use and occupation of this hillslope. There are a number of Mesolithic burials uncovered in the course of the renewed work at Vlasac that are also cut into this 'red soil.'

The remainder of the profile succession then consists of hillwash material composed largely of angular limestone rubble of <5cm across in all orientations. This occurs in thick horizons located extensively across the hillslope over depths of *c.* 1–3m. There is also hillwash material infilling either large tree-throw pits and/or small gullies, that bisect the base of the slope. These pits are up to *c.* 1.5m in depth and 8m in width. The hillwash material sometimes exhibits discontinuous bedding lenses of limestone rubble fragments of up to 10cm in size as well as more undifferentiated zones with smaller limestone fragments in all orientations. It is suggested that this indicates overland flow mechanics of deposition as well as deflation through slope run-off and the stop/start nature of deposition. There are also units of browner, more organic and soil-rich hillwash, which are indicative of some temporary stabilisation or at least a slowing in colluvial depositional processes. These variations are probably as much associated with the nature of the vegetative growth and cover on the hillside as human activities. Also, there may be differential colluvial deposition occurring around *in situ* trees on the slope; there is certainly differential infilling with coarser/more abundant limestone fragments within large tree-throw pits.

Above and upstream from the trapezoidal structure, this level is characterised by a mixture of fine limestone rubble, colluvially derived, and a greyish brown calcitic silt in which both occupation material and burials are found. Elsewhere and downstream, this same level in the stratigraphy is essentially free of cultural material and is dominated by limestone rubble hillwash deposits. The greater soil and organic component of this post-structure horizon suggests that this area represents a much slower aggradational dynamic. It may well represent a series of temporary or standstill soil surfaces alternating with minor, intermittent colluvial episodes, which have subsequently become mixed through bioturbation and some fine soil wash. Giving a temporal dimension to this is very difficult, but it could be envisaged in terms of 100 years or so if you consider turf development taking a few years in such a context.

Finally, the sequence is capped with the modern woodland floor on a *c.* 45 degree slope. It is composed of *c.* 20–25cm of dark brown silt loam with leaf litter matt and oxidised organic component and much modern rooting, with small angular limestone pebbles increasing in frequency with depth.

Fig. 10. North-facing section in Trench 3/2006 through burial sequence and possible dwelling floor with the last inhumation Burial context 53 exposed (© D. Borić).

Slope processes

The whole area under excavation and the complete profile represents the episodic deposition of variable mixtures of soil and chalk hillwash occurring around *in situ* trees in greater or lesser degrees of open woodland. This had the result of leaving some areas of the hillside more intact and stable than others, with other adjacent areas being severely affected by overland flow hillwash processes. Certainly there is much tree throw activity in evidence, areas of former root bowls and root disturbed areas, which are often associated with concentrations of Mesolithic artefacts.

The hillwash activity was essentially occurring on the bare, devegetated slopes by overland flow. This colluvial slumping may have led to some folding over of existing deposits on the hillside, such as in the upper/uphill fills of the inhumation burials, and even inversion of sediments.

The main archaeological levels, even though they occur at different levels on the hillside, are probably indicative of the same stabilised soil surface level in the Late Mesolithic, from *c.* 7300 cal BC. Nonetheless, there is little doubt that this relative stability was broken from time to time by some downslope soil movement. When the woodland on the slope above became seriously disturbed/exploited, hillwash events began in earnest, and may well have led to the abandonment of this part of the site at the base of the slope. On archaeological grounds this does not appear to have occurred before the end of the Middle Neolithic, *i.e.* sometime between 5700 and 5500 cal BC.

Comparison with the 1970s excavations

Our observations indicate the importance of an adequate understanding of the complexity of colluvial processes for the correct interpretation of the stratigraphic sequence at Vlasac. Although some elements of the stratigraphic sequence at the part of the site where new excavations are taking place must differ from those features observed at the part of the site excavated in the 1970s, it seems that we may suggest some revisions of the previous understandings of Vlasac's stratigraphy with the benefit of more detailed geoarchaeological and micromorphological observations that we have provided. First, the important role in this revision is played by the nature of depositional processes that depended on the dynamics of woodland clearance, creation of tree-throws and the intensity of hillwash downslope movement and its accumulation in particular depressions, which prevent any constancy in the deposition and formation of cultural levels across the site and, moreover, cause the movement and re-deposition of some cultural materials. From the descriptions provided by the excavators, it is clear that they also had difficulties in seeing their phases Vlasac Ia–b to III as clearly recognizable layers across the site, which is understandable bearing in mind the complex colluvial sequence just described.

From the bottom of the stratigraphic sequence we can equate Srejović and Letica's 'virgin soil II' (see Fig. 3) with our description of the bedrock consisting of gray limestone scree. What they describe as 'virgin soil I' is what we have identified as 15–40cm thick reddish brown calcitic clay. This is palaeosol with some stability, representing incipient soil formation with woodland cover in the early Holocene. In mid profile in this soil, one can recognize some anthropogenic activity, possibly related to the woodland clearance, which, with time, intensified with the downslope erosion of scree and its deposition

Fig. 11. North-facing section of the base of the colluvial sequence with the palaeosol at about 20–55cm above the base of the profile developed on scree at Vlasac in squares 104/98 and 105/98, Extension Trench 1/2007 (© D. Borić).

in depressions and tree-throws. Cultural activities sometimes continued for more than a millennium (see below) even in those areas affected by the hillwash accumulation as witnessed in the case of the burial sequence discovered in Trench 3 in 2006. Such activities were often associated with larger depressions left after earlier Mesolithic use of particular locations. On the basis of our understanding of the colluvial sequence at Vlasac, it is difficult to justify the assumption that cultural levels Vlasac Ia–b to III identified by Srejović and Letica were laid continuously across the site since the deposition of cultural strata at Vlasac must have been taking place at different times in different areas of the site. Thus two related processes created the cultural stratigraphy at Vlasac: on the one hand, the dynamics of hillwash movement affected by woodland clearance, and, on the other hand, complex cultural practices of inter-cutting and re-depositing of older layers and materials. These inter-cuttings are often hardly visible in the type of hillwash deposits, which most of the stratigraphic sequence at Vlasac consists of, where one finds gravels of different sizes to be a significant component of the soil matrix.

These observations are further aided by radiometric dating that connects the previously described nature of formation processes with the absolute temporal framework by dating architectural features and articulated burials found in this complex stratigraphic matrix.

Radiometric dating

There are now 43 dates from Vlasac of which 17 dates were previously made on charcoal and 26 are AMS dates made on samples of human (13 dates) and animal (13 dates dating 12 contexts) bones (Tab. 1 – see Appendix). Most of the charcoal dates from Vlasac were reported in Srejović and Letica (*1978.129*) original publication as BC corrected ages while original results can be found in Quitta (*1975.283–284*) for Berlin (Bln-) dates and in Radiocarbon 17 (p. 151) for Zagreb (Z-) dates. Bonsall et al. (*1997; 2000*) published first 5 AMS dates (OxA-5822–5826) on human burials from Vlasac obtained through the Oxford Radiocarbon Accelerator Unit (ORAU). There are also 5 dates made on human burials from Vlasac obtained through the National Science Foundation Arizona AMS Facility at the University of Arizona (AA-), and the details of these will be published by Price and Borić (*forthcoming*).

Bonsall et al. (*1997; 2000*) were first to note the problem with the aquatic reservoir effect when dating human burials. A similar problem occurs when dating dog bones in the Danube Gorges due to the intake of 'old carbon' from a foodweb that is in this

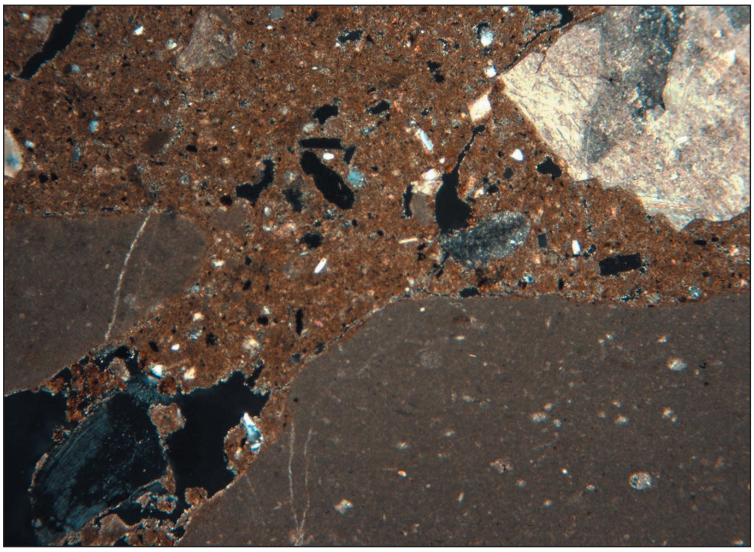


Fig. 12. Photomicrograph of horizontally oriented line of fine limestone fragments in context 145 of the possible trapezoidal structure (cross polarised light; frame width = 4.5 mm).

particular case dependent on freshwater sources (see also *Borić et al. 2004; Borić and Miracle 2004; Grupe et al. 2003*). Several methods were suggested for the correction of these dates that appear too old and require a correction before they are calibrated (*Cook et al. 2002*). For the correction of the results made on human burials we used method 2 suggested by Cook et al. (*2002*) (see Table 1 in Appendix).

Addressing this problem of correction of reservoir affected dates made on human and dog bones from Vlasac and other sites in the Danube Gorges, most recently, two of us (DB and VD) obtained 16 new AMS dates through the Oxford Radiocarbon Accelerator Dating Service (ORADS) funded by the Arts and Humanities Research Council (AHRC) and the Natural Environmental Research Council (NERC) of the UK. From this group of dates 13 dates were made on animal and three on human bones (Tab. 1 – in Appendix). There are six new AMS results that date features from new excavations at Vlasac and 10 dates were made on the material from old collections. This new dating programme was partly designed to establish the date for the occupation of trapezoidal dwellings, which in their rudimentary form occur at Vlasac for the first time. Trapezoidal structures had been assigned to Srejović and Letica's phase I and it was necessary to establish the exact date for the construction and occupation of these features bearing in mind that this architectural form plays an important part in chronologically later developments found at Lepenski Vir. Several other samples were chosen to test previous dates on charcoal or human bones that produced problematic dates, and, also, to date contexts from new excavations at Vlasac.

All available dates[2] from this site are presented in Table 1 (in Appendix), grouped by context or by their stratigraphic relations with one another where possible. In the following we discuss this dating evidence. We are aware of the necessity to provide adequate Bayesian modeling of these groups of dates and the given ranges are for the moment only coarse estimates.

Dwelling 1 (phase Ia) (see Figs. 2, 14)

There are three old, conventional dates from this building (Bln-1051, Bln-1051a and Z-262), dating samples that were allegedly collected from the floor of the building (spit 26). These dates give respective ranges 5988 to 5642, 5893 to 5522 and 6032 to 5720 cal BC at 95 per cent confidence. These rather Middle Neolithic dates do not correspond with two new AMS dates obtained on animal bones found on the dwelling floor (spit 25): OxA-16214 and OxA-16215 give ranges 7163 to 6818 and 7042 to 6699 cal BC at 95 per cent confidence. There are two other old charcoal dates (Bln-1050 and LJ-2047a) that come from the same excavation square C/III where Dwelling 1 is located but from upper levels (spits 15 and 22) assigned by the excavators to phase Vlasac II. Surprisingly, these two dates are in a much better agreement with the two new AMS dates from the building floor and give ranges 7082 to 6574 and 7049 to 6642 cal BC at 95 per cent confidence. The explanation for these similar ranges of charcoal samples at higher levels (almost 1m in the case of Bln-1050) than the floor level of Dwelling 1 can perhaps be related to the fact that the trapezoidal dwellings at Vlasac were dug into the sloping terrace or placed into existing depressions in the terrain (Fig. 14). Hence these charcoal samples might have come from the area outside of the semi-subterranean dwelling (*i.e.* on the level from which the dwelling was dug, representing the level

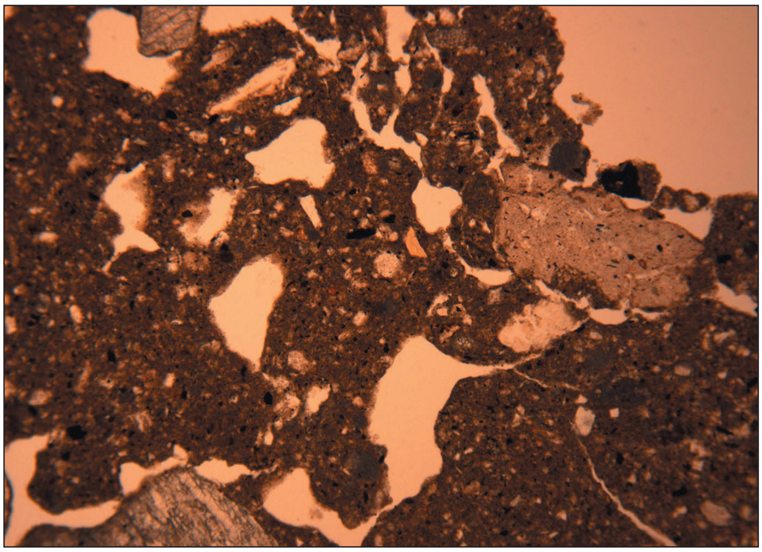


Fig. 13. Photomicrograph of very fine bone and charcoal inclusions in context 145 of the possible trapezoidal structure (plane polarised light; frame width = 4.5 mm).

2 One should note that the dating results of the nitrogen activation analysis of Vlasac burials (Butzko et al. 1978) cannot be accepted as reliable and are not listed here.

of the occupation horizon on the slope outside the dwelling). On the other hand, there are two ways to explain the inconsistency of the first three charcoal dates from Dwelling 1 with the rest of now existing dates in the area of this building. The first explanation is to reject the three charcoal dates as statistical outliers. The second explanation, given their consistent Middle Neolithic dates, is to assume some type of later intrusion from the level of the Middle Neolithic occupation of the site (see below) to which excavators assign a significantly thick layer (80cm) exactly in the area of squares C/I, C/II and C/III (*Srejović and Letica 1978.13*). This type of possible intrusions are seen on the published section from this area of the site, where phase Vlasac III is non-existent (*Srejović and Letica 1978.profil 14*). At present, we can only speculate how this charcoal of later date reached the floor of Dwelling 1 in spit 26 where it was allegedly collected. New AMS dates indicate the chronological framework for the construction and use of this dwelling sometime in the first century after 7000 cal BC.

Fig. 14. Dwelling 1 from Vlasac with reddish flooring (2.70m long and 1.20m wide) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

Dwelling 2 (phase Ia) and Burial 31 (phase I) (see Figs. 2, 15)

There are two older dates on charcoal (Bln-1053 and Bln-1014) from this feature and both of these, similarly to charcoal samples from the floor of Dwelling 1, give Middle Neolithic dates in the range 5983 to 5618 and 5966 to 5534 cal BC at 95 per cent confidence. We may either reject these dates as outliers or suppose some sort of intrusion as the excavators mention a thin layer of Eneolithic occupation in square a/18 where Dwelling 2 is found (*Srejović and Letica 1978.11*). To check the dating of this feature, we have dated a roe deer skull with antlers that was found lying on the floor of the building (*Srejović and Letica 1978.22*). OxA-16216 dates this sample in the range of 7047 to 6699 cal BC at 95 per cent confidence. This date corresponds very well with the two dates obtained from the floor of Dwelling 1, and may indicate the overall contemporaneity of construction and use of these two dwellings. We have also dated a red deer tool that was marked as coming from the area beneath the floor of this

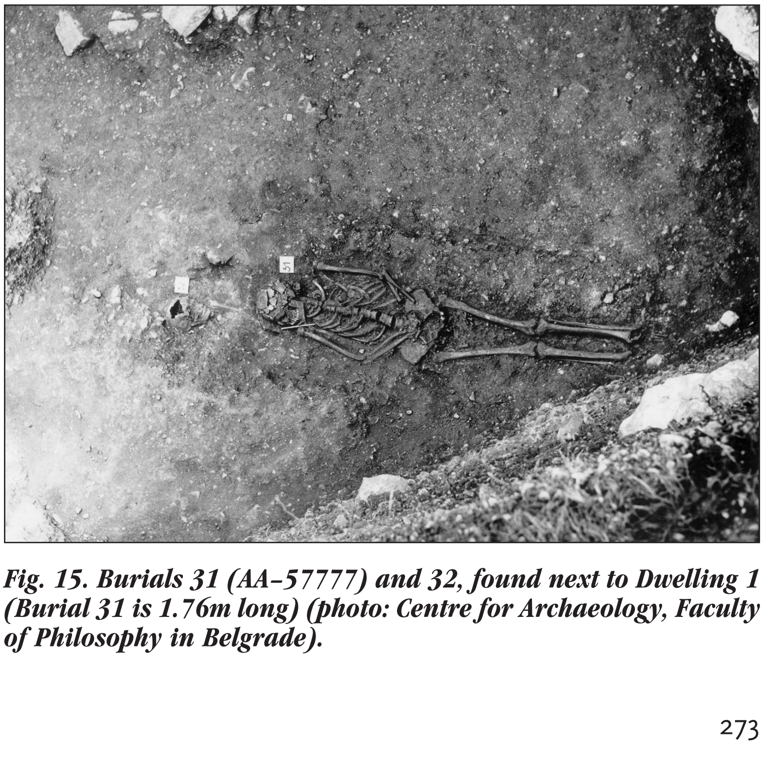


Fig. 15. Burials 31 (AA-57777) and 32, found next to Dwelling 1 (Burial 31 is 1.76m long) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

dwelling. The obtained OxA-16217 gives the range 6900 to 6593 cal BC at 95 per cent confidence. This date is younger than expected and may indicate a later intrusion. It is likely that the date does not come directly from beneath the floor of the dwelling, what we initially assumed when choosing it for dating, but from the level on its side, *i.e.* lower than the floor of Dwelling 2 but next to it rather than directly beneath the floor. This possibility is perhaps also supported by the new date AA-57777 for Burial 31 (Fig. 15). After the correction for the freshwater reservoir effect, Burial 31 is dated in the similar range 6823 to 6436 cal BC at 95 per cent confidence. Srejović and Letica (*1978.21*) note that Dwelling 2 was damaged along its south-eastern side by interment of Burials 32 and 31 (see Fig. 2). Burial 31 was found 20cm below the floor level of Dwelling 2 and in the same spit 23 as the red deer antler tool dated by OxA-16217. Hence it is likely that Dwelling 2 was partly damaged by later Mesolithic intrusions.

Dwelling 3 (phase Ib) (see Fig. 2)

The new OxA-16218 date for a red deer antler found on the floor of Dwelling 3 is in the range 7028 to 6651 cal BC at 95 per cent confidence and confirms the contemporaneity of this feature with Dwellings 1 and 2 (see above).

Dwelling 4 (phase Ib) (Figs. 2, 16–17)

Earlier charcoal date Bln-1170 dates this dwelling in the range 7036 to 6496 cal BC at 95 per cent confidence and corresponds very well with the range of dates obtained for Dwellings 1 to 3. With new OxA-16219 we have now dated a modified red deer antler from the floor of Dwelling 4 that surprisingly gives the range 9756 to 9321 cal BC at 95 per cent confidence. It is very unlikely that this date represents the actual date for the construction/use of this feature and it is more likely that it represents residual materials that come from layers much older than the use of this dwelling. A similar phenomenon was observed at the site of Lepenski Vir (*Borić and Dimitrijević in press*). Due to the specificity of the process of construction of buildings at these sites by cutting into the sloping terrace, older occupation zones are turned over and re-deposited, which brings older, residual materials into stratigraphically and chronologically later contexts. However, this early date for the occupation of Vlasac is important as it indicates the existence of the earliest occupation zone at the site that can be attributed to the regional Early Mesolithic. With a similarly early date obtained for Burial 72 (see below), one may suggest that the site was used in the early phases of the regional Early Mesolithic. Traces of this Early Mesolithic occupation are preserved sporadically at Vlasac. There is one more date that can be connected to Dwelling 4: AA-58321 dates Burial 25 that was found some 90cm above the floor level of the building and thus gives a *terminus ante quem* for the occupation of Dwelling 4 in the range 7026 to 6481 cal BC at 95 per cent confidence (after the correction for the freshwater reservoir effect). This date overlaps with the occupation of Dwelling 4 and may indicate a quick infill of the dwelling cut over the floor area before Burial 25 was interred here. Yet, only modelling of these dates within the Bayesian statistical framework may indicate a more precise tempo of these processes.

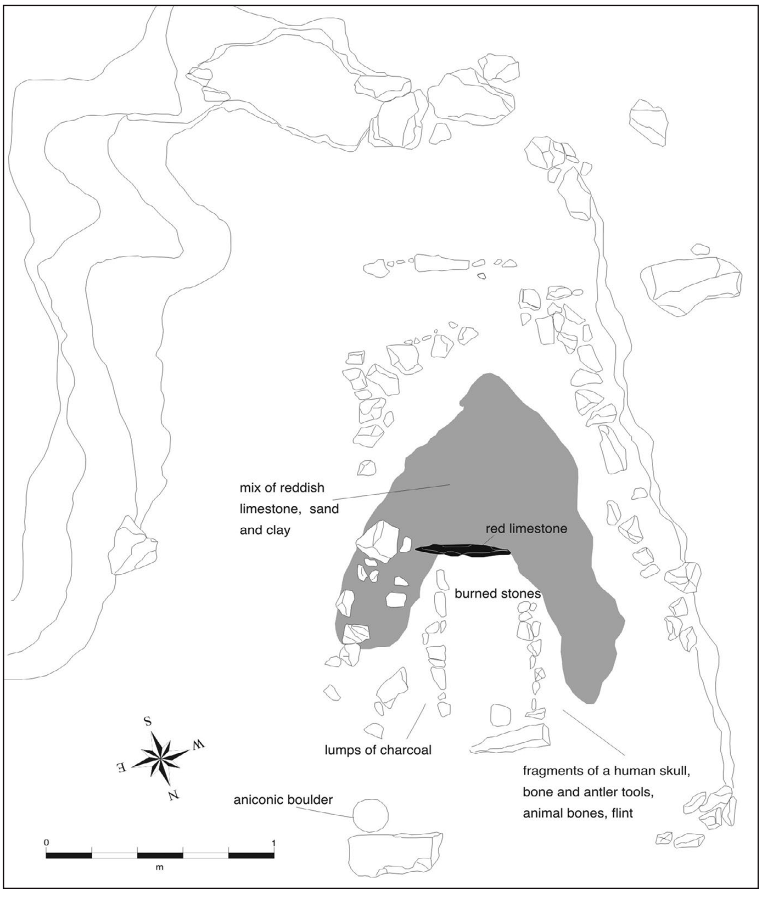


Fig. 16. Dwelling 4 from Vlasac (adopted after **Srejović and Letica 1978.Fig. 12***).*

Dwelling 5 (phase Ib) (see Fig. 2)

This dwelling is dated (OxA-16543) by a typologically characteristic bone chisel from an aurochs' metapodial (Fig. 18) found on the floor of this feature. The date is in the range 7034 to 6693 cal BC at 95 per cent confidence. This dating significantly overlaps with previous dates obtained for four other dwellings that all had traces of reddish limestone flooring around the rectangular stone-lined hearths (see above).

Hearths 20 (phase II) and 16 (phase III) (see Fig. 2)

The layer beneath Hearth 16 has previously been dated with Z-267 made on charcoal in the range 6592 to 6236 cal BC at 95 per cent confidence. There is another conventional ^{14}C date (Bln-1168) made on charcoal from this square, which gives a partly overlapping range 6496 to 6093 cal BC at 95 per cent confidence. In order to check previously obtained dates on charcoal, we have dated a red deer antler found beneath Hearth 16 with OxA-16080 and OxA-16220 (duplicate) which give almost identical ranges 6638 to 6479 and 6634 to 6474 cal BC at 95 per cent confidence. These new dates are in agreement with the previous charcoal dates from this area and suggest mid-7th millennium BC use of this part of the settlement. Almost exact overlap of Hearths 20 (at 64.81 m asl) and 16 (at 65.18 m asl) may indicate a relatively short period for the accumulation of deposits between them (see *Srejović and Letica 1978.T. XVII*). Assigning these two hearths to two different phases could be problematic. One is left to speculate whether the construction of a new hearth at the same place here related to the intensity of downslope movement and scree accumulation (see above), which slowly buried previously used features and the area around them, or to ideas about a symbolic renewal of a particular social place.

Burial 72 and Hearth 23 (both phase I) (see Fig. 2)

OxA-5824 dates Burial 72 and after the correction for the freshwater reservoir effect gives the range 9756 to 8804 cal BC at 95 per cent confidence. It is currently the oldest dated human burial from Vlasac. This burial is found 30cm below Hearth 23 along its eastern side. The excavators date this burial to the earliest phase Vlasac I (*Srejović and Letica 1978.57*). Radovanović (*1996.217*) rephases Burial 72 into her later phase burial. In order to check this surprisingly early date, we have dated a wild boar tusk tool found in association with Burial 72 (*Borić 2002b.Appendix 4*). The obtained OxA-16221 gives the range 7033 to 6686 cal BC at 95 per cent confidence. This Late Mesolithic date has not resolved the problem with this early date on Burial 72. The new AMS date on the wild boar tusk tool should probably be considered as representative for the dating of Hearth 23, which might have been contemporaneous with the construction/occupation of dwellings with floored areas around them since it was placed in the virgin soil. In the light of recently obtained OxA-16219 from Dwelling 4 that suggested the existence of Early Mesolithic levels at Vlasac (see above), the problematic OxA-5824 can be considered as certainly dating a human bone of an early Mesolithic age given its isotopic signature. What is not quite certain is whether the sample for this date came from Burial 72 or from a loose human bone fragment that might have been found in its vicinity and was collected as Burial 72, since no information is available on what skeletal part was dated. It is important to mention that in the area of the site where this burial was found, behind the rocky plateau (see above), one finds the most deeply stratified deposits, which may contain materials more than a millennium earlier than the phase of dwellings with floors that has now been dated to the beginning of the 7th millennium BC. In addition, an older charcoal date (Bln-1169) from this square, collected at the level of spit 14,

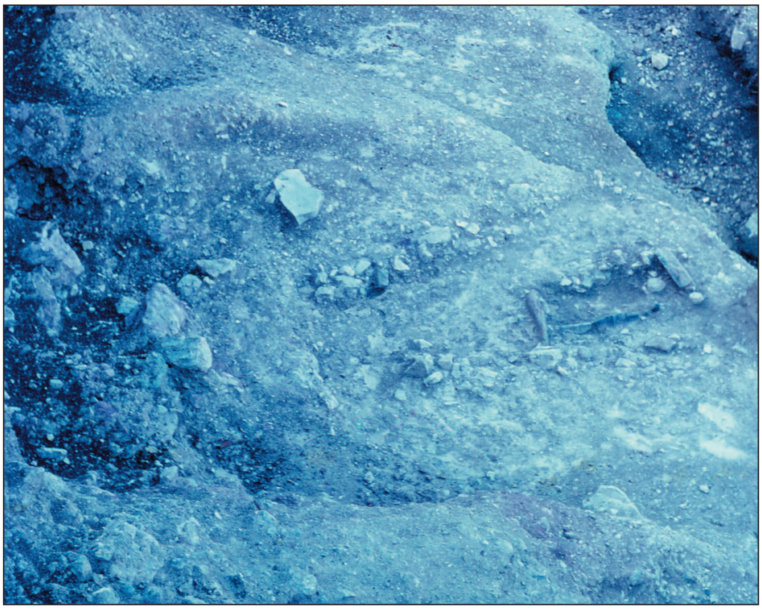


Fig. 17. Dwelling 4 from Vlasac, north-facing (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

gives a later Mesolithic date in the range 6744 to 6295 cal BC at 95 per cent confidence, indicating that the location remains in use throughout the Late Mesolithic.

Burial 17 (phase I) (Fig. 19) and phases II and III in square A/II

AA-57776 dates one of the most intriguing burials from Vlasac: Burial 17 was placed in a sitting position with crossed legs (Fig. 19). After the correction for the reservoir effect the date is in the range 8286 to 7749 cal BC at 95 per cent confidence. This early Mesolithic date has an overlapping range with the dates obtained for burials found in the same position at other sites (for Padina see *Borić and Miracle 2004* and for Lepenski Vir see *Bonsall et al. 2004; Radovanović 2006.Fig. 4*). At present, there are no other dates that overlap with the dating of Burial 17. In the same square A/II, from spit 14, comes a charcoal date LJ-2047 with the range 6438 to 6213 cal BC at 95 per cent confidence. This date indicates that the location continued to be used throughout the Late Mesolithic.

Fig. 18. Bone chisel (OxA-16543) made on an aurochs' metapodial (my inv. 1271) from the floor of Dwelling 5 (© D. Borić).

Burials 54, 45 and 51a (phase I) (see Figs. 2, 20, 21)

There is a complex sequence of overlapping and inter-cut features, such as hearths and burials, in squares A/17 and A/18. We have 3 dates from three burials in this zone. All three burials had to be corrected for the freshwater reservoir effect. AA-57778 dates Burial 45 in the range 6654 to 6411 cal BC at 95 per cent confidence. Only the skull and part of the right arm survived from this burial as it was cut by a later interment of Burial 55. Burial 55 was covered by Hearth 17. Burial 54 was found as a pile of disarticulated bones and was covering articulated inhumation Burial 53 found beneath it (Fig. 20). OxA-5823 for Burial 54 is in the range 7024 to 6394 cal BC at 95 per cent confidence after the correction for the reservoir effect. This date predates Hearth 17 and postdates child Burial 53. These ranges overlap and may indicate that this complex sequence was formed over a relatively short period of time in the mid-7th millennium BC. There is an older charcoal date (Z-264) from Burial 54 in the range 5480 to 5062 cal BC at 95 per cent confidence. It must represent a later intrusion in this burial zone that brought the remains of younger charcoal in association with Burial 54. In the vicinity of this sequence, closer to the river edge, there are several burials that were covered by later stone-lined rectangular Hearths 19 and 19a (Fig. 21). One of these burials, Burial 51a, is dated with OxA-5822 in the range 7572 to 7082 cal BC at 95 per cent confidence. This is the oldest date for the Late Mesolithic sequence of burials at Vlasac and likely predates the construction of dwellings with floors, which are built only after 7000 cal BC. Although all three burials were assigned to phase I, it is clear now that they can be confined to the Late Mesolithic development, with Burial 51 relating to an earlier phase of the Late Mesolithic, in the second half of the 8th millennium BC, while Burials 45 and 54 can be assigned to a later part of this

Fig. 19. Burial 17 (AA-57776) in sitting position with crossed legs (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

likely continuous development throughout the 7th millennium cal BC.

Burial 6 (phase III) and square a/6

Dates from this part of Vlasac somewhat help us understand the stratigraphic sequence in this central part of the settlement. A previous charcoal date Z–268 that was associated with Burial 11 gives the range of 5762 to 5480 cal BC at 95 per cent confidence, which is a Middle Neolithic date and is likely an intrusion from upper levels. This is not surprising in this central part of the settlement, just behind the rocky plateau, as archaeological levels here have an average thickness of only 50cm and the excavators mention a single, homogenous horizon with burials and very little other material (*Srejović and Letica 1978.12*). AA–57775 dates Burial 6, found in this zone, in the range 6600 to 6235 cal BC at 95 per cent confidence, and we may assume that most of other burials in this square can be connected with this later phase of the Late Mesolithic use of Vlasac as a burial ground.

Other Late Mesolithic dates from Vlasac

There are several other dates from Vlasac that have also given mid-7th millennium dates for the use of the site for burial interments. OxA–5825 and OxA–5826 date Burials 24 and 83 respectively (see Fig. 2) in the ranges 6640 to 6220 and 7024 to 6430 cal BC at 95 per cent confidence after the correction for the reservoir effect. There is also a date in the similar range for the first discovered burial in the course of new excavation work at Vlasac (*Borić 2006*): OxA–16541 dates burial context 2 in the range 6775 to 6470 cal BC at 95 per cent confidence. Three more charcoal dates (Bln–1171 Bln–1052, and Bln–1054) from two different zones of the settlement give partly overlapping ranges 7030 to 6478, 6644 to 6250 and 6460 to 6085 cal BC at 95 per cent confidence, confirming the intensity of inhabiting and/or using this locale for burial purposes in the course of the Late Mesolithic, and especially in the course of the 7th millennium BC.

Sequence with the dwelling floor and burials in Trench 3/2006

There are several new dates for the sequence of burials above the possible dwelling floor level excavated in the course of renewed work at Vlasac. This is an important feature as it provides well-stratified contexts that indicate the continuity in the use of this location throughout the Late Mesolithic, transformational/Early Neolithic and Middle Neolithic phases in the Danube Gorges. The transformational/Early Neolithic phase is best represented at the site of Lepenski Vir with the phase of trapezoidal buildings (*Borić and Dimitrijević 2007; in press*). The newly discovered burial sequence at Vlasac for the first time indicates the existence of this transformational phase at this site too, while associated items of material culture indicate the process of cultural transformation that was taking place at the time. Here is the brief description of the sequence with associated AMS dates and their stratigraphic positions.

At the bottom of the sequence, the reddish burned flooring (context 149) (Fig. 10) of a possible semi-subterranean dwelling had only a partly preserved rear area and one is left to speculate whether it might have had a trapezoidal shape since the Danube waters eroded away the front part of this feature. It seems that upon the abandonment of this feature a layer of sterile soil (context 145) was intentionally placed over the floor, while there are several cremation pits found around this dwelling floor with traces of intense burning and containing burned human remains. These pits must have been dug at a later date around the abandoned depression. From this area comes the AMS dated projectile point (OxA–16540), which gives the range 6654 to 6484 cal BC at 95 per cent confidence and thus likely postdates the

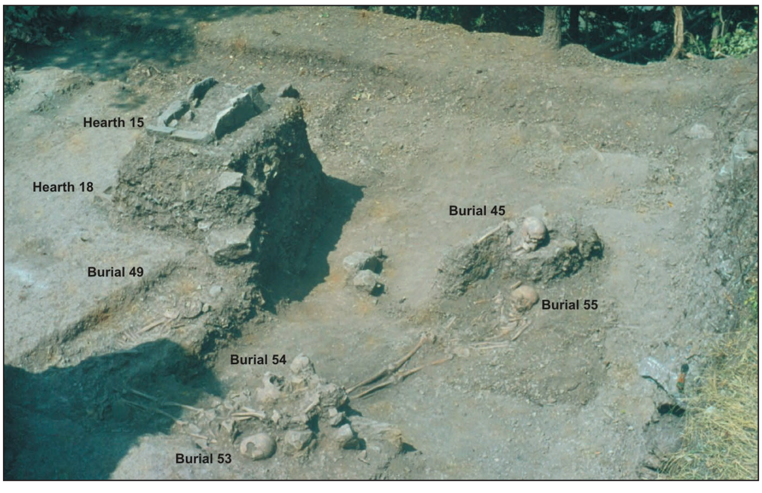


Fig. 20. Burials 55 (176cm long), 45 (AA–57778), 53, 54 (OxA–5823) and 49, after lifting Hearth 17; Hearths 15 and 18 in the background (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

Fig. 21. Burial 51a (OxA-5822) and Hearth 19 (1.05m long) (photo: Centre for Archaeology, Faculty of Philosophy in Belgrade).

occupation at the dwelling floor. Assuming that this dwelling floor was similar to other dwellings found during the first excavations at the site and now dated sometime in the first century after 7000 BC, we may expect a similar date for the construction/occupation of this floored feature. The first burial interred in this area could have been either adult disarticulated Burial context 136, child Burial context 297 or adult Burial context 232, which was placed over an oval cremation pit containing burned human remains and bone projectile points (Feature 26). Burial context 136 was damaged by one of the cremation pits and only its right leg below knees and feet survived in the articulated position. This burial is now dated with OxA-18865 in the range 6775 to 6473 cal BC at 95 per cent confidence after the correction for the reservoir effect. At a higher level along the same axis and with the same position and orientation Burial context 81 was found, again damaged by the interment of headless adult inhumation Burial context 63, found cutting through it. Burial context 63 is after the correction for the freshwater reservoir effect dated with OxA-16542 in the range 6232 to 6018 cal BC at 95 per cent confidence. This is presently the youngest date for a burial at Vlasac found buried according to the typical Mesolithic burial rite. Here, finds of Spondylus beads as well as red and white limestone beads, identical to those found in several burials from Lepenski Vir (see *Borić 2006; 2007b*), indicate the effect of cultural changes in the region through the acceptance of new, Neolithic-looking ornaments, which sits very well with the obtained date. There was a partly burned child burial placed over the chests of Burial context 63. Burial context 63 was damaged on its left side by the interment of neonate Burial contexts 62 and 69, found one on top of the other. Another cremation pile was covering all these interments, while on the top of this cremation the last articulated burial, context 53 (Fig. 10), was placed along the same axis as previous burials, although with the head pointing in the opposite direction from other burials, *i.e.* upstream. It was covered with stone plaques over the head and the pelvis, and a red deer skull with antlers (context 19) was placed on top of it. OxA-16544 dates this red deer skull in the range 6006 to 5838 cal BC at 95 per cent confidence and this is currently the youngest AMS date from Vlasac, which corresponds very well with the stratigraphic position of older, dated Burial contexts 63 and 136. This date is also a *terminus post quem* for the layer with Starčevo pottery found on top of large stones that were covering this burial location. This pottery level is dated to the regional Middle Neolithic. OxA-16539 which was chosen to date this level of Middle Neolithic occupation in Trench 3/2006 has given a slightly earlier range than expected: 6393 to 6229 cal BC at 95 per cent confidence. It could be either that the Starčevo-type pottery found in the dated context is thus present at Vlasac already around this time, or, more likely, that with this date we dated slightly older, residual material found in a later stratigraphic context.

