

The 8200 calBP 'climate event' and the process of neolithisation in south-eastern Europe

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ABSTRACT – Climate anomalies between 8247–8086 calBP are discussed in relation to the process of transition farming and to demographic dynamics and population trajectories in south-eastern Europe.

IZVLEČEK – Predstavljamo klimatske spremembe med leti 8247–8086 calBP v povezavi s procesom neolitizacije, demografskimi dinamikami in populacijskimi trajektorijami v jugovzhodni Evropi.

KEY WORDS – 8200 calBP 'climate event'; neolithisation process; population trajectories; south-eastern Europe

Introduction

Since the Last Glacial-Interglacial transition was marked by rapid and pronounced climatic oscillations during general deglaciation, many investigations have focused on this period. Little attention has been devoted to climate variation during the Holocene period, although the climate was characterised by a wide, abrupt and repeating series of climatic anomalies. The abrupt climate change "occurs when the climate system is forced to cross some threshold, triggering a transition to a new state at a rate determined by the climate system itself and faster than the cause" (Alley et al. 2003.2005). During the Holocene, these climate changes were manifested by cooling oscillations, tropical aridity, and major atmospheric circulation changes at round 8200, 5200, 4200, 3500, 1200, and 600 calBP (Mayewski et al. 2004.243–255; see also Alley et al. 2003.2005–2009) (Fig. 1). The most recent manifestation is known as the Little Ice Age.

Climate anomalies between 82000–8000 calBP

The '8.2 ka BP event' has often been compared to the much wider Younger Dryas event; it has been hypothesised that the latter punctuated the termination of the last glacial with a flood outburst from the

final deglaciation of the Laurentide ice sheet. The proposed mechanism for the first Holocene climatic event is similar. Although it has been suggested that the cooling was linked to reduced solar output, the generally accepted explanation points to pulse a melt and cold fresh water released by a sudden drainage of the proglacial Laurentide lakes in North America into the North Atlantic, and to the curtailment and slowdown of North Atlantic Deep Water formation and associated northward heat transport. Ellison et al. (2006.1929–1932) showed that the near-bottom flow speed of the Iceland-Scotland Overflow Water, an important component of the Atlantic meridional overturning circulation, declined significantly at the onset of the cold event. Climate models forced with a strong fresh water pulse into the North Atlantic do suggest widespread consequences. Anomalies have been observed around 8200 calBP in palaeoclimate archives on a near-global scale, except for the high southern latitudes. It appears to have been generally cool over much of the Northern Hemisphere throughout this anomaly, as evidenced by major ice rafting, strengthened atmospheric circulation over the North Atlantic and Siberia, and more frequent polar north-westerly (winter) outbreaks over the Aegean Sea. Mountain glacier advances occur in north-western

North America and Scandinavia, and the tree line limit is lower in Sweden. At low latitudes this is a period of widespread aridity. The record of German tree-ring widths shows a distinct low caused by colder and more arid climatic conditions over northern-central Europe. Summer monsoons over the Arabian Sea and tropical Africa weaken dramatically. Widespread and persistent drought occurs in central Asia and Africa, but precipitation increases in the Middle East (*Alley and Agüstsðóttir 2005.1123–1149; Rohling & Pälike 2005. 975–979*).

The 8200 calBP ‘climate event’ was first clearly noted in Greenland ice core records and in deep sediment cores in Lake Ammersee in southern Germany. In summer 1992 (within the European Greenland Ice Core Project – GRIP) the core was drilled at the top of the Greenland ice cap, some 30 km east of the parallel core of US Greenland Ice Sheet Project 2 (GISP2), which reached bedrock a year later.

Significant changes in chemical concentrations of different elements were detected in certain sections of the cores: GRIP from 1320 to 1340 m, and GISP from 1310 to 1355 m. Sharp anomalies were found in the oxygen isotopic ratios of ice $\delta^{18}\text{O}$, indicating rapid cooling. The sharp decrease in atmospheric methane concentration shows a decline of biogenic methane sources generally associated with wetlands in response to aridity in high, mid and low-latitude (monsoon) regions. Anomalies in chloride and calcium accumulations mark a larger-scale atmospheric response: chloride primarily from sea salt indicates strength of atmospheric circulation or distance from oceanic source areas; while calcium, primarily from continental dust, is a signal of dust availability, dryness, and transport vigour from continental regions (*Alley et al 1997.483–486; von Grafenstein et al. 1998.73–81; 1999.1654–1657; Alley and Agüstsðóttir 2005.1123–1149*).

The palaeoclimate records from across Europe show events very probably correlative with the 8200 calBP ‘climate event’. The typical signature of cooling in

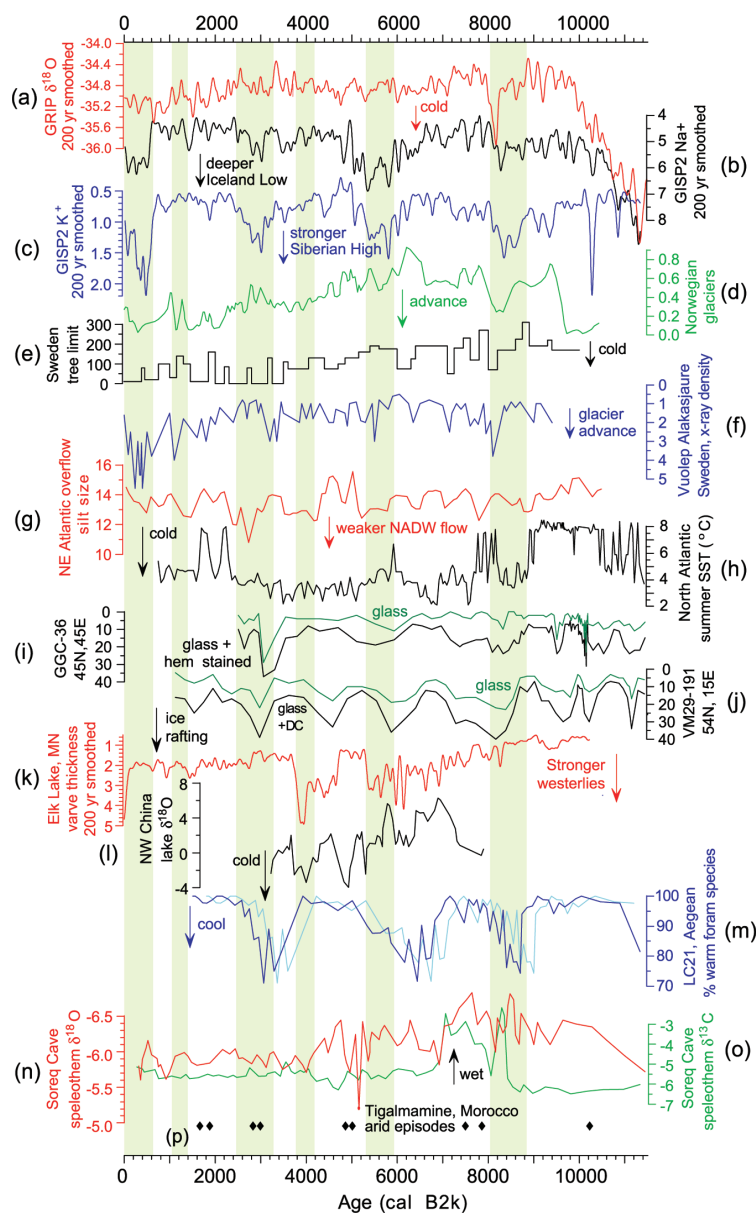


Fig. 1. The sequence of Holocene climate oscillations (from Mayewski et al. 2004.Fig. 3).

the Norwegian Sea, the Mediterranean and Adriatic marks the interruption of cooler and drier conditions in Sapropel S1(a) formation and an increase in the appearance of the left-coiling planktonic foraminifer *Neogloboquadrina pachyderma* (*Trincardi et al. 1996.53; Ariztegui et al. 2000.226; Weninger et al. 2005.79–82; 2006.401–420; Rohling & Pälike 2005.975*) (Fig. 2 a–c).

Cooling in Scandinavia and the Baltic region is marked by reduced annual temperatures in the Estonian Lake Rõuge, by the advance of Norwegian glaciers, and by a decrease in the early flowering of *Alnus*, *Corylus* and *Ulmus* pollen productivity and reproduction, which indicates frost damage in early spring