Summary of the dating evidence

The sequence of all available radiometric dates is shown in Fig. 22. At present, the radiometric evidence suggests that Vlasac might have been sporadically inhabited with possible burial interments (Burial 72) very early in the Holocene sequence, some time in the mid-10th millennium BC. A more secure date for the use of the site as a burial ground comes from the end of the 9th millennium BC or the beginning of the 8th millennium on the basis of the date for the only sitting burial with crossed legs found at Vlasac (Burial 17). The practice of burying selected individuals in a sitting position with crossed legs is found at several other sites in the region and has so far been dated at two other sites with an overlapping time range, suggesting of the same cultural phenomenon across this region even at this early date. A more intensive occupation/use of the site follows from the mid-8th millennium, which can be considered the start date of the Late Mesolithic in the region, and continues, most likely without interrup-

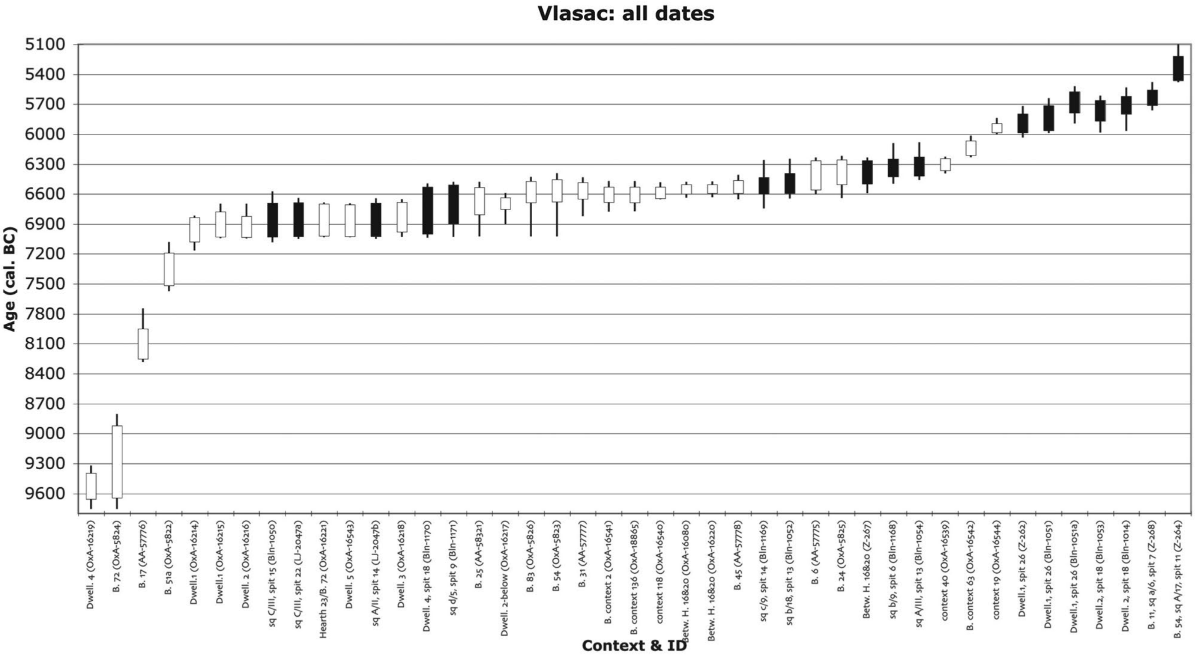


Fig. 22. Calibration ranges at 1 and 2 standard deviations (cal BC) of all dates from Vlasac. Dates calibrated with OxCal v. 4.0 (**Bronk Ramsey 1995; 2001*****). Solid bars show 1 s.d.; lines show 2 s.d.. Black fill: charcoal/conventional dates; white fill: AMS dates.***

tions, for more than two millennia. First trapezoidal dwellings with experiments in providing a reddish limestone floor are built around or after 7000 BC and might have been contemporaneously occupied. It seems that this practice of flooring features dies out in the course of the 7th millennium. Only rectangular stone-lined hearths are built in the course of the 7th millennium, sometimes overlapping with each other. Whether this practice of building new hearths at the place of older similar features is only related to the symbolic renewal of these features (*cf. Borić 2003; 2007a*) or, also, to the pressing reality of downslope erosion of scree, which quickly accumulated over occupation areas after episodes of woodland clearance, remains an open question. There is now evidence, coming from new excavations at the site, that Vlasac remained in use, at least as a burial ground, throughout the period that saw the flourishing of the phase with trapezoidal buildings at Lepenski Vir, *i.e.* the period of transformational/Early Neolithic phase, *c.* 6200 to 5900 cal BC. There is also clear evidence for the Middle Neolithic use of the site, from both old as well as new excavations. A number of charcoal dates from Vlasac that were accidentally associated with older Mesolithic features and that gave the Middle Neolithic time spans could be connected with the use of the site during this later period. One should also add that the dating evidence does not support a scenario as suggested by Bonsall et al. (*2002*) that this site, along with some other sites in the Danube Gorges, might have been abandoned due to floods of large magnitude related to the 8.2 k BP event, *i.e.* from 6300–5950 cal BC (*cf. Borić and Miracle 2004*). Future Bayesian modelling should add greater chronological sharpness to these main trends that the current dating evidence offers.

Conclusions

The complex stratigraphic sequence at the Mesolithic-Neolithic site of Vlasac was examined by comparing details of stratigraphic relations established in the course of the first excavations at this site in the 1970s with the observations made in the course of renewed work at the site that started in 2006. It has also added new geoarchaeological and micromorphological examinations of these colluvial deposits. We suggest that the complexity of colluvial process, dependent on woodland clearance and downslope movement of scree, must be incorporated in an adequate understanding of formation processes at this site. The stratigraphy of Vlasac largely consists of hillwash deposits formed above a palaeosol found at the base of the stratigraphic sequence. Minor colluvial episodes continued to affect this soil, alternating with periods of stability and incipient soil development, and together led to slow soil aggradation and thickening throughout the later Mesolithic and into the Early and Middle Neolithic. This early Holocene soil is essentially a 'cumulative colluvial soil.'

Furthermore, cultural practices of cutting through older features and the complexity of placing features on the sloping terrace complicate any attempts to assign the same cultural horizon to features found on the same level. For example, due to the nature of placing trapezoidal, horizontally levelled areas on these slopes, similar to other sites in this region, such as Lepenski Vir and Padina, the phenomenon of residual materials ending up in later, secondary stratigraphic contexts is a serious potential danger when attempting to assign cultural materials to a particular feature without the help of absolute dating.

Previous and new radiometric dates to a great extent clarify stratigraphic matters. The current dating evidence does not correspond very well with the phasing of the site into phases Vlasac I(a–b), II and III as suggested by the first excavators of the site. The inconsistencies are clearly shown by comparing obtained dates with phases that excavators assigned to particular features (Tab. 1 – Appendix). These phases can have a heuristic value only at particular locations to distinguish the sheer verticality of deposited layers one on top of the other. However, it is impossible to use them as meaningful chronological entities across the site, and the combination of new field research and continuing radiometric dating of particular contexts along with the re-examination of archaeological collections from the old excavations can be the way forward in sketching a more reliable cultural stratigraphy of Vlasac.

ACKNOWLEDGEMENTS

We would like to acknowledge the funding received for the archaeological excavations at the site of Vlasac through the British Academy grants (SG–42170 and LRG–45589) and the McDonald Institute for Archaeological Research, University of Cambridge grants in the period 2006–2008. We acknowledge the funding for the dating project that was provided through the Oxford Radiocarbon Accelerator Dating Service NERC–AHRC programme. Arizona Lab dates (AA-) were obtained in the course of the strontium isotope project made at the University of Wisconsin Madison with T. D. Price as the principal investigator and funded by the National Science Foundation (USA), grant number BCS–0235465. DB thanks the Leverhulme Research Programme "Changing beliefs of the human body: comparative social perspective" based at the University of Cambridge for funding his research in the course of which this paper was written. For comments on an earlier draft of this paper we are grateful to Ben Davenport.

∴

REFERENCES

BANU A. 1972. *Geology, in The Iron Gates Complex Atlas*. Bucuresti: 157–161.

BONSALL C., LENNON R., MCSWEENEY, K. STEWART C., HARKNESS D., BORONEANŢ, V., BARTOSIEWICZ L., PAYTON R. and CHAPMAN J. 1997. Mesolithic and early Neolithic in the Iron Gates: a palaeodietary perspective. *Journal of European Archaeology 5(1): 50–92.*

BONSALL C., COOK G., LENNON R., HARKNESS D., SCOTT M., BARTOSIEWICZ L. and MCSWEENEY K. 2000. Stable isotopes, Radiocarbon and the Mesolithic-Neolithic Transition in the Iron Gates. In M. Budja (ed.), *7th Neolithic Studies. Documenta Praehistorica 27: 119–132*.

BONSALL C., MACKLIN M., PAYTON R. and BORONEANŢ A. 2002. Climate, floods and river gods: environmental change and the Meso-Neolithic transition in southeast Europe. *Before Farming 3–4(2): 1–15*.

BONSALL C., COOK G. T., HEDGES R. E. M., HIGHAM T. F. G., PICKARD C. and RADOVANOVIć I. 2004. Radiocarbon and stable isotope evidence of dietary changes from the Mesolithic to the Middle Ages in the Iron Gates: new results from Lepenski Vir. *Radiocarbon 46(1): 293–300*.

BORIĆ D. 2002a. The Lepenski Vir conundrum: reinterpretation of the Mesolithic and Neolithic sequences in the Danube Gorges. *Antiquity 76: 1026–1039*.

2002b. *Seasons, life cycles and memory in the Danube Gorges, c. 10 000–5500 BC.* Unpublished Ph.D. Dissertation. University of Cambridge.

2003. 'Deep time' metaphor: mnemonic and apotropaic practices at Lepenski Vir. *Journal of Social Archaeology 3(1): 41–75*.

2006. New discoveries at the Mesolithic-Early Neolithic site of Vlasac: Preliminary notes. *Mesolithic Miscellany 18(1): 7–14*.

2007a. The House Between Grand Narratives and Microhistories: A House Society in the Balkans. In R. A. Beck Jr. (ed.), *The Durable House: House Society Models in Archaeology*. Center for Archaeological

Investigations. Occasional Paper No. 35. Carbondale: 97–129.

2007b. Mesolithic-Neolithic Interactions in the Danube Gorges. In J. K. Kozłowski and M. Nowak (eds.), *Mesolithic-Neolithic Interactions in the Danube Basin*. Archaeopress. Oxford: 31–45.

BORIĆ D. and DIMITRIJEVIĆ V. 2007. When did the 'Neolithic package' reach Lepenski Vir? Radiometric and faunal evidence. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica 34: 53–72*.

(in press) Apsolutna hronologija i stratigrafija Lepenskog Vira (Absolute Chronology and Stratigraphy of Lepenski Vir). *Starinar*.

BRONK RAMSEY C. 1995. Radiocarbon calibration and analysis of stratigraphy: the OxCal Program. *Radiocarbon 37(2): 425–430*.

2001. Development of the radiocarbon program OxCal. *Radiocarbon 43(2A): 355–363*.

BUCZKO C. M., NEMESKÉRI J. and SAS L. 1978. Age dating of bones from Vlasac. In M. Garašanin (ed.), *Vlasac – mezolitsko naselje u Djerdapu (II)*. Srpska akademija nauka i umetnosti. Beograd: 75–76.

BULLOCK P., FEDOROFF N., JONGERIUS A., STOOPS G. and TURSINA T. 1985. *Handbook for Soil Thin Section Description*. Waine Research. Wolverhampton.

COOK G., BONSALL C., HEDGES R. E. M., MCSWEENEY K., BORONEANŢ V., BARTOSIEWICZ L. and PETTITT P. B. 2002. Problems of dating human bones from the Iron Gates. *Antiquity 76: 77–85*.

FRENCH C. 2007. *Vlasac and Environs, Danube Gorges, Serbia: Geoarchaeological Assessment*. Unpublished report, Department of Archaeology, University of Cambridge.

2008. *Preliminary micromorphological analysis of the palaeosol at Vlasac, Serbia*. Unpublished report, Department of Archaeology, University of Cambridge.

GRUBIĆ A. 1972. Nastanak i prirodne osobenosti Đerdapske klisure. In A. Spasić (ed.), *Neimari Đerdapa 1964–1971*. Export press. Beograd: 11–14.

GRUPE G., MANHART H., MIKIĆ Ž. and PETERS J. 2003. Vertebrate food webs and subsistence strategies of Meso- and Neolithic populations of central Europe. In G. Grupe and J. Peters (eds.), *Documenta Archaeobiologiae 1. Yearbook of the State Collection of Anthropology and Palaeoanatomy, München, Germany*. Rahden/Westf. Verlag M. Leidorf: 193–213.

MARKOVIĆ-MARJANOVIĆ J. 1978. Geologija i stratigrafija. In M. Garašanin (ed.), *Vlasac – mezolitsko naselje u Djerdapu Vol. II*. Srpska akademija nauka i umetnosti. Beograd: 11–27.

MATTHEWS W., FRENCH C., LAWRENCE T. and CUTLER D. 1996. Multiple surfaces: the micromorphology. In I. Hodder (ed.), *On the surface: Çatalhöyük 1993–95*. McDonald Institute for Archaeological Research/British Institute of Archaeology at Ankara Monograph 22. Cambridge: 301–342.

MATTHEWS W., FRENCH C., LAWRENCE T., CUTLER D. F. and JONES M. 1997. Microstratigraphic traces of site formation processes and human activities. *World Archaeology 29(2): 281–308*.

MURPHY C. P. 1986. *Thin section preparation of soils and sediments.* AB Berkhamsted. Academic.

NEMESKÉRI J. 1978. Demographic structure of the Vlasac Epipalaeolithic population. In M. Garašanin (ed.), *Vlasac – mezolitsko naselje u Đerdapu (II)*. Srpska akademija nauka i umetnosti. Beograd: 97–133.

PRICE T. D. and BORIĆ D. (forthcoming) Foragers and Farmers in the Danube Gorges: Mobility, Interaction, and Exchange. *Journal of Anthropological Archaeology*.

QUITTA H. 1975. Die Radiocarbondaten und ihre historische Interpretation. In D. Srejović (ed.), *Lepenski Vir. Eine vorgeschichtliche Geburtsstätte europäischer Kultur*. Gustav Lübbe Verlag. Bergisch Gladbach: 272–285.

RABRENOVIĆ D. and VASIĆ N. 1997. Characteristics of Jurassic and Lower Crataceous of Geticum – Golubac Mts. In A. Grubić and T. Berza (eds.), *Geology in the Danube Gorges*. International Symposium, Donji Milanovac-Orsava, 23.–26.IX 1997, Geoinstitute Special edition 25: 181–190.

STEVANOVIĆ Z. 1997. Characteristics of Karst Areas in Djerdap Zone. In A. Grubić and T. Berza (eds.), *Geology in the Danube Gorges*. International Symposium, Donji Milanovac-Orsava, 23.–26.IX 1997, Geoinstitute Special edition 25: 181–190.

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

2006. Further notes on Mesolithic-Neolithic contacts in the Iron Gates Region and the Central balkans. In M. Budja (ed.), *13th Neolithic Studies. Documenta Praehistorica 33: 111–128*.

ROKSANDIĆ M. 1999. *Transition from Mesolithic to Neolithic in the Iron Gates gorge: Physical anthropol-*

ogy perspective. Unpublished Ph.D. dissertation, Department of Anthropology, Simon Fraser University, Vancouver.

2000. Between Foragers and Farmers in the Iron Gates Gorge: Physical Anthropology Perspective. Djerdap Population in Transition from Mesolithic to Neolithic. In M. Budja (ed.), *7th Neolithic Studies. Documenta Praehistorica 27: 1–100*.

SREJOVIĆ D. 1972. *Europe's First Monumental Sculpture: New Discoveries at Lepenski Vir*. Thames and Hudson. London.

SREJOVIĆ D. and LETICA Z. 1978. *Vlasac. Mezolitsko naselje u Djerdapu (I arheologija)*. Srpska akademija nauka i umetnosti. Beograd.

WHITTLE A., BARTOSIEWICZ L., BORIĆ D., PETTITT P. and RICHARDS M. 2002. In the beginning: new radiocarbon dates for the Early Neolithic in northern Serbia and south-east Hungary. *Antaeus 25: 63–117*.

2005. New radiocarbon dates for the Early Neolithic in northern Serbia and south-east Hungary. *Antaeus 28: 347–355*.

∴

APPENDIX

Tab. 1. Radiometric dates from Vlasac on charcoal (17 dates), human (13 dates from 13 contexts) and animal (13 dates from 12 contexts) bones. Dates are calibrated with OxCal v. 4.0 (*Bronk Ramsey 1995; 2001*). Ages are corrected for those that have δ15N values >+10‰ (affected by the aquatic reservoir effect), using Method 2 as suggested by Cook et al. (*2002*). The δ15N values used to estimate percentage of aquatic diet; a = 100% reservoir correction applied (440 ± 45 years); b = 50% reservoir correction applied (220 ± 23 years).

Laboratory code	Sample no. and material	Radiocarbon age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Calibrated date (68% and 95% confidence)
Dwelling 1 (phase Ia)					
Bln–1050	1/70, charcoal from square C/III (Sonda A), spit 15 (phase II)	7935 ± 100	–	–	68.2% probability 7028 BC (21.8%) 6931 BC 6920 BC (9.8%) 6878 BC 6848 BC (36.6%) 6691 BC 95.4% probability 7082 BC (95.3%) 6590 BC 6578 BC (0.1%) 6574 BC
LJ–2047a	charcoal from square C/III, spit 22 (phase II)	7925 ± 77	–	–	68.2% probability 7025 BC (14.4%) 6966 BC 6948 BC (3.3%) 6934 BC 6916 BC (9.0%) 6880 BC 6840 BC (41.5%) 6686 BC 95.4% probability 7049 BC (95.4%) 6642 BC
Z–262	charcoal from Dwelling 1 in square C/III (Sonda A), spit 26 (4.1 m below the surface)	7000 ± 90	–	–	68.2% probability 5984 BC (68.2%) 5798 BC 95.4% probability 6032 BC (95.4%) 5720 BC
Bln–1051	2/70, charcoal from Dwelling 1, C/III (Sonda A), spit 26	6915 ± 100	–	–	68.2% probability 5964 BC (1.6%) 5958 BC 5901 BC (66.6%) 5715 BC 95.4% probability 5988 BC (95.4%) 5642 BC
Bln–1051a		6790 ± 100	–	–	68.2% probability 5786 BC (66.9%) 5616 BC 5581 BC (1.3%) 5575 BC 95.4% probability 5893 BC (95.4%) 5522 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
OxA–16214	VL40, brown bear canine from the floor of Dwelling 1 in square C/IV, spit 25, my inv. 1797	8055 ± 45	–19.5	8.4	68.2% probability 7080 BC (37.4%) 7023 BC 6968 BC (6.6%) 6946 BC 6936 BC (7.4%) 6914 BC 6882 BC (16.8%) 6836 BC 95.4% probability 7163 BC (0.2%) 7160 BC 7142 BC (95.2%) 6818 BC
OxA–16215	VL41, red deer antler tool from the floor of Dwelling 1 in square C/IV[3], spit 25, my inv. 1793	7960 ± 39	–21.3	7.8	68.2% probability 7028 BC (33.0%) 6930 BC 6922 BC (15.3%) 6876 BC 6860 BC (17.1%) 6804 BC 6788 BC (2.8%) 6778 BC 95.4% probability 7042 BC (90.3%) 6735 BC 6726 BC (5.1%) 6699 BC
Dwelling 2 (phase Ia) and Burial 31 (phase I)					
Bln–1053	4/70, charcoal from Dwelling 2 in square a/18, spit 18	6865 ± 100	–	–	68.2% probability 5868 BC (0.8%) 5866 BC 5846 BC (67.4%) 5660 BC 95.4% probability 5983 BC (4.9%) 5939 BC 5931 BC (90.5%) 5618 BC
Bln–1014	charcoal from Dwelling 2 in square a/18, spit 18	6805 ± 100	–	–	68.2% probability 5799 BC (68.2%) 5622 BC 95.4% probability 5966 BC (0.5%) 5957 BC 5902 BC (94.9%) 5534 BC
OxA–16216	VL43, roe deer skull from the floor of Dwelling 2 in square a/18, my inv. 1250	7970 ± 45	–22.1	5.8	68.2% probability 7033 BC (68.2%) 6821 BC 95.4% probability 7047 BC (90.4%) 6744 BC 6738 BC (0.5%) 6735 BC 6726 BC (4.5%) 6699 BC
AA–57777	Burial 31, cranial fragment of young adult male, extended, NE–SW, in square a/17, 2.64 m from the surface, spit 23 (64.04 m asl, 29/10/1970), next to the east side of Dwelling 2 and 20 cm below the floor level; on the right shoulder a large bone awl; Cyprinidae and *Cyclope neritea* beads	Uncorrected 8196 ± 69 Corrected 7756 ± 82[a]	–20.7	16.1	68.2% probability 6649 BC (68.2%) 6483 BC 95.4% probability 6823 BC (95.4%) 6436 BC
OxA–16217	LV44, red deer antler tool from the area below the floor of Dwelling 2 in square a/17, spit 23, my inv. 1265	7850 ± 40	–22.4	6.5	68.2% probability 6752 BC (13.3%) 6720 BC 6710 BC (54.9%) 6636 BC 95.4% probability 6900 BC (0.6%) 6890 BC 6826 BC (94.8%) 6593 BC

3 There seems to be a mistake in the labelling of the antler tool that we dated here. The labels on the antler tool indicate that they come from Dwelling 1 and square here should be C/III and not C/IV.

Laboratory code	Sample no. and material	Radiocarbon age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Calibrated date (68% and 95% confidence)
Dwelling 4 (phase Ib) and Burial 25 (phase II) – stratified					
AA–58321	Burial 25, cranial fragment of old adult male, extended W–E, in square C/V, 1.95 m from the surface (61.61 m asl); fragmented dog mandible on his chests	Uncorrected 8267 ± 56 Corrected 7827 ± 72[a]	–20.0	16.2	68.2% probability 6804 BC (3.0%) 6788 BC 6778 BC (62.0%) 6588 BC 6581 BC (1.9%) 6570 BC 6541 BC (1.2%) 6534 BC 95.4% probability 7026 BC (5.0%) 6964 BC 6949 BC (1.1%) 6934 BC 6917 BC (3.6%) 6880 BC 6842 BC (85.7%) 6481 BC
Bln–1170	3/71, charcoal from Dwelling 4[4] in square BC/V, spit 18	7840 ± 100	–	–	68.2% probability 7000 BC (1.2%) 6992 BC 6985 BC (1.9%) 6972 BC 6912 BC (4.2%) 6884 BC 6830 BC (59.0%) 6568 BC 6544 BC (1.9%) 6531 BC 95.4% probability 7036 BC (95.4%) 6496 BC
OxA–16219	VL47, red deer antler from the floor (60.7 m asl) of Dwelling 4 in square BC/V, my inv. 1808	10 000 ± 45	–21.1	6.7	68.2% probability 9655 BC (23.8%) 9576 BC 9552 BC (44.4%) 9394 BC 95.4% probability 9756 BC (4.5%) 9717 BC 9698 BC (90.9%) 9321 BC
Layer between Hearths 20 (phase II) and 16 (phase III)					
Bln–1168	1/71, charcoal from square b/9, spit 6 (phase II)	7475 ± 100	–	–	68.2% probability 6427 BC (68.2%) 6248 BC 95.4% probability 6496 BC (95.4%) 6093 BC
Z–267	beneath Hearth 16 in square b/9	7559 ± 93	–	–	68.2% probability 6497 BC (56.7%) 6352 BC 6310 BC (11.5%) 6264 BC 95.4% probability 6592 BC (95.4%) 6236 BC
OxA–16080	VL49, red deer antler tip fragment found beneath Hearth 16, in dark, burned soil (my inv. 1328)	7731 ± 39	–20.6	6.6	68.2% probability 6598 BC (68.2%) 6504 BC 95.4% probability 6638 BC (95.4%) 6479 BC
OxA–16220		7720 ± 38	–20.8	6.6	68.2% probability 6593 BC (68.2%) 6504 BC 95.4% probability 6634 BC (95.4%) 6474 BC
Burial 72 and Hearth 23 (phase I)					
Bln–1169	2/71, charcoal from square c/9, spit 14	7665 ± 100	–	–	68.2% probability 6601 BC (68.2%) 6434 BC 95.4% probability 6744 BC (0.6%) 6726 BC 6700 BC (92.7%) 6345 BC 6312 BC (2.1%) 6259 BC

4 In the listing of charcoal dates that Srejović and Letica (*1978.129*) provided, this sample is connected with Dwelling 5, while quadrants BC/V are given for Dwelling 4. There was some re-labeling of these features in the course of excavations and post-excavation analyses that must have caused this confusion, and it is almost certain that this sample comes from Dwelling 4 and not Dwelling 5.

Laboratory code	Sample no. and material	Radiocarbon age (BP)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	Calibrated date (68% and 95% confidence)
OxA–16221	VL51, wild boar tusk tool found in association with Burial 72, on the same level and next to Hearth 23	7936 ± 40	–20.7	7.0	68.2% probability 7022 BC (2.5%) 7012 BC 7005 BC (10.2%) 6970 BC 6944 BC (1.6%) 6938 BC 6914 BC (9.8%) 6882 BC 6832 BC (44.1%) 6698 BC 95.4% probability 7033 BC (95.4%) 6686 BC
OxA–5824	Burial 72, adult female extended, perpendicular to the Danube-head upslope in square c/9, 2.57 m from the surface (64.23 m asl), along the longer side of Hearth 23, 30 cm below the level of the hearth	Uncorrected 10 240 ± 120 Corrected 9800 ± 130[a]	–19.3	14.5	68.2% probability 9643 BC (2.2%) 9615 BC 9514 BC (0.3%) 9510 BC 9455 BC (57.7%) 9122 BC 9000 BC (8.0%) 8920 BC 95.4% probability 9756 BC (1.4%) 9716 BC 9700 BC (94.0%) 8804 BC
Burial 17 (phase I) and square A/II (phases II and III)					
LJ–2047b	charcoal from square A/II, spit 14 (phase II)	7930 ± 77	–	–	68.2% probability 7025 BC (14.9%) 6966 BC 6948 BC (3.4%) 6934 BC 6916 BC (9.3%) 6880 BC 6840 BC (40.6%) 6690 BC 95.4% probability 7048 BC (95.4%) 6646 BC
AA–57776	Burial 17, scapula fragment of young adult male in sitting position with crossed legs in square A/II, 0.72 m from the surface (63.67 m asl), in the bedrock	Uncorrected 9353 ± 86 Corrected 8913 ± 97[a]	–20.7	15.1	68.2% probability 8250 BC (68.2%) 7951 BC 95.4% probability 8286 BC (95.4%) 7749 BC
Burials 54, 45 and 51a (phase I)					
Z–264	charcoal from Burial 54 in square A/17, spit 11	6335 ± 92	–	–	68.2% probability 5465 BC (6.5%) 5442 BC 5423 BC (4.3%) 5406 BC 5382 BC (57.4%) 5218 BC 95.4% probability 5480 BC (84.0%) 5196 BC 5180 BC (11.4%) 5062 BC
OxA–5823	Burial 54, adult male, disturbed and disarticulated pile of bones in square A/17, 1.92 m from the surface (64.27 m asl); beneath Hearth 17 and covering child Burial 53	Uncorrected 8170 ± 100 Corrected 7730 ± 110[a]	–19.1	14.9	68.2% probability 6678 BC (1.3%) 6671 BC 6659 BC (66.9%) 6454 BC 95.4% probability 7024 BC (2.4%) 6966 BC 6948 BC (0.5%) 6934 BC 6916 BC (1.6%) 6880 BC 6841 BC (90.9%) 6394 BC
AA–57778	Burial 45 (possible phase I), cranial fragment of possible old adult male, postcranial skeleton, extended perpendicular to the Danube, NE–SW, disturbed by Burial 55, in square A/17, 2 m from the surface (64.32 m asl)	Uncorrected 8117 ± 62 Corrected 7677 ± 77[a]	–19.5	15.6	68.2% probability 6591 BC (68.2%) 6462 BC 95.4% probability 6654 BC (95.4%) 6411 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
OxA–5822	Burial 51a (phase I), adult female, extended, NE–SW, perpendicular to the Danube in square A/18, 2.73 from the surface (63.83 m asl), buried in the virgin soil, beneath Hearth 19	Uncorrected 8760 ± 110 Corrected 8320 ± 120[a]	–19.1	14.4	68.2% probability 7518 BC (56.6%) 7290 BC 7273 BC (3.7%) 7254 BC 7228 BC (7.9%) 7190 BC 95.4% probability 7572 BC (95.4%) 7082 BC
Burial 6 (phase III) and square a/6					
Z–268	charcoal from Burial 11 in square a/6, spit 7	6713 ± 90	–	–	68.2% probability 5711 BC (51.1%) 5604 BC 5596 BC (17.1%) 5559 BC 95.4% probability 5762 BC (95.4%) 5480 BC
AA–57775	Burial 6, cranial fragment of possible old adult male, extended, parallel to the Danube, head pointing downstream in square a/6, 1.77 m from the surface (63.96 m asl); neonate Burial 6a on its right shoulder; graphite in burial	Uncorrected 8012 ± 84 Corrected 7572 ± 95[a]	–19.8	16.4	68.2% probability 6558 BC (1.6%) 6550 BC 6506 BC (59.2%) 6354 BC 6307 BC (0.8%) 6303 BC 6294 BC (6.5%) 6266 BC 95.4% probability 6600 BC (95.4%) 6235 BC
Burial sequence and dwelling floor in Trench 3/2006					
OxA–16539	VL18, large mammal bone fragment in context 40, x.8, Trench 3/2006, square 95/96 (20) (30/05/2006)	7425 ± 39	–21.7	6.8	68.2% probability 6362 BC (50.9%) 6286 BC 6272 BC (17.3%) 6246 BC 95.4% probability 6393 BC (95.4%) 6229 BC
OxA–16544	VL50, red deer skull from context 19 placed over the burial sequence in Trench 3/2006 (22/04/2006)	7035 ± 40	–21.3	6.8	68.2% probability 5984 BC (68.2%) 5891 BC 95.4% probability 6006 BC (95.4%) 5838 BC
OxA–16542	VL45, rib of adult headless female Burial context 63; extended parallel to the Danube, head downstream (08/07/2006)	Uncorrected 7701 ± 39 Corrected 7261 ± 60[a]	–17.7	17.0	68.2% probability 6212 BC (41.1%) 6136 BC 6116 BC (27.1%) 6066 BC 95.4% probability 6232 BC (95.4%) 6018 BC
OxA–18865	VL1/2008, right tibia of human adult Burial context 136; extended, parallel to the Danube, head downstream; partially preserved – only right leg below knees and feet (20/07/2006)	Uncorrected 8231 ± 36 Corrected 7791 ± 58[a]	–18.5	16.2	68.2% probability 6684 BC (62.5%) 6566 BC 6546 BC (5.7%) 6530 BC 95.4% probability 6774 BC (95.4%) 6472 BC
OxA–16540	VL21, bone projectile point from context 118, x.1, above the floor (context 149) of Feature 12 in Trench 3/2006 (18/07/2006)	7764 ± 38	–22.1	7.7	68.2% probability 6644 BC (60.5%) 6567 BC 6544 BC (7.7%) 6531 BC 95.4% probability 6654 BC (94.7%) 6494 BC 6490 BC (0.7%) 6484 BC
Contexts with one sample per context					
Bln–1054	5/70, charcoal from square A/III, spit 13 (phase III)	7440 ± 100	–	–	68.2% probability 6416 BC (68.2%) 6229 BC 95.4% probability 6460 BC (95.4%) 6085 BC

Laboratory code	Sample no. and material	Radiocarbon age (BP)	δ13C (‰)	δ15N (‰)	Calibrated date (68% and 95% confidence)
Bln–1052	3/70, charcoal from square b/18, spit 13 (phase II)	7610 ± 100	–	–	68.2% probability 6590 BC (68.2%) 6394 BC 95.4% probability 6644 BC (87.3%) 6326 BC 6320 BC (8.1%) 6250 BC
Bln–1171	4/71, charcoal from square d/5, spit 9 (phase Ib)	7830 ± 100	–	–	68.2% probability 6899 BC (1.3%) 6890 BC 6826 BC (60.8%) 6560 BC 6550 BC (6.1%) 6508 BC 95.4% probability 7030 BC (18.7%) 6874 BC 6866 BC (76.7%) 6478 BC
OxA–16218	VL46, red deer antler from the floor of Dwelling 3 in square C/VI, B/VI, my inv. 1802	7912 ± 39	−22.5	5.9	68.2% probability 6981 BC (1.4%) 6975 BC 6908 BC (6.1%) 6886 BC 6828 BC (60.7%) 6681 BC 95.4% probability 7028 BC (16.6%) 6931 BC 6920 BC (9.4%) 6877 BC 6859 BC (69.4%) 6651 BC
OxA–16543	VL48, bone chisel made on an aurochs' metapodial from Dwelling 5 in square D/I, II, C/II, my inv. 1271	7945 ± 40	−21.9	7.2	68.2% probability 7026 BC (18.8%) 6965 BC 6948 BC (4.2%) 6934 BC 6916 BC (12.0%) 6880 BC 6841 BC (29.4%) 6750 BC 6721 BC (3.9%) 6708 BC 95.4% probability 7034 BC (95.4%) 6693 BC
OxA–5825	Burial 24 (phase III), adult female, extended, S–N, head upslope in square b/17, 1.7 m from the surface (65.74 m asl)	Uncorrected 8000 ± 100 Corrected 7560 ± 110[a]	−18.6	14.7	68.2% probability 6504 BC (53.9%) 6338 BC 6315 BC (14.3%) 6256 BC 95.4% probability 6640 BC (95.4%) 6220 BC
OxA–5826	Burial 83 (phase III), possible adult female, extended, perpendicular to the Danube, N–S, in square a/1, 1.07 m from the surface (64.72 m); on the right shoulder a detached human mandible Burial 83a	Uncorrected 8200 ± 90 Corrected 7760 ± 100[a]	−19.1	14.6	68.2% probability 6685 BC (68.2%) 6470 BC 95.4% probability 7024 BC (2.8%) 6967 BC 6947 BC (0.6%) 6935 BC 6916 BC (2.0%) 6880 BC 6840 BC (90.0%) 6430 BC
OxA–16541	VL42, rib fragment from Burial context 2, extended parallel to the Danube, head downstream in Trench 1/2006 (10/04/2006)	Uncorrected 8228 ± 40 Corrected 7788 ± 60[a]	−18.2	16.3	68.2% probability 6681 BC (62.0%) 6566 BC 6546 BC (6.2%) 6530 BC 95.4% probability 6775 BC (95.4%) 6470 BC

back to contents

UDK 903'12/'15(4/5)''633/634'':575.17; 903'12/'15(4/5)''633/634'':574.91
Documenta Praehistorica XXXV (2008)

Micro-regions of the Lepenski Vir culture: Padina in the Upper Gorge and Hajdučka Vodenica in the Lower Gorge of the Danube

Borislav Jovanović
Serbian Academy of Sciences and Arts, Belgrade, Serbia
bjovanovic@yubc.net

ABSTRACT – *This paper was compelled into existence when confronting the fact that the most commonly discussed transitional period connecting the Late Mesolithic and the Early Neolithic in the Đerdap or the Iron Gates Gorges (present-day Serbia and Romania) is determined by the often emphasized lack of adequately published evidence, thus leaving this period largely unknown. We examine previous conclusions concerning the Lepenski Vir culture, or at the very least, try to put such discussions back in their archaeological context. We discuss the features that are essential for the organisation of the settlements, stratigraphy, and adaptability of architecture caused by geomorphology and climate, as well as the remarkable loss of settlement space due to different types of erosion.*

IZVLEČEK – *Članek je nastal kot odgovor na dejstvo, da pogoste diskusije o prehodu med mezolitikom in neolitikom v soteski Đerdap (v današnji Srbiji in Romuniji) ne temeljijo na ustrezno objavljenih rezultatih izkopavanj in katalogih najdb. V članku reanaliziramo interpretacije kulture Lepenski vir in jih s pomočjo rezultatov naših izkopavanj umestimo v arheološke kontekste. Predstavljamo namreč ključne značilnosti prostora, ki so vplivale na organiziranost naselij in arhitekturo, prilagojeno geomorfološkim in klimatskim pogojem. Predstavljamo tudi krčenje njihovih obsegov in spremenjenih stratifikacij kot posledic velikega števila erozij.*

KEY WORDS – *Late Mesolithic; Neolithic; Iron Gates Gorges; Lepenski Vir culture; settlement structures; stratigraphy*

Introduction

Viewed from a distance of nearly forty years (1970–2007), the excavations at Padina and Hajdučka Vodenica were done in the same way as those that are usually conducted at prehistoric lowland and hill-fort sites. To date, the results have been published fragmentarily, which has contributed to conflicting views on the origins and chronologies of these two sites. Such discussions were mostly concerned with unique features of the Lepenski Vir culture, such as stone sculpted boulders, specific architecture and typical settlement organization situated at specially selected locations (Fig. 1). Evaluations of the archaeological content of such sites based on stratigraphic and typological grounds alone has proven inadequate – among other reasons, due to the lack of relevant analogies in the prehistory of the Balkans and south-eastern Europe (*Banffy 2004.367–69*). The stagnation in the study of the Lepenski Vir culture, however, was avoided largely thanks to the activities of the Neolithic Seminars that have been continuously held at the Department of Archaeology, Ljubljana University, and publications of the *Documenta Praehistorica* series.