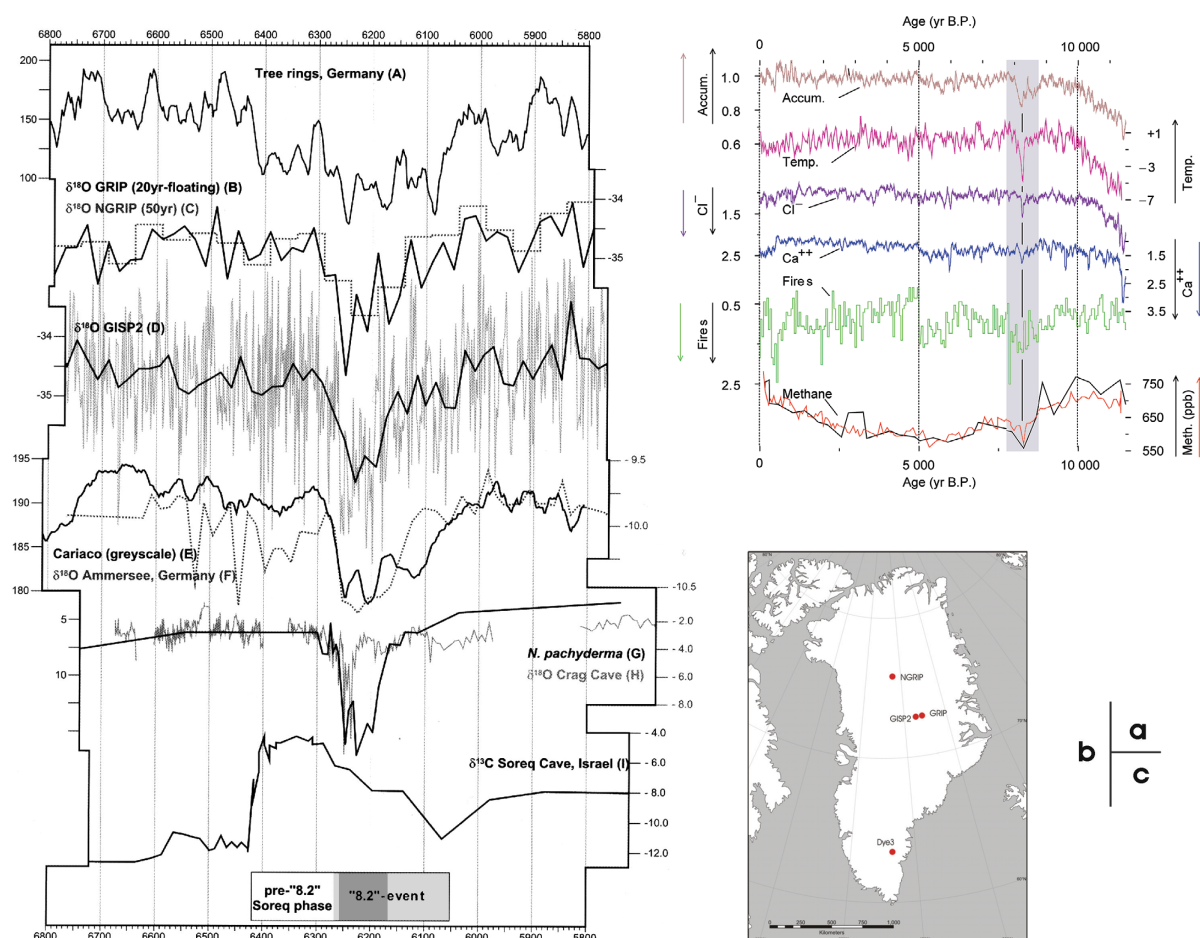


Fig. 2. The climate data from GISP2 and GRIP Greenland ice-cores show changes in concentration of chloride, calcium, methane, temperature, snow accumulation rate, and frequency of fallout of forest-fire smoke mark at c. 8200 calBP (from Alley and Ágústsdóttir 2005.Fig 2) (a). Climate proxies from Europe and Near East that correlate to climate anomalies: oak tree-ring width in Central Europe; appearance of left-coiling planktonic foraminifer *Neogloboquadrina pachyderma* (Norwegian Sea); $\delta^{18}\text{O}$ ostracodes (Ammersee); $\delta^{13}\text{C}$ stalagmite (Soreq Cave, Israel); $\delta^{18}\text{O}$ stalagmite (Crag Cave, Ireland) (from Weninger et al. 2006.Fig. 1) (b). Greenland ice-cores GISP2 and GRIP location (from Thomas et al. 2007.Fig 1) (c).

and lower summer temperatures (Rohling & Pälike 2005; Sarmaja-Korjonen and Seppä 2007.457–467). A synthesis of well-dated high-resolution pollen records, however, suggests a spatial structure in the 8200 calBP event in northern Europe. The temperate Thermophilous tree taxa, especially *Corylus*, *Ulmus*, and *Alnus*, decline abruptly between 8300 and 8000 calBP at most sites located south of 61°N, whereas there is no clear change in pollen values at sites located in the north European tree-line region. Pollen-based quantitative temperature reconstructions and several other, independent palaeoclimate proxies, such as lacustrine oxygen-isotope records, reflect the same pattern, with no detectable cooling in the sub-arctic region. Seppä et al. (2007.165–195), thus suggesting a spatial pattern in the 8200 calBP event, with more distinct evidence of cooling in the Baltic region and in southern Fennoscandia than in the central and northernmost parts of the region.

In southern Germany, the abrupt climate change is dendro-climatically recorded in oak trees in the Main valley. Between 8200 and 8000 calBP, the ring widths of oaks were at a low level, implying poor growing conditions during summer. The extraordinarily low deposition rate of trees was synchronous with reduced germination and a shift in the dominant growth trend in the trees, indicative of poor regeneration conditions. After two centuries, normal conditions were re-established. The climate anomaly thus reduced the growth and germination of oak, but did not reduce forest density. Pollen analysis from Germany also shows a short-term climate change, evident as an increase in pine and a contemporaneous decrease in mixed hazel and oak forest, indicating cooler and/or drier conditions (Spurk et al. 2002.711–712).

The climate anomaly in the Levant was detected in stalagmites in Soreq Cave in the Judean Mountains

in central Israel, where periods of wetter conditions from 8400 to 6900 calBP were interrupted by a dry period at 8250–8000 calBP (Bar-Matthews *et al.* 2003.3181–3199). The Dead Sea sedimentary record indicates a rapid drop in lake level at 8100 calBP, and the rise of the lake some 300 years later (Migowski *et al.* 2006.421–431).

The anomaly, however, was not detected in Anatolia, neither from Lake Gölhisar, located in the Taurus Mountains in south-west Turkey, nor from Lake Van in eastern Turkey (Eastwood *et al.* 2007.327–341). The interpretation of the data can be biased because of rough sampling, which may be reflected in the low temporal resolution of stable isotope and pollen data.

A similar climate anomaly was recorded in the stalagmites in Carburangeli Cave in Sicily. The wet phase, comprised of periods of high rainfall in winter from 8500 to 7500 calBP, was interrupted by a prolonged, relatively dry period centred at around 8200 calBP (Frisia *et al.* 2006.388–400).

A weak isotopic signal, recorded in the stalagmites in Poleva Cave in the Danube Gorge in Romania indicates temperature changes that correspond to a short-term cold event (Constantin *et al.* 2007.322–338). No evidence of anomalies corresponding to the 8200 calBP ‘climate event’ has been found in the Telemann Valley, a tributary of the Danube in the Romanian Plain, although the remaining sequence of alluvial deposits shows changes in river activity and accelerated sedimentation around 12 800 calBP, 4900–4800 calBP, 4000–3800 calBP, 3300–2800 calBP, 1000 calBP, and within the past 200 years (Howard *et al.* 2003.271–280).

In southern-central Europe, pollen spectra show pronounced and immediate responses and a restructuring of terrestrial vegetation in response to the climatic change at 8200 calBP. A sudden disappearance of *Corylus avellana* (hazel) was accompanied by the rapid expansion of *Pinus* (pine), *Betula* (birch), and *Tilia* (lime), and by an invasion of *Fagus sylvatica* (beech) and *Abies alba* (fir). Temporary expansions of *Betula* and *Pinus* are dated at 8170–8050 and at 8120–8000 calBP, respectively, whereas the disappearance of *Corylus* occurred between 8170 and 7950 calBP. This change in vegetation reorganization is thought to relate directly to annual temperatures decreasing by about 2–3°C, and to increased moisture availability (see below). The rapid retreat of drought-adapted *Corylus* was probably caused by

taller and longer-lived trees (*e.g.* *Pinus*, *Betula*, *Tilia*, *Quercus*, *Ulmus*, *Fraxinus excelsior*) forming dense and more shaded stands. In the long term, these trees were in their turn overwhelmed across the continent by the stepwise expansion of *Fagus* and *Abies* (Tinner and Lotter 2001.551–554; 2006.526–549).

For the southern Balkans, Bordon (*et al.* 2007; see also Denèfle *et al.* 2000.423–432) suggests rainfall seasonality changes during this climate event, with a drastic decrease in autumn to spring precipitation, and considerable falls in temperature. This suggestion is based on a re-evaluation of pollen-climate transfer functions applied to the Holocene pollen sequence of Lake Maliq and Lake Ohrid in Albania, and Lake Ioannina (Pamvotida) in Epirus in Greece.

The reconstruction of climatic parameters from European lake-level fluctuation data suggests distinct regional patterns of hydrological change in response to the 8200 calBP ‘climate event’. Regions at mid-latitudes between around 43° and 50°N underwent wetter conditions in response to the cooling, whereas northern and southern Europe was marked by a drier climate. The hydrological tri-partition of Europe has been thought to relate to a shift between two prevalent climatic modes. A strong high-pressure system over Central Europe, connected with enhanced westerly (humid) airflow in Scandinavia, was important before 8200 calBP. Thereafter, the high-pressure field over Central Europe weakened and a low-pressure anomaly over western Ireland became established, allowing the rerouting of humid air masses towards Central Europe. This new, persistent setting in atmospheric circulation would have induced more humid oceanic conditions in Central Europe (Magny *et al.* 2003.1589–1596) (Fig. 3).

The records from Lake Annecy in the French pre-Alps, Le Locle in the Swiss Jura, Soppensee and Haas at Wallisellen-Langachermoos, a former oligotrophic lake on the Swiss Plateau, and Lago di Mezzano in north-central Italy show a sequence of lake level maxima (preceded and followed by lake level minima) that correlates to the 8200 calBP cold event. The increasing moisture was observed in Schleinseeand in Germany, and a parallel increase in river discharge was recognized in the middle Rhône basin and in the Durance Valley in France. A fall in water level in the same period was recorded in Lake Siles in southern Spain, in Lago di Vico in central Italy and lakes Albano and Nemi in Central Italy (Magny and Schoellammer 1999.183–197; Magny *et al.* 2003. 1591–

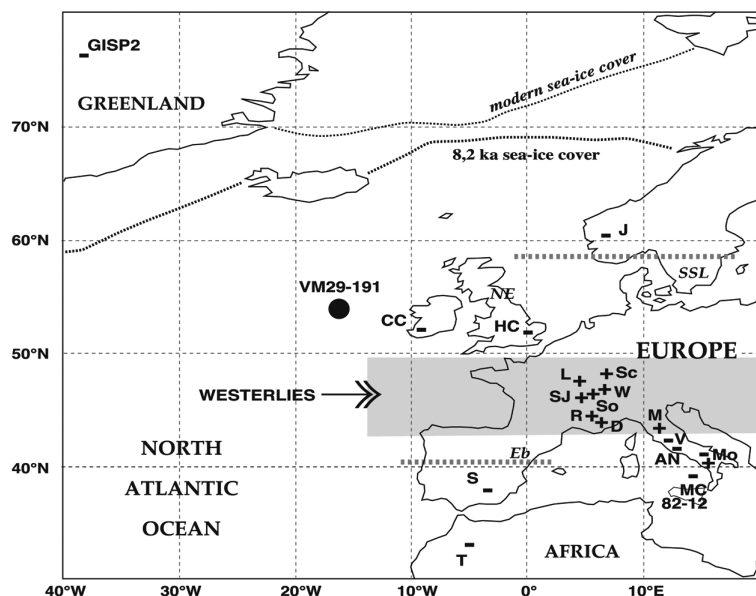


Fig. 3. The hydrological tri-partition of Europe. Shaded area marks mid-European zone with wetter conditions and marked lake-level maxima (+) and minima(-) that correlates to 8.200 calBP cold event. AN – lakes Albano and Nemi, L – Le Locle, M – Lago di Mezzano, Mo – Lago Grande di Monticchio, S – lake Siles, Sc – Schleinsee, SJ – Saint-Jorioz, So – Soppensee, T – lake Tigalmamine, V – Lago di Vico (from Magny et al. 2003.Fig.2).

1593) (Fig. 3). The abrupt climate deterioration (cold and wet period) was recognized recently in the sediment core from the Alpine lake Oberer Landschitzsee, located at the southern slope of the Niedere Tauern in the Austrian Central Alps (Schmidt et al. 2006. 499–500).

The contrasting patterns of hydrological change were confirmed by radiocarbon dated fluvial deposits and river dynamics in Poland, Great Britain and Spain, indicating the period was particularly dry (Macklin et al. 2006.145–154; Starkel et al. 2006.24–33; Thorndycraft and Benito 2006.34–41). The dry climatic conditions and lake level fluctuations observed in southern and northern Europe have equivalents in major falls in water level reconstructed for the event in African tropical lakes (Gasse 2000.189–211) due to lower sea surface temperature and weaker evaporation, which fully accords with the interruption of Sapropel 1 formation in the Mediterranean, as mentioned above.

However, there is considerable imbalance in interpreting the rapidity, duration, and extent of the 8200 calBP 'climate event' on

the global scale. Alley and Agustsdottir (2005) discuss the contrast between longer anomalies (several centuries) at some sites and short, high-amplitude anomalies at others. Recent calculations show that the cold event in central Greenland started at 8247 calBP, and ended at 8086 calBP. The event was asymmetrical, with considerable decadal variability in the record as shown by the presence of relatively warm spikes at around 8220 and 8160 calBP, within which there is a central cold event of 69 years, when values were significantly below the Holocene average.¹ The length for the full event is calculated at 160.5±5.5 years, and 69±2 years for the central event (Thomas et al. 2007.72–76) (Fig. 4). A similar duration of 180 years was estimated for the isotopic anomaly in Ammersee in central Europe (von Grafenstein et al. 1998.77).