The immediate surroundings of the Late Mesolithic and Early Neolithic in the Upper Gorge of the Danube was the winding coastal zone, *i.e.* the space between the steep cliffs of the hinterland and the Danube basin. Such a position, narrowed by the rocky cliffs and the course of the river was the site of various types of erosion (Fig. 3). The geomorphology of the Danube Gorges must be emphasized, with slight differences visible everywhere in this landscape – which restricted the settlement space for both the Late Mesolithic populations and the Lepenski Vir culture. After the abandonment of these settlements, the impact of erosion significantly altered the original configuration of the terrain, and to a large extent reduced the original size of settlements. Hence, for the stratigraphic determination of architectural features and portable material culture, it is necessary to estimate the extent of the preservation of different settlements at Sectors I–IV at Padina (*Jovanović 2004.63–74*).

Longitudinal and transversal erosions are related to the dynamics of the Danube River, as well as smaller rivers, streams and seasonal torrents in the immediate vicinity. Their channels, full of cascades carved in the rocky base, crossed sidewise settlement spaces, occasionally producing floods of destructive power. The simplified classification of erosion dynamics we recognized in the stratigraphic sequence at Sectors I–III of Padina is as follows:

- 1. Erosion caused by the Danube (erosion activity visible on river banks; changing river courses).
  2. Erosion caused by seasonal torrents (outbursts that caused large quantities of sediment to be washed down the steep cliffs).
  3. Erosion caused by short watercourses (water in established channels; from the spring to their confluence with the Danube, altering the direction of the river course).

- 1. Eolic and atmospheric erosion in the deposition of anthropogenic layers (mini erosions within a settlement of upper and lower terraces, between buildings).
  2. Stratigraphic significance of archaeological finds that were impacted by the Danube River erosion (accumulated or redeposited artefacts next to the cleaned river banks).
  3. Stratigraphic significance of archaeological finds that were impacted by seasonal torrents (destructive power that such torrents had within semi-subterranean buildings and crofts, accumulated archaeological finds).

- Stratigraphic significance of archaeological finds at palaeo-surfaces and occupation levels (settlement surfaces placed on different terraces).
- Relative chronological significance of ^{14}C results in comparison to the stratigraphy (inconsistencies between ^{14}C results and their stratigraphic position).

Padina. Gospođin Vir (Upper Gorge)

The site of Padina consists of several settlements located at horseshoe shaped coves downstream from the Gospođin Whirlpool (Sectors I–III). The earliest phase here belongs to the Late Mesolithic of the Iron Gates, followed by the entire development of the Lepenski Vir culture. After a long hiatus, the Late Neolithic Kostolac culture, which at the time spread across the Danube and the Sava river basins, is the next cultural manifestation at this site, finally followed by the Early Iron Age Kalakača culture. Sporadic finds have been assigned to the Roman and Medieval periods.

Sectors I to III were connected, while the significantly larger Sector IV looked like a spacious plateau, bordered with steep cliffs. Various geomorphological characteristics affected formation processes: Sector Ia, which was almost at the same level as the Danube River, was significantly affected by high waters (Fig. 2).

Padina A. Sector I, Trench 1, Profile 1

The Late Mesolithic period. Sector I consists of two stepped stony terraces: the lower is bounded by the high river bank profile, at the base of which is a palaeosoil sporadically covered by river sand. Partly preserved remains of architectural features at this sector provided a reliable vertical stratigraphy. Depressions in the bumpy rocky base surfaces of both terraces, as well as of segments 1 and 2 in front of the river bank profile, are largely filled with this palaeosoil of intense black colour. It contains Late Mesolithic flint and bone artefacts. No Early Neolithic Starčevo pottery is found at this level (Fig. 4).

Padina A – B. Base of a building structure. Phase of contacts. Iron Gates Late Mesolithic, the Early Neolithic Starčevo culture

The layer of river-deposited sand in segments 1 and 3 extends almost to the high river bank profile. In segments 2–3, this deposit covers the flattened base of an architectural feature from the final stage of the Late Mesolithic – the phase of contact. A long rectangular hearth, made from vertically placed stone blocks, was found in the central part of this base. In the vicinity, there is a scatter of split and slab-like stones left behind on the levelled palaeosoil. Only a few stone and bone artefacts were found here, while the Early Neolithic Starčevo pottery is absent (*Jovanović 1971.Pl. III, Figs. 1, 5, 6*).

Padina B1. House 1. The Lepenski Vir culture

On a narrow ridge of one of the cliffs that slopes toward the river (segment 3), a rectangular hearth of House 1 was found, directly above the previously described feature dated to the contact phase. The hearth platform was composed of two parallel stone slabs, while between them was a partly damaged boulder–altar *in situ* occupying a standard place when it comes to architectural features of all phases of the Lepenski Vir culture. Here, in the washed-out layer around the platform of House 1, only a few fragments of coarse and monochrome ware were found (Fig. 6).

Padina B2. House 2. The Lepenski Vir culture

Houses 2 and 3 mark the next two building horizons. These were semi-subterranean structures dug into the culture layers deposited on two rocky terraces up to a depth of 2m. The terraces slope toward the Danube. In other words, segment 1 represents a series of settlements located in a small arc-shaped cove. These settlements were built on river terraces, like hill-top sites, where their downtowns are placed on their steep slopes all the way to the base of the hill.

The riverbank profile of Sector I, which was the result of river erosion, in segments 1 and 2 exposes the trapezoidal base of the semi-subterranean House 2, assigned to the Lepenski Vir culture. The hard-beaten clay floor and a rectangular hearth with an aniconic boulder were found next to the back of the platform. The floor of House 2 levelled the palaeosoil, *i.e.* the Late Mesolithic layer found on terrace 1. This layer is only sporadically preserved next to the rocky base, and contains bone tools, and no pottery. On the floor of House 2, similar bone artefacts were associated with Starčevo-Criş pottery (*Jovanović 1971.T. V.1*) (Fig. 7).

Padina B2. House 3. The Lepenski Vir culture

Although two buildings on these terraces were not built at the same time – House 3 is definitely younger – their end was simultaneous. They were destroyed by a torrent wave; and marked in the section of this Sector as layer 3b. It had prominent contents of torrent-like washed-out materials: deposited mud and a light yellow deposit of gravelly sand. The torrent's thrust crossed both terraces diagonally, hitting with full force across the area of the current river bank to the old channel of the Danube, split both terraces diagonally, and continued with full strength down to the present river bank area into the Danube. Since House 2 was built at the highest spot of the settlement, it was the first to be hit by the torrent: its walls of piled stones were cut through, while its simple ridged wooden roof was destroyed. The rectangular hearth of stone blocks was moved from its foundations and transported down the slope between the terraces and stopped by some kind of barrier, but in the inverse position from the one in the base of House 3. It is unusual that the hearth construction was preserved, as well as both A-supports, one on each of the longer, lateral sides (Fig. 8). On the floor of House 3, a semi-subterranean construction next to the rocky edge of terrace 2, fragments of coarse pottery were found, as well as a complete model of an oven (25 x 35cm) decorated by impresso technique (Fig. 30 A).

After this catastrophic event, these buildings on terraces 1 and 2 were not renewed. However, it did not mean that life had stopped down at the coastal part of the settlement, which was at this time covered by river sand or washed out down to the rocky base (as was the case at Sector Ia).

Padina B2. Pottery workshop between Houses 2 and 3

One more feature found between Houses 2 and 3 relates to settlement horizon B2. This was probably a large, open-air hearth, ellipsoid in shape, paved with small flat stones, and encircled by a wider ring of piled stones (1.50m by 1.10m). The hearth and the area around it were carefully levelled. Pieces of carbonized wood and ash were found, along with clusters of larger fragments of coarse pottery. One such cluster allowed a reconstruction of a typical pot-amphora, ornamented with impresso technique, and with symmetrical placed handles, similar to those of the Starčevo-Körös-Criş cultural complex. This feature is most likely a pottery kiln, or an open-air (?) hearth with or without a dome. This might have been a workshop with a simple hearth, where prepared pots were covered by wooden brunches, and fired in a pyre. It is the first indication of the existence of local pottery workshops in the Lepenski Vir culture.

Padina B occupation level

As previously shown, the architectural features of the upper and lower terraces fairly precisely define the occupation level in the immediate vicinity of Houses 2 and 3. The croft of House 2 was also clearly outlined in segment 2 of the riverbank profile, and can also be seen in the longitudinal sections of Trench 1 (quadrants 1 and 2). The occupation levels of the croft and of the floor of House 2 are identical, which is also confirmed by a round base made of split stones found at the same level in quadrant 1a. The surface level of the occupation zone outside the semi-subterranean croft is identical to the level from which the trapezoidal base of House 2 was dug, and this is clearly visible on segment 1 of the riverbank section (Fig. 7).

In this way, there is a more secure stratigraphic determination of surface activities for the period when Houses 2 and 3 were in use. This horizon yields a larger concentration of finds in comparison with the culture layer above and below the given level. Leaving aside the division of the Late Mesolithic and the Lepenski Vir culture settlements on the erosive zones of both terraces and the costal zone, it is possible to comprehend the connections between these occupation levels of the terrain, which sloped even more steeply toward the Danube in those days. Archaeological material was in this way washed away from the occupation levels upslope and deposited at the base of the terrace, in the costal zone. This process caused inverted and complex stratigraphy in the costal zone, characterized by inverted ^{14}C dates (see below). This inverted stratigraphy of absolute dates was noticed at Padina immediately after the first ^{14}C results in 1978 (*Clason 1980*). The inverse stratigraphy was also noticed in the costal zone of Sector III, after it was realized that every higher terrace with semi-subterranean buildings of the Lepenski Vir culture had been gradually depositing its waste on the lower horizon of abandoned buildings. Thus, some finds from Sector I, such as a cult table, were refitted from pieces that originated from two different culture levels (segments 3 and quadrant 1a) (Fig. 30 B).

The dynamic of formation processes at Padina enabled definitions of different zones of the settlement on the basis of an approximate order by which the archaeological material was deposited. The stratigraphy and relative chronology of this sector can be reduced to the order of occupation levels of successive living horizons. The absolute heights of the living horizon start from architectural features in order to connect a particular cultural layer with the base of a feature, *i.e.* ideally its floor.

Padina. Sector I. Relative chronology of the settlements

It is obvious that occupation levels at settlements based on slopes are not characterized by significant horizontal deposits, since the cultural layers are formed around horizontally placed buildings. The occupation layer should be considered as the ensemble of single surfaces inserted and placed on the steep sides of the gorge, or secondarily connected to the costal zone. The cultural layer of Sector I rests on a natural, rocky base, which prevented the pit-digging that characterizes settlements located on loess or clay soils.

Stratigraphy at Sector I begins with costal palaeosoil, which contains Late Mesolithic finds. On this thin layer of palaeosoil, with an average thickness of 0.30m, the first Mesolithic dwellings were placed in pockets of the cliffs and on the sloping platforms of the rocky base. Such dwellings were more prominently present at Sector II.

Another important aspect related to Sector I was determining the precise stratigraphic position of the rectangular hearth connected to phase Padina A–B. This architectural feature enables us to connect the heights of the stone-lined hearth and the occupation horizon around it. The entire feature covers the levelled zone of the palaeosoil (Mesolithic cultural layer), and does not reach down to the rocky base of segment 2 of the costal zone (Fig. 5). This leveling, made here before the feature was built, confirms that the hearth (or oven) covers undisturbed palaeosoil with Late Mesolithic occupation residues. It is unclear how much time elapsed between the Late Mesolithic occupation in this zone and the period when this later feature was built, although there is perhaps some continuity of occupation. There is no evidence that this feature was built by digging into the ground. It is probable that the period that followed the Late Mesolithic occupation was characterized by an architectural form different from the preceding period as much as from the architecture built during the ensuing phase of the Lepenski Vir culture.

The anthropogenic layer formed over this atypical architectural feature upon its abandonment was formed after a considerable temporal hiatus, since at this location one finds a building with recognizable elements of the early Lepenski Vir culture. This building (No. 1) had only the rear platform of the hearth, with two stone slabs and an ornamented boulder between them. Between this surprisingly well-preserved architectural detail of the building (▼ 1.50m) and the feature from the contact phase (A–B ▼ 2.80m) is a cultural layer 1.28m thick (Fig. 5–6).

When it comes to the architecture of the Lepenski Vir culture at Padina, the level of the hearth and floor mark the average depth of digging for a particular building – around 0.85m (cut of House 2 in Trench I, quadrant 16). From this, one can indirectly calculate the accumulation of cultural layers: the difference between the floors of the contact phase feature and the Lepenski Vir culture building (House 1) is 1.28m. One can then add the average depth for the latter feature of 1.50m. These two values indicate the build-up of the occupation layer at this point in the settlement (2.75m), which can then be checked against the section of Sector I, Profile I, segments 2–3. One notices an accelerated development of the settlement during the contact phase (A–B) (Fig. 7).

Three settlement horizons – the Late Mesolithic, contact phase and the early Lepenski Vir culture phase – were preserved only in the coastal zone (segments 1–3). This also means that Sector I represents the periphery of these settlements, which spread up to the steep cliffs of the gorge. Unfortunately, the central area of these settlements used to be in the present-day Danube channel. Architectural features (Houses 2 and 3) at both terraces were well-elaborated, containing elements from sedentary Balkan-Danubian Early Neolithic communities, such as pottery and polished stone tools. However, it is less clear what caused the abandonment of the youngest settlement horizon of the Lepenski Vir culture. It seems this might have been caused by local climatic changes (some isolated catastrophe in the case of House 18), but even more probably by a more significant series of events, which also might have caused the abandonment of other settlements of the Lepenski Vir culture that were concentrated in such a narrow zone of the Upper Gorge of the Danube.

The pottery from Sector I is important for two reasons: its first appearance at the site dates to the beginnings of the Lepenski Vir culture, and, its typological classification to a special (Iron Gates) variant of Early Neolithic culture known as the Starčevo and Criş culture complex.

The stratigraphic significance of this pottery is determined on the basis of its context in Sector I, and divided into the following zones:

❶ Pottery of the coastal zone (Profile I, segments 1–3), which was deposited secondarily by hill-wash erosion from terraces 1 and 2, as well as by the additional accumulation of pottery finds from eroded blocks of Profile I undercut by the Danube. The pottery that was washed down from the terraces belongs to various levels of the cultural layer, or from damaged and abandoned buildings; the pottery that came from the eroded profile I could be connected to older levels of the cultural layer, characterized by a mixture of archaeological material from both terraces. The chronological classification of these findings is primarily based on typology and is thus not completely reliable.

❷ Pottery (in much smaller amounts) from architectural features, found both on and beneath the floors, around open-air hearths or ovens, as well as *in situ* pots – these can be considered as closed finds; in addition, those finds connected with the occupation horizon can be said to have a slightly less prominent stratigraphic significance.

Early Neolithic pottery from Padina leaves the impression of a coherent typological and ornamental whole. The narrow range of ornamental motifs and techniques is noticeable when compared with the Starčevo culture settlements outside of the confines of the Danube Gorges. The pottery assemblage at Sector I is dominated by coarse ware, weakly tempered, with chuff and larger sand grain inclusions. The dominant form is the large open dish with a rectangular hollow pedestal with openings, as well as chronologically younger specimens with flat bases and shallower receptacle. Spherical pots and deeper spherical bowls and amphorae are less numerous, but were of better quality and temper.

Most of the ornamentation of these vessels involved two techniques: coarsening or engraving surfaces, *i.e.* polishing. The first technique relies on impressions made by fingertips or semi-circular nail/impression (impresso), producing various combinations of horizontal and vertical impressions, often showing the recognizable motif of a wheat ear. Sometimes, these imprints were made with the tip of a wooden or bone tool. Thin lines, cut by a sharp blade, form asymmetrical sheaves or simple geometrical motifs, occasionally coupled with a series of triangles. The second technique, used on monochrome vessels by polishing their surfaces, was confined to bowls and amphora-like vessels.

Ornamentation by painting or barbotine (the surface of the vessel is channelled with irregular plastic appliqués imitating tree bark), widespread across the area of the Starčevo culture, were not found on pottery from the Lepenski Vir culture settlements at Padina Sectors I–III.

Horse-shoe polished stone axes, which characterize the Starčevo culture, were found in pottery horizons at all 3 Sectors of Padina, mostly outside closed contexts (*Antonović 2004.Fig. 4–6*). Cult objects from the Lepenski Vir culture settlement at Sector I were few and had different roles. The aniconic boulder from House 2 and damaged boulder-altar (ornamented) from House 1 were the only finds of this kind in buildings. Admittedly, the hearth of House 3 was moved from its original location, and the presence of the boulder-altar (on the rear platform) is not completely certain. However, an ornamented model of an oven (Fig. 30) with close typological links to a similar model from Ajmana, the settlement of the Starčevo culture in the Ključ (lower Danube region) (*Stalio 1986.Fig. 13*), comes from the floor of this building.

Padina. Sector I. Relative-chronological division

Settlement of the Iron Gates Late Mesolithic

As previously explained, the occupation layer of the Late Mesolithic settlement is primarily related to palaeosoil full of organic material and discarded artefacts. The most important among these finds were flint blades and flakes, as well as fragmented bone tools found beneath the rectangular hearth. This layer had lenses of charcoal and burning, distinguished from the strip of burned soil under the firebox. The hearth was placed on the palaeosoil. In the layer under the rectangular hearth, no pottery was found. A similar context was found beneath the partly damaged floor of House 2; the layer contained flint and bone artefacts found in the palaeosoil deposited over the rocky base.

Architectural feature with elongated rectangular hearth. Profile I. Segments 2–3

We have already explained the stratigraphic position of this feature found between House 1 of the Lepenski Vir culture (segment 3) and the occupation horizon of the Mesolithic settlement (palaeosoil) (segments 2–3). The functions as well as construction details of this feature remain unclear. The interior of the feature has no partitions, unless the piles of stone slabs were not the remains of partitioning walls. There were no traces of a floor or any kind of subsidiary stone construction. The elongated hearth has analogies only in the architecture of Vlasac and Hajdučka Vodenica (the latter in the Lower Gorge of the Danube, see below), although in a different context (Figs. 5 and 6).

Architectural elements – cult place of House 1. The Lepenski Vir culture. Profile 1

Leaning against the steep cliff, which limits the downstream edge of the cove, the base of House 1 was partially preserved, with the rear platform of the hearth and ornamented boulder-altar. On the one hand, this architectural detail dates House 1; and on the other, it testifies the long duration of the early phase of the Lepenski Vir culture settlement to which this building belongs. The orientation of House 1 did not deviate from the generally accepted rule found in the Upper Gorge: in all settlements of this culture, the buildings faced the Danube with their (wider) frontages most commonly at a right-angle or slightly deviating, depending on the topography of a particular terrain. It has been mentioned previously that the approximate dimensions of the base of House 1 cover the whole gauge of the older feature with the rectangular hearth. In this way, a clear stratigrafic relationship was established between two architectural features, or two different phases in the development of the Lepenski Vir culture (Fig. 5).

House 2. The Lepenski Vir culture. Trench 1, quadrant 1b

The floor of this building was situated on a levelled surface of the palaeosoil. The floor, made of fine clay, was not preserved entirely. The trapezoidal base, which was fairly accurately constructed, had a rectangular fireplace with slab-free firebox embedded on its front. The ash-place with massive slabs arranged fan-like, extended to the front (entrance) area of the base. On the cross-section of the frontal of House 2 and segment 1 (Profile 1), one can clearly notice the cut into the cultural layer that was formed before the construction of the trapezoidal base. This section of the cultural layer confirms that the settlement spread farther on the sloping, wide terrace 3, where the riverbed is found today. The accumulation of this layer confirms that the primary phase of the settlement (B1), which precedes the construction of House 2, was not only related to terrace 3, but that it lasted considerably longer, before the construction of Houses 2 and 3 (Fig. 7).

House 3. The Lepenski Vir culture. Trench 2, quadrant 2b

This building was located at the far end of the area occupied by the settlements of the Lepenski Vir culture, and bordered by the semi-circular cove of Sector I, above which there are steep, uninhabited cliffs. We have previously mentioned the destruction of House 3 in a catastrophe which left only part of the floor, while the fireplace slid down along the steep edge of the ridge. The context of finds from this base has already been considered. The settlement of the Lepenski Vir culture expanded to this natural border only during its youngest phase (Houses 2 and 3; B2) (Figs. 5 and 8).

Stratigraphy and chronology

The first ^{14}C date for Sector I at Padina was obtained through the collagen analysis of Burial 2, dug next to the edge of House 2 (Trench 1, quadrant 1b) belonging to phase B2 of the Lepenski Vir culture settlement: BM–1143, 6220 (95.4%) 5740 calBC. In the absence of a larger series of ^{14}C dates, it is useful to connect the archaeological evidence with available ^{14}C dates in order to estimate their correspondence. On the basis of this date, Burial 2 could have been interred between the last quarter of the 7th millennium and the first quarter of the 6th millennium BC (*Borić and Miracle 2004.315*). A similar date probably refers to the collective burial interred in the vicinity of the house 3 (Fig. 9).

It is not possible to make a reconstruction of the Lepenski Vir culture settlements at Sector I, and even less so of the Late Mesolithic settlement. We can only estimate the area of the settlement space. Previously discussed evidence indicates a significant loss of the cultural layer, including portable finds and architectural features, to the Danube. On the basis of the dimensions of segments of Profile 1, which was researched at the low water levels of the Danube, the eroded cultural layer was found in a range of 6.0m from Profile 1. This layer was coverd by sand and gravels, thinning gradually down the slope of terrace 3, which was in part already under the Danube waters.

The settlement of the Late Mesolithic phase left no trace of building features at this sector and consisted only of the cultural layer that is the same as the palaeosoil. Between the palaeosoil and layer of the Lepenski Vir culture, two architectural features were found with a particular building element and a special stratigraphic position: the elongated rectangular hearths in Trench 1, block 1. Both features were placed on the palaeosoil, making them stratigraphically younger than the Mesolithic settlement.

The position of the building with the rectangular hearth indicates the periphery of the settled area at this time, which also included terrace 3, the lowest and widest of which is today under the Danube. It is certain that this entire terrace was settled during the phase of contact between the autochthonous population and the Early Neolithic Starčevo culture incomers (Padina phase A–B).

If the architectural pattern of the base with the rectangular hearth is compared with the rear platform with boulder-altar of House 1, one notices a progress in the development of architecture, for which one lacks transitional examples. The evidence of such a transitional example must have disappeared with the erosion of the cultural layer of terrace 3 and the coastal zone. On the other hand, a certain level of development can be determined by comparing Houses 1–3 of the Lepenski Vir culture (Profile 1, segment 2; Trench 1, quadrants 1b, 2b). The last two features repeat the same form, with likely differences in details and dimensions. The exclusive use of a dry wall technique was undoubtedly conditioned by the rocky terrain of terraces 1 and 2, unsuitable for a wooden dwelling construction (Fig. 5).

Yet another characteristic of the stratigraphy of phase B1–B2 at Sector I is the existence of the 'invisible dwelling horizon', which is represented by the remains of stone constructions of abandoned or destroyed buildings. The damaged trapezoidal base between Houses 1 and 2, found along the edge of segments 2 and 3 of profile 1, belongs to this horizon. This trapezoidal base was noticed on the basis of horizontal groups of split stones and stone slabs that were at first marked as 'stone constructions'. Further, the remains of the rear hearth platform were preserved in the profile of segment 1, near House 2. Judging from their stratigraphic position, these construction elements point to the existence of an interpolated horizon with 2 building features between House 1 and the end of segment 1 (Profile 1, point A).

One can thus speak of settlements rather than of a settlement of the Lepenski Vir culture at Sector I. In this way one recognizes, at least in basic outlines, the evolution of the architecture typical of this culture, formed during phases B1–B2 at Sector I. The same relative-chronological framework can be applied to the presence of the Early Neolithic pottery at Sector I. Depending on the stratigraphic position of such pottery finds, it is possible to follow the evolution of this local variant of the Starčevo-Criş culture.

Padina A. Sector II. The settlement of the Iron Gates Late Mesolithic

A narrow ridge that diagonally slopes down the stepped cliffs into the Danube, divided Sectors I and II as two separately populated spaces. Less under the impact of river erosion, Sector II is characterized by more favourable conditions for the Late Mesolithic settling of this area than Sectors I and III. It was exactly at this place that the central settlement of the Late Mesolithic period at Padina was located. This layer, with lenses of burning and rich in decomposed organic materials, was characterized by a dark colour and the compactness of the deposit (Fig. 10). Similar to Sector I, flint artefacts and modified bones were found in this layer. Here, such finds were concentrated around the remains of dwelling structures: oval or ellipsoid surfaces built of split or slab stones.

This central part of the sector (Trench II, quadrants 2a–3a; 3b–4b) was not under the erosion impact of the Danube, which does not apply to the parts of the settlement closer to the river bed. In comparison to the river bank of Sector I, it is likely that approximately only half of the original Late Mesolithic settlement was eroded away. The riverbank profile of Sector II extends for 52m, with an average height between 2.20 and 2.80m. This profile was firstly vertically cut and then marked similarly to the longitudinal section of the whole sector.

The pattern of the distribution of the Late Mesolithic dwelling features at this sector indicates some degree of organisation, based on the chosen position, and indicates a semicircular arrangement on the left shore of a small tributary of the Danube. Coming down the steep slopes of the Gorge, this stream cut a narrow bed in order to flash out onto the open and sloping terrain of Sector II.

For the base of dwellings, people chose shallow or wider depressions, as well as channels between particular rocky blocks. The oval base of the biggest dwelling, placed approximately in the centre of the settled space, had two floor levels made of piled stone slabs and smaller pebbles. Dwellings were placed along the left bank of the tributary, where the central dwelling was found.

According to the bases with piled stones, there were eight dwellings, the size of which varied between 3.60 by 1.90m and 0.80 by 0.54m. The total area approximated 30m^2, but it might have been considerably larger, since the paving of the bases of dwellings was done in particular due to the special functions of these surfaces: hearths, workshops, sleeping areas. On these surfaces, along with the remains of charred wood, there were residues of stone and bone tools, next to flat, massive boulders with shallow depressions in the centre (anvils and pounders).

The structure of particular paved areas in blocks 3a–4a of Trench 2 provides enough examples of this kind: Base 4 pavement consisted of sparsely distributed stones, among which was a larger slab stone (dimensions 0.46m x 0.20m) indicating a working surface like a table; the construction of Base 5 pavement was an exception, since it was built entirely of massive stone slabs from 0.50m by 0.21m to 0.24m by 0.20m; Base 7 pavement was the biggest, oval surface (around 6.50m^2) and was constructed from stone slabs of the following dimensions: 0.40m by 0.18m and 0.10m by 0.08m; Base 8 pavement had an approximately square shape, with a massive table-like stone slab that was 0.50m by 0.22m.

The gully of the brook was fan-shaped across the sector close to the riverbank, providing an outlet for periodic outbursts of seasonal torrents down the steep slopes of the Gorge. The diagonal course of this gully and its gradual shifting towards the downstream rocky ridge was caused by the higher terrain in the north-western part of the sector. The south-eastern part of the sector, according to this evidence, was composed of the following zones of Mesolithic settlement: a functional zone next to the right bank of the brook, without dwellings; a central, settlement area along the left bank of the brook, with a concentration of dwellings; a periphery, towards the south-eastern border of the excavation area, with no dwellings.

As visible on the profiles of the costal zone, the Mesolithic cultural layer (palaeosoil) is present in segments 1–3, Profile 2 due to hill wash processes that accumulated Mesolithic occupation residues in this zone. As a consequence, in this part of the profile the Mesolithic layer has a thickness of up to 0.75m, covering the rocky ground evenly.

These differences in the occupation of the upper and lower zones/terraces at Sector II depended on the course of the torrential brook and topography of the rocky base. Two preconditions for settling during the Mesolithic period were fulfilled at this sector: a source of running water and a convenient place for the construction of dwellings. Such differences in the use of space at Sector II affected the stratigraphy here. It remains unclear how large was the area that the Mesolithic settlements covered in this cove, and it probably depended on the width and depth of bordering rocky ridges at Sector II.

The most frequent category of Mesolithic material culture at Padina were chipped stone tools, which can be separated by form and function into 14 basic types. Most of these finds were found at Sector II, *i.e.* in the preserved part of the settlement. It was possible to separate these finds stratigraphically: the majority were found in the central dwelling that had two floor levels (the intermediate layer between them was 0.16m thick), while a similar pattern was seen in other dwellings. One should also mention workshop areas on the left side of the brook, closer to the downstream ridge of the sector (*Radovanović 1981*).

Besides the secure stratigraphic position of flint finds and retouched boulders, the irregularity in their deposition was caused by a specific terrain of the sector. We should also remember that a part of this settlement was destroyed by the Danube. The most numerous chipped stone artefacts were scrapers and sidescrapers (32.83%). This is followed by denticulates and notched tools (17.16%). Retouched flakes constituted 23.19%. These percentages together make up 73.18% of all 332 retouched specimens. There is a notable increase in burins between the older A1 (1.28%) and younger A2 (5.42%) phases, which may indicate more frequent wood-working activities. Other tools must have been used for hide-working, and were possibly hafted in wooden or bone handles (*Radovanović 1996.Fig. 5.4; Fig.5.5; Mihailović 2004.67–86; Kozłowski 2001.61, Fig. 9*).

A special category of knapped stone tools at Padina were trapezoidal choppers/axes (ranging in size between 3.5cm–6.5cm). They also occur in the Upper Palaeolithic and Mesolithic of the Lower Danube area, the Ukrainian steppes, and in the north and north-east of Europe. This common trait may indicate that this type of tool originates in the early Mesolithic of the Lower Danube region (Fig. 12).

That these artefacts are related on typological grounds is based on the following common features: straight and trapezoidal head and slightly banded, edge as well as massive shafting, part rectangular in section. This tool must have been hafted in a wooden or bone handle, which enabled its multipurpose use. Interestingly, this type of tool is very rare in the collection of chipped stone tools from the discussed area: the duration of this type of tools is restricted between the use of larger Late Mesolithic chipped stone tools and polished stone tools, and were similar in shape to shoe-last axes that characterize the Early Neolithic of the Danubian-Carpathian zone (Figs. 12 and 29). The largest number of these tools were found at Padina. Moreover, it seems that there is evidence for their relatively longer use at this site: two specimens can be assigned to phase A1, and the other four specimens to phase A2 of the Mesolithic settlement at Sector II. There is also a slight typological difference between them – during phase A1, their typical form was not completely developed, while they are perfected during phase A2. The stratigraphy of stone constructions of the central dwelling in square 2a from where these finds originate is securely established, and this also holds for artefacts found in this area. It is clear that between the two phases there is a typological progress in the symmetry of these specific tools, as well as in the shape and retouching of the cutting edge, and also in variations in size. All these elements indicate that such improvements were directly proportional to the use of such a new tool for wood-working, which resulted in the gradual development of a more secure type of dwelling structure. In this way, the population minimized its dependence on the local (rocky) relief of Padina (Fig. 12). On the basis of the spread of this type of tool across the plains of northern Europe and southern Danubian areas, such innovations could be understood as signs of the process that conjoined the early experience of plant cultivation with a long tradition of hunting and gathering.

Bone artefacts. Trench II, square 2a. Phase A1–A2

Bone artefacts were made for specific purposes and their form is more or less constant, hence they are usually a chronologically less sensitive class of material culture. One of the larger closed features of this class of tools from Padina relates to the two previously described horizons of the Mesolithic settlement (Trench 2, block 2a – A1–A2) (Fig 11).

Phase A1

The layer under the construction of the older floor of the central dwelling in the settlement (block 2a), lying directly on the rocky base, contained the following forms of bone tool:

1. Projectile, ellipsoidal cross-section, length 4cm.
2. Awl tip – prod, end broken (5.2cm x 1.2cm)
3. Awl – pin, round cross-section (6.8cm x 2cm)
4. Awl – prod (10.8cm x 2.1cm)
5. Scraper – polishing tool, rounded tip (9.2cm x 2.2cm)

On the stone construction of the floor of the central dwelling bone artefacts were few:

6. Pin – prod, tip of red deer antler (12.5cm x 2.0cm)
7. Fragmented polishing tool of good quality (9.5cm x 2.3cm)
8. Boulder/anvil, found with bone artefacts (Fig. 13)

Phase A2

The following finds come from the younger floor of the central dwelling and directly above it:

1. Projectile, round cross-section (Length 5cm)
2. Arrow tip (pin with spike) (5.3cm x 1.3cm)
3. Perforator, lower part in the form of a chisel (3.9cm x 1.3cm)
4. Knife (blade?) made of boar tusk (5.4cm x 1.5cm)
5. Dagger (top of spear?), hollow bone (8.0cm x 2.2cm)
6. Double-sided awl, round cross-section (length 10.8cm)
7. Needle, lower portion broken (6.7cm x 1.1cm)
8. Polishing tool – scraper (6.2cm x 1.8cm)
9. Head of scraper, oval blade (6.5cm x 5.0cm)
10. Chisel, damaged, flat blade (6.5 cm x 3.5 cm)

From the renewed floor of the central dwelling of the Mesolithic settlement, there is a complete list of bone artefacts belonging to the younger phase of the settlement, made of red deer antler, wild boar tusk, hollow and cylindrical animal bone (Fig.14).

From the upper level of the palaeosoil above the floor of the central dwelling (block 2a).

1. Awl, oval cross-section (Length 6.2cm)
2. Perforator, red deer antler (Length 5.5cm)
3. Perforator, red deer antler (Length 5.6cm)

Padina B–2. The Lepenski Vir culture

Although larger than Sector I, Sector II was not inhabited so extensively during the Lepenski Vir culture phase. The advantage of having running fresh water in this zone was of less importance than the fear of the destructive power of the occasional torrential flood. However, the terrace of Sector II had other purposes during this period. The south-eastern corner of the terrace that was outside of the flood zone seems to have served as a workshop zone for Houses 1–3 from Sector I, or even of a part of the settlement of Sector III. Separated by a diagonal ridge, the terrace might have served as a corral for stock-breeding, or as a workshop for fishing activities, with some additional stone constructions that can be recognized here. A larger amount of split stones, the remains of fireplaces and smaller stone constructions, as well as a significant amount of pottery fragments of Starčevo-Criş (the Iron Gates), along with other finds, indicate an everyday range of activities.

Burials in the course of the Lepenski Vir culture phase are few at this sector, without particular burial constructions or offerings. The deceased were lying in extended positions on their backs, with their arms along their bodies. The dead were mostly buried in the costal zone (Trench 2, block 1b).

One should also mention another burial where no burial cut was recognized. The burial contained only a skull, and was found at the periphery of the terrace in the foothill of the steep sides of the gorge. This partial burial, with some symbolic significance, was found in block 5d, Trench 2, cut into the Mesolithic palaeosoil that was later covered by a massive layer of hill wash; such a stratigraphic position could date this cut to the contact phase (A–B). The skull was covered by several stone plaques which were encircled with split stones, partly damaged by erosion. The remains of burning were noticeable in the vicinity of this construction to a diameter of 1.20m. Among broken bone finds there was a haft of a red deer antler. Apart from skull fragments, no post-cranial fragments were found here (Fig. 15). There is one ^{14}C date on a skeletal inhumation (Burial 7) from this sector (analyzed bone collagen) with the result BM-1144: 8250–7600 calBC (*Borić and Miracle 2004.Tab. 1*).

Padina B1 – 3. Sector III

The chronology of prehistoric cultures at Padina indicates how particular locations were used during these periods, which depended on the micro-characteristics of the terrain, as well as on the technical capabilities of the culture to adapt to a particular chosen location. The settled area of Sector III is much larger than the two previous sectors, and is also more complex with regard to the organization of the settlement, including the separate area of a necropolis. Although the erosion of the costal area is also prominent at Sector III, due to the higher absolute level of the terrain, it was less destructive than at two other sectors (Fig. 16). The following functional zones can be separated on the basis of their relative chronological order:

- The costal area with high profiles is the limit of the river erosion.
- The lower level of the costal zone, with partly preserved traces of buildings (B–1) – the second row is in a better preserved part of the settlement, above the costal profile (B–2). The upper horizon of the terrace at the periphery of the settled area, *i.e.* the third row of buildings (B–3).
- Necropolis: a group of burials around elongated stone constructions of the necropolis (A2); a group of burials beneath dome-like and other stone constructions (A–B); a group of burials buried around buildings of the third row (B–3).
- All burial groups were found in the foothills of the steep sides of the gorge at the very periphery of the terrace and were south–north orientated.
- The necropolis of Sector III of the Lepenski Vir culture settlement can be divided into two groups: The first was contemporaneous with those settlements (B–3), while the other one significantly precedes it (A–B; A2). In both instances, one must accept the possibility of burials of people who were not part of the settlement at Sector III (Fig. 16).

Padina A2. Trench 7. Sector III. The necropolis with elongated stone constructions

The oldest building feature at Sector III was not placed next to the costal zone as one would expect. The opposite was the case: a relatively long construction (10–12m), some type of a shallow base, built in four levels of piled stones, extended along the foothills of the vertical massive gorge. Built and piled one on top of the other, separated by a levelled layer of soil, the stone constructions were a sacred feature – a site place for only few, single burials. However, the dead were not placed inside constructions, but beside them or in their vicinity (Figs. 17 and 18).

Another important (technical) characteristic of these stone piles was a layer of loessic soil with some gravels that separated the layers of stones. In this way, the whole area of the necropolis was gradually elevated, reaching a height of 0.50m–0.65m and a width of 0.80m–2.60m. Inside the construction, or in the levelled zones, there were broken bone artefacts, small pieces of chipped stone, fragments of animal bone and, in places, notable remains of burning and charred wood.

In total, in all three levels of the necropolis, there were four burials: in the older levels (1–2) there were three burials – Burials 19, 21, 22; in the youngest level (4) there was only one – Burial 23. Burials were of two types: with the deceased lying supine in an extended position oriented towards the Danube (Burials 19 and 22); in a sitting position, which demanded more complex stone constructions. Usually, the latter stone constructions and the burial remains in them were less preserved. An older burial of this kind comes from level 2 (Burial 21), and a younger one from the final level 4 (Burial 3).

Burial concentration with domed stone constructions. Trench 6, block 2

Immediately beside the necropolis of elongated stone construction, there was a burial zone with domed stone constructions. They were constituted of a stone ring, wider at its base, narrowing toward its top. Inside these constructions, there were one or two burials in sitting positions with crossed legs – Burials 15 and 16 (two burials in the same stone construction); it is not absolutely clear about Burials 17 and 18, since the stone construction was damaged, although the individual in Burial 17 was most likely placed in a sitting position (Fig. 19). However, within this group of burials there are also interments placed in flexed positions and with their hands below their heads: Burials 14 and 26. Domed-like burials were less frequent on the left bank of the Danube; a good example is found in the mortuary record of the Late Mesolithic and Early Neolithic of Ostrovul Corbului; a burial of this type was discovered there, and assigned to the Starčevo-Criş culture. On the right bank of the Danube, at the sites of Kula and Velesnica, burials in sitting positions were also discovered. Kula was situated across the Mesolithic site at Ostrovul Mare, and dated to its younger phase (Kula II) was a burial in sitting position, covered with a layer of split stones. Velesnica is situated in the region of Ključ – in the vicinity of the Mesolithic settlement at Ostrovul Corbului – and in the Early Neolithic horizon of this multi-layered site, there was a group burial with seven burials: one of the deceased was buried in a sitting position; according to the pottery found in association with this interment, the group burial was dated to the Early Neolithic (the Starčevo-Criş culture) (*Paunescu 1996. 177, Fig. 10; Sladić 1986.432; Vasić 1986.268, Figs. 15–16*).

A larger number of this type of burials and their links with the Lepenski Vir culture phase characterize the right bank of the Upper Gorge. At Vlasac, in a double Burial 16–17, one of the individuals was buried in a sitting position: the long bones were crossed, the spine was banded, and the skull was lying on top of the pelvis; one could suppose a domed stone construction here. The stratigraphic position of this burial is in the early phase, Vlasac I. The date is in the range 8286 to 7749 calBC at 95 per cent confidence (*Borić, French, Dimitrijević this volume Table 1*). At the site of Lepenski Vir, a burial of this type was found in an undisturbed anatomical position, with legs lying wide open, banded at the knees, while the heels were touching. It is dated to Lepenski Vir phase Ia (*Srejović and Babović 1981.55–56*).

To some extent, Padina is an exception in this case: burials with the deceased in sitting positions were found in elongated stone constructions (Burials 18b, 21 and 23) and within the group of burials with domed stone constructions (Burials 12, 15–16 and 17) (Fig. 19). Three of them have been radiocarbon dated recently. AMS dates give a range of 9250 to 7960 calBC at 95 per cent confidence (for details see *Borić and Miracle 2004.348–357, Tabs. 1 and 5*).

In total, there are 6 burials with the deceased in sitting positions, which by far outnumbers burials of this type from other sites. One notices very strict burial rites, with an emphasis on burying the dead with stone constructions specially built for the purpose. However, burial offerings were absent; burials in pairs is not a strict rule, while all of these burials faced the Danube.

Padina A1–2, A–B and B1–3. Architecture

As previously published works show, it is clear that the Lepenski Vir culture is accepted and identified on the basis of its peculiar architecture and ritual and figurative artworks. Other categories of finds were connected to the Epi-Palaeolithic/Mesolithic traditions. Hence the terminology of the Mesolithic-Neolithic transition was applied to, at the time, the newly discovered culture of the Danube Basin. The enigmatic question about contacts and the appearance of the Lepenski Vir culture was in this way equated with the Late Mesolithic of the Danube Gorges on the one hand, and with the Starčevo-Criş pottery complex, as the representative of the Early Neolithic in the wider region, on the other.

To date, the published and debated evidence about the architecture of the Lepenski Vir culture has been primarily limited to building floors with recognizable trapezoidal bases, built-in stone foundations, stone artworks, which were grounded in the symbolism of the Danube Gorges sandstone boulders of specific colouration and different sizes.

Not much ink has been spilled on the fact that this cultural phenomenon was confined within such a small area of the gorges at the time of its flourishing, exhibiting its exceptional stylistic and typological features at only two known settlements in the course of its entire development: Lepenski Vir and Padina in the Upper Gorge of the Danube. Although Padina was occasionally discussed when talking about this specific phenomenon of the Middle Danube Basin, there have been limitations due to delayed publishing of its rich corpus of finds and data. This has limited the spectrum of evidence documented about the site during the 1968–1970 excavations. To some extent, these limitations are being rectified here. For instance, Sector III at Padina offers a unique possibility to fill in the gaps in our knowledge of the Lepenski Vir architecture, both with regard to building techniques as well as the organization of the settlement.

Built along the steep cliffs of the Gorge, the settlements of the Lepenski Vir culture at the eponymous site and at Padina were built in parallel rows, one higher than the other, forming stepped terraces. Such was the layout of Padina after excavations. However, it was necessary to establish the stratigraphic relationship between different living horizons, with complex distribution – previously unknown buildings characterized by dug-in bases of trapezoidal shape (example of House 12, middle row, phase B–2) (Figs. 21, 22, 23). Rows of such buildings placed parallel to the Danube were the main stratigraphic features with a contemporaneous existence. One possibility is that each row was inhabited during the same period as a single settlement horizon, while the older horizon was abandoned and littered with the residue of the settlement (Fig. 20). In the following, we discuss the function of Houses 13, 15, 17, and 18 from the younger and middle rows of the Lepenski Vir culture settlement at Sector III, chosen due to their position, size, architectural details and artefacts found *in situ*.

House 13. Middle row. Profile III, segment 2

It is unnecessary to repeat the main construction details of this and other buildings described here, since these are common to the whole architectural tradition. It is more useful to discuss specific, *i.e.* local construction details. House 13, for instance, was the only building at Padina with its rear zone limited by blocks of rock placed vertically, similar to a massive stone wall. Bringing such large rocks (1.50m–0.80m), which probably originated from the cliffs that overhang the costal zone, must have depended on developed engineering skills. The configuration of the terrain at this site excludes any ritual function for such a dry wall in the back of the building – House 13 had, in fact, a stone dam as protection against the torrential brook that ran down the hill into the Danube, and that also impacted House 18, which will be mentioned later. Hence the protective role of this rocky dam: preventing flooding, washing out or destruction of the building, similar to the problem that caused the destruction of House 3 at Sector I (Figs. 16 and 21).

House 18. Trench 5, block 1 – Trench 6, block 2

With regard to this building, it was most important to establish the time of its abandonment, which might have been caused by the torrential brook or preceded this event. The base of this building was completely preserved, its complete inventory was found *in situ*, which was rare for the settlements of the Lepenski Vir culture at Sector III. House 18 was also one of the youngest buildings in this row (B3) and certainly indicates the end of the use of this settlement (Fig. 27); on the floor of the building a group of pots was found which were typologically different from the typical Starčevo-Criş pottery found in other buildings (with the exception of House 15 in the same row), in the occupation layer or middens of the costal zone.

It seems that the torrential brook took the inhabitants by surprise, but was not the only reason for the abandonment of this settlement. It seems that the abandonment of this building marks much larger changes in the traditional economic system, such as a decline in demand for fish from the Danube, especially of anadromous fish, such as beluga and other species of *Acipenseridae*, or other large fish species that were fished by collective efforts. Thus, the abandonment of House 18, *i.e.* its youngest settling horizon, certainly was not sparked by a sudden disappearance of these species, since up until the hydroelectric dams Đerdap I and II were built, the whole region was famous for fishing on these species.

In stratigraphic terms, House 18 cut the front of House 17, built on higher terrain (0.30m–0.40m), hence its lower position is an exception to the rule of building the Lepenski Vir culture settlements – younger buildings always being on higher terrain. The exception to this rule must have been related to the lack of adequate space in the given area; shifting House 18 to the lower position exposed it to the torrential brook. Being positioned on loessic sand, House 18 could not have been supported by a wall of massive stone blocks like House 13.

In front of wider side of House 18, *i.e.* in front of its entrance, there was a preserved part of the floor, partly levelled by gravels and small size split stone, like a porch of some kind. The buildings of the second row, and to some extent those of the first horizon, or at least some of them, could also have had a similar paved porch, thus giving horizontal access to the building, as some kind of narrow platform that was cut into the layer of loessic sand (Figs. 16 and 17).

House 15. Trench 5, block 2

The entrance area with the porch is clearly visible in the case of this building, similar in its construction to House 18. What distinguishes this building from other buildings is a completely preserved cut for the building, with dug-in sides that were almost vertical, and with a carefully levelled, trapezoidal floor, along with the massive rectangular built-in hearth. There is an exception in this building when it comes to the construction of the hearth. The longer massive stone slab was found slanting on the side of the hearth, as thrown into the hearth; it might have served various functions. There is also a large block of rock in this building with a slanting flat surface in the back of the building. The stone might have served as a firm construction element for the longitudinal beam of a gabled roof with the necessary inclination. Pots found on the floor of House 15 were few, and were typologically similar to those found in House 18 (Figs. 16, 26, 28).

House 17. Trench 5, block 1

The floor construction of this building, in the youngest settlement horizon at Sector III, was carefully furnished, while the building can be connected to a special sacred/sacrificial function. At the bottom of a funnel-shaped pit (depth from the floor level 0.50m), an oval stone slab was placed as a lid of some sort, while underneath it, a carefully manufactured ellipsoidal stone altar with a shallow receptacle and a draining lip (0.35m by 0.20m) was found. Similar to other cult places in the settlement, at this place there were neither visible traces of ritual offerings nor animal bones. Remains of burning and charcoal were not very prominent here, which is clear judging by the absence of ash and soil burning. A ritual rite dedicated to a particular divinity might have been symbolic. House 17 was also abandoned without any visible traces of violent or hasty abandonment. Yet the inventory of finds discovered on the floor of this building is quite modest (Figs. 16 and 24).

Padina B1 – 3. Sector III. Settlement organization

The settlement of the Lepenski Vir culture at Sector III is not found on top of a previous settlement as was the case with contemporaneous trapezoidal buildings at Sector I. However, this could be related to the loss of settlement space due to the erosion caused by the Danube. This was the reason test trenches were dug in the costal zone in order to check the possibility of the existence of the oldest horizon in the settlement. In the immediate vicinity of the excavation area (1968–1970), using a sandy ridge formed during the low water table, Trench 3, Sector 3 was excavated to a depth of 2.50m, when underground water was reached. This showed that the slope of the terrace was significantly steeper at the time of the duration of this settlement than at the time of the excavation. This conclusion was also confirmed by a limited number of Early Neolithic finds in this zone, putting the boundary of the prehistoric coastal zone 15–20m toward the Danube from the riverbank profile encountered in the 1960s.

It is clear that the width of this zone was irregular, depending on the topography, although it is possible to assume that approximately one third of the settlement of Sector III was lost. Such an estimate could be supported on the basis of the current costal profile, with a cross-section of the bases of trapezoidal buildings in the middle row (B2), while the bases of the first, and the oldest, row of buildings were covered by layers of sand which accumulated when the water table of the Danube was high, *i.e.* during inundations.

The organization of the settlement space at Sector III during the Lepenski Vir culture phase was not dependent on the complex of necropolises, which were significantly older than this settlement, or on the preceding phase of contacts with the Early Neolithic groups, since the space where we might have had such traces is now covered by the Danube. What survived was a settlement from the time of the developed Lepenski Vir culture, with three rows of typical buildings. This settlement was gradually built up. It is realistic to suppose that the main settlement horizon (B2) was connected with the buildings of the older phase (B1), during which the preparations for the building of a new row of buildings was anticipated (B3) (Fig. 28).

The middle row of buildings on the settlement plan contained Houses 11–15/1 (in total 5 floors); the older, lower horizon contained Houses 5–10 (in total 6 floors) (Fig. 25). One can notice that the middle row is reduced by one building (6:5), although it is advanced on the basis of a new architectural detail that was introduced at the time: A-frames placed asymmetrically over the hearth. This reduction in the number of buildings continues, if one compares the middle row of buildings (B2) with the latest, higher row (B3), which was also reduced by one building (5:4), since the space for building was narrowed. The conclusion that the settlement space previously used went out of use at this time, and even stopped being visible during the latest horizon (B3), is based on the existence of an exceptionally large midden zone (*c.* 28m by 6.5m), covering the middle and older parts of the settlement, reaching up to the very platforms of Houses 15 and 18. The thickness of the midden was uneven, and it was formed by a gradual accumulation of residues from each higher level of buildings (Fig. 16). This explains why no rubbish pits were found at the sectors of Padina. This role was taken up by the costal zone (with the zone of the abandoned settlement horizon) and high waters of the Danube. The most important palaeozoologial and ichthiological finds from Padina (for the settlement of the Lepenski Vir culture) were found in this particular stratigraphic feature. The scarcity of finds from the contact phase is understandable, since these were probably washed out by the Danube at Padina, in this way deepening the enigma about the appearance/disappearance of the Lepenski Vir culture.

Padina. Sectors I–III. Pottery and the chronology of the Lepenski Vir culture

Pottery is not often found within closed contexts in the Lepenski Vir phase buildings at Padina, despite the small settlement area and density of finds within the buildings. Therefore, we focus on the discovery of circumstances and contexts of those finds and not on the typological or chronological schemes based on pottery. There are only two, quantitatively different groups of pottery finds. The first type of pottery comes from the cultural layer, including middens, and the second, much smaller, from buildings, hearths and burials. Traditionally, most attention has been paid to the Starčevo-Criş pottery from the Lepenski Vir settlements, mostly representative vessels, which are even more scarce than the second group of finds (*Budja 1999.134–35; 2007.50, Figs. 31, 32, 33, 34, 35*).

However, the first group of pottery finds is surprisingly large in number, even if it is compared to the assemblages from the Early Neolithic sites from the middle Danube area. But formal analogies do not imply that the pottery is the same, as pottery from the Upper Gorges sites represents a distinctive variant of the Starčevo-Criş complex. This pottery is robust and poorly made. Vessels of large dimensions are common; monochrome pottery of better quality is rare, while the painted pottery is almost absent. At Padina, this last technique of ornamentation is completely missing. On the other hand, decoration of the outer surface of the vessel by pinching and impressing is the dominant method of decoration from the beginning to the end, when it becomes less common. Typical Starčevo ornamentation techniques such as combing, relief furrowing and the application of wet clay (barbotine) is completely absent (*Borić 1990.49–53*).

The stratigraphic position of concentrations of pottery within the cultural layer is uncertain, due to the formation of large middens upslope. Like on hillforts, large fragments tend to move down slope, where they cover abandoned parts of the settlement. An important issue when discussing the emergence and the development of the Iron Gates variant of Early Neolithic pottery is to locate its production. There is now evidence for local production at Padina (at Sector I, block Ib), but only after the contact phase. The same can be said, at least in principle, for chipped and polished stone tools, especially at Sector III (Fig. 29).

Padina. Sectors I–III. ^{14}C dates and their correlations with stratigraphy

A series of ^{14}C dates from several laboratories have been obtained for samples from Padina over the years, and due the publication of new AMS dates from Padina and Hajdučka Vodenica, we present the full list here. We stress the context of samples and their correlation with the stratigraphy of the settlement.

❶ The first contradictions between the stratigraphy of building horizons at Padina and corresponding ^{14}C dates (from 1978 and without calibration which was performed subsequently) were caused by the inverse relative chronology, where younger horizons were defined as the oldest:

GRN-8229; 6570 ± 55 BP; 5630–5380 calBC at 95 per cent confidence (charred wood, the hearth from House 8, Sector III, Profile 3);

GRN-7981: 7100±80 BP; 6160–5780 calBC at 95 per cent confidence (cultural layer, Sector III, Trench 6, block 1 [phase B3]);

GRN-7981: 7075 ±50 BP; 6030–5800 calBC at 95 per cent confidence (charred wood, House 15, Sector III, Trench 5, block 2 [phase B3]).

This contradiction was later attributed to the contamination of samples due to the middens. A large volume of the midden material affected the samples, while middens were also post-depositionaly disturbed by flash floods.

Obtained dates can be arranged in two intervals – the first half of the 6th millennium for phase B3, and the second half and end of the 7th millennium for phase B2 (*Borić and Miracle 2004.345*).

A part of the same sample of charred wood from the floor of House 8 (B1) was dated to 7065 ± 110 BP; 6105–5725 calBC at 95 per cent confidence, which is approximately contemporary with the date GrN-8229. This unpublished analysis was carried out by the University of Minnesota (USA) in 1974. Absolute dates for House 9 (B1), situated immediately adjacent to House 8, is according to the date of the sample from the floor calibrated in the range 6410–6090 calBC at 95 per cent confidence (*Canis familiaris*, OxA-9056), which puts the date for phase B1 (according to its stratigraphical priority) in the expected place. House 9 is therefore dated to the middle and second half of the 7th millennium BC (*Borić and Miracle 2004.346*).

❷ Temporal interval between Houses 15, 17 and 18 of the youngest dwelling horizon, Sector III, Trench 5-6 (B3).

Houses 18 and 15

OxA-9052, floor of House 18 (deer antler, *Cervus elaphus*): 6965 ± 60 BP; 5990–5720 calBC at 95 per cent confidence.

OxA-9054, under House 15 (Mammalia, worked bone): 6790 ± 55 BP; 5780–5560 calBC at 95 per cent confidence.

The absolute temporal gap between both houses, which is between 210 and 160 calendar years, suggests that they are more or less contemporary, which confirms the stratigraphic relationships recognized during the excavations (*Borić and Miracle 2004. 347*).

Houses 17 and 18

OxA-11103, from the hearth of House 17 (Mammalia, bone tool): 7315 ± 55 BP; 6250–6025 calBC at 95 per cent confidence.

Absolute temporal gap between both houses from the same horizon, B3, which is between 305 and 260 calendar years. This confirms the stratigraphical relation between houses, where the floor of House 17 was cut during the construction of House 18. The question remains as to whether they are really separated by three centuries (*Borić and Miracle 2004. 347*).

Two chronological terminus, related to the base of House 18

OxA-9052. House 18 (red deer antler, *Cervus elaphus*): 5990–5720 calBC at 95 per cent confidence.

OxA-9053. House 18 (under the house floor/*Canis familiaris*): 6440–6210 calBC at 95 per cent confidence.

The age difference of both samples corresponds to their stratigraphical position. However, the interval between dates seems to be too large, almost half a millennium (450–490 calendar years). It is possible that the sample of *Canis familiaris* belongs to the Late Mesolithic phase, which in turn leads us to discuss the age of dog domestication at Padina (*Borić and Miracle 2004.346*).

Age difference between Burial 11, under the floor of House 15 and the base of this building

OxA-11104. Burial 11, under the floor of House 15 (Sector III, Trench 5, block 2): 9360–8920 calBC at 95 per cent confidence.

OxA-9054 (Mammalia, worked bone): 5780–5560 calBC at 95 per cent confidence.

These dates are separated by three millennia. Ignoring the issue of the acceptability of this difference, we can observe that the pit for Burial 11 could not have been cut during the existence of House 15. Burial 11 is located 0.6m below the building floor, which together with the depth for the cut made for the building floor (0.65m) amounts to 1.25m. This is significantly deeper than the depth of burials next to the stone structure of the Late Mesolithic necropolis in test Trenches 6 and 7 of the same sector. This is similar to the case of Burial 13 under House 18, which was interred before the building was constructed. As the radiocarbon dates indicate, Burial 11 is older than House 18. The large age difference can be provisionally explained by the early settling of the local Late Mesolithic population of the Danube Gorges (*Borić and Miracle 2004.Tab. 3 and 5; Bonsall at al. 2002/3. Figs. 3–4*).

Burials 1a and 2. Sector 1, Trench 1, blocks 1 and 1b

Burial 1a is greatly disturbed, only the bones of lower extremities were preserved. Their position indicates an unusual position of the body, which was positioned supine (test Trench 1, block 1). However, in the photograph published by Borić and Miracle (*2004.Fig. 4*) instead of Burial 1a, Burial 2 (test Trench 1, block 1b) is shown, located next to the Lepenski Vir culture House 2. This is due to the mislabelling of the photograph of this burial in Živanović (*1973–1974*) that Borić and Miracle used in their paper. However, the stratigraphic position of both burials puts them in the contact phase or the earliest stage of the Lepenski Vir culture (B1) (Fig. 5).

The comparisons of ^{14}C dates with the stratigraphic evidence from Padina does not end with these examples, and it remains important to provide an adequate correspondence between these sets of evidence as one of the key issues in the study of the Late Mesolithic and Early Neolithic settlements at Padina and the Upper Gorges.

Padina I–III. The Lepenski Vir culture

The study of the stratigraphic relationships of the Mesolithic settlements of the Lepenski Vir culture is focused on those parts of the cultural layer, occupation surfaces and features that were spared post-depositional disturbances caused by erosion or the movement of material from middens in areas outside the living settlement zone. This approach has brought new ideas about the appearance of settlements, based on the excavated area with the horizontal and vertical arrangement of trapezoidal buildings with stone constructions on the inner sides of their cuts. These entities are composed of past occupation surfaces, positioned on terraced surfaces outside the areas exposed to flood hazards caused by the Danube and away from torrent streams coming down the slopes of the Gorges. Building horizons excavated at the Sectors I and II provide a good example of their primary function on which the organization of the settlement is based, by adapting to the specific environment. Thus, there is a symbiosis between the natural environment and the technology for extracting particular resources.

People were making very selective choices about where to settle in the Upper Gorges in the Late Mesolithic, sometimes even inconsistently in the choice of suitable locations, as some less favorable locations were selected. However, as a general rule, settlements were located in the vicinity of whirlpools (Lepenski Vir, Gospođin Vir), or in the vicinity of rapids and cataracts (Greben near Vlasac), usually located downstream from a particular settlement. The hospitable riverbank at Sector IV at Padina, from the fossil Gospođin Vir at Sector III to the outlet of the Čezava River was not settled, nor was the river bank between Stubica and Padina. However, it should be stressed that the shallow coves of Padina's sectors were located along the last rapids of the Gospođin Vir whirlpool.

These locations were suitable for collective fishing focused on large fish. The presence of large European sturgeon, which weighed around 200 kg and was up to 5m in length, was attested by ichthyological analyses of fish bones from Padina (*Brinkhuizen 1986.18*). However, no fish hooks were found at Padina. Bone fish hooks present in riverine settlements can often be the evidence of organized fishing. Therefore, we must assume the use of fish nets and traps at these locations, where similar fishing techniques were used until the construction of the Iron Gates dam.

Fishing in the course of the Lepenski Vir culture is an interesting issue. The cultural development of communities was based on the exploitation of certain natural resources with a highly developed specialized technology, which resulted in unique cultural expressions. We will only briefly touch upon these phenomena. One of the more general points about the essence of the Lepenski Vir culture is that its uniqueness can be connected directly with the transformation of the Late Mesolithic populations into the communities of the first producers of food in the area.

If we observe the whole process of transformation outside the existing classificatory schemes, we can note that Mesolithic populations were already involved in a system of production, fishing the large seasonal migratory *Acipenseridae*, which was very similar to food production. A careful consideration of the material and religious superstructure of these early communities before the adoption of farming may indicate constant efforts at achieving the stage of a food-producing economy. The moment of abandoning the millennia-long tradition of hunting and gathering at Lepenski Vir and Padina was preserved by chance.

Hajdučka Vodenica, Mali Kazan (Lower Gorge)

The prehistoric site of Hajdučka Vodenica is located in the Lower Gorge of the Danube (Mali Kazan) and consists of two locations: the settlement in the centre of a large semicircular depression below the Mali Štrbac mountain massif, while the necropolis was located beside the Danube to the west. However, neither of these two locations have been extensively researched or studied, despite large-scale systematic excavations between 1965 and 1969. Hypothetically, the settlement might have been situated in the middle of the cove, near a large spring. This water source was strong enough to run a wooden mill, hence the name of Hajdučka Vodenica (meaning Hajduk's mill or outlaw's mill).

The construction of Roman and Byzantine settlements, which were parts of the Danube *limes*, significantly disturbed the earlier Early Neolithic settlement. The construction of a guardhouse in the middle of the last century further demolished the site. The rescue excavations revealed a large quantity of residual Starčevo pottery, redeposited in the foundations of the Roman rampart, and discovered a necropolis of the Lepenski Vir culture that was located at the western entrance to the Mali Kazan Gorge (Fig. 36). The site can be described as a necropolis, more so on the basis its purpose than on the basis of its contents. There were complex architectural elements and stone constructions, previously unknown in the Iron Gates and in the wider region.

Due to significant post-depositional destruction of the cultural layer here, similar to other sites in the Danube Gorges, it is very difficult to provide a detailed description of this feature of the Lepenski Vir culture. The location of the sacrificial feature was identified due to a large slide from the riverbank profile. Test trenches dug at this spot revealed a tangle of stone constructions full of charcoal, ash, burned soil, washed out human bones, and finally burials. The site could be characterized initially as both a settlement and a necropolis, although we are still seeking a more detailed description (for details, see *Jovanović 2004.58; Fig. 4*).

Whilst clearly differing from other necropolises of the Lepenski Vir culture in the Upper Gorge, Hajdučka Vodenica belongs to the same tradition. Firstly, here, no clear relations between the settlement and the necropolis can be established. There are some similarities between the oldest building horizon at Hajdučka Vodenica and other sites. This oldest horizon consists of chaotically distributed hearths on a flattened living floor, which are not on the same level as the building horizons. These hearths were oriented in different directions, mainly with the narrow side facing the Danube. Sometimes stone plaques covered these constructions made of vertically placed stone blocks, crudely worked. There were visible traces of burning, sometimes on the edges of the hearth construction in the form of a strip of burning, which could indicate that such hearths were covered with a dome of some kind. Hearths were not damaged, but had been abandoned long enough to be covered by a layer of intense black colour containing organic remains. Lithic and stone tools were generally absent from this layer, reduced only to a few cores, debitage, and massive stone tools such as anvils and hammers (Figs. 48 and 49; Horizon 1).

This contrasts with the abundance of bone tools found in horizon 1, such as points, awls, chisels, scrapers, projectiles and small hoes made from antler. No pottery was found in this horizon. Moreover, this horizon was excavated at the depth of 0.8–1m below the current level of the Danube. Therefore the expanse of the founder horizon at this settlement, which perhaps might have been attributed to an unarticulated phase of the Lepenski Vir culture, remains completely unknown (Figs. 52, 53, 54; Horizon 1).

Above this, a new cultural layer was deposited which is characterized by a completely new building technique: it begins with piling large stone constructions; large, split stones were used and arranged more or less horizontally, consisting of groups, circles and irregular heaps at particular locations. Bone tools are also present here, as well as traces of burning, and sporadic burials that were interred within the stone constructions. The deceased were placed in extended positions and were differently oriented, although the general orientation was made in relation to the Danube. Thus building activities using the same template continued, forming four horizons of roughly piled stone. There was an unexpected exception here. In horizon 2, a small feature was built resembling a model of a classic building of the Lepenski Vir culture. However, it was constructed on an uneven, rocky surface, where it was not possible to identify the floor level or even less the floor. This structure had a rectangular hearth, covered by a stone slab, and with an accompanying aniconic boulder (Figs. 49, 50, 51; Horizon 2).

The dry stone wall, which was 2.0–4.0m wide, was almost 2.0m high, with vertical and very stable sides, with no traces of tear, except some later erosion caused by the Danube, which covered the earliest phase with hearths in a thick layer of sand (Figs. 44, 45, 46, 47, 48).

In the last two horizons of the stone feature, Early Neolithic Starčevo-Criş pottery appears. Here one finds fragments of large, crudely made and monochrome vessels, which predominate; mainly bowls and pots-amphorae were present. Pottery was obviously broken at specifically chosen locations, since fragments were not uniformly distributed at the level of the construction, but were found in piles and associated with traces of burning (Figs. 44, 45; Horizon 3–4).

All the above could indicate a new type of sacrificial construction in the burial ritual of the early phases of the Lepenski Vir culture. Downstream from the stone constructions, builders set apart a special area, clearly planned in advance. In the stratigraphic sense, this is a secondary shift of the sacrificial altar, which would be in the tradition of the Lepenski Vir culture, although the feature in itself is slightly different from this tradition (Fig. 37).

The first construction of a narrow and long hearth, with elongated lateral sides, was carried out on the level of loessic sand, based on preserved foundation ditches. Similar to the construction technique in the horizon with rectangular hearths in the zone of stone constructions, long and large stone slabs were inserted in the foundation trenches here. The immediate area around this hearth remains unknown, although it is certain that on both sides of this first hearth burial rites were performed, connected with the burials found in the cultural layer (Figs. 38, 43).

The hearth was accompanied by an older boulder of green volcanic stone, the surface of which was channelled by narrow flutings, which form an ornamental motif distantly related to patterns found on the boulders of Lepenski Vir (*Srejović and Letica 1983. Fig. 27*) (Fig. 55).

After some time, the space around the sacrificial hearth was filled in and the whole construction was moved back, away from the river bank. A burial chamber, cut deep into the layer of flowstone between two ridges which ran into the Danube, was extended further (dimensions 7.5 x 4.0m, Fig. 41).

A new hearth was built, no longer rectangular, but in a funnel-like shape, with a narrow channel along one of its lateral sides. There can be no doubt about its function – it is a conduit for liquid, which does not come immediately from the sacrificial altar, but accumulates at the end of the channel. The design of this type is unknown among the hearths of the Lepenski Vir culture (Figs. 38, 39, 42).

The time lapse between the older and younger sacrificial hearths is evident in the basis of the change in style of decorating the boulder associated with the younger hearth. It is a sandstone boulder, with some anthropomorphic details (*Srejović and Letica 1983; Antonović 2004.73–74*) (Fig. 56).

The floor, built on both sides of the hearth (6.0 x 2.5m), does not respect the symmetry of the construction – with the hearth on the main axis – which is one of the main construction rules of the Lepenski Vir culture. The part of the floor that was upstream the Danube from the location of the hearth was twice as large in comparison to the one on the opposite side; the floor even partly covered the hearth and was on the same level with two stone slabs. The first, a massive rectangular slab, functioned as the threshold, while the other one, much narrower, leads to the hearth. There is no ash place, as both stone slabs were located where the ash place is usually found. The hearth might not have been constructed for keeping a continuing fire, but for special (cult), periodic events (Fig. 39).

Some burials (Burial 11 and partial remains of other burials, Figs. 38, 39, 40) were located below the horizon with hearths, in a layer of dark earth with considerable quantities of charcoal.

The burial chamber extends directly from the sacrificial hearth. Here, a large number of bodies were buried in single, double or multiple burials, in the extended position, parallel to the Danube, with the heads pointing downstream (*Roksandić 2000.37–38*). In the latest horizon, burials were covered by stone plaques, and the whole feature was abandoned. It was preserved until the excavation, with both sculpted boulders accordingly in association with the hearths to which they belonged.

We have no answer to the question about the population which maintained this as well as other ritual constructions for such a long period. Preliminary comparisons can be made with Hajdučka Vodenica, Vlasac (*Borić, French, Dimitrijević this volume*) and Padina A–B during the contact phase. For example, the long hearth from this phase at Padina (approximately 1.50m x 0.50m in Sector I, segment 2–3) is the only example of the elongation of lateral sides of the hearth.

These similarities are related to the earliest phase in the formation of the Lepenski Vir culture, namely with the first material evidence of the contact phase. They demonstrate the influence of local traditions in the process of accepting the sedentary life-style and food production. The strong presence of the Lower Danube variant of Starčevo culture, with important settlements found distributed down from Kladovo to Prahova and to the mouth of the Timok River, should be taken into consideration when discussing the process of transformations at Hajdučka Vodenica. On the other hand, there are no reliable data on the fate of the destroyed settlement with Starčevo pottery found in the middle part of the Hajdučka

Vodenica cove. Such pottery was also found in horizons 3 and 4, with elongated stone constructions of the necropolis.

Hajdučka Vodenica necropolis, radiocarbon dates – correlations with the stratigraphic position of burials

A series of 4 AMS dates from Hajdučka Vodenica date 4 burials from the necropolis with the sacrificial construction (*Borić and Miracle 2004.346, Tab. 3*; for OxA-13613 this replaces previously published OxA-11128 see *Borić et al. 2004.Tab. 3*). They belong to different levels of this construction:

❶ OxA-13613. Burial 8: 7076–6699 calBC at 95 per cent confidence. One of the oldest double burials cut into loess, at the south-east corner of the foundation trench of the first sacrificial hearth. The body was placed supine with arms crossed, parallel to the Danube, elevation ▼ 46.86m.

❷ OxA-11127. Burial 12: 6500–6230 calBC at 95 per cent confidence. The burial was placed directly on the floor next to the sacrificial hearth, after the sacrificial hearth had been abandoned. Here, one again finds a double Burial (12 and 9): both skeletons were fully articulated, elevation ▼ 47.74m.

❸ OxA-11109. Burial 20: 6440–6090 calBC at 95 per cent confidence. The burial was placed in the extension of the burial chamber and belonged to a group burial (Burials 17, 17a, 18, 19), elevation ▼ 48.14m.

❹ OxA-11126. Burial 15: 6470–6230 calBC at 95 per cent confidence. This burial was covered with stone constructions and belonged to the burials of the second, younger horizon, elevation ▼ 48.54m.

The elevation of the excavated area of the site located on the riverbank is ▼ 48.86m, which makes a height difference of 3.32m, exactly the height of the section above the construction of the necropolis. The deposition of the scree hill-wash can be attributed to the time interval between the abandonment of the site and our excavations. This thick deposits contributed to the preservation of the cultural layer and stone constructions.

AMS dates suggest two chronological horizons of the necropolis. The older belongs to the beginning of the 7th millennium BC (Burial 8), while the younger can be dated to the middle and second half of the 7th millennium BC. In other words, there may be a temporal gap of several hundred years in the use of the necropolis. Both sacrificial structures are clearly related, and the renovation of the younger necropolis continues from the use of the older.

Discussion of the date of the construction of the first sacrificial structure is hindered by the lack of analogous features from other areas. Certain architectural analogies with the contact phases of Vlasac and Padina point to the middle and the second half of the 7th millennium BC (*Borić, French, Dimitrijević this volume*). We must also consider the amount of work put into the construction of massive stone structures layered one on top of the other. In this way, a monumental stone structure was built, the dimensions of which can only be guessed at. The appearance of Early Neolithic pottery in the third and the fourth horizons of the stone structure places the whole (sacral?) settlement in the formation phase of the Lepenski Vir culture.

Conclusions

The results of the systematic excavations of Padina and Hajdučka Vodenica have been concisely presented here. However, since these views are very distant from the time of the initial excavations, they are viewed through the lenses of several decades of research and interpretation of the the Lepenski Vir culture. The issues presented here are the result of heterogeneous strands of evidence in the present knowledge of the Lepenski Vir culture, which has for a long time served as a model for the Neolithisation of the frontier area on the Danube. This discussion, based on facts and finds gathered from Padina and Hajdučka Vodenica, actually announces their imminent monographic publication.

If Padina is taken as a point of departure, then the issue was the difficulty of establishing the relative chronological position of the material from Sectors I and III in relation to other settlements of the Lepenski Vir culture.

Sector I was first thought to be chronologically older, as its closed assemblages are typical of the blooming of the traditional elements of this culture, while the considerably larger settlement at Sector III, organically incorporated into the known scheme of rows of buildings with trapezoidal floors, is distinguished by a unique find – a closed assemblage of pottery from the floor of the latest House 18. This assemblage has no stylistic or formal similarities with Starčevo-Criş pottery; it is more similar to an unexpected phenomenon of the "Proto-Vinča pottery", with black burnished or grey vessels, of rather biconic than spherical forms, together with the entire absence of ornamental styles of classic Starčevo-Criş production. After the abandonment of this building in the final phase (B–3) of the settlement, Padina was not settled. In that sense, Sector I rather indicates the origin of this culture in the Late Mesolithic of the Danube Gorges and in the subsequent contact phase (A–B).

It is impossible to define precisely the bearers of these changes and the range of relationships that might have existed between the older sedentary (static) community in this region and newcomers, *i.e.* expanding Early Neolithic populations. However, the community of the Lepenski Vir culture might have been complex in make-up:

- the generation from downstream areas of Danube Gorges that was first exposed to contacts and became familiar with Early Neolithic sedentary groups who established settlements in the Ključ and Oltenia.

- the generation from the Lower Gorges of the Danube, for example from Hajdučka Vodenica, might have experienced the first melting of populations and the appearance of 'interbreeding' through biological reproduction or merely through the diffusion of the experience or knowledge of the Early Neolithic cultures.

- the generation from the Upper Gorges forms a new indigenous lifestyle based on interbreeding with incoming Early Neolithic populations. This generation lived to see the end of the Lepenski Vir culture, when its specific ways of fishing were declining as the primary food procurement strategy.

If we accept this outline as a point of departure for further discussion, then the process of transformation consisted of a mosaic of micro-processes dependent on the production stage of individual communities.