The paleoclimatic records from across Europe clearly show that these cold conditions spread beyond Greenland, but as Rohling and Pálike (2005. 975–978) have pointed out, at most locations out of the North Atlantic the signals around the event are smaller, and these sudden climate changes appear superimposed on a longer period of 4 to 6 centuries of cooling, beginning as early as 8600 calBP. It was not related to the impact of a slowdown in North Atlantic Deep Water formation, but to variations in solar radiation and output fluctuations. Thomas et al. (2007.77–79) on the other hand suggest that a re-examination of chemical data in the ice core records shows smaller changes in the chemical deposition of Ca and Cl than those reported previously, which could reflect

Age of markers in the 8.2 ka event			
Event	Depth (GRIPm)	Age (GICC05yr BP)	Age (GICC05yr b2k)
Start	1340.12	8247	8297
Start central event	1336.45	8218	8262
End central event	1329.96	8141	8191
End	1324.77	8086	8136

Fig. 4. The age of 8200 calBP 'climate event' (from Thomas et al. 2007.Tab.1).

¹ The tripartite nature of the 8200 calBP 'climate event' has also been observed in French and Swiss lake sediments at Lake Annecy and Haas at Wallisellen where two lake-level maxima was separated by a lowering episode (Magny et al. 2003.1592).

small changes in Asian conditions and only minor changes in atmospheric circulation. There was, however, an alternative hypothesis of climate mechanisms and precipitation climatology in the eastern Mediterranean, western Asia, and the Indian subcontinent, whether linked to North Atlantic oscillation, or solar radiation variability, suggested by Staubwasser and Weiss (2006.372–387). They believe that a change in the subtropical upper-level flow and its steering of precipitation over the eastern Mediterranean and Asia was responsible for the reduced winter rainfall and long-term trend towards drier conditions in the Levant, and for the weakness of the Indian monsoon over its northernmost region in the Ganges and Indus catchments and the western Arabian Sea.

Climate events, the transition to farming and population trajectories

A strong parallelism between climate events and Middle and Near Eastern, and European cultural and social trajectories in the Neolithic was suggested recently (Staubwasser, Weiss 2006.372–387; Migowski et al. 2006.421–431; Weninger et al. 2005.75–118; 2006.401–420). The 8200 calBP ‘climate event’ was associated with the transition from the Pre-Pottery to Pottery Neolithic, which was marked by the collapse of a ‘ritual economy’ and agricultural PPN aggregation centres in Levant. The Jericho settlement was abandoned, and the arid period appears to coincide with the temporal abandonment of settlements at Ain Ghazal in the Levant and Catalhöyük-East in Central Anatolia. Weninger et al. (2005.75–118; 2006.401–420) suggest correlating the climate anomaly with both a ‘great exodus’, and ‘demic’ diffusion, in which Levantine and Anatolian farmers spread from West Asia and the Near East into Europe. Bonsall et al. (2002(2003).1–15) propose, on the other hand, that in the hunter-gatherer cultural context at Lepenski Vir, the large stone boulders which were decorated with sculpted representations of fish-human beings represented material commemorations of the 8200 calBP ‘climate event’, which caused floods in the Danube Gorge in the Northern Balkans.

The climate oscillations undoubtedly chronologically correlates with the process of Neolithisation of south-eastern Europe, and certainly affected regional envi-

Settlement context	Sample reference	¹⁴ C age (BP)	Calendric Age calBP
Deszk	OxA-9396	7030 ± 50	7870 ± 55
Miercurea Sibiului	GrN28520	7050 ± 70	7875 ± 67
Pitvaros	OxA-9336	7060 ± 45	7898 ± 41
Vinogradi-Bečej	OxA-8557	7080 ± 55	7909 ± 48
Foeni-Salas	GrN-28454	7080 ± 50	7910 ± 45
Ocna Sibiului	GrN-28110	7120 ± 60	7940 ± 56
Magareči Mlin	GrN-15973	7130 ± 60	7946 ± 57
Gura Baciului	GrA-24137	7140 ± 45	7971 ± 30
Perlez-Batka	OxA-8605	7145 ± 50	7973 ± 34
Donja Branjevina	GrN-15974	7155 ± 50	7981 ± 32
Topole Bač	OxA-8639	7170 ± 50	7993 ± 33
8200 calBP ‘climate event’ in Greenland			8247–8086
Padina H17	OxA-11103	7315 ± 55	8118 ± 61
Padina H12	OxA-9034*	7755 ± 65	8530 ± 64
Lepenski Vir H 54	Z-143	7300 ± 124	8142 ± 128
Blagotin Poljna	OxA-8608	7480 ± 55	8239 ± 65
Poljanica Platoto	BlN-1571	7535 ± 60	8326 ± 68
Nea Nikomedeia	P 102	7557 ± 91	8348 ± 96
Anza	Lj-2519	7560 ± 70	8355 ± 65
Hoca Çeşme IV	BlN-4609	7637 ± 43	8449 ± 42
Sesklo ‘Initial Neolithic’	P-1681	7755 ± 97	8570 ± 111
Achilleion Ia	LJ-4449	7540 ± 140	8346 ± 137
Argissa ENI/II	H-889-3080	7760 ± 100	8582 ± 120
Knossos X	BM-278	7910 ± 140	8780 ± 120
Franchthi o/1	P-2094	7930 ± 100	8798 ± 148