Outside the Danube Gorges, there were no conditions for the existence of the Lepenski Vir population *sensu stricto*. All the elements of this culture originated from the gorges during the phase of contact: the organization of settlements and unification of the big river cult, which countered the agricultural fertility cult. In this way, the respect for the 'deity of fertility of the water world' is a response to the adoration of the 'Magna Mater' of the Early Neolithic agriculturists. Instead of sacral areas in Starčevo-Criş dwellings, in the buildings of the Lepenski Vir culture, the rear area of the hearths of trapezoidal buildings was appropriated with sacrificial pits covered by sacred boulders.

The history of the Lepenski Vir culture after the abandonment of its settlement remains unclear, especially of Lepenski Vir and Padina. If the buildings were left desolate, the good preservation of their floors and the household inventories is surprising. How can we explain that anthropomorphic, fishlike deities at Lepenski Vir were concentrated in one of the buildings ('sanctuary XLIV'), placed in two rows, facing each other, where they awaited the excavators? It is more likely that one relatively scarce, mixed population of fishermen, hunters and probably even cattle breeders, already accepting the new mode of sedentary, Early Neolithic lifestyle, peacefully abandoned their previous environmental zone. While the locations of previous settlements were still respected, they remained without visible traces of seasonal camps, until the Late Eneolithic, when Kostolac and Cotofeni settlements appear in the Iron Gates Gorges.

REFERENCES

ANTONOVIĆ D. 2004. Stone Objects from Padina and Hajdučka vodenica. Late Foragers and Early Farmers of the Lepenski vir – Schela Cladovei Culture in the Iron Gates Gorges. *Acts of The XIVth UISPP Congress. Liege 2001, BAR International Series 1302*. Archaeopress. Oxford: 69–75.

BANFFY E. 2004. *The 6th Millennium BC Boundary in Western Transdanubia and its Role in the Ventral European Neolithic Transition (The Szentgyörgyvölgy-Pityer-dombSettleme. Varia Archaeologica Hungarica 15*. Publicationes Instituti Archaeologici Academiae Scientiarum Hungaricae Budapestini. Budapest.

BONSAL C., MACKLIN G. M., PAYTON R. W., BORONEANŢ A. 2002. Climate, floors and river gods: environmental change and the Meso – Neolithic in Southeast Europe. *Before Farming 3–4 (2): 1–15*.

BORIĆ D. 1999. Places that created time in the Danube Gorges and beyond c. 9000 – 5500 BC. In M. Budja (ed.), *4th Neolithic Studies. Documenta Praehistorica 24: 41– 70*.

BORIĆ D. and MIRACLE T. P. 2004. Mesolithic and Neolithic (dis)continuities in the Danube Gorges: New AMS dates from Padina and Hajdučka vodenica (Serbia). *Oxford Journal of Archaelogy 23(4): 341–371*.

BORIĆ D., GRUPE G., PETERS J. and MIKIĆ Ž. 2004. Is the Mesolithic-Neolithic subsistence dichotomy real? New stable isotope evidence from the Danube Gorges. *European Journal of Archaeology 7(3): 221–248*.

BRINKHUIZEN D. C. 1986. Features observed on the skeletons of some recent European Acipenseridae. Their importance for the study of excavated remains of sturgeon. In D. C. Brinkhuizen and A. T. Clason (eds.), *Fish and Archaeology, BAR International Series 294*. London: 18–33.

BUDJA M. 1999. The transition to farming in mediteranean Europe – an indigenous response. In M. Budja (ed.), *4th Neolithic Studies. Documenta Praehistorica 24: 119–141*.

2007. The Dawn of Ceramics. In Blečić M., Črešnar M., Hansel B., Hellmuth A., Kaiser E. and Metzner-Nebelsik C. (eds.), *Scripta Praehistorica in Honorem Biba Teržan, Situla 44: 41–55*.

CLASON A. T. 1980. Padina and Starčevo, Game, fish and cattle. *Palaeohistoria 20: 141–173*.

GARAŠANIN M. and RADOVANOVIĆ I. 2001. A pot house 54 at Lepenski vir I. *Antiquity 75(287): 118–125*.

JOVANOVIĆ B. 1971. Chronological Frames of the Iron Gate Group of the Early Neolithic period. *Archaeologia Iugoslavica 10: 23– 38*.

2004 Padina and Hajdučka vodenica: Sites of the Lepenski vir Culture in the upper and lower Gorges of the Iron gates. *Acts of The XIVth UISPP Congress. Liege 2001, BAR International Series 1302*. Archaeopress. Oxford: 55–59.

KOZŁOWSKI K. S. 2001. Eco-cultural/stylistic zonation of the Mesolithic/Epipaleolithic in Central Europe. In R. Kertesz and J. Makkay (eds.), *From the Mesolithic to the Neolithic. Proceedings of the International Archaeological Conference held in the Damjanich Museum of Szolnok, September 22–27.1996*. Archaeolingua Foundation. Budapest: 261–282.

MIHAILOVIĆ D. 2004. Chipped Stone Industry from horizons A and B at the site Padina in the Iron Gates. *Acts of The XIVth UISPP Congress. Liege 2001, BAR International Series 1302*. Archaeopress. Oxford: 61–68.

PAUNESCU A. 1996. Die mesolitische Siedlung der Schele Cladovei – Kultur. In H. Hauptmann und P. Roman (eds.), *Ostrovul Corbului. Institutul Roman de Tracologie*. Bucuresti: 115–155.

RADOVANOVIĆ I. 1981. *Ranoholocenska kremena industrija sa lokaliteta Padina u Djerdapu*. Građa, knjiga 4. Arheološki institut, Beograd.

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

ROKSANDIĆ M. 2000. Between Foragers and Farmers in the Iron Gates Gorge: Physical Anthropology perspective. In M. Budja (ed.), *7th Neolithic Studies. Documenta Praehistorica 27: 1–100*.

SLADIĆ M. 1986. Kula pre Mihajlovac – un site prehistorique. *Đerdapske sveske – Cahiers des Portes de fer III: 271–285*.

STALIO B. 1986. Le site prehistorique Ajmana a Mala Vrbica. *Đerdapske sveske – Cahiers des Portes de fer III: 27–35*.

SREJOVIĆ D. and LETICA Z. 1978. Vlasac I. A Mesolithic settlement in the Iron Gates. In M. Garašanin (ed.), *Vol. I Archaeology*. Serbian Academy of sciences and arts, Belgrade.

SREJOVIĆ D. and BABOVIĆ L. 1983. *Umetnost Lepenskog vira*. Izdavački zavod Jugoslavija, Narodni muzej Beograd.

VASIĆ R. 1986. Compte – rendu des Fouilles du site prehistorique a Velesnica 1981– 1982. *Đerdapske sveske – Cahires des Portes de fer III: 271– 301*.

Figures

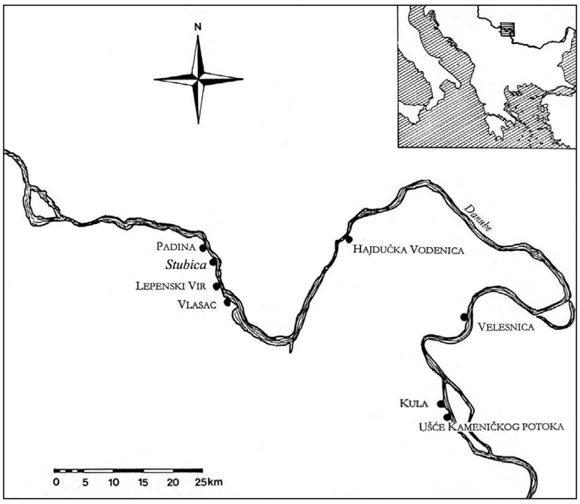


Fig. 1. Upper and Lower Gorges of the Danube with settlements of the Lepenski Vir culture (protective excavations on the territory of the hydroelectric dam Đerdap I; 1965–1970).

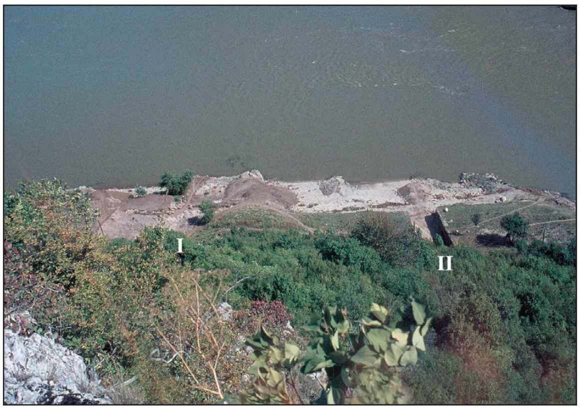


Fig. 3. Padina. View over Sectors I and II during excavations (1968) from the top of the steep side of the gorge.

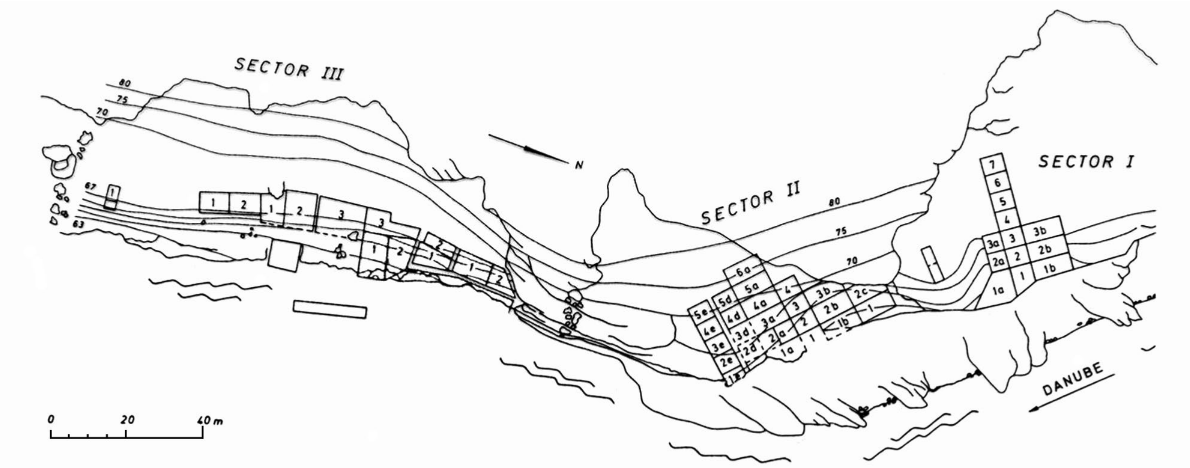


Fig. 2. Padina – Gospođin Vir. Sectors I–III, semi-circual coastal coves with the settlements of the Iron Gates Late Mesolithic and the Lepenski Vir culture.

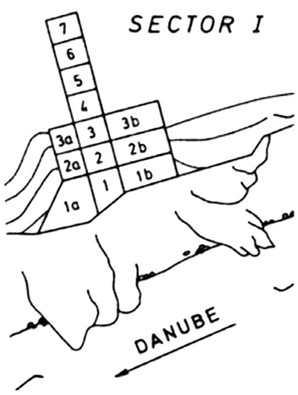


Fig. 4. Padina. Excavated areas at Sector I (without segments 1–3 in the coastal zone).

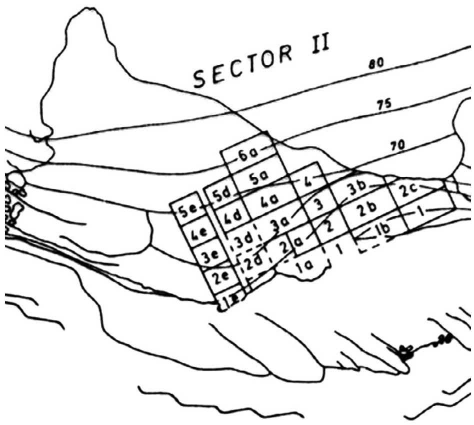


Fig. 10. Padina. Sector II, Trench 2, profile 2. Grid over the excavated area. Half-circular cove divided by the mountain creek.

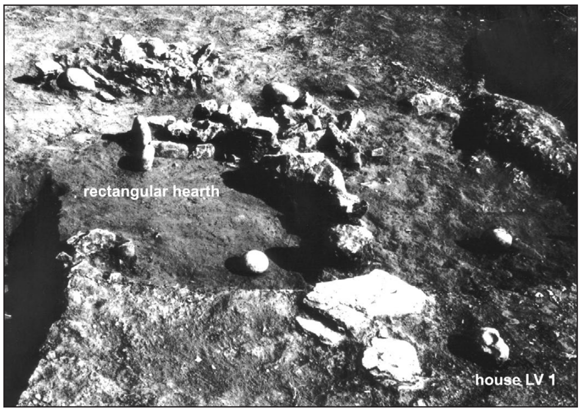


Fig. 6. Padina. Architectural features of phase A: the feature with long rectangular hearth, covered by the remains of House 1 (phase B1, the Lepenski Vir culture) with slabs of the rear platform of the hearth and the ornamented boulder (altar in situ*, Sector I, Profile 1, segments 2 and 3 of the coastal area.*

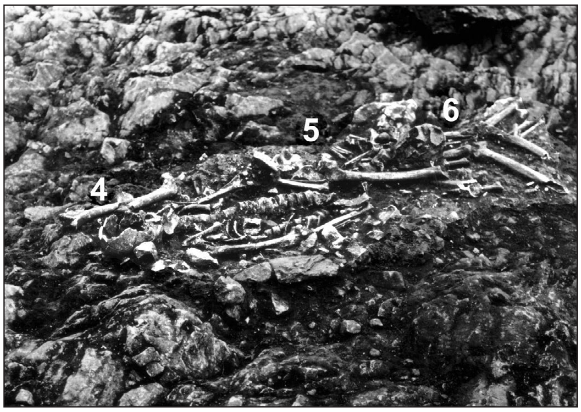


Fig. 9. Padina. Sector I, Trench 1, block 1a. Group burial at the level of palaesoil. Burials 4, 5 and 6 interred in different positions. Burials were made in the croft of House 2 (B2).

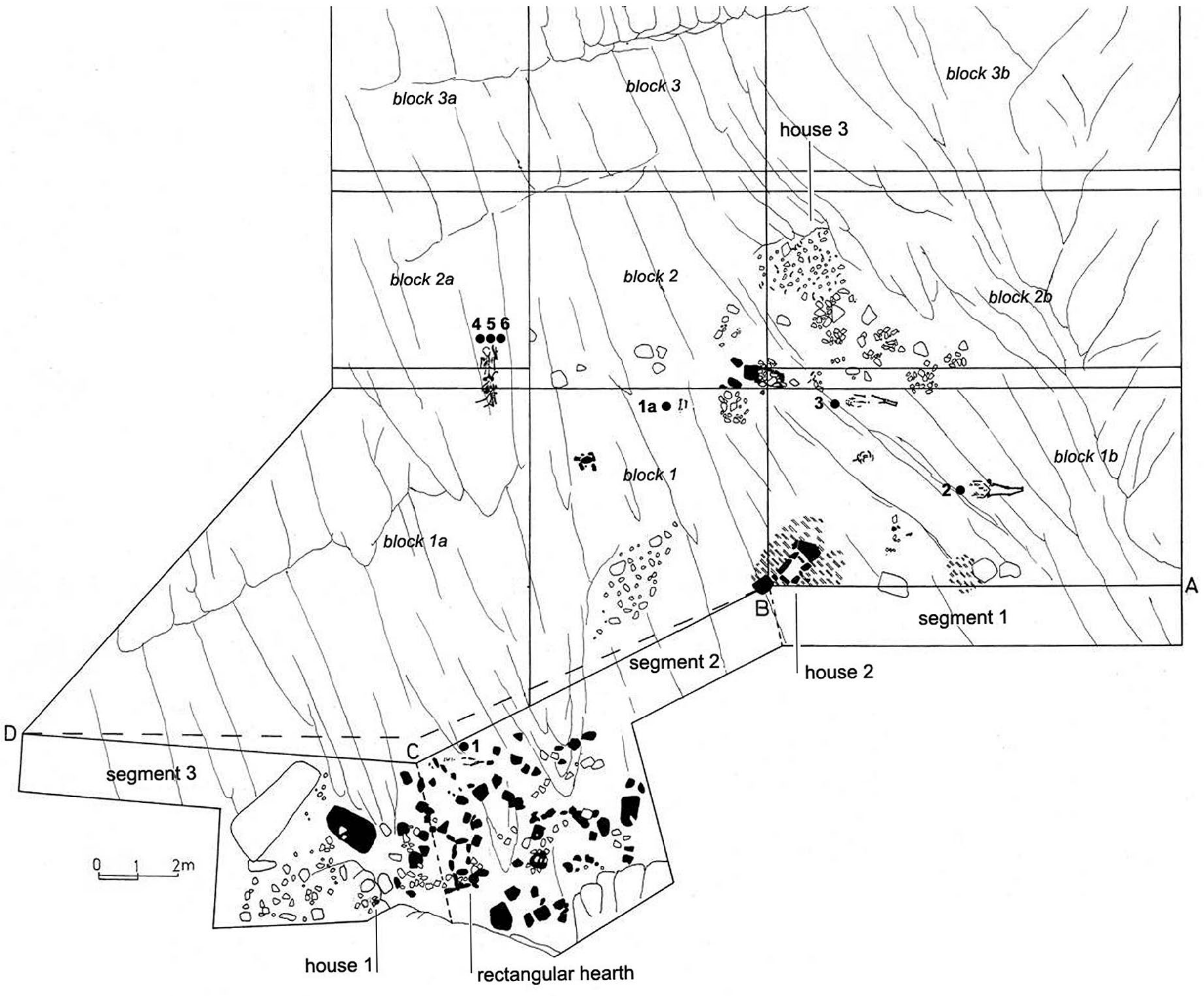


Fig. 5. Padina. Excavated areas at Sector I with features and burials belonging to chronological phases Padina A, A–B, B1 and B2.

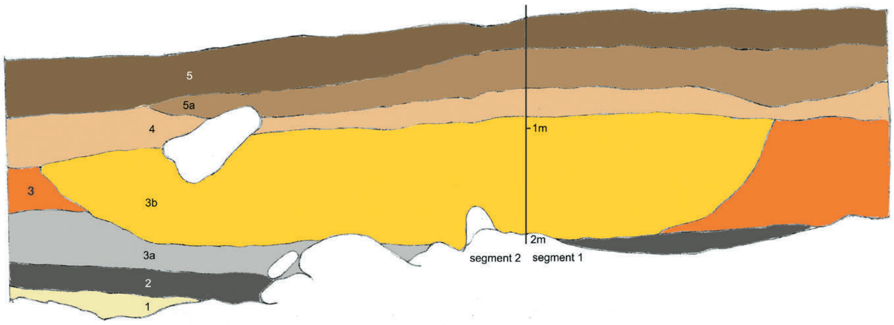


Fig. 7. Padina. Sector I, Profile 1, segments 1–2, cross-section of the cut for the trapezoidal base of House 2 (B2) of the Lepenski Vir culture. Legend: A – hillwash layers. (1) Yellow sandy soil. Grey soil with pebbles and sand (3a); B – palaeosoil/cultural layer of the Mesolithic settlement formed on the bedrock (2); C – layers associated with the Lepenski Vir culture. Cut for House 2 (B2) filled with the torrential hillwash and archaeological finds (3b). Cutting of the building and its croft in the older layers of the same settlement (3). D – Layer of the Late Eneolithic and the Iron Age (4). E – Modern humus and subhumus (5 and 5a).

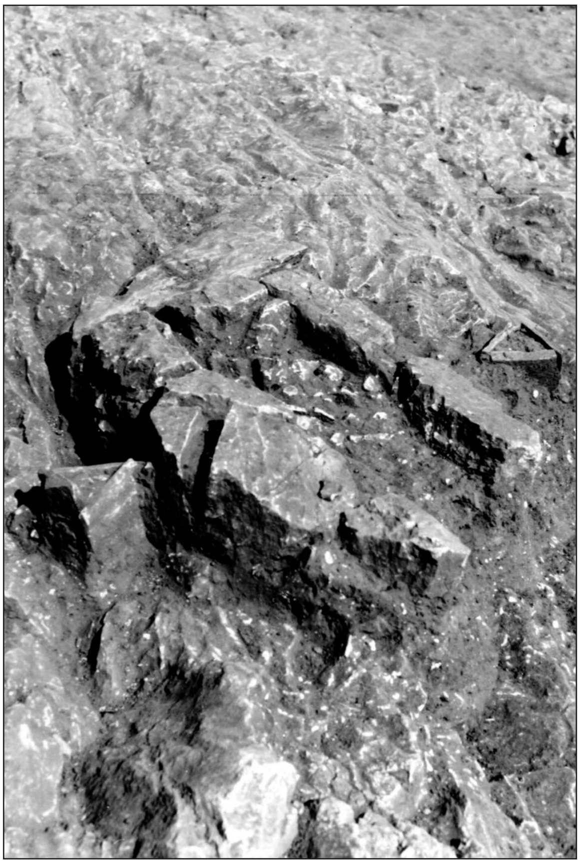


Fig. 8. Padina. Sector I, Trench 1, block 2b. Hearth of House 3 (B2) of the upper terrace in the secondary position after the impact of the torrential outburst. On the moved base, two A supports were preserved.

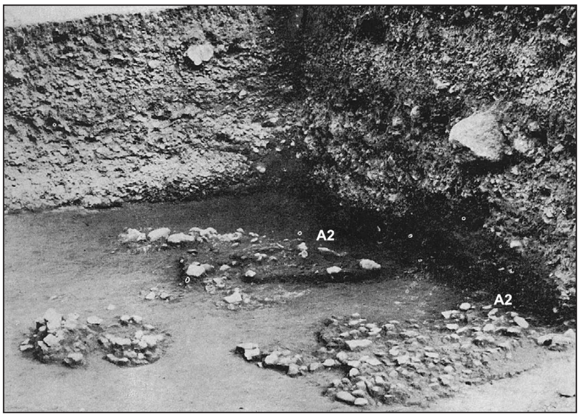


Fig. 11. Padina. Sector II, Trench 2, block 2a. The base of dwellings of the central part of the Iron Gates Late Mesolithic settlement on the level of palaesoil layered over the bedrock.

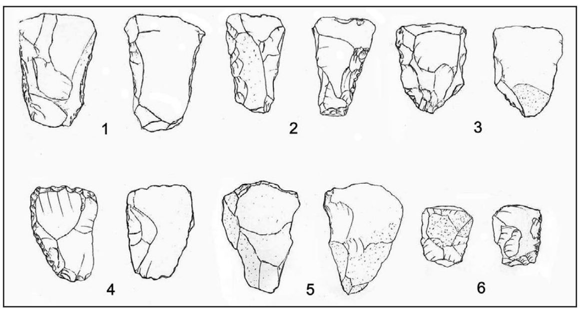


Fig. 12. Padina. Trench 2, block 2a, 5e. Flint axes, Late Mesolithic settlement. No. 1 – 3. From the floor of the dwelling, block 2a (phase A2). No. 5. From the floor of the dwelling, block 2e (phase A2). No. 4. From Profile 2, Trench 2 (phase A1). No. 6. From the floor of the dwelling, block 2a (phase A1).

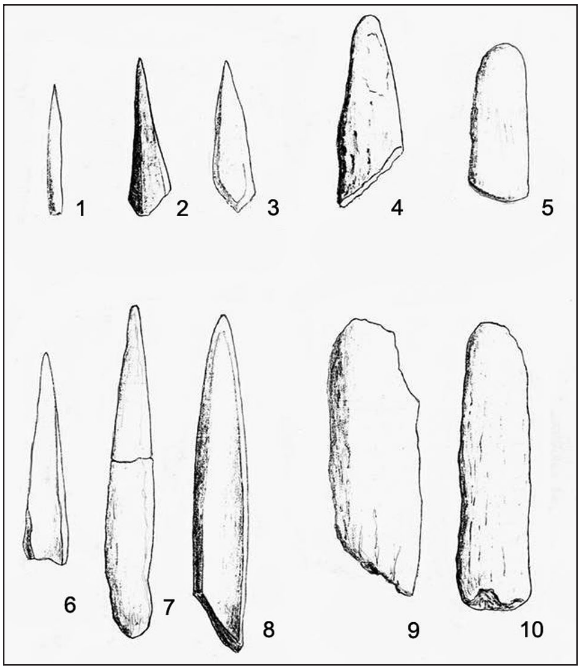
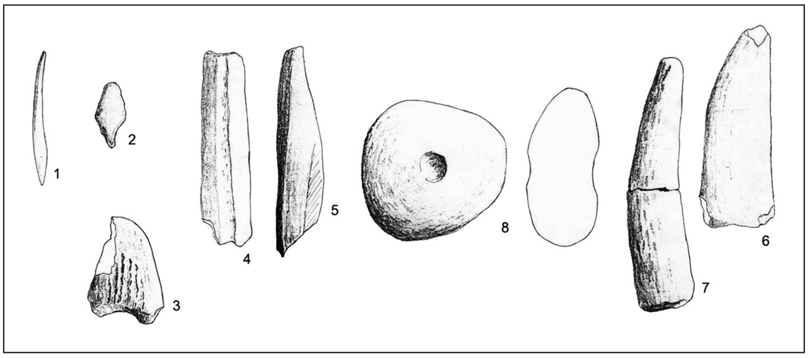


Fig. 14. Padina. Trench 2, block 2a. Bone artefacts, from the floor of the dwelling, Late Mesolithic settlement (phase A2).

Fig. 15. Padina. Sector II, Trench 2, block 2e. Partial burial; ritually buried skull from the level of the palaeosoil, cut from the Lepenski Vir culture layer (late phase A–B).

Fig. 13. Padina. Trench 2, block 2a. Bone and stone artefacts, from the floor of the dwelling, Late Mesolithic settlement (phase A1).



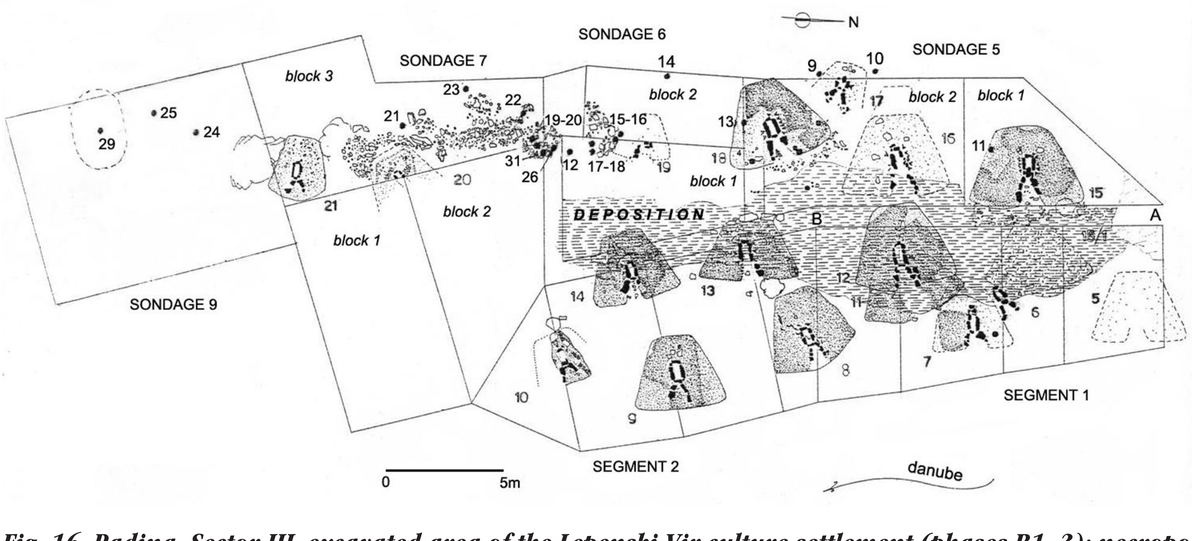


Fig. 16. Padina. Sector III. excavated area of the Lepenski Vir culture settlement (phases B1–3); necropolises with elongated stone constructions, Iron Gates Late Mesolithic (phase A2); necropolises with domed-like stone constructions (contact phase, A –B); single burials around the building of phase B3.

Fig. 17. Padina. Sector III, Trench 7, block 3. Necropolises with elongated stone constructions, horizon 1, Late Mesolithic settlement (phase A2).

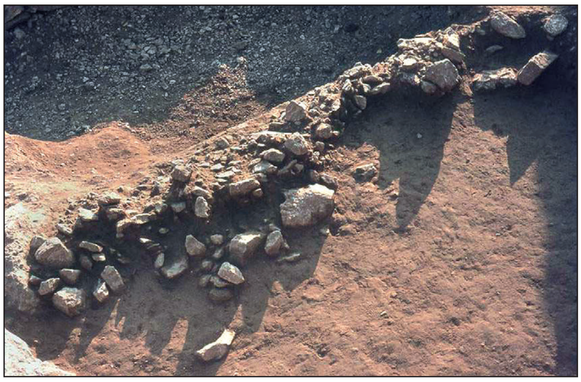


Fig. 18. Padina. Sector III, Trench 7, block 3. Necropolises with elongated stone constructions, horizon 2. Distinguishing different horizons of the necropolis was difficult due to layers of soil between them and due to the existence of separate surfaces with piled stones. Late Mesolithic settlement (phase A2).

Fig. 19. Padina. Sector III, trench 6, block 2. Burials with domed-like stone constructions; the deceased were placed in sitting positions with crossed legs, protected by dome-like piles of stone. Double Burial 15–16 (phase A).

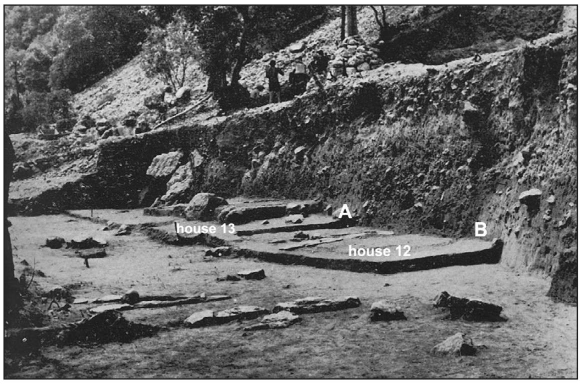


Fig. 21. Padina. Sector III. details of the coastal profile, segment 2, position of the cross-section of semi-subterranean House 12 (points A–B). Order of the deposition of layers (1–6) in the cut of House 12 upon its abandonment.

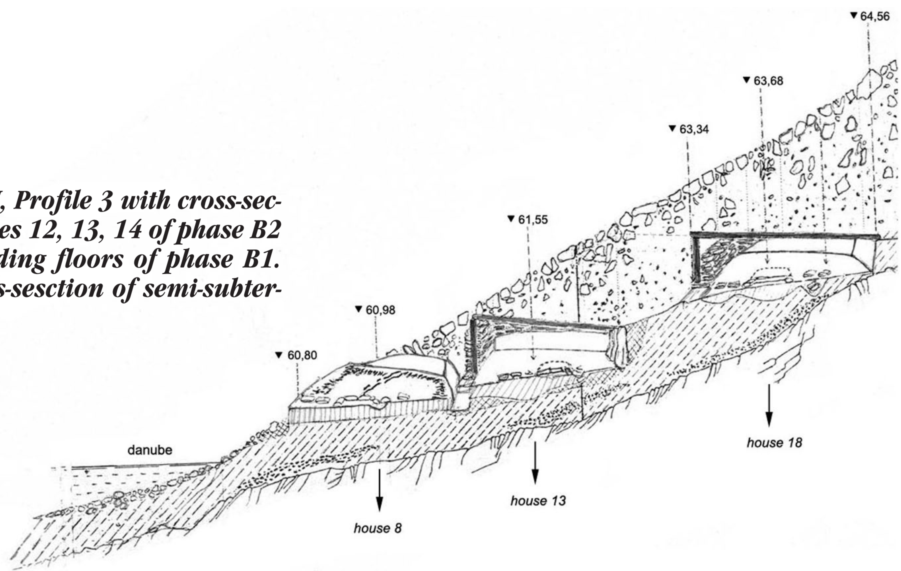


Fig. 20. Padina. Sector III, Profile 3 with cross-sections of the bases of Houses 12, 13, 14 of phase B2 and the remains of building floors of phase B1. A–B: position of the cross-sesction of semi-subterranean House 12.

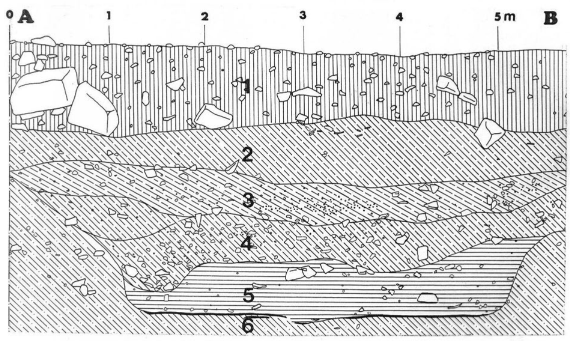


Fig. 22. Layer no. 6. Natural, sandy loess. Layer no. 5. Lower level. Dark strip of the floor made of compact and at places burned clay, the limit of the ellipsoid cut for House 12, which came down the depth of 1.16m in the loessic base (vertical T. A – 1.10m vertical T.B). In this way, between the floors of buildings 12–13 and 12–15 there is a zone of sterile loess, limited by the level of palaesoil and rocky base. Layer no. 5. Upper level. Floor of House 12 was covered by a compact layer of crushed black soil that contained a large quantity of fish bones and remains of charcoal (0.20m –0.50m). This layer was formed after the abandonment (or demolishion) of the building, with the remains of the wooden construction of the roof or household inventory that was left behind. Layer no. 4. Horizon of mixed grey soil, smaller crushed stones, fragments of pottery, and remains of burning (0.20m–0.40m) with a large amount of fish bones. This horizon corresponds with the successive backfill of the building's cut with the remains coming from buildings of the upper row (B3), i.e. *midden layers (Fig. 16). Layer no. 3. Level of lighter soil and crushed stone belonging to the deposition in the partly backfilled cut of House 12 from the level of present-day humus (0.20m–0.40m). Layer no. 2. Light grey cultural layer also covers other bases of the middle row buildings (B2) and contains common categories of finds, belonging to the end of the leveling process that probably took place after the abandonment of the upper, third horizon of buildings (B3). Layer no. 1. Massive modern humus, composed of eroded materials of hillwash scree, with darker soil and the remains of vegetation (0.50m–0.80m).*

Fig. 23. Padina. Sector III, Anthropomorphic boulder (altar from House 12, rear platform of the hearth).

Fig. 25. Padina. Sector III, coastal strip, segment 2. Trapezoidal base and floor of House 8, lower settlement horizon (phase B1). Burned remains found on the floor from the upper construction of a gabled roof.

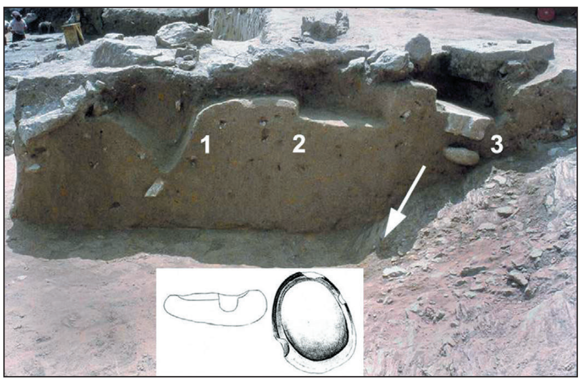


Fig. 24. Padina. Sector III, Trench 5, block 1. Longitudinal cross-section of House 17 (B3). Installation of the inner stone constructions: 1. cut for the ash-place; 2. cut for the rectangular hearth; 3. cut for the cult pit with ritual stone bowl at its bottom.

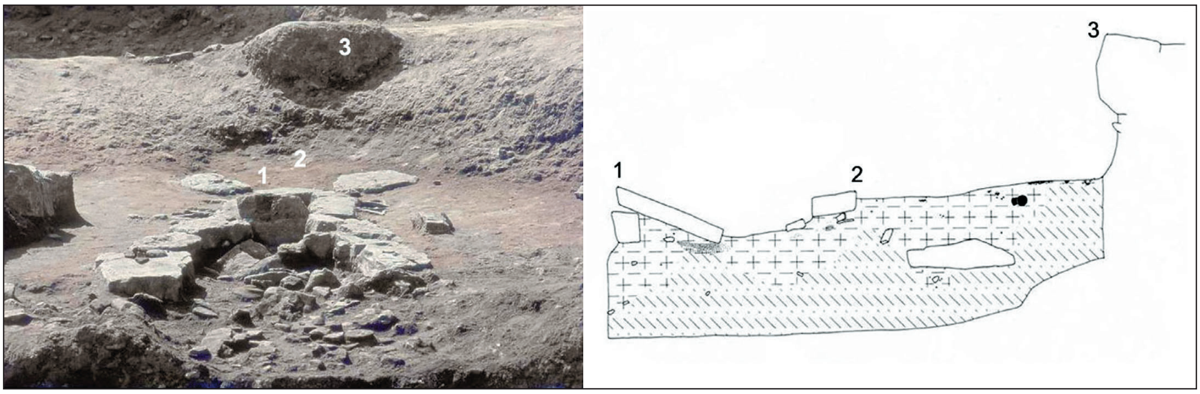


Fig. 26. Padina. Sector III, Trench 5, block 2. Longitudinal cross-section of House 15 (B3). 1. Hearth with a stone slab for ash disposal or for heating and preparation of dry fish. 2. Rear platform of the hearth with a cult pit at the bottom, covered by a large stone slab. 3. Large stone blocks at the rear edge of the cut for the trapezoidal base served to support the main beam for the roof construction. Slanted construction of this support reflects the slant of the gabbled roof.