Tab. 1. The list of settlement contexts and the ¹⁴C sequence of initial appearances of farming and pottery (Lepenski Vir and Padina) in the Balkans, south-eastern part of Pannonian Plain and Southern Carpathians (Boyadziev 1995.149–191; Borić and Miracle 2004.341–371; Whittle et al. 2002.15–62; Biagi and Spataro 2005.41–50; Eingruher and Thissen on-line 2005). The dates are calibrated using the calibration curve CalPal2007_HULU (www.calpal-online.de). *The OxA-9034 (Canis familiaris, tibia) was not corrected for the freshwater reservoir effect, as suggested in Borić and Miracle (2004.347, 350, tab. 4). If we apply it, the date is 200–500 years younger.

ronmental conditions. How it affected contemporary hunter-gatherers and farmers and the process of transition to farming is a question still awaiting an answer. Weninger et al. (2006.418) have proposed that ‘the rapid spread of early farming to South-East Europe can be most plausibly understood as a direct and immediate reaction to abrupt climate forcing’. This scenario seems unlikely, as they showed that the first agriculture in the Peloponnesus, and the southern, central and northern Balkans clearly predate this event (L.c. 411–417). Pottery, on the other hand, appeared in hunter-gatherer contexts at Lepenski Vir and Padina in the Danube Gorge, in the

most northerly region of the Balkans, before this climatic oscillation. Animal domesticates, however, arrived there immediately after. Domestic goat *Capra hircus*, pig *Sus scrofa domesticus* and domestic cattle *Bos Taurus* were found in association with pits and a domed oven that were not in direct association with the trapezoidal buildings at the site. Animal domesticates were introduced into the Lepenski Vir culture context as early as 7891 ± 38 calBP (see *Borić and Dimitrijević, this volume*).

The ^{14}C series (Tab. 1) shows that the full 'Neolithic package' crossed the Danube and entered the southernmost Pannonian Plain after the climate event, and stopped there for several centuries.

There are not many analyses of climate records of the early and middle Holocene in Central and South-eastern Europe. We may hypothesise, however, that the 8200 calBP 'climate event' and associated increase in regional precipitation, floods, and restructuring of terrestrial vegetation at mid-latitudes between around 43° and 50°N (see above) hampered the Neolithisation of south-eastern and central Europe. The Morava River valley, which was traditionally recognized as a river waterway connecting the southern Balkans to north-central Europe supposed to be badly affected by river dynamics and floods. It is well known, on the other hand, that prior to hydrological regulation, the Pannonian Plain was flooded at least twice a year (*Sümegei and Kertész 2001.405–415*) (Fig. 5), and perhaps we may speculate (in agreement with the model in *Magny et al. 2003.1589–1596*; see also *Szlavik and Rátky 2001.121–140*) that there was an extension of wetlands and long-term flooding in the region at the time of the climate event. In one of the modified models of 'demic' diffusion it was suggested, paradoxically, that the migrating farmers preferred to occupy the flood plains of rivers and lakes in south-eastern Europe, where they supposedly reached 'saturation' in population growth, which allowed them to drive 'demic' diffusion to the next floodplain towards the Carpathian basin (*van Andel and Runnels 1995.481–500*). The settlement distribution pattern in the Middle Morava valley is instructive, where a single site of 28 Early Neolithic sites of Starčevo culture (phase I) was located in the river valley. All the sites

are distributed within the surrounding hilly areas (*Vetnić 1998.76–77*; *Perić 204.26–27*) (Fig. 6). It is worth remembering that *Todorova* and *Vajsov (1993.62, see also Todorova 2003.267)* have already pointed out the reverse direction of Neolithic dispersal in north-eastern Bulgaria. They hypothesised that because of climate instabilities and falling temperatures after 6000 cal BC, farmers migrated southward, settling northern Thrace.

We do not know, if and how the 8200 calBP 'climate event' affected hunter-gatherer and farming population demographics in the various climatic (wetter and drier) conditions in various Eurasian regions. We know that an increase in infectious diseases has been noted in various regions following a transition from foraging to farming subsistence (*Larsen 1997.85–87*). We also know that climate change, including rising and falling temperatures, and greater frequency and magnitude of extreme events such as drought and flood, appear to be inevitable influences on effective population size. Variations in population size bring us to two important population processes that shape populations: bottleneck and founder effects. Both processes result in a reduced ancestral population size, but founder effects relate to the process of colonization and the genetic separation of a subset of the diversity present within the source population (hypothesised farming migration from Near East). In contrast, bottlenecks refer to dramatic reductions in size of a single, previously larger, population and the loss of prior genetic diversity. This may relate to hunter-gatherer and farmer populations in flooded plains and between river valleys

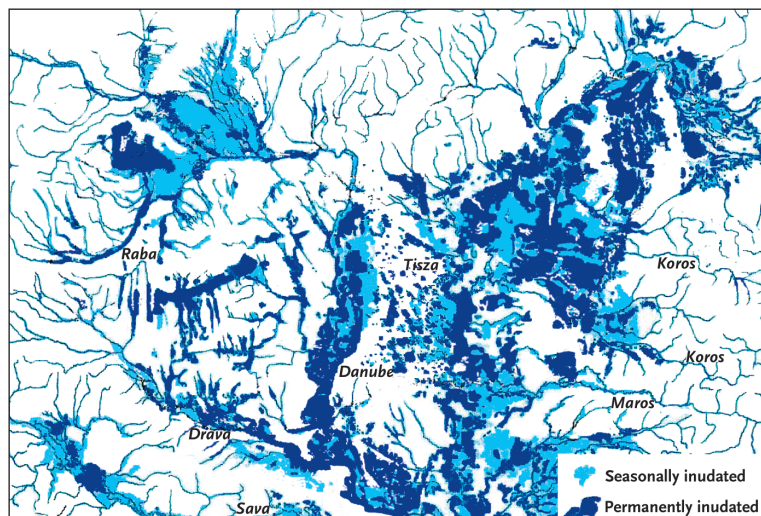


Fig. 5. The Pannonian Plain: periodically and permanently flooded areas prior to the flood control and drainage in 1830 (from Szlavik on-line www.om.hu/research/framework5/ist/copenhagen/SZLAVIK/FMIS_Hungary.ppt)

in the Balkans, the Pannonian Plain, and the Carpathians, who were isolated during the climate event.

Population geneticists correlate the paternal Y-chromosome gene flow, objectified in Palaeolithic-Mesolithic sub-haplogroup I1b* and Neolithic haplogroups J and E, with the Neolithisation of south-eastern Europe and the Mediterranean (*Budja 2005. 56–60*). Haplogroup J is subdivided into two major clades, J1 (M267) and J2 (M172). Their estimated ages, particularly those calculated using microsatellite mutation rates (YMRCA) at around 8400 and J2 at 3600 years ago, demonstrate that the genetic record of south-eastern Europe and the Mediterranean can be read as a palimpsest of repeatedly overwritten demographic dynamics (*Di Giacomo 2004. 364–366; Novelletto 2007. 158–160*); and, we suggest, they may have correlated with climate anomalies in the Neolithic and Bronze Age. Additionally, the expansion time for clade V13 within haplogroup E (M78) was calculated at about 5300 years ago (*Cruciani et al. 2007.1307*). It seems that these population trajectories fit well with the cooling periods, aridity, and major atmospheric circulation changes in the Holocene mentioned in the introduction.

In place of concluding remarks

The 8200 calBP ‘climate event’ which abruptly and drastically changed global environments during the transition to farming has been overlooked in almost all the archaeological interpretations of the Neolithisation process in Eurasia. It was overlooked in reconstructions of demographic dynamics and population trajectories, whether based on analyses of classical and DNA markers within modern populations, or on ancient DNA records from Mesolithic and Neolithic populations.

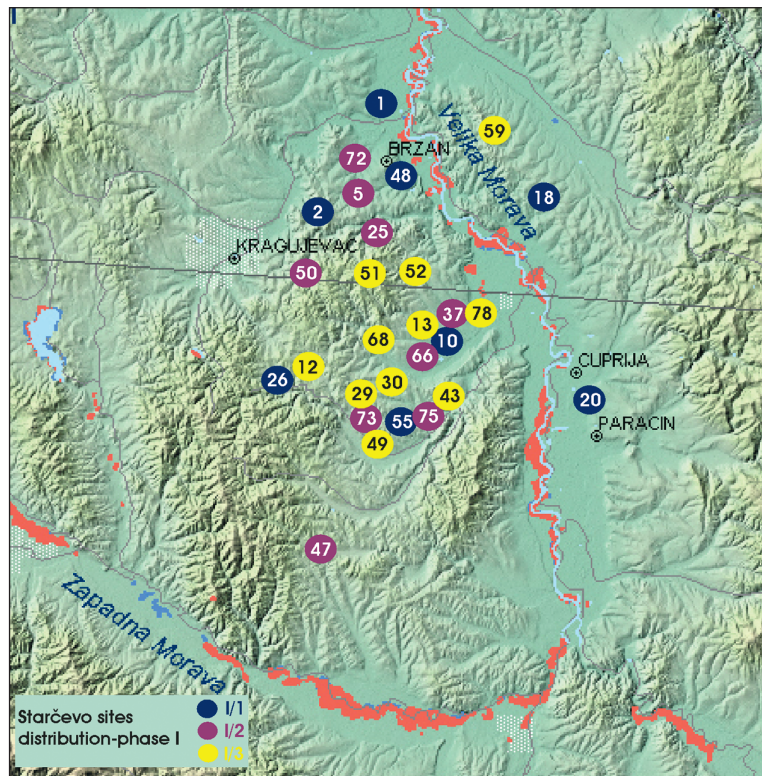


Fig. 6. The Middle Morava Valley and Early Neolithic farmers’ settlement dispersal. The 2006 floods in Morava River basin is marked in red. The figure is based on a relief map www.reliefweb.int/rw/rub.nsf/db900sid/LPAA-6QJMBS?OpenDocument and Maps no. 3 and 4 from Perić (2004.26–27).

The climate anomalies chronologically correlate with the process of Neolithisation in Near East and south-eastern Europe, and they certainly affected regional environmental conditions. How it affected the contemporary hunter-gatherer and farmer populations and the process of transition to farming is a question that still needs to be answered. We may hypothesise that the collapses of a ‘ritual economy’ and agricultural PPN aggregation centres in the Levant correlate with the cooling period and aridity. The initial agriculture in Peloponnesus and most of Balkans predate the climate event at around 6200–6000 cal BC, but the ‘Neolithic package’ seems to have crossed the Danube and entered the southernmost region of the Pannonian Plain after the major climate fluctuations, and stopped there for centuries.