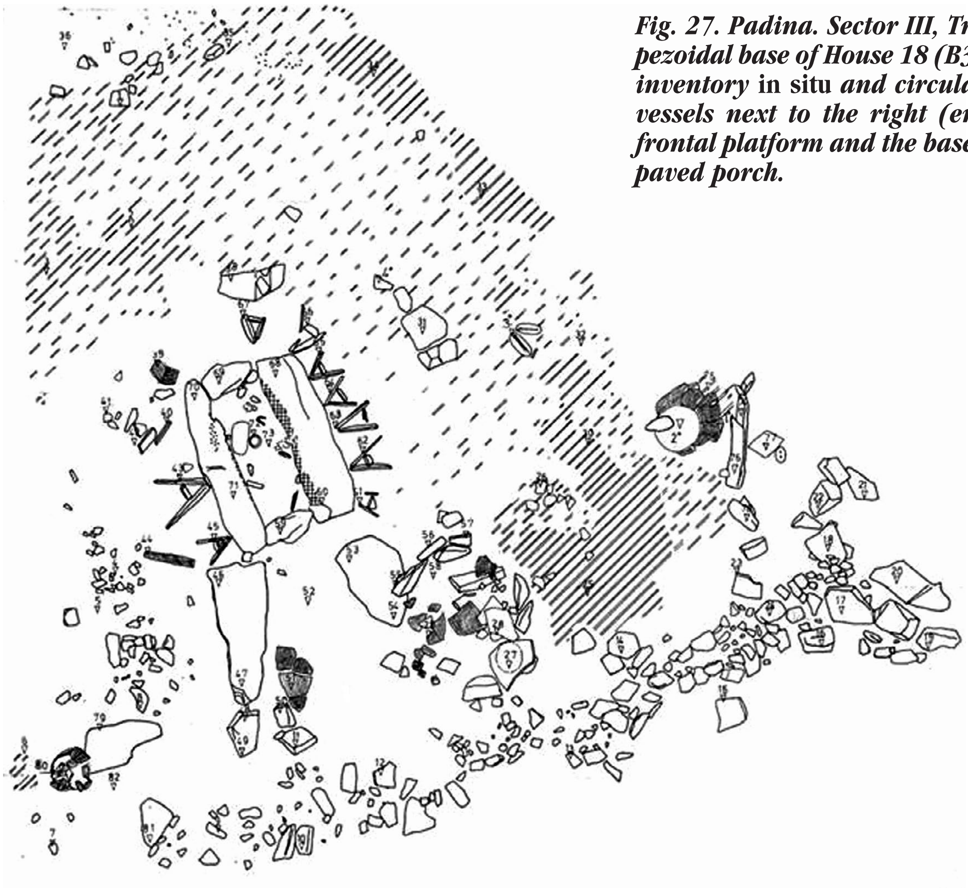


Fig. 27. Padina. Sector III, Trench 5, block 1. Trapezoidal base of House 18 (B3) with the household inventory **in situ** ***and circular space for ceramic vessels next to the right (entrance) side of the frontal platform and the base of the approaching, paved porch.***

Fig. 28. *Padina. Sector III. View over lower (B1), middle (B2) and upper (B3) rows of buildings; House 15 with approaching paved porch. The Lepenski Vir culture settlement.*

Fig. 29. Padina. Sector III. A selection of polished stone tools. The Lepenski Vir culture settlement.

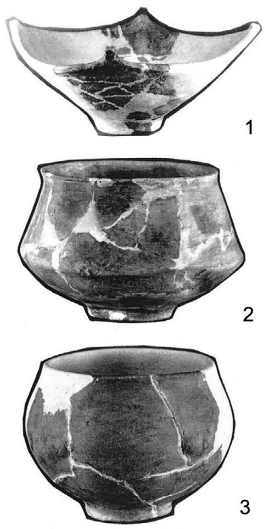


Fig. 32. Padina. Sector III, Trench 5; 1 – 3 vessels from the floor of House 18 (B3); the Lepenski Vir culture.

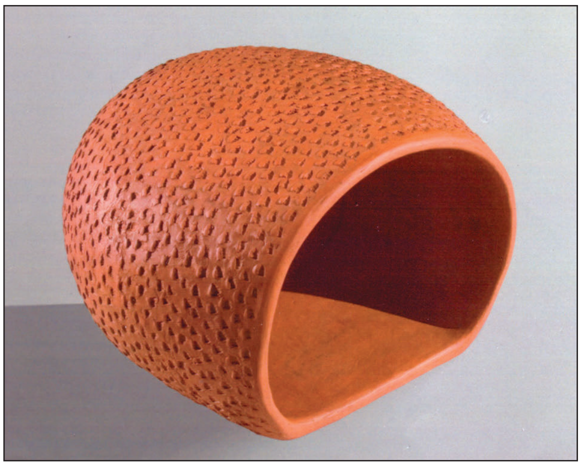


Fig. 30 A. Padina. (B2) Model of an oven (25 x 35cm) decorated by impresso technique, found on the floor of House 3.

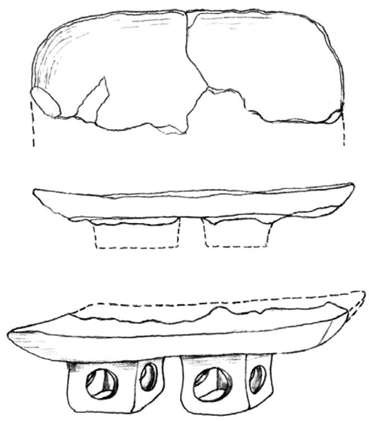


Fig. 30 B. Ritual table. Parts of the cultic vessel found in two different zones of the settlement. The Lepenski Vir culture. Sector I. Coastal zone, Profile I, segment 2; Trench I, block 1a.

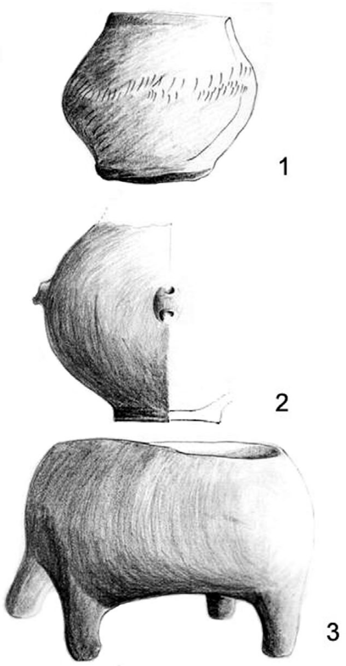


Fig. 31. Padina. Sector III, Trench 5 and 6; 1–2 vessels from the level of occupation of the third row of buildings (B3); 3. Altar from the floor of House 17 (B3), Trench 5, block 1. The Lepenski Vir culture.

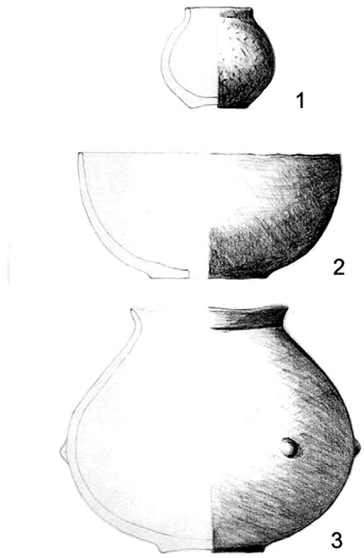


Fig. 33. Padina. Sector III, Trench 5, block 1. Vessels from the floor of House 18 (B3); the Lepenski Vir culture.

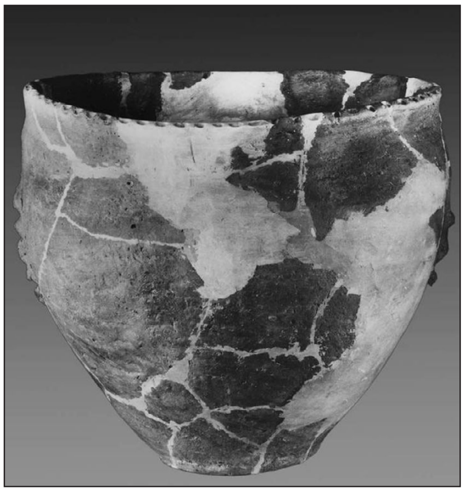


Fig. 35. Padina. Sector III, Trench 5, block 2. Large pot/pythos from the floor of House 15 (B3). The Lepenski Vir culture settlement.

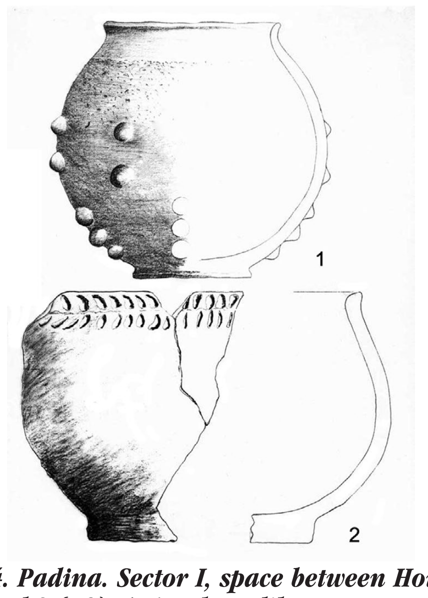


Fig. 34. Padina. Sector I, space between Houses 2 (B2) and 3 (B2); 1. Amphora-like pot, pottery oven (open-air hearth?); Sector I, block 1b; 2. Half-spherical bowl, the floor of House 2 (B2). The Lepenski Vir culture settlement.

Fig. 36. Hajdučka Vodenica. Position of the site; entrance to Mali Kazan, Lower Gorge of the Danube.

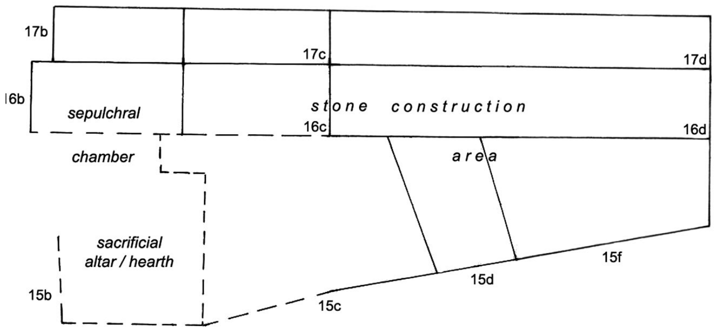


Fig. 37. Hajdučka Vodenica. Excavated areas of the necropolises 1967–1969 with the functional organization of space. Excavated area 630m².

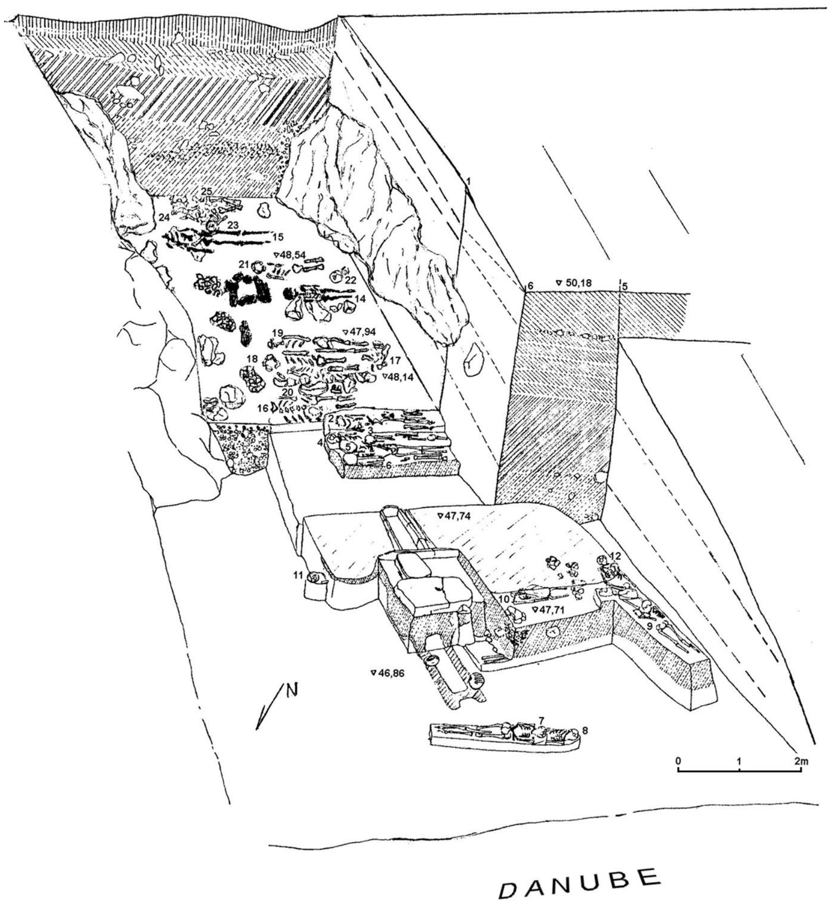


Fig. 38. Hajdučka Vodenica, isometric reconstruction of the sacrificial/ritual construction and the burial chamber with four horizons of burials.

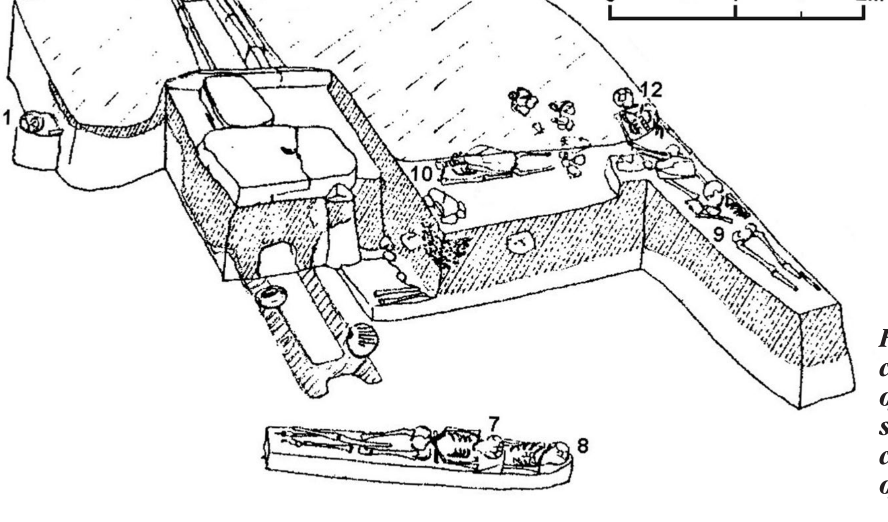


Fig. 39. Hajdučka Vodenica, isometric reconstruction of the sacrificial/ritual construction and the burial chamber with two horizons of burials.

Fig. 40. Hajdučka Vodenica. Stratigraphic position of the sacrificial construction of the necropolis.

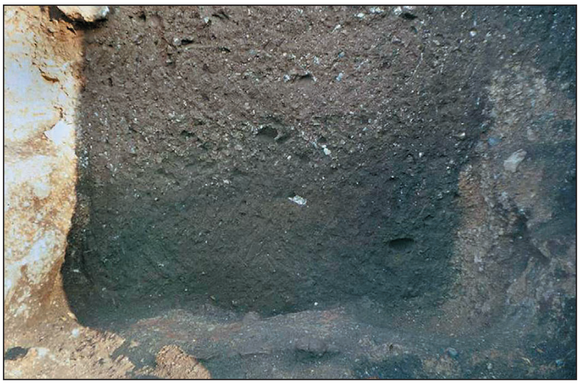


Fig. 41. Hajdučka Vodenica. Section of the burial chamber behind the sacrificial construction of the necropolis. Lower level of the section filled with abundant remains of burning belonging to the horizon of burials.

Fig. 42. Hajdučka Vodenica. Stratigraphy of building phases of the sacrificial construction; older phase: foundation channel of the first elongated heart, dug into the loessic base; younger phase: approaching platform; elongated with associated finds; surrounding zone furnished with burned clay.

Fig. 43. Hajdučka Vodenica. Outline of the older elongated hearth on the basis of its foundations for the stone construction, level of sterile loess.

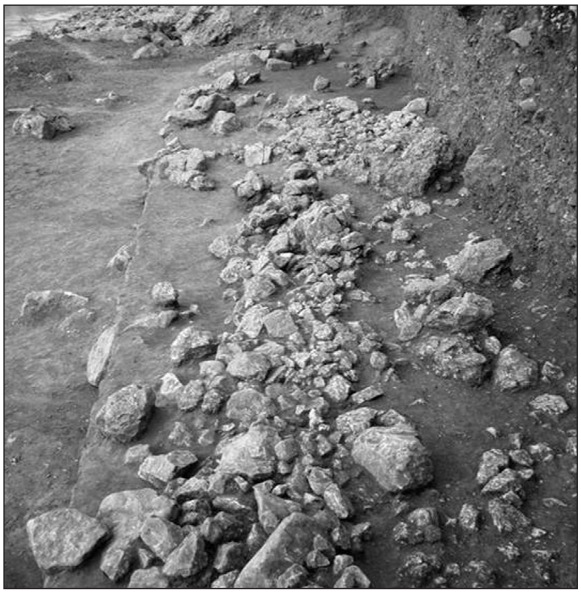


Fig. 44. Hajdučka Vodenica. Elongated stone constructions of the necropolis, horizon 4.

Fig. 45. Hajdučka Vodenica. Elongated stone constructions of the necropolis, horizon 3.

Fig. 47. Hajdučka Vodenica. Stratigraphy of elongated stone constructions of the necropolis, horizons 4–2; Facing south-west, upstream from the location of the sacrificial/ritual constructions and burial chamber of the necropolis.

Fig. 46. Hajdučka Vodenica. Elongated stone constructions of the necropolis, horizon 2. In the foreground grouped stone blocks with a rectangular hearth.

Fig. 48. Hajdučka Vodenica. Longitudinal section of the elongated stone constructions of the necropolis, north-east and south-west, with horizons 3–4 under excavations and noticable stratigraphic position of horizons 1–2.

Fig. 49. Hajdučka Vodenica. Stratigraphic position of the hearth with the approaching stone slab and an aniconic boulder, horizon 2 of the elongated stone constructions of the necropolis.

Fig. 50. Hajdučka Vodenica. Detail of the rectangular hearth of horizon 2 of the elongated stone constructions of the necropolis.

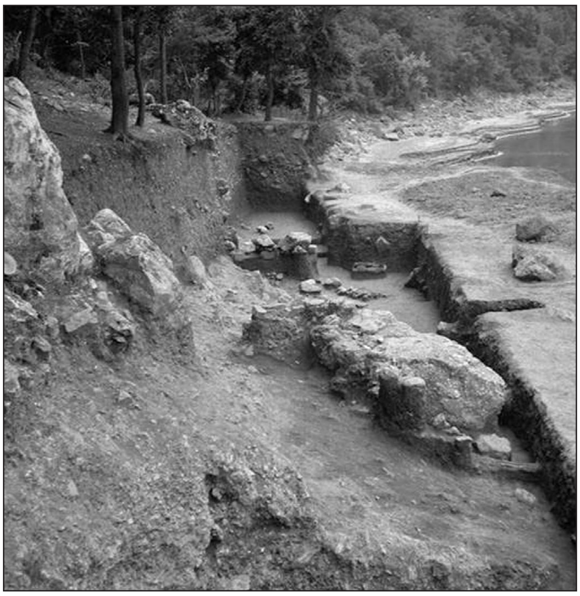


Fig. 51. Hajdučka Vodenica. Stratigraphic relationship of horizon 1 and rectangular hearth of horizon 2 of the elongated stone constructions of the necropolis.

Fig. 52. Hajdučka Vodenica. Horizon 1, lower level, rectangular hearth placed on the level of palaeosoil. In the foreground a hearth covered with piled stones.

Fig. 53. Hajdučka Vodenica. Horizon 1, lower level, detail of the base with rectangular hearths.

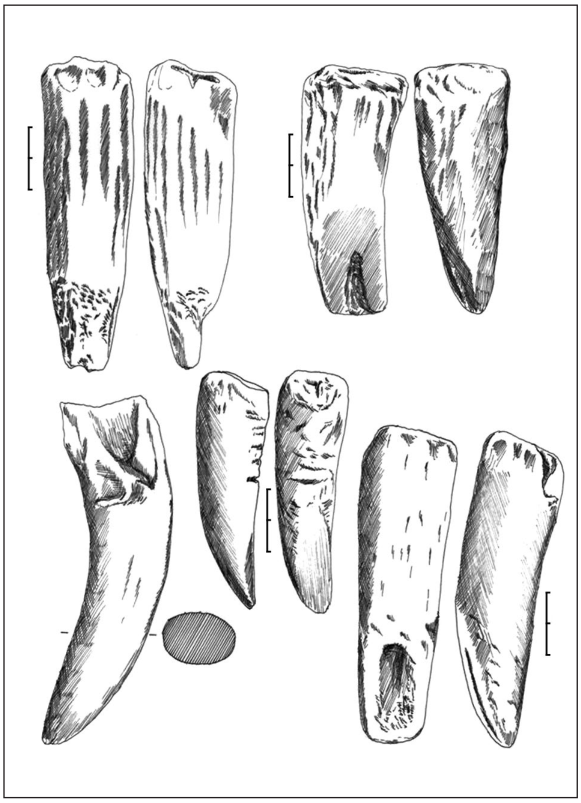


Fig. 54. Hajdučka Vodenica. Horizon 1, selection of red deer antler tools.

Fig. 55. Hajdučka Vodenica. Older sacrificial/ritual construction, ornamented boulder (volcanic rock, green colour, channeling technique) (dimensions 25cm x 18cm x 19cm).

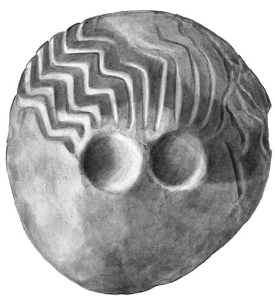


Fig. 56. Hajdučka Vodenica. Younger sacrificial/ritual construction, ornamented boulder (sandstone, chalky colour, incision technique) (dimensions 31cm x 27cm x 24cm).

back to contents

UDK 903.23(498)"634"
Documenta Praehistorica XXXV (2008)

Archaeological research in Miercurea Sibiului – Petriş (Sibiu County, Romania): the Starčevo-Criş level during 1997–2005 (a preliminary report)

Sabin Adrian Luca[1], Dragoş Diaconescu[2] and Cosmin Ioan Suciu[3]
1 *Lucian Blaga University Sibiu and National Brukenthal Museum Romania,* sabin.luca@brukenthalmuseum.ro
2 *National Brukenthal Museum Sibiu Romania*, goshu_d@yahoo.com
3 *Lucian Blaga University Sibiu Romania*, cosmin.suciu@ulbsibiu.ro

ABSTRACT – *The article presents an archaeological description of the Starčevo-Criş close complexes at Miercurea Sibiului-Petriş, one of the Earliest Neolithic settlements in Romania. The site belongs to the early wave of First Temperate Neolithic communities who reached Romania. Each complex is presented through plans, statistical ceramic analyses and some representative materials. White painting is present here in the earlier complexes.*

IZVLEČEK – *Članek predstavlja arheološko obravnavo zaprtih kompleksov kulture Starčevo-Criş na najdišču Miercurea Sbiului-Petriş, enem najzgodnejših neolitskih najdišč v Romuniji. Najdišče pripada prvemu valu skupin 'prvega neolitika zmernega pasu' (First Temperate Neolithic), ki so dosegle Romunijo. Vsak kompleks je predstavljen na načrtih, skozi tipološko analizo lončenine in nekaterimi reprezentativnimi najdbami. V zgodnejših kompleksih se pojavlja tudi belo slikanje.*

KEY WORDS – *Early Neolithic; Starčevo-Criş; white painting; radiocarbon; statistical analyses*

General context

The Petriş archaeological site is situated 500m east of the Miercurea Băi halt, 50–80m north of the Sebeş Alba–Sibiu highway, along the Secaş river terrace which is 4–5m in height (Plan 1). The archaeological discoveries are over an area of about 300/100m.

Systematic research at the site commenced in 1997, and at the moment the excavators comprise researchers and representatives of several institutions in Romania and abroad[1].

The interdisciplinary profile of the accomplished research (the statistics on ceramics; the analysis of soil types as rough materials in ceramics processing; the pre-elevation of samples and the ^{14}C data; the designated analysis of items of flaked obsidian and flint; the zoo-archaeological analysis of the remnants; the analysis of the route attained by the adornments, tools and weapons made of bone, horn and shell; the analysis of seed remnants, etc.), as well as the particularities of the site's settlement, has led to outstanding findings and remarkable conclusions.

For a better understanding of the topographical setting, detailed measurements were taken (Plan 2), allowing correlation with advanced technology pro-

1 Sabin Adrian LUCA – „Lucian Blaga" University of Sibiu and The Brukenthal National Museum of Sibiu, Romania; Dragoş DIACONESCU, Adrian GEORGESCU, Gheorghe NATEA, Florina Maria NIŢU, Anamaria ŞEULEAN – The Brukenthal National Museum of Sibiu, Romania; Cosmin Ioan SUCIU, Florian DUMITRESCU CHIOAR – „Lucian Blaga" University of Sibiu, Romania; Paolo BIAGI – Ca'Foscari University of Venice, Italy; Michela SPATARO – British Museum, London, U.K.; Georgeta EL SUSI – Institute of Archaeology of the Romanian Academy, Bucharest, Romania; Corneliu BELDIMAN – „Dimitrie Cantemir" University of Bucharest, Romania; Diana SZTANCS – teacher; Marius CIUTĂ – Romanian Police, Alba Iulia; Beatrice CIUTĂ – „1 Decembrie 1918" University of Alba Iulia, Romania.

grammes such as Google Earth. The area in which the site is located enjoys high quality satellite imagery provided through this particular programme. In the near future, we will be able to publish the results of the topographic data processing, *i.e.* geographical simulations and mathematical processing of data. In order for this to happen, a geo-magnetic study of the area is still needed; the site's stratigraphy promises a particularly relevant geomagnetic map.

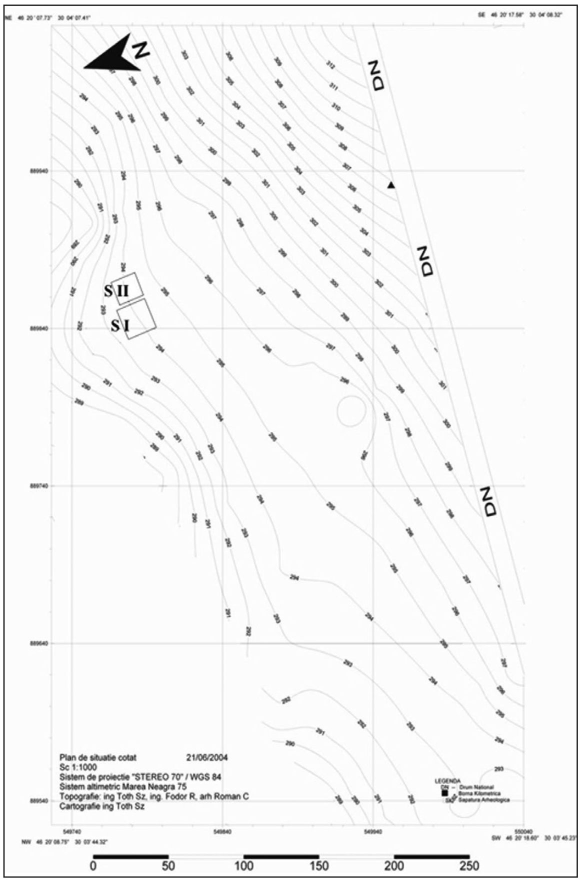
Plan 1. The Miercurea Sibiului city map with the archaeological site at Petriş.

In the first stage, research at the site was conducted by means of stratigraphic control trenches, for which purpose the eastern zone was chosen (Plan 2); Plan 3 clearly presents the exact positioning (S_1/1997 – 20/1.5m; S_2/1998 – 16/2m; S_3/1998 – 16/2 m; S_4/1999 – 16/2m and S_5/2000 – 20/1.5 m).

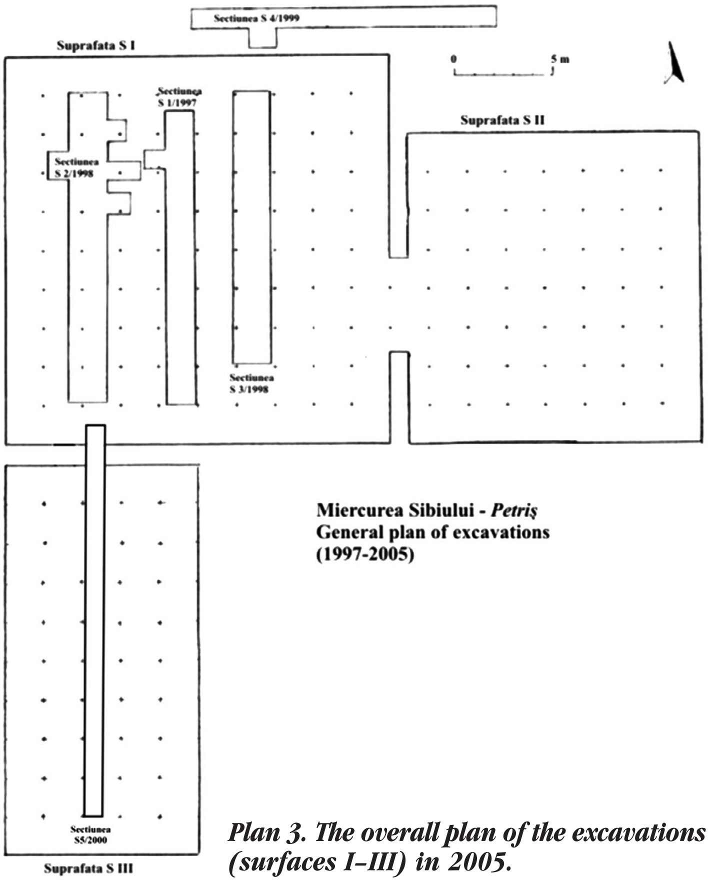
In the next stage (begun in 2001) the digging system was changed on the researched surfaces because it was observed that the stratigraphy is extensive and horizontal, in which circumstances the archaeological complexes rarely intersect and the dwellings, pits and other constructions could be excavated very productively. That is why it was decided to set aside the archaeological material coming from the cultural level, and concentrate efforts on as closely as possible on the architectural remnants, artefacts and biological remnants in the enclosed archaeological complexes. The surfaces studied (Plan s2 and 3) have the following measurements and numbers: SI/2001–2003 – 20/20m; SII/2004–2005 – 15/16m; SIII/ 2006–2007 – 20/10m; SIV/2006 – 40/40m (no image; it is to be traced out north of the SI–II surfaces; still to be excavated); SV/2007 (still to be excavated).

The present article is concerned with the analysis of the Starčevo-Criş levels, systematically researched from 1997–2005 in S_{1-5}/1997–2000 sections, and SI–II/2001–2005 surfaces. In brief, the stratigraphy of the site is as follows:

I – the first and the oldest dwelling level appertains to the Starčevo-Criş culture, presenting several sub-levels:
Ia – the deepened dwellings of this sub-level appertain to the Starčevo-Criş IB phase;
Ib – the deepened dwellings of this sub-level appertain to the Starčevo-Criş IC–IIA phase;
Ic – after a *hiatus* (?), the deepened dwellings of this sub-level appertain to the Starčevo-Criş IIB–IIIA phase.
II – the second level appertains to the Vinča culture, old phase (A, and evolving to B1):
IIa – the dwellings of these sub-levels – dwelling pits – are constructed in two stages:
IIa_1 – the dwellings of this stage appertain to the Vinča A_{2-3} phase (typologically and stylistically);



Plan 2. Topographical plan of the terrace and location of surfaces I and II.



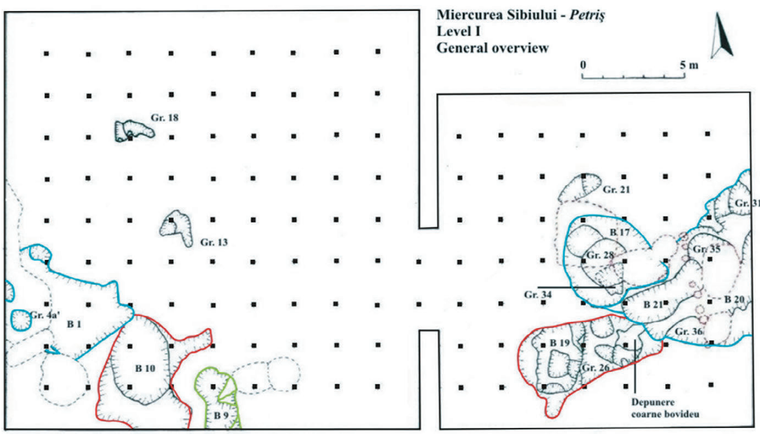
Plan 3. The overall plan of the excavations (surfaces I–III) in 2005.

IIa$_2$ – the dwellings of this stage appertain to the Vinča A_3 phase.
IIb – the surfaced dwellings of this sub-level appertain to the Vinča A_3–B_1 phase.
II/III level – unpublished research in 2007, led to the discovery of several pits containing archaeological material from the Vinča B_1 phase, yielding painted decorations specific to the Lumea Nouă Transylvanian culture; future research will reveal more details of this aspect. Considering the fact that the stratigraphy of the site was already published, we chose to name this level: II/III, which anyway emerged after Vinča B_1 and before Vinča C_2.
III – this level appertains to the Petreşti culture; its surfaced dwellings, with massive clay floors, appertain to the AB phase of the culture.
IV – the pits at this level were dug by Celto-Dacians in II–I BC.
V – the graves and some of the heterogeneous archaeological complexes at this level appertain to the Gepid period.
VI – this level is represented by a semi-deepened dwelling, with a stone oven that could be dated to the first millennium A.C.

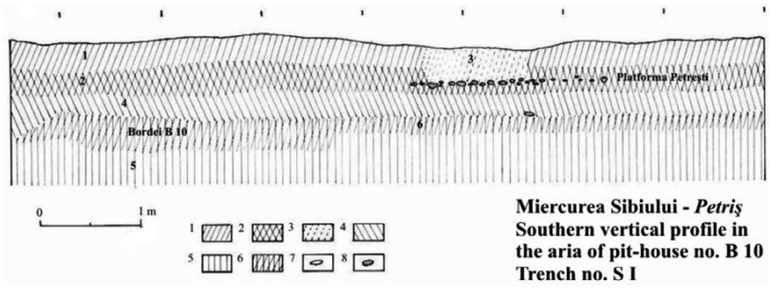
The present article analyses the architectural remnants of the oldest first level in Miercurea Sibiului-Petriş, researched between 1997 and 2005. All the dwellings at this level were sunk deep into the ground (Plan 4), the analysis being done in the order of their age. The criteria were a result of a study of the direct stratigraphic relations, architecture, typological and stylistic examinations, studies in mathematics and statistics, and absolute radiocarbon chronology.

The architecture of the complexes was severely damaged – in the upper part of the dwelling pit – the resultant dyke (levee) is earthen, formed by earth and other elements dug out, on the pit's margins, during contemporary agricultural activities and construction enterprises of the inhabitants who have subsequently followed the Starčevo-Criş culture. This is why we deal mainly with the lower part of the construction, meaning 50–60 % of it.

The later work determined, in most cases, the destruction of the first (I) Starčevo-Criş layer. In its preserved parts (Plan 5 – level number 6) it is no thicker than 0.10m; it is discontinuous and presents a yellow-reddish colour, a clay-like consistency mixed with gravel, lying on gravel containing sand and loess. The reddish shade of the archaeological layer could indicate the formation of forest soils during the post-Ice Age period. Over the whole region of Transylvania, the first farmers settled on this type of soil which, after the sedimentation of vegetal remains resulting from human activities over many generations, evolved into the humus visible in the area of the site.



Plan 4. Starčevo-Criş complexes in 2005 (level Ia–c).



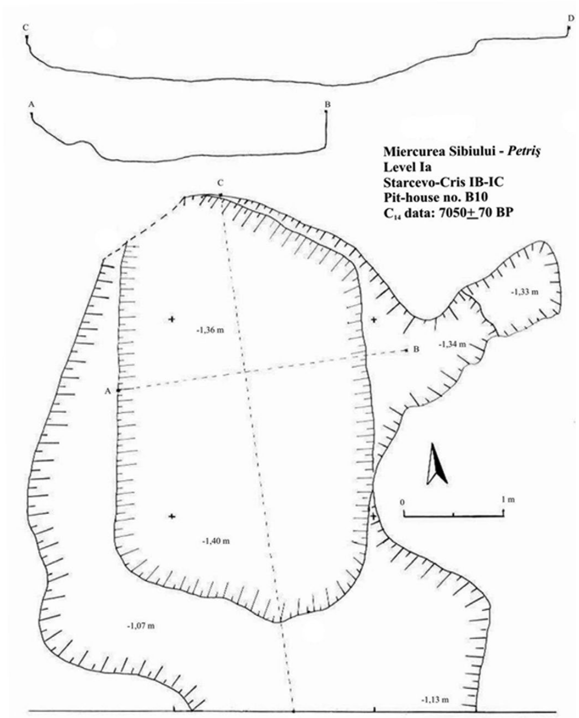
Plan 5. Miercurea Sibiului-Petriş. Vertical stratigraphic profile in the zone of the B_{10} dwelling pit.

As could be observed, the vertical stratigraphy of the site is not very well developed (1–1, 20m), this being one of the features of most Transylvanian archaeological sites.

The Ia sub-level

Dwelling-pit B_{10}/2003 – Starčevo-Criş Culture (Plan 4, surface I, lower-centre; Plan 5, Plan 6; Fig. 1; Photo 1; Tab. 1)

From a chronological and cultural perspective, the oldest dwelling-pit was discovered in Miercurea Sibiului-Petriş, gate number 10. It is rectangular and oriented approximately north-south. Part of the entrance on its eastern side has survived (Plan 6). The general features of the digging method in prehistory reveals it as a semi-dwelling-pit, the area designed for air circulation being deepened approximately 0.40m in comparison with the lateral part designed as a



Plan 6. Miercurea Sibiului-Petriş. Horizontal plan of the B_{10} dwelling pit.

sleeping area (Plan 5). There is no heating system. Also, there are no elements of a dyke (levee) formed by the earth that was dug out, or pole-pits to indicate its architecture. The pit's filling shows that the dwelling was left on purpose and rapidly filled in with the remains of other constructions. The ^{14}C data indicate that the dwelling was in use before 7050 ± 70 calBP (Tab. 2 (see Appendix), Fig. 9). The artefacts and biological finds do not indicate disturbances other than those caused by human activity.

Some 382 ceramic fragments comprise the B_{10} complex (Fig. 1, Photo 1, Graphic 1, Tab. 1). Fine ceramics predominate with 47%, closely followed by semi-fine ceramics (41%) and only 17% coarse ceramics. The colour of the exteriors are mainly shades of red: russet (27%) and cardinal red (7%). Brick represents a 19%, followed by shades of brown: dark brown (12%) and light brown (5%). Grey (11%) and yellowish (5%) also occur. The temper consists of sand and husk (86%) or just sand (8%). The exterior surface is polished (49%) and smoothed (48%). 97% of the fragments do not present ornaments. All the above data make the B_{10} dwelling pit at Miercurea Sibiului-Petriş one of the oldest archaeological complexes of this type north of the Danube.

The B_{19} dwelling-pit (Plan 4, surface II, lower left; Plan 7; Fig. 2)

This item is closely connected – chronologically and culturally – to the G_{26} pit (Plan 4, surface II, next to the B_{19} to the right; Plan 7 – right). The features of G_{26} will be described and discussed on another occasion. At this point we restrict ourselves to affirming that it indicates a ritual character (related to hunting and success in hunting rituals and practices; the pit contains dozens of pairs of *Bos primigenius* horns deposited, it seems, at the conclusion of a successful hunt; on this occasion, it is possible that a Neolithic community had been established). The ^{14}C data show that the pit was in use around 7010 ± 40 calBP (Tab. 2, Fig. 9).

The B_{19} dwelling pit is rectangular and is oriented approximately north–south, as B_{10} is. To the south, the entrance is partially preserved (Plan 7). The general features of the digging method used reveals it as a semi-dwelling-pit, the part designed for air circulation being deepened approximately 0.40m in comparison with the lateral parts designed as slee-

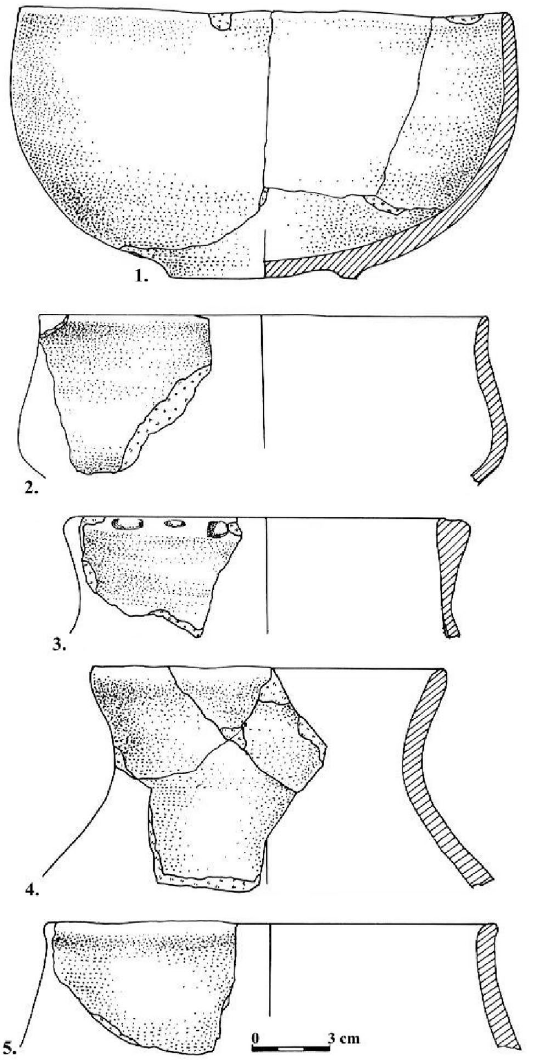


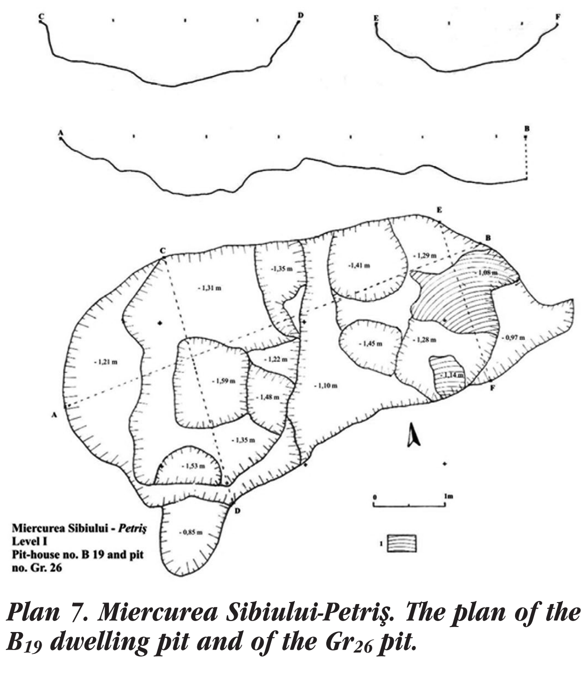
Fig. 1. Miercurea Sibiului-Petriş. Sherds from the B_{10} dwelling pit.

ping area. There is no heating system. Also, there are no elements of a dyke (levee) formed by the earth that was dug out, or pole-pits to indicate its architecture. The pit's contents show that the dwelling was left on purpose and rapidly filled with the remains of other constructions. The artefacts and biological finds do not suggest disturbances other than those resulting from human activity. Stratigraphic observations show that the B_{19} dwelling pit was made after the digging of G_{26}.

720 ceramic fragments, comprising the B_{19} content, have been analysed (Fig. 2, Tab. 1, Graphic 1). The semi-fine ceramics predominate with 45%, followed by coarse ceramics (35%) and fine ceramics (20%). There are mainly shades of brown: brown (21%), dark brown (20%) and light brown (16%). There are presented also reddish brown (9%), russet (6%), greyish-black (5%), brown with flaps (4%), brick-colour (4%) and grey (4%). The other nuances are less than 2% each. In the composition of the paste husk prevails in several combinations: husk and sand (38%), sand and husk (23%), sand, shivers and husk (11%), husk and shivers (8%), husk (8%), sand, husk and small stones (4%). The smoothing of the exterior surface of the fragments is as follows: smooth (30%), detached slip (22%), rough (20%), polished slip (15%), polished (5%), well smoothed (4%), smoothed slip (3%) and applied barbotine (ledge) (1%). The presence of ornaments is only 6%.

In our opinion, at the present moment, the oldest Neolithic horizon is in Miercurea Sibiului-Petriş, indicated by the mark Ia and defined by the B_{10}, B_{19} dwelling pits and the G_{26} pit (Figs. 1, 2, Tab. 2, Photos 1, 2). These dwellings are not very deep, rectangular, with rounded corners. The B_{10} dwelling pit is partially cut in its north-western corner by the B_1 dwelling pit which appertains – as we shall see as follows – to a subsequent phase of the same culture. If we are to compare this type of dwelling with other types at contemporary sites, we notice that the profile is identical (regarding shape, depth, the fashion of digging) with the one of the oldest dwellings in Gura Baciului (*Lazarovici and Kalmar 1995.63*) (a comparison with Ocna Sibiului is not possible yet, due to the lack of complete publication of the plans describing the oldest dwellings).

The study of the ceramics in these complexes shows that we are facing some of the oldest dwellings appertaining to farmers domesticating plants and animals during the Neolithic in Romanian areas. Comparing the categories of the ceramics in the presen-



Plan 7. Miercurea Sibiului-Petriş. The plan of the B_{19} dwelling pit and of the Gr_{26} pit.

ted site with those in Gura Baciului (a comparison with Ocna Sibiului is impossible due to the lack of published statistical data) a great many similarities are ascertained. These dwelling complexes, completely dug, also have singular characteristics like the presence of ceramic fragments painted with small spots of white-yellowish colour on a red, polished, glass-like background (Figs. 1, 2). This feature, specific to a technology extent in the very old cultural horizon (Gura Baciului I – the dwelling complexes at the inferior part of the level), is also specific to the archaeological complexes studied in Miercurea Sibiului.

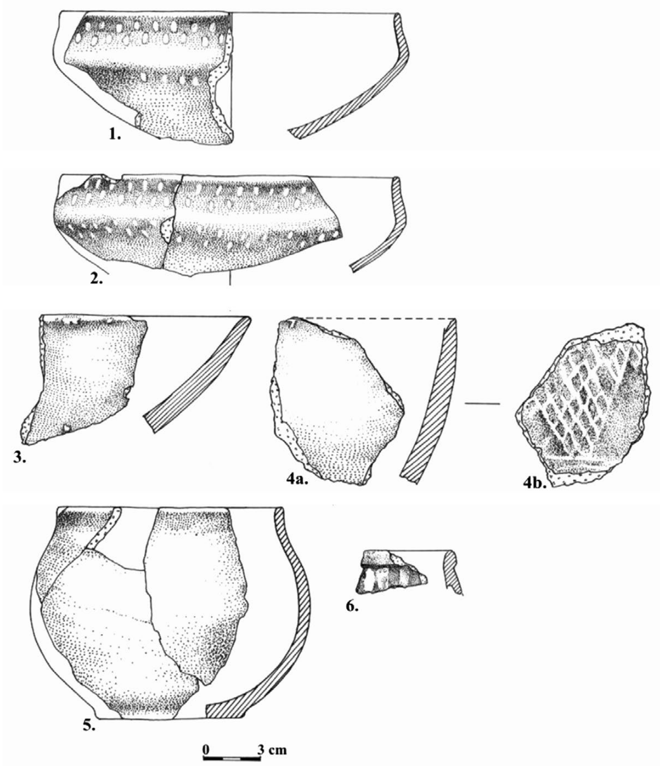


Fig. 2. Miercurea Sibiului-Petriş. Sherds from the B_{19} dwelling pit and Gr_{26} pit.

In this regard, the $B_{10,19}$ dwelling pits and the G_{26} pit in Miercurea Sibiului-Petriş are to be considered as part of the first migration in the opinion of Gheorghe Lazarovici and Zoia Kalmar (*Lazarovici and Kalmar 1995.199–200*), and regarding Gura Baciului I, in Nicolae Vlassa's opinion (*Vlassa 1976.198–264*), or Precriş Ia in Iuliu Paul's opinion (*Paul 1995.30–31, Abb. 2, 5*), the cultural horizon of the archaeological complexes being Starčevo-Criş IB (*Lazarovici 1979.40–41*).

The Ib sub-level

The B_{17} dwelling-pit (Plan 4, surface II, centre; Plan 8; Fig. 3, Tab. 1)

This dwelling pit is round, being interrupted on its southern side by a complex of pits: B_{20-21}; $G_{31,35-36}$. To the south-east, the dwelling pit is disturbed by an oven-hearth at the Vinča level (a surfaced dwelling that appertain to the Vinča level is dated 6359 ± 130 BP). The pits anthropically upsetting the dwelling pit are G_{28} and G_{34} (Plan 8). The depth of the dwelling pit is greater than in the case of the dwelling pits of the Ia level by approximately 0,60m. The dwelling pit has lateral 'beds'.

649 ceramic fragments from the B_{17}'s content have being analyzed (Fig. 3, Graphic 1, Tab. 1). Regarding the categories of ceramic, semi-fine ceramic (44%) predominate, followed by coarse (38%) and fine (18%) ceramic. As for colour, nuances of brown are most common: brown (28%), light brown (19%), dark brown (11%) and brown with flaps (7%). The reddish nuances are: reddish (11%), reddish-brown (11%) and cardinal red (3%). The temper used for the paste is mainly made up by different combinations of husk: husk and sand (64%), sand, husk and small stones (10%), sand and husk (8%) and husk (7%). Regarding the smoothing of the exterior surfaces, there are to be observed: smoothed slip (29%), detached slip (27%), rough (19%), smoothed (11%), smoothed slip (9%) and barbotine (3%). 89% of the fragments are not decorated, with barbotine (3%), application (3%), application and cell (3%) and finger tip impressions (1%). The pit is dated at 7030 ± 50 BP (Poz–24697 – Thanks to prof. dr. hab. Janusz Kozlowski who kindly accepted the sample in FEPRE project – Tab. 2, Fig. 9).


Photo 1. Miercurea Sibiului-Petriş. Painted sherd from the B_{10} dwelling pit (no scale).

The B_{20-21} dwelling-pits and the $G_{31,35-36}$ pits (Plan 4, surface II, centre-right; Plan 9; Figs. 4 and 5)

The B_{20-21} dwelling pits and the $G_{31,35-36}$ pits are special cases in Miercurea Sibiului-Petriş. The five complexes are in a very small area. Because they intersect in such a manner, we faced difficulties in establishing their stratigraphic succession, considering their chronological succession at the same time. So, we resorted to intermediary stratigrafic profiles (cross-section) in order to establish the succession of these units. It was clear that, from a stratigraphic point of view, B_{21} is the latest, as it 'cuts up' the filling of B_{20} and G_{35} which, in turn, intersects B_{20}. The latter is intersects the G_{36} pit. The difficulty resided in establishing the stratigraphic position of G_{31} in relation to the other four complexes, due to its eccentric position. The dwelling pits were abandoned and corked up at short notice, and a palisade at the Vinča level, as well as other two pits at the same level (indicated by the dotted line contours) 'passed' through the middle of the intersection of pits, making more difficult the chronology reading of the complexes.

129 ceramic fragments were recovered from B_{20}. Semi-fine ceramics predominate (41%), followed by coarse ceramics (37%) and fine (22%). The nuances of brown are the most numerous: brown (24%), light

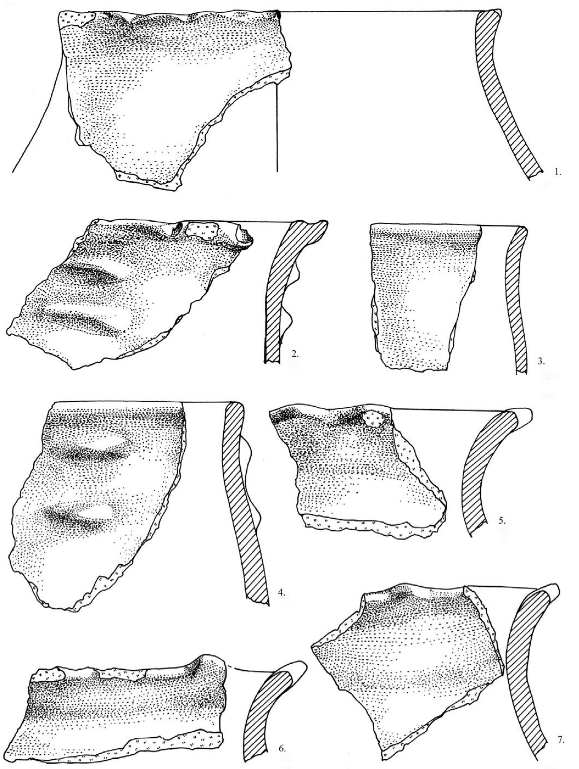
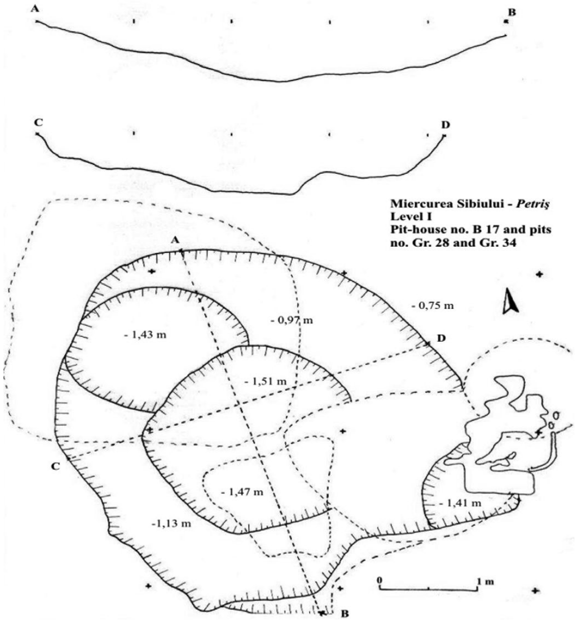


Fig. 3. Miercurea Sibiului-Petriş. Sherds from the B_{17} dwelling pit. dwelling pit.



Plan 8. Miercurea Sibiului-Petriş. The plan of the B_{17} dwelling pit.

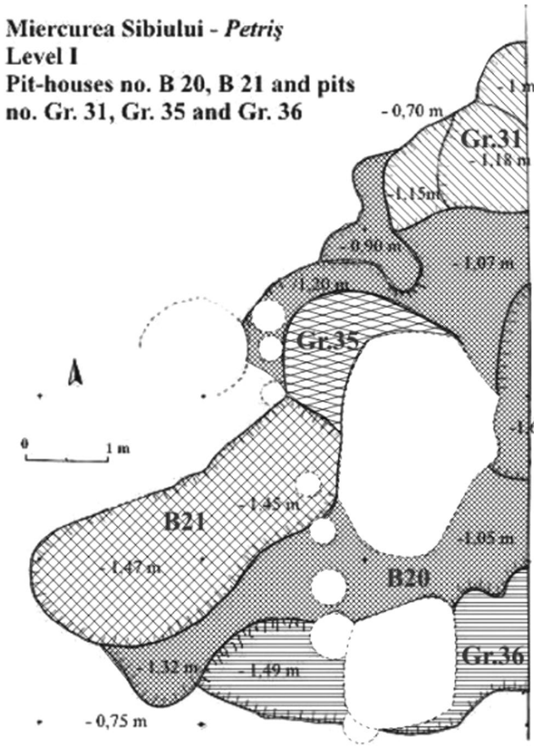
brown (19%), brown with flaps (8%). There are also nuances of red such as reddish-brown (6%), reddish (5%), cardinal red (3%), and nuances of grey: grey (10%), greyish-black (3%), light grey (3%) and grey with black flaps (1%). The temper used for the paste is mainly made up of different combinations of husk: husk and sand (70%), sand and husk (12%) and sand, husk and small stones (12%). The exterior surfaces are: detached slip (35%), polished slip (33%), rough aspect (17%), applied barbotine (5%) and smoothed slip (5%). Only 15% of the ceramic fragments are ornamented, with barbotine (5%) and application (2%) are predominant, and the rest of the decoration types being below 1%.

From B_{21}, 186 ceramic fragments were analysed (Figs. 4 and 5), with semi-fine ceramic (51%) being the most frequent, followed by fine (25%) and coarse (24%). The exterior colour of the fragments is dominated by nuances of brown: brown (25%), light brown (21%), dark brown (20%) and brown with flaps (5%). The nuances of red are: reddish (5%), reddish brown (4%) and cardinal red (2%). Husk prevails in the composition of the paste: husk and sand (62%), sand and husk (17%) and sand, husk and small stones (9%). The exterior surfaces were: detached slip (40%), polished slip (22%), rough (13%) and smoothed (18%). Only 9% of the fragments are decorated, the percentage for every type of decoration being below 2%.

When analyzing the ceramics in these complexes (which offered enough data for a comparative analysis on typological and stylistic bases) we decided to integrate the complex of pits in the Ib sub-level (even if from a stratigraphic point of view there is a clear chronological difference between the five deepened complexes, the ceramic materials discovered here argue for the relative contemporaneity of these pits in the IC–IIA phase of the Starčevo-Criş cultural complex).

The B_1 dwelling pit (Plan 4, surface I, left; Plan 10; Photo 3, Tab. 1)

It seems that the initial pit of B_1 was round. Unfortunately, its initial shape was damaged by the B_4 Vinča dwelling pit (which reached the bottom of B_1 only here and there, but modified its initial shape) and the M_3 grave (level V – a Gepid necropolis). The ^{14}C data for this dwelling complex, 6920 ± 70 calBP, is the base – along with the typological and stylistic characteristics – for the absolute chronology of the Ib horizon here, representing the real time of the complex (the archaeological material discovered here is characteristic of fully functional house-ware). Two pits were preserved in the interior of B_1, namely G_{4a} and $G_{4a'}$ (Plan 4, surface I, left; Plan 10). It seems that they were part of this complex as pole-pits (?) of large dimensions. The archaeological materials discovered in the two pits and in the dwelling pit prove that they are contemporaneous.



Plan 9. Miercurea Sibiului-Petriş. The plan of the B_{20} and B_{21} dwelling pits.

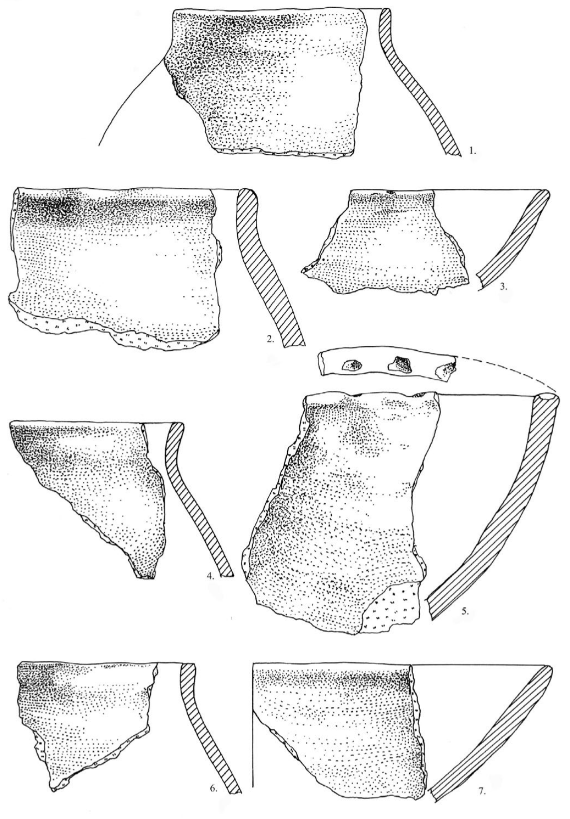


Fig. 4. Miercurea Sibiului-Petriv. Sherds from the B_{21} dwelling pit.

Only 141 ceramic fragments were recovered from B_1 (Fig. 6, Graphic 1, Tab.1). Fine ceramic predominates (41%), followed by semi-fine ceramic (37%) and coarse (22%). Brick colour (23%) is followed by the brown (18%), reddish (13%), cardinal red (11%), dark brown (9%), light brown (9%), grey (6%) and yellowish (2%). Husk prevails as a supplement in the composition of the paste: sand and husk (81%), husk and sand (13%) and fine sand (3%). The exterior surface is smoothed (56%) and polished (40%). Undecorated ceramics predominate (92%), most of the decorative elements being cells (5%). The rest of the ornaments are below 1%.

An item of special character was discovered in this dwelling pit. The schematic amulet (Fig. 6/4a–b; Photo 3) represents an 'idol bucranium' or a 'labret' (*Karmanski 1986.12, prilog 1*) and is made of clay. In Romania, this kind of amulet is to be found in settlements that appertain to the Starčevo-Criş cultural complex: Cluj-Napoca-Gura Baciului (*Vlassa 1976. 211, 230, Fig. 14/3–4; Lazarovici and Kalmar 1995. 155, Fig. 22/6; Brukner 2000.298–299*), Dubova-Cuina Turcului (*Lazarovici 1979.34; Păunescu 1979. 37, fig. 14/ 11*), Foeni-Sălaş (*Ciubotaru 1998.75, Pl. III/6–7, 9*), Miercurea Sibiului-Petriş (*Luca 2002*),

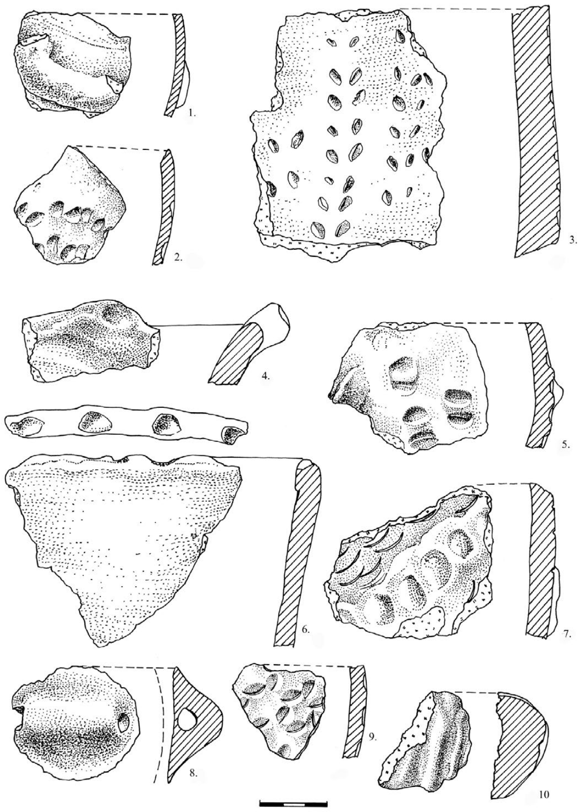


Fig. 5. Miercurea Sibiului-Petriş. Sherds from the B_{21} dwelling pit.

Ocna Sibiului-Triguri (*Paul 1995.51, Pl. VIII/5–6; XXX/3 a–b, 4 a–b*) and Sălcuţa (*Lazarovici 1979. 34, n. 170*). Dumitru Berciu integrates very early the first level of the Piscul Cornişorului (*Berciu 1961. 29–30, 160, 161, 162, 167, 185–192*), the same perspective being that in the case of the site at Timişoara-Fratelia (*Draşovean 2001.34, Pl. 4/4–5*), analogies in South-Eastern Europe being developed with Blagotin (*Ciubotaru 1998.75*). This author states that the items were discovered in the vicinity of a cultic complex and could have a utilitarian purpose, perhaps in connection with the religious practices, as they have been hypothesised at Divostin (*Karmanski 1988.12*), Dobanovici-Ciglana (*Karmanski 1988.12*), Donja Branjevina (*Lazarovici 1979.34, n. 166; Karmanski 1989.Pl. 9/2–6, 10–12, 14; 2000, T. XXII; Brukner 2000.309*), Grivac (*Lazarovici 1979.34, n. 168*), Knjepište (*Brukner 2000.309*), Kozluk (*Srejović 1969.306, Pl. 8; 85/2; Tasić 1973. 90; Lazarovici 1979.34, n. 167*), Lepenski Vir (*Srejović 1969.306, Pl. 8; 85/2; Tasić 1973.90; Lazarovici 1979.34, n. 167*), Lug-Obrenovac (*Jovanović 1967.20; Tasić 1973.90; Lazarovici 1979.34, n. 169*) and Rakitovo (*Matsanova 1996.105–127*). Culturally, these items are to be integrated with the Starčevo-Criş culture, the IC–IIA phase (*Lazarovici 1983. 13; Ciubotaru 1998.75; Draşovean 2001*).

The chronological and cultural integration of the Ib sub-level

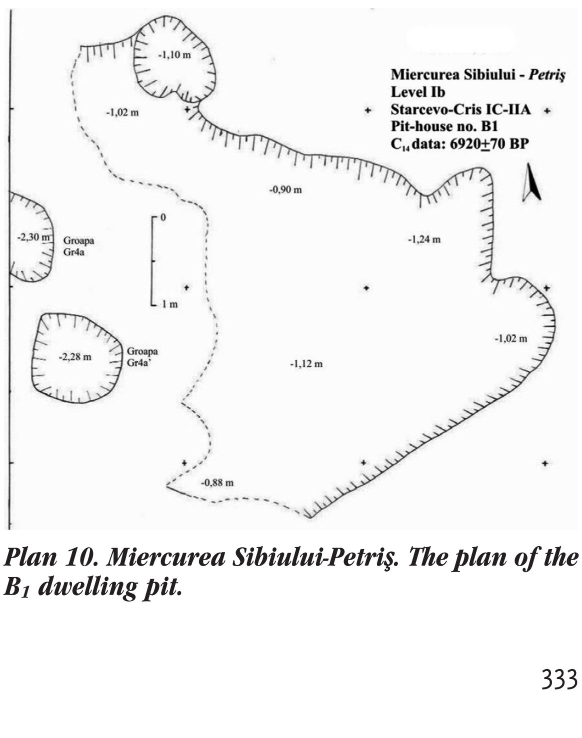
The B_1 dwelling pit is contemporary with Starčevo-Criş IC–IIA, according to the similartities regarding ceramic and plasters. In the same way, the ^{14}C data and the seriation with other data obtained from the same site clearly indicate a relation with the anterior sub-level and a certain evolution at the same time.

The Ic sub-level

The B_9 dwelling pit (Plan 4, surface I, lower centre; Plan 11; Fig. 8)

This deepened dwelling shows – through the cropped archaeological material, as well as through architectural characteristics – that we are dealing with a different cultural and chronological horizon, a later one, appertaining to the Starčevo-Criş culture. The ^{14}C data for this archaeological complex – 6180 ± 40 BP – reflects an important reality of the stratigraphy of the site in Miercurea Sibiului – the existence of considerable disturbance due to human activity, rodents and carnivores. In our case, the disturbance was caused by humans – as shown by the stratigraphy. During the 2007 research, we observed that the B_9 dwelling pit continues in surface III (no illustration) and is strongly affected by a pit appertaining to the II/III level (Lumea Nouă culture), the one which follows here to the II horizon complexes, dated Vinča A_3–B_1. This complex has an extended, oval shape, with a short axis of small dimensions (2m), and is ot very deep (see Plan 11).

In total, this complex comprises 585 fragments (Fig. 8, Tab. 1, Graphic 1). Rough ceramics predominate



Plan 10. Miercurea Sibiului-Petriş. The plan of the B_1 dwelling pit.

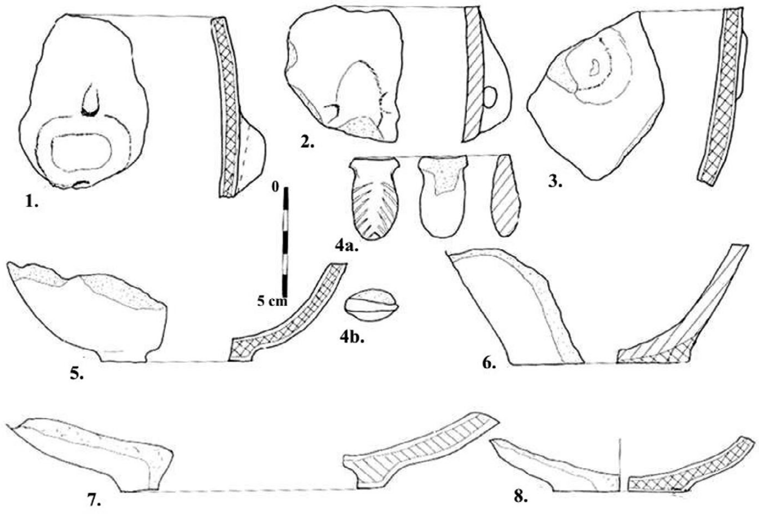


Fig. 6. Miercurea Sibiului-Petriş. Sherds from the B_1 dwelling pit.

(43%), followed by semi-fine (37%) and fine (20%). The exterior colour is different from that in earlier complexes, where the nuances of red (reddish, cardinal red, reddish brown) played an important role. In this complex, nuances of brown are predominate (brown 18%, light brown 13%, and dark brown 13%), followed by the nuances of grey (grey–9%, whitish grey–6% and greyish dark–3%). The nuances of brick colour are almost at the same percentage (14%).

The way that the exterior surfaces were smoothed indicates an affinity for a higher quality of product through the polished (30%) and smoothed (27%) surfaces. In the same context, the barbotine technique can be observed in 25% of the material. The ceramic paste contains sand and husk (45%), or husk and sand (28%) as a degreaser. The fragments containing sand of various consistencies are not more than 14% of the total of the analyzed fragments. The greater parts of the fragments have no decoration (74%). The barbotine (25%) (barbotine is considered to be a technique for treating surfaces, as well as a type of decoration) predominates, while the remainder of decorative types comprise about 1% (applications, pinches, nail impressions, incisions and cuts).

The chronological and cultural integration of the Ic sub-level

The archaeological material discovered in this dwelling pit also appertains to the Starčevo-Criş culture. As we could observe from a study of the ceramics, there is a *hiatus* between the settlements characteristic of the Ia–b and sub-levels. The ceramics with barbotine appear in such a great number – being decorated in the technique of organized barbotine (Fig. 8) – that we are led to the opinion that we are dealing with a moment of 'starčevisation', integrated after the IIB phase of the Starčevo-Criş culture.

The statistics of the analyzed complexes

In Table 1 and on the Graphic 1 the materials of the complexes we are concerned with, are analyzed. Thus, B_{10}, B_{19}, G_{26}, B_{17} were examined almost completely. B_1 comprises partial results because of the exterior disturbances which affected its structure. B_9 was researched in 2003 and 2007, when the bulk of the ceramic fragments were recovered.

The situation is relatively constant regarding the extant relation between the three categories of ceramics. Thus, for the B_{10}, B_{19}, G_{26}, B_{17} and B_1 complexes, there is a larger proportion of semi-fine rough ceramics, while B_9 is the only complex having a higher percentage of rough ceramics.

The most substantial differences are registered for the fine category, with B_{10} and B_1 having values over 40%.

Photo 2. Miercurea Sibiului-Petriş. Painted sherds from the Gr_{26} pit (no scale).

Apart from the B_1 complex (comprising a small number of fragments for each category), the other complexes yielded a constant number of fine ceramic fragments (between 119 and 162 fragments).

We believe that the analysis of the degrease of the paste, as one of the most important elements defining the technology of ceramics, shows small differences between the three sub-levels, constituting, along with the analysis of the categories of ceramics, a ba-

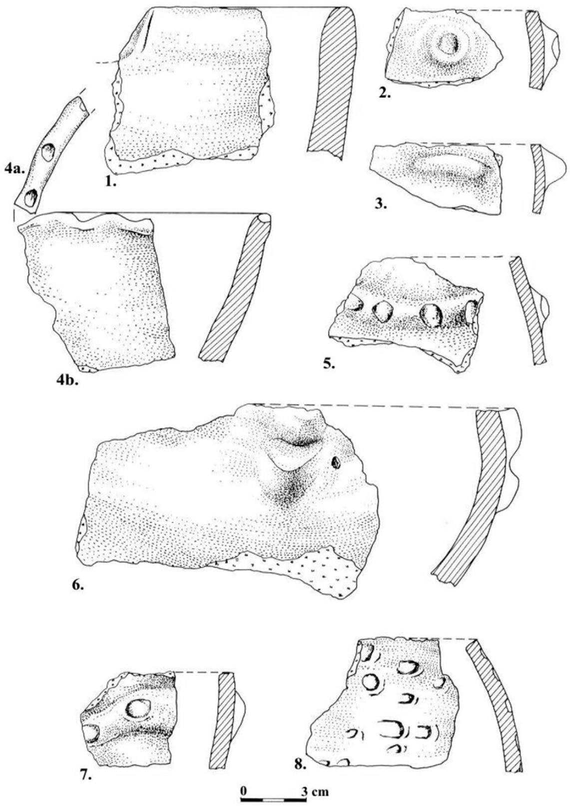


*Fig. 7. **Miercurea Sibiului-Petriş. Sherds from the B_1 dwelling pit.***

sic argument for ‘dividing’ the level corresponding to the Upper Neolithic in Miercurea Sibiului-Petriş.

Thus, in the case of the B_{10} dwelling pit, we observe a certain prevalence of the combination based on ‘sand and husk’ (the order is given by the element that predominates) (87%), ‘husk and sand’ totalling only 4% (the sum of the two categories having values of 91%). We present the combined values for the two types of degreaser ‘sand and husk’ and ‘husk and sand’, as the analysis of the ceramics is done macroscopically and could sometimes cause confusion regarding the prevalence of one or another component. B_{19} demonstrates a contrasting situation, favouring degreaser containing ‘husk and sand’ in 40%, the other combination of ‘sand and husk’ having a percentage of 24% (the sum of the two categories having values of 64%). There is to be noted the introduction of ‘pounded shivers’ in three different mixtures, amounting to 21% of the total of ceramic fragments in this complex. In which regard, the G_{26} pit we consider to belong, with the other two units described above, to the Ia sublevel; it presents a slightly different situation: the ‘husk and sand’ have values of 63%, ‘sand and husk’ 16% (the total being 79%), while the mixtures with ‘pounded shivers’ total 8%.

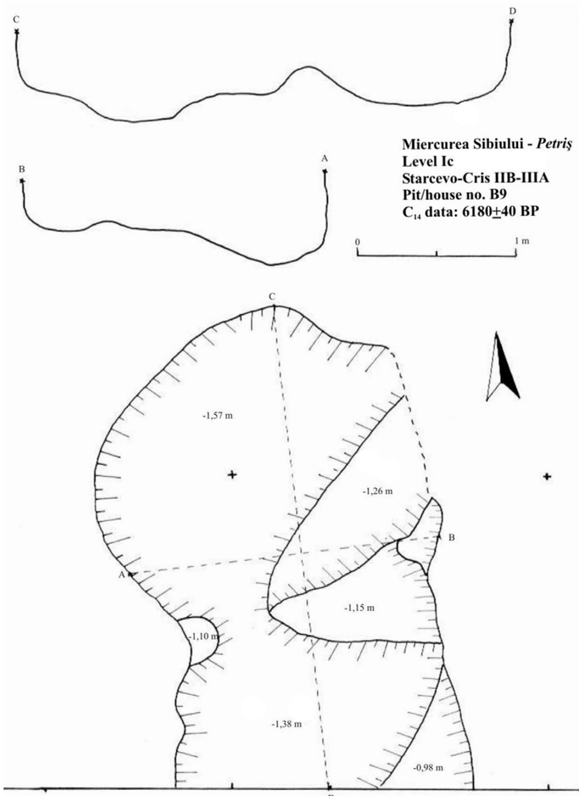
The Ib sub-level includes, as the most representative complexes, the B_{17}, B_{20}, B_{21} and B_1 dwelling pits. For B_1, the values of the two categories (‘sand and husk’, ‘husk and sand’) total 96%; for B_{17}, 74% (this complex presents a large range of combinations of different materials for a degreaser), for B_{20}, 88%, and for B_{21}, 85%.

Up to this moment, B_9 is the only identified unit integrated in the Ic sub-level. In our estimation, the percentage of the two categories is 74%.

A common element is also to be observed regarding the technological aspect of ceramics processing in the early Neolithic communities, as shown by the site at Petriş: the two types of material used as a supplement for the rough material (clay), husk and sand and sand and husk, have a percentage higher than 60% in the case of every unit analyzed, a fact that could indicate a ‘rule’ through several phases in the evolution of the Starčevo-Criş cultural complex at the Miercurea Sibiului site.

Conclusions

The earliest manifestation of the Neolithic in Transylvania is the Starčevo-Criş cultural horizon, as defined by most scholars in the specialized literature of the



*Plan 11. **Miercurea Sibiului-Petriş. The plan of the B_9 dwelling pit.***

last three decades (*Vlassa 1966.9–48; Lazarovici 1975.8–12; 1977.34–42; 1979.39–56; 1983.9–34; 1984.49–104; 1992.25–59; 1993; Dumitrescu 1983. 69; Ursulescu 1984.90; Paul 1989.3–28*).

The mode dissemination by the newcomers was determined – to all appearances – by the existence of some areas newly uncovered from under glaciers. This is the only way of explaining the conclusion of Breunig regarding Europe, obtained through the correlation of all the ^{14}C data (in the BC period) having a natural and direct relation to the process of Neolithisation (*Breunig 1987.86*).

Concerning the terminology for naming the Neolithic newcomers, we are circumspect regarding the acceptance of the idea that the old phases of the Starčevo-Criş cultural complex must be considered 'a genetic phase of the Starčevo-Criş culture' (*Pavúk 1993.231; Brukner 2000.287*). Especially in Transylvania, the defined terminology for the concept of Precriş culture (*Paul 1989; 1995; Ciută1998; 2000; 2001*) is based on the scarcity of precise observations, complete research of the archaeological complexes, statistics, complete analysis, and horizontal and vertical stratigraphies (*Lazarovici 2001.42–45*).

The existence of a 'first Neolithic wave', represented through the 'aceramic' or 'pre-ceramic' Neolithic horizon, as discovered in Thessaly (*Milojčić 1959.230–232; 1960; Benac 1978.16; Garašanin 1978.34; 1980.58*) or in other locations, especially in caves (*Benac 1971.98*), cannot be a demonstration of the situation in Transylvania. The closest site and associated assemblage of this cultural and chronological horizon was hypothesised at Dârţu-Ceahlău (*Păunescu 1958.269–271; Berciu 1958. 91–98*), which proved to be of later date (*Vlassa 1964.463–464*).

The evolution of the large Carpatho-Balkan cultural complex of the Early Neolithic, Starčevo-Criş – a component of the Balkano-Anatolian complex of the Early Neolithic (*Garašanin 1978.32–33, 35–38; 1980*) – begins in Transylvania, at least theoretically, at the same time as the 'Frühkeramik' or 'Monochrom' phase (*Milojčić 1949; 1959; Milojčić-Zumbusch 1971.25*). The archaeological materials of this phase are shown hypothetically at Romanian sites (*Lazarovici 1977.34; 1979.17; 1984.53–55*). The existence of the monochrome, fine and polished ceramic, is beyond doubt, present among the other pottery in all the locations yielding early Neolithic ceramics in Transylvania (*Paul 1989.20*). It is enough to mention here the settlements at Gura Baciului I

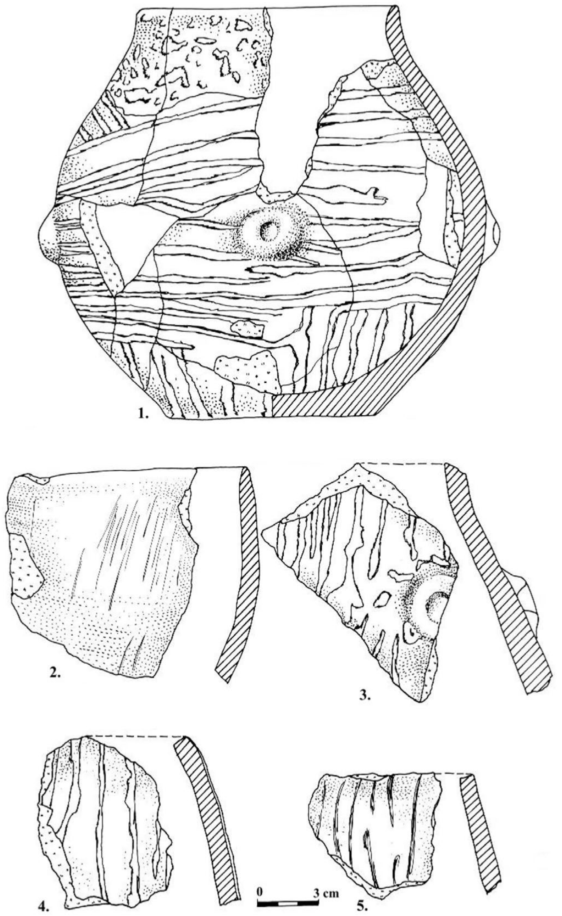


Fig. 8. Miercurea Sibiului-Petriş. Sherds from the B_9 dwelling pit.

(*Vlassa 1976.198–264; Lazarovici and Kalmar 1995.199, 201*), Ocna Sibiului-Triguri I and II (*Paul 1989; 1995.28–68*) and Miercurea Sibiului-Petriş Ia–b (*Luca 2002; 2004; Luca et ali 1998; 1999; 2000a; 2001; 2002*).

Perhaps the most important location pertaining to the primary moment of Neolithisation – 'post aceramic' is at Cluj-Gura Baciului. The first (I) horizon here (*Vlassa 1976.198–264*) comprises archaeological complexes beginning their evolution as early as the IA phase of the Starčevo-Criş cultural complex (*Lazarovici and Kalmar 1995.63, 68–79*). The most important dwelling complex is the B_{2A} dwelling pit, considered by its discoverers to be the oldest Neolithic (*Lazarovici and Kalmar 1995.68–69*). Other complexes and archaeological materials – along with those in the B_1 dwelling pit and G_{1a} pit, the B_8 dwelling pit, the B_{2A1} dwelling pit, the G_{11} pit, the B_{9B} dwelling pit, the G_{33} pit, and the B_{10} and B_{2B} dwelling pits – are part of horizon I at Gura Baciului (*Lazarovici and Kalmar 1995.68–79*), considered by Vlassa to be parallel with the 'Protosesklo' stage (*Vlassa 1976.257–260*).

Photo 3. Miercurea Sibiului-Petriş. The bucranium idol from the B_1 dwelling pit (no scale).

An important location of the early Neolithic in Transylvania is at Ocna Sibiului-Triguri (*Paul 1989; 1995. 28–68*), considering its stratigraphy and archaeological material. The first three successive levels of this site (Ia–IIa) appertain to the 'Protosesklo' horizon. The IIb level could appertain to the transit phase to the Criş culture (a synchronic phase with Gura Baciului II); while the last two levels – IIIa–IIIb – appertain to some sequences of the Starčevo-Criş cultural complex (*Paul 1989.10*). He suggested that the 'Protosesklo' horizon appears as a distinct culture, having a relatively long evolution, which he names 'Precriş', two regional aspects of which were noticed north of the Danube: the 'Wallachian aspect' in Cârcea (Oltenia) and the 'Transylvanian aspect' in Ocna Sibiului-Gura Baciului, observing the existence of two developing stages as well – I and II (*Paul 1989.11*). Against a unitary evolution of the early Neolithic in the northern zone of the Balkans, under the name of Starčevo-Criş cultural complex (*Lazarovici 1992.27*), Paul is seeking a detailed phase I and partial phase II of this chronological system, which was not confirmed directly in the context of the newest discoveries in Transylvania, especially in Gura Baciului or Miercurea Sibiului-Petriş. It is to be observed that, no matter in what perspective we consider the development of the first Neolithic phases (such as the Starčevo-Criş cultural complex, phase I and partial II, or Precriş I–II, or a cultural group – or culture – Gura Baciului-Cârcea), the recent discoveries will lead to the required nuances and reconsiderations. Finally, we notice that, in the publication of this site, no clear observations were made of the dwellings and the evolution of the ceramics at each successive level of the dwellings. Analysing the published material, we could offer the opinion that – besides the consideration that the author has other data – the oldest dwellings here would be a dwelling pit (*Paul 1995.30–31, Abb. 2*) for Precriş Ia phase, along other one in SXII (*Paul 1995.Abb. 5*), and a semi-dwelling pit (*Paul 1995.30–31, Abb. 2*), dwelling 9 and a pit (*Paul 1995. Abb. 5, 6*) for the Precriş Ib phase. Without renouncing to a research system based on the prospect of the stratigraphy in narrow sections, the author remains captive to some theoretical concepts which are only tangentially based on the data from a thorough analysis of both the architecture and the artefacts (*Lazarovici 2001.42*).

The observations made in Transylvania, as well the latest discoveries, compel us to draw attention to the Early Neolithic cultural penetration along the valley of the River Olt to Ocna Sibiului, continuing (Miercurea Sibiului – thermal springs) towards the salt mines at the far north curve of the central stretch of the River Mureş and towards the settlement at Gura Baciului. It is difficult to consider that we are dealing with migration in the real sense of the word (*Lazarovici and Kalmar 1995.42–43*), especially because the data relating to ceramic technology do not match those from Thessaly, for example. The ways of diffusions are not clear (*Lazarovici and Kalmar 1995.42–43*). We have to accept that, for the time being, these remain the only possible definitions if we consider them in succession: migration and diffusion. However, the Ib level is – in the case of the location at Miercurea Sibiului – the association of a piece of bucranium type with the ceramics of the B_1 dwelling pit which compel us to integrate the artefact and the archaeological complex in the IC–IIA phase of the mentioned culture. As a consequence, it is contemporary with Gura Baciului I (a part of the complexes: the B_8 dwelling pit, B_{2A1} dwelling pit, the G_{11} pits, the B_{9B} dwelling pit, the G_{33} pit, the B_{10} dwelling pit and B_{2B} dwelling pit) (*Lazarovici and Kalmar 1995.68–79*) or with Precriş Ib – the pit, semi-dwelling pit, dwelling 9 (*Paul 1995. 30–31, Abb. 2, 5–6*) and dwelling 1/1997 in Şeuşa-La cărarea morii (*Ciută 1998; 2000*). To the same chronological and cultural horizon appertains the archaeological site discovered in Cerişor-Peştera Cauce.

A new horizon presenting mainly *monochrome* ceramics could be defined among the latest discoveries at Cerişor-Peştera Cauce, where there is cultural layer in which the ceramics are mainly fine and poli-

The Stratigraphic Position	The Complex Code	Rough	Semi-fine	Fine
Sub-level Ia	B10	65	155	162
	B19	251	322	147
	G26	151	233	119
Sub-level Ib	B17	246	288	115
	B1	31	52	58
Sub-level Ic	B9	248	218	119

Tab. 1. Distribution of ceramic fragments from the analysed complexes.

shed, but we cannot give it a definite date. We note that no painted ceramic fragments were discovered here.

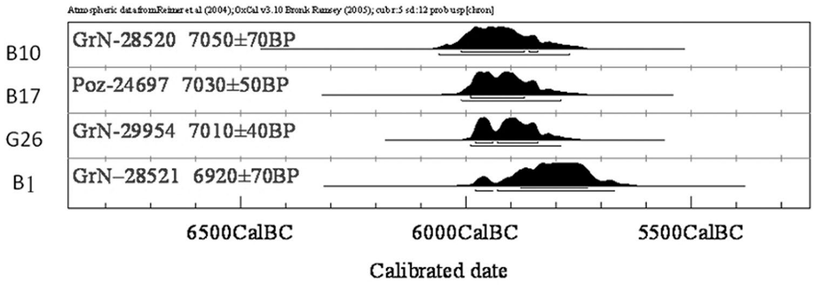


Fig. 9. Miercurea Sibiului-Petriş – plot with radiocarbon data from Early Neolithic complexes.

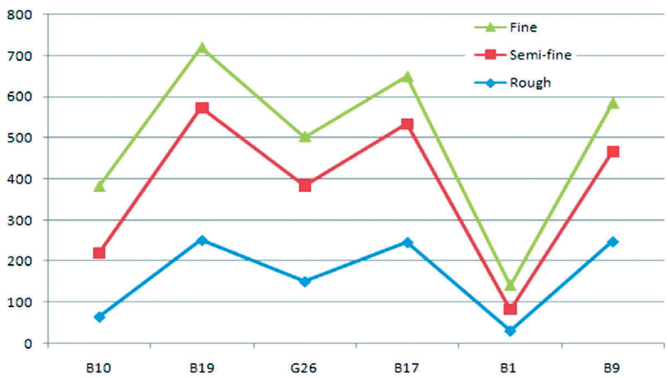
On the other hand, the existence of this kind of settlement in Romania was announced by the discovery in Iosaş-Anele (*Luca and Barbu 1992–1994*). Some Romanian researchers preferred to integrate the early Neolithic settlements that presented no painting ('Monochrom' in the Dimitrijević (*1974*) system), in the IC–IIA phase of this large cultural complex, the chronological level at which was stipulated the disappearance – or the very rare appearance – of painting (*Lazarovici 1979.43*). That is characteristic, however, of the IA phase as well, and it is certain that there are other characteristics which made the period at the beginning of Neolithic a separate unit. Considering our knowledge, the painting of white dots develops in the IB and IC phases of the Starčevo-Criş cultural complex, while its presence in other periods is rather accidental.

As a matter of fact, the ceramics painted in white appear quite rarely in Şeuşa-La cărarea morii (3–4 fragments) (*Ciută 2000.67–68, Fig. 25/1–3*), so the author suggests that the ceramic material here is monochrome, chromatically speaking (*Ciută 2000.65*). The same author though, expresses in other pages of the same work, his doubts about the existence of a 'Monochrom' horizon in Romania (*Ciută 2000.76*). We are to conclude that, until complete research of an old Neolithic site the north of the Danube, we cannot clearly envisage which the characteristics of a possible 'Monochrom' horizon could be (be it the oldest or more recent in the chronological perspective). If so, we must avoid the integration of some dwellings with painted ceramic fragments – a few – in the IA phase of the Starčevo-Criş cultural complex!

We may hypothesise the 'Monochrom' (in Dimitrijević's perception), would mark the second migration suggested by Lazarovici and Kalmar (*1995.200; Lazarovici 2001.42*).

Now, the 'traditional' way of Early Neolithic cultural penetration in Transylvania (via Oltenia) is doubled by another, towards the south-west (Banat), of which vestiges are to be found, most probably, in the karst caves of Poiana Ruscă Mountains, as well, or in the south Apuseni Mountains (Cerişor-Peştera Cauce, see *Luca et al. 1997.19, 24*, or Crăciuneşti-Peştera Balogu, see *Roman et Diaconescu 2001.7–8*). The biggest problem remains the unsatisfactory state of archaeological research in this area, with many of the karstic formations here remaining un-researched or even unidentified. The supposed way of access would have been developed step by step, with the result that, in the period of 'starčevisation' of the communities in southern Transylvania, the way along the valley of the Oltul River was closed for a while.

The phenomenon of 'starčevisation' was linked to the end of the second Starčevo-Criş phase in Transylvania, (*Paul 1989.18*). The settlement in Ocna Sibiului-Triguri loses its importance, failing to develop painting in black, characteristic of the late horizons of the cited cultural complex (*Paul 1989.21*). The early Neolithic locations in the valley of the middle Mureş River develop (Miercurea Sibiului-Petriş and Pustia, Orăştie-Dealul Pemilor, point X_8, Limba-Bordane etc.) under the cultural influence of the west and south-west such elements as barbotine, applied ornament, incision or 'impresso' decorative motifs (*Paul 1989.21*) along with painting in black (*Draşovean 1981.42*), or altars with leg-like postaments with eyes marked on them (*Luca et al. 1998*). All these observations demonstrate that we still can



Graphic 1. The distribution of the sherds number through complexes.

discuss cultural unity over large areas, a fact that was accepted under the name of the Starčevo-Criş cultural complex even by Paul (*Paul 1989.24*).

It is possible now to integrate the discoveries in Ocna Sibiului-Triguri IIa and Miercurea Sibiului-Petriş, the B_9/2003 dwelling-dwelling pit, in the vertical and horizontal stratigraphy here.

Even if there are some differences in comparison with the above described complexes, we notice a technological unity, easy to demonstrate, and an evolution having common roots which generated the complexes in Miercurea Sibiului-Petriş.

The influences generated in Transylvania from the Banat region and the plain of the Tisa River, and from south of the Danube, become more and more visible in the III[rd] phase (Gh. Lazarovici's system) of the Starčevo-Criş cultural complex. At the same time as the middle of this phase, the appearance of the first Vinča communities in Transylvania is to be observed (*Luca 1995–1996; Luca et al. 2000; 2000b*).

The evaluation of the data of absolute chronology in the development area of this cultural complex (see Tab. I) indicates the relative contemporaneity of the Ia sub-level in Miercurea Sibiului with the Ib and II level in Anza, partially with the 'Monochrom' level in Donja Branjevina, with Gura Baciului, Ocna Sibiului (level VIII), Şeuşa, Foeni-Sălaş. Miercurea Sibiului Ib has the same chronological level as Donja Branjevina (the red on white level), Endrőd 39, Anza II, Foeni-Gaz, Dudeştii Vechi, Endrőd 119, Biserna Obala-Nosa, Szarvas 23 etc. The last sub-level of the site in Petriş was wrongly dated to 6180 ± 40 BP, due to its being intersected by a later pit.

∴

REFERENCES

BENAC A. 1971. Le néolithique dans les Balkans du Nord-Ouest et ses relations avec les régions voisines. In G. Novak (ed.), *Actes du VIII[e] Congres International des Sciences Préhistoriques et Protohistoriques 1*. Union Internationale des Sciences Prehistoriques et Protohistoriques. Beograd: 97–108.

1978. Les theses fondamentales sur l'origine de néolithique dans les Balkanes et les régions avoisinantes. *Godišnjak 16: 9–19*.

BERCIU D. 1958. Neolitic preceramic in Balcani. *Studii şi comunicări de istorie veche (şi arheologie) 9(1): 91–100*.

1976. *Zorile istoriei in Carpaţi şi la Dunăre*. Editura Ştiinţifică. Bucureşti.

BIAGI P., SPATARO M. 2004. New radiocarbon dates from Criş culture settlements of Banat and Transylvania (Romania). *Patrimonium Banaticum 3: 7–20*.

1973. Recherches archéologiques sur la culture Schela Cladovei de la zone des „Portes de Fer". *Dacia 17: 5–39*.

1980. Probleme ale culturii Schela Cladovei-Lepenski Vir in lumina noilor cercetări. *Drobeta 4: 27–42*.

1996. La 30 de ani de la inceperea săpăturilor arheologice de la Schela Cladovei. *Drobeta 7: 3–11*.

BREUNIG P. 1987. *C[14]-Chronologie des vorderasiatischen, südost-und mitteleuropäischen Neolithikums. Monographien zur Urgeschichte, reihe A, bd. 13*. Köln – Wien.

BRUKNER B. 1968. *Neolit u Vojvodini. Dissertationes 5*. Arheološko društvo Jugoslavije. Novi Sad.

2000. Beitrag zum Studium synchroner Beziehungen zwischen der Karanovo I und der Protostarčevo (Starčevo I) Periode. *Beiträge zum Neolithikum in Südosteuropa. 3: 287–310*.

CIUBOTARU D. L. 1998. Plastica neolitică din aşezarea de la Foeni-Sălaş (jud. Timiş). *Analele Banatului 6: 73–82*.

CIUTĂ M. M. 1998. O locuinţă de suprafaţă aparţinând neoliticului timpuriu de la Şeuşa-La cărarea morii (com. Ciugud, jud. Alba). *Apulum 35: 1–14*.

2000. Contribuţii la cunoaşterea celui mai vechi orizont al neoliticului timpuriu din România. Cultura Precriş – descoperirile arheologice de la Şeuşa-La cărarea morii. *Apulum 37(1): 51–101*.

2001. Contribuţii la cunoaşterea celui mai vechi orizont al neoliticului timpuriu din România: cultura Precriş (II). *Apulum 38(1): 9–26*.

2002. O locuinţă neolitică timpurie descoperită in situl de la Limba-Bordane (jud. Alba). *Apulum 39: 1–30*.

DRAŞOVEAN FL. 1981. Cultura Starčevo-Criş in bazinul Mureşului mijlociu. *Apulum 26: 9–47*.

2001. Early Neolithic settlement at Timişoara-Fratelia. *Bibliotheca Historica et Archaeologica Banatica (Festschrift für Gheorghe Lazarovici) 30: 33–40*.

1970. Cu privire la cea mai veche cultură neolitică din România. *Studii şi comunicări de istorie veche (şi arheologie) 21(2): 187–198*.

DUMITRESCU VL., BOLOMEY A., MOGOŞANU M. 1983. *Esquisse d'une préhistoire de la Roumanie*. Editura Ştiinţifică şi Enciclopedică. Bucureşti.

GARAŠANIN M. 1978. Le néolithisation dans le sud-est et dans le centre de la Peninsule Balkanique. *Godišnjak 16: 31–44*.

1980. Les origines du néolithique dans le Bassin de la Méditerranée et dans le sud-est Européen. In J. K. Kozłowski and J. Machnik (eds), *Problémes de la néolithisation dans certaines régions de l'Europe*. Cracovia: 57–72.

GIMBUTAS M. 1989. *Civilizaţie şi cultură*. Editura Meridiane. Bucureşti. 1989.

1997. *Civilizaţia Marii Zeiţe şi sosirea cavalerilor războinici*. Bucureşti. 1997.

JOVANOVIĆ B. 1967. La signification de certeins éléments de culte de groupe de Starčevo. *Starinar 18: 19– 20*.

KARMANSKI S. 1986. *Donja Branjevina*. Odžaci.

1988. *Nalazi labreta*. Odžaci.

1989. *Donja Branjevina*. Odžaci.

LAZAROVICI GH. 1975. Unele probleme ale ceramicii neoliticului din Banat. *Banatica 3: 7–24*.

1977. *Gornea. Preistorie*. Muzeul Banatului. Reşiţa.

1979. *Neoliticul Banatului*. Muzeul de Istorie al Transilvaniei. Bibliotheca Mvsei Napocensis IV. Cluj Napoca.

1983. Neoliticul timpuriu din zona Porţilor de Fier (Clisură). *Banatica 7: 9–34*.

1984. Neoliticul timpuriu in România. *Acta Musei Porolissensis 8: 40–104*.

1992. Aşezarea neolitică timpurie de la Zăuan şi câteva dintre problemele privind neoliticul impuri din Balcani. *Acta Musei Porolissensis 16: 25–59*.

1993. Les Carpates Meridionales et la Transylvanie. In J. Kozłovski (ed.), *Atlas du Néolithique européen. L'Éurope Orientale. E.R.A.U.L.* 45 Liège: 243–284.

2001. Despre locul descoperirilor de la Şeuşa in neoliticul timpuriu din sud-estul Europei. *Bibliotheca Musei Porolissensis 4: 37–47*.

LAZAROVICI GH., KALMAR Z. M. 1995. Gura Baciului. Monografie arheologică. Cluj-Napoca.

LUCA S. A. 1995–1996. Die Vinča-Siedlung aus Rumess. Die A–Phase der Vinča-Kultur in Siebenbürgen. *Sargetia 26: 45–62*.

2002. Eine zoomorphe Statuette aus der Jungsteinzeitlische Siedlung von Reussmarkt/Miercurea Sibiului/ Szerdahely-Petriş, in Cultură şi civilizaţie la Dunărea de Jos. *Călăraşi 19: 96–106*.

2004. O statuetă zoomorfă stilizată descoperită in staţiunea de la Miercurea Sibiului-Petriş (Jud. Sibiu, România) şi câteva opinii despre inceputul neoliticului timpuriu din Transilvania. *Istros 11: 3–26*.

2004a. La Miercurea Sibiului locuinţe de acum 8.000 ani. *Magazin istoric 38(2/ 443): 59–60*.

2004b. Opinii noi despre inceputul neoliticului timpuriu din Transilvania. Nivelul I din staţiunea neolitică de la Miercurea Sibiului. *Transilvania, Supliment Miercurea Sibiului: 3–12*.

LUCA S. A., BARBU M. 1992–1994. Aşezarea neolitică de la Iosaş-Anele (jud. Arad). *Sargetia 25: 13–24*.

LUCA S. A., SUCIU C. 2005. The Begining of the Early Neolithic in Transylvania. In N. Ursulescu (ed.), *Scripta praehistorica. Miscellanea in honorem nonagenarii magistri Mircea Petrescu-Dîmboviţa oblata*. Universitatea A. I. Cuza. Iaşi: 139–156.

LUCA S. A., GEORGESCU A. 1998. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 44*.

1999. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 69*.

LUCA S. A., CIUGUDEAN H., ROMAN C., DRAGOTĂ A. 2000. Faza timpurie a culturii Vinča in Transilvania. Repere ale orizontului cronologic şi cultural. *Angustia 5: 37–72*.

LUCA S. A., GEORGESCU A., SPÂNU A. L. 2000a. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 86*.

LUCA S. A., CIUGUDEAN H., ROMAN C. 2000b. Die frühphase der Vinča-Kultur in Siebenbürgen. Anhaltspunkte des chronologischen und ethnokulturellen horizontes. *Apulum 37(1): 1–50*.

LUCA S. A., GEORGESCU A., SUCIU C. 2001. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 143*.

LUCA S. A., GEORGESCU A., GONCIAR A., BATIUK S., SUCIU C. 2002. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 204*.

LUCA S. A., DIACONESCU D., GEORGESCU A, SUCIU C. 2003. Miercurea Sibiului-Petriş. *Cronica Cercetărilor Arheologice: 196–197*.

2004. Şantierul arheologic Miercurea Sibiului. *Cronica Cercetărilor Arheologice: 124*.

LUCA S. A., PINTER Z. K., ŢIPLIC I. M., GEORGESCU A., DIACONESCU D. 2005. Descoperiri gepide la Miercurea Sibiului-Petriş (jud. Sibiu). Relaţii interetnice in Transilvania. *Secolele VI–XIII: 19–32*.

MATSANOVA V. 1996. Cult objects from the Early Neolithic site at the town Rakitovo. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika v Sloveniji 23: 105–127*.

MILOJČIĆ V. 1959. Ausgrabungen in Thessalien. In *Neue Deutsche Ausgrabungen im Mittelmeergebiet und im Vordern Orient*. Berlin: 225–236.

1960. Präkeramisches Neolithikum auf der Balkanhalbinseln. *Germania 38(3–4): 320–325*.

PAUL I. 1989. Unele probleme ale neoliticului timpuriu din zona carpato-dunăreană *Studii şi comunicări de istorie veche (şi arheologie) 40(1): 3–28*.

1992. *Cultura Petreşti*. Editura Museion. Bucureşti

1995. *Vorgeschichtliche Untersuchungen in Siebenbürgen*. Editura Imago. Alba Iulia.

PAVÚK J. 1993. Beitrag zur Definition der Protostarčevo-Kultur. *Anatolica 19: 231–238*.

PĂUNESCU A. 1958. Locuirea neolitică de la Dârţu-Ceahlău. *Studii şi comunicări de istorie veche (şi arheologie) 9(2): 269–271*.

1970. *Evoluţia uneltelor şi armelor de piatră descoperite pe teritoriul României*. Bucureşti.

1979. Cercetările arheologice de la Cuina Turcului-Dubova (jud. Mehedinţi). *Tibiscus 5: 11–56*.

ROMAN C., DIACONESCU D. 2001. Noi descoperiri neolitice şi eneolitice pe teritoriul judeţului Hunedoara. *Corviniana 7: 7–29*.

SREJOVIĆ D. 1969. *Lepenski Vir*. Srpska književna zadruga. Beograd.

1971. Die Anfänge des Neolithikums im Berich des mittleren Donaurames. In G. Novak (ed.), *Actes du VIIIe Congres International des Sciences Préhistoriques et Protohistoriques I, 3*. Union Internationale des Sciences Prehistoriques et Protohistoriques. Beograd: 252–262.

1978. Néolithisation de la région des Portes de Fer. *Godišnjak 16: 21–29*.

TASIĆ N. 1973. *Neolitska Plastika*. Beograd, 1973. Katalog V. Serija zbirke i legati Muzeja grada Beograda. Beograd.

URSULESCU N. 1984. *Evoluţia culturii Starčevo-Criş pe teritoriul Moldovei*. Muzeul Judeţean Suceava. Suceava.

VLASSA N. 1964. În legătură cu neoliticul timpuriu de la Dârţu-Ceahlău. *Acta Musei Napocensis 1: 463–464*.

1966. Cultura Criş in Transilvania. *Acta Musei Napocensis 3: 9–48*.

1976. *Neoliticul Transilvaniei*. Studii, articole, note. Bibliotheca Musei Napocensis 3. Cluj-Napoca.

Appendix

Tab. 2. The absolute chronology data for the Starčevo-Criş cultural complex.

Phase	Settlement	LABNR	BP	Error	Description
IA Monochrome	Anza Ia	LJ–2181	7270	140	unspecified
Starčevo, white on red painted	Grivac Barice	Bln–869	7250	50	Sonda B
White on red, IB–IIA?	Anza Ib	LJ–2341	7230	170	unspecified
IA Monochrome	Anza Ia	LJ–3032	7210	50	unspecified
IA Monochrome	Anza Ia	LJ–2330–31	7170	60	unspecified
Monochrome – IA	Donja Branjevina	GrN–15974	7155	50	layer III, trench V/1986–1987 pit dwelling
IA Monochrome	Anza Ia	LJ–3183	7150	50	unspecified
IB–IC	Gura Baciului	GrA–24137	7140	45	structure in trench E–D, square 8
IA Monochrome	Anza Ia	LJ–3186	7140	70	unspecified
Monochrome – IA	Donja Branjevina	GrN–15976	7140	90	layer III, trench V/1986–1987 outside dwelling pit
White painted horizon	Magareći Mlin	GrN–15973	7130	60	unspecified
White on red, IB–IIA?	Anza Ib	LJ–2339	7120	80	unspecified
Pre-Criş? IB–IC	Ocna Sibiului	GrN–28110	7120	60	layer VIII
White on red, IB–IIA?	Anza Ib	LJ–2332	7110	120	unspecified
White on red, IB–IIA?	Anza Ib	LJ–2342	7100	80	unspecified
Early Körös	Gyálarét –Szilágyi	Bln–75	7090	100	
IB–IIA	Anza II	LJ–2337	7080	60	unspecified
IIA–IIB	Foeni Sălaş	GrN–28454	7080	50	dwelling pit, square 5, level 7, locus 23, Bos sp. Radius
Monochrome –IA	Donja Branjevina	OxA–8557	7080	55	layer III, trench 2/1987
Precriş? SCIB–IC	Şeuşa	GrN–28114	7070	60	level
IB–IC	Miercurea Sibiului Petris	GrN–28520	7050	70	B_{10}/2003, level Ia
IB–IIA	Anza II	LJ–2351	7040	90	unspecified
IB–IC	Miercurea Sibiului Petris	GrN–29954 29954	7010	40	G_{26}/2005, nivel Ia, ritual pit
Linear A Phase, IB–IIA	Zadubravlje	Z–1 nec	6995	115	pit 10
IIB	Dudeştii Vechi	GrN–28111	6990	50	neolithic ditch, trench 1, sector E4–5, cervus elephus, humerus dx
Körös	Röszke-Lúdvár	Deb–2730	6972	59	unspecified
mid-late Körös	Endrőd 39	BM–1668R	6970	110	unspecified
IB–IIA, White on red	Donja Branjevina	GrN–15975	6955	50	unspecified
mid-late Körös	Endrőd 39	BM–1870R	6950	120	unspecified
mid-late Körös	Endrőd 39	BM–1863R	6950	140	unspecified
IB– IIA	Anza II	LJ–2405	6940	80	unspecified
IIB	Dudeştii Vechi	GrN–28113	6930	50	trench 3, sector A2, cm 165, Bos sp. Astragalus
IIB	Foeni- Gaz	GrA–25621	6925	45	dwelling pit 1, cm 125, Long bone flake
IC–IIA	Miercurea Sibiului Petris	GrN–28521	6920	70	B_1/2003, level Ib
IIIA	Dudeştii Vechi	GrA–24115	6920	80	Trench 3, sector A, cm 75–80, bone perforator
IB–IIA, White on red	Endrőd 119	OxA–9587	6915	45	unspecified

Phase	Settlement	LABNR	BP	Error	Description
II B	Măgura	Wk–14435	6896	61	
IB–IIA, White on red	Endrőd 119	OxA–9583	6895	45	unspecified
IB–IIA, White on red	Biserna Obala-Nosa	OxA–6875	6875	55	unspecified
IB–IIA, White on red	Ludoš-Budžak	OxA–8554	6875	55	unspecified
IIIA	Parţa	GrN–28460	6860	60	dwelling pit 1, trench II, square 7–5, cm 380, Cervus Elaphus, metatarsal
IB–IIA, White on red	Szarvas 23	OxA–9375	6855	55	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9588	6855	45	unspecified
IB –IIA	Anza II	LJ–2409	6850	50	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9586	6850	45	unspecified
Linear Phase, IB–IIA	Donja Branjevina	OxA–8555	6845	55	Layer III
II	Dudeştii Vechi	GrA–26951	6845	40	Acorn (Quercus sp.)
White on red, IB–IIA?	Anza Ib	LJ–2333	6840	100	unspecified
Linear Phase, IB–IIA	Zadubravlje	Z–2 nec	6835	110	unspecified
Körös	Méhtelek-Nádas	Bln–1331	6835	60	pit 1–3/a
II B	Măgura	Wk–14436	6833	53	
mid-late Körös	Endrőd 39	BM–1971R	6830	120	unspecified
IIB–IIIB linear and spiral	Soroca II	Bln–586	6825	150	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9584	6825	45	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9582	6825	45	unspecified
IIIA	Dudeştii Vechi	GrN–28876	6815	70	trench 1, sector C, Square 1 and 2, oven, quercus and ulmus charcoal
IB–IIA, White on red	Endrőd 119	OxA–9590	6815	50	unspecified
Protostarčevo, IB–IIA	Donja Branjevina	GrN–24609	6810	80	layer II
IB–IIA	Anza II	LJ–2338	6800	140	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9585	6795	50	unspecified
II B	Măgura	Wk–14437	6784	56	
Early Körös	Szarvas 23	BM–1866R	6780	110	unspecified
Linear Phase, IB–IIA	Donja Branjevina	OxA–8556	6775	60	Layer III
Starčevo	Mostonga III	GrN–24117	6750	50	level
IB–IIA, White on red	Biserna Obala-Nosa	OxA–8540	6740	75	unspecified
IB–IIA, White on red	Biserna Obala-Nosa	OxA–8552	6725	60	unspecified
IB–IIA, White on red	Endrőd 119	OxA–9589	6720	45	unspecified
III	La Hoţu Cave	Sac–2001	6710	80	unspecified
Linear Phase, IB–IIA	Zadubravlje	Z–3 nec	6705	95	unspecified
IB–IIA, White on red	Biserna Obala-Nosa	OxA–8553	6705	55	unspecified
IB–IIA	Anza II	LJ–2345	6600	110	unspecified
IIB–IIIB linear	Golokut Vizic	OxA–8695	6520	50	unspecified
IIB–IIIB	Anza III	LJ–2185	6510	110	unspecified
III/IV?	Valea Răii-Copăcelu	KN–I.102	6480	75	
Starčevo end	Starčevo	GrN–9033	6475	60	unspecified
Körös	Hódmezővásárhely-Kotacpart	Bln–115	6450	100	potsherd
IV sau Cârcea III	Cârcea Viaduct	Bln–1982	6430	60	unspecified
IIB–IIIB linear and spiral	Gura Baciului	Lv–2157	6400	90	grave M6
Early Körös	Szarvas 23	BM–1865R	6400	170	unspecified
IV, Cârcea III	Cârcea Viaduct	Bln–1983	6395	60	
IIB–IIIB linear and spiral	Trestiana	Lv–2155	6390	100	unspecified
IV	Limba – Bordane	GrN–28112	6290	50	L3 house, square 6–8, cm 110–130