REFERENCES

- ALLEY R. B., MAYEWSKI P. A., SOWERS T., STUIVER M., TAYLOR K. C., CLARK P. U. 1997. Holocene climatic instability: A prominent, widespread event 8200 yr ago. *Geology* 25(6): 483–486.
- 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.
- ALLEY R. B., ÁGÚSTSDÓTTIR A. M. 2005. The 8k event: cause and consequences of a major Holocene abrupt climate change. *Quaternary Science Reviews* 24(10–11): 1123–1149.
- ARIZTEGUI D. et al. 2000. Palaeoclimate and the formation of sapropel S1: inferences from Late Quaternary lacustrine and marine sequences in the central Mediterranean region. *Palaeogeography, Palaeoclimatology, Palaeoecology* 158(3–4): 215–240.
- BAR-MATTHEWS M. et al. 2003. Sea–land oxygen isotopic relationships from planktonic foraminifera and speleothems in the Eastern Mediterranean region and their implication for paleorainfall during interglacial intervals. *Geochimica et Cosmochimica Acta* 67(17): 3181–3199.
- BIAGI P. and SPATARO M. 2005. Rapid Rivers and Slow Seas? In L. Nikolova, J. Fritz and J. Higgs (eds), *Prehistoric Archaeology & Anthropological Theory and Education. Reports of Prehistoric Research Projects 6–7*: 41–50.
- BONSALL C., MACKLIN M. G., PAYTON R. W., BORONEANT A. 2002/3. Climate, floods and river gods: environmental change and the Meso-Neolithic transition in southeast Europe. *Before Farming* 4(2): 1–15.
- BORDON A., PEYRON O., LÉZINE A.-M. 2007. Vegetation history and quantitative climate estimates in Balkan peninsula from Maliq and Ohrid pollen sequences (Albania): the last climatic cycle, the lateglacial and the Holocene. *Geophysical Research Abstracts* 9: 1–2.
- BORIĆ D. and MIRACLE P. 2004. Mesolithic and Neolithic (Dis)Continuities in the Danube Gorges: New Ams Dates from Padina and Hajdučka Vodenica (Serbia). *Oxford Journal of Archaeology* 23(4): 341–371.
- BORIĆ D., DIMITRIJEVIĆ V. 2007. When did the 'Neolithic package' arrive to Lepenski Vir? Radiometric and faunal evidence. In M. Budja (ed.), *14th Neolithic Studies. Documenta Praehistorica* 34.
- BOYADZIEV Y. 1995. Chronology of Prehistoric Cultures in Bulgaria. In D. W. Bailey and I. Panayotov (eds.), *Prehistoric Bulgaria. Monographs in World Archaeology* 22: 149–191.
- BUDJA M. 2005. The process of Neolithisation in South-eastern Europe: from ceramic female figurines and cereal grains to entoptics and human nuclear DNA polymorphic markers. In M. Budja (ed.), *12th Neolithic Studies. Documenta Praehistorica* 32: 53–72.
- CONSTANTIN S., BOJAR A.-V., LAURITZEN S.-E., LUNDBERG J. 2007. Holocene and Late Pleistocene climate in the sub-Mediterranean continental environment: A speleothem record from Poleva Cave (Southern Carpathians, Romania). *Palaeogeography, Palaeoclimatology, Palaeoecology* 243(3–4): 322–338.
- CRUCIANI F. 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(6): 1300–1311.
- DENÈFLE M. LÉZINE A.-M., FOUACHE E. DUFAURE J.-J. 2000. A 12,000-Year Pollen Record from Lake Maliq, Albania. *Quaternary Research* 54(3): 423–432.
- DI GIACOMO F., LUCA, F., POPA L. O., AKAR N., ANAGNOU N., BANYKO J., BRDICKA R., BARBUJANI G., PAPOLA F., CIAVARELLA G., CUCCI F., DI STASI L., GAVRILA L., KERIMOVA M. G., KOVATCHEV D., KOZLOV A. I., LOUTRADIS A., MANDARINO V., MAMMI C., MICHALODIMITRAKIS E. N., PAOLI G., PAPPAS K. I., PEDICINI G., TERRENATO L., TOFANELLI S., MALASPINA P., NOVELLETTO A. 2004. Y chromosomal haplogroup J as a signature of the post-neolithic colonization of Europe. *Human Genetics* 115(5): 357–371.
- EASTWOOD W. J., LENG M. J., ROBERTS N. and DAVIS B. 2007. Holocene climate change in the eastern Mediterranean region: a comparison of stable isotope and pollen data from Lake Gölhisar, southwest Turkey. *Journal of Quaternary Science* 22(4): 327–341.
- ELLISON C. R. W., CHAPMAN M. R. and HALL I. R. 2006. Surface and Deep Ocean Interactions During the Cold Climate Event 8200 Years Ago. *Science* 312(5782): 1929–1932.
- FRISIA S., BORSATO A., MANGINI A., SPÖTL C., MADONIA G., SAURO U. 2006. Holocene climate variability in Sicily from a discontinuous stalagmite record and the Mesolithic to Neolithic transition. *Quaternary Research* 66(3): 388–400.
- GASSE F. 2000. Hydrological changes in the African tropics since the last glacial maximum. *Quaternary Science Reviews* 19(1–5): 189–211.

- von GRAFENSTEIN U., ERLÉNKEUSER H., MUÜLLER J., JOUZEL J., JOHNSEN S. 1998. The cold event 8200 years ago documented in oxygen isotope records of precipitation in Europe and Greenland. *Climate Dynamics* 14(2): 73–81.
- von GRAFENSTEIN U., ERLÉNKEUSER H., BRAUER A., JOUZEL J., JOHNSEN J. S. 1999. A Mid-European Decadal Isotope-Climate Record from 15,500 to 5000 Years B.P. *Science* 284 (5420): 1654–1657.
- HOWARD A. J., MACKLIN M. G., BAILEY D. W., MILLS S. and ANDREESCU R. 2004. Late-glacial and Holocene river development in the Teleorman Valley on the southern Romanian Plain. *Journal of Quaternary Science* 19(3): 271–280.
- LARSEN C. S. 1997. *Bioarchaeology*. Cambridge University Press, Cambridge.
- MACKLIN M. G., BENITO G., GREGORY K. J., JOHNSTONE E., LEWIN J., MICHCZYŃSKA D. J., SOJA R., STARKEL L., THORNDYCRAFT V. R. 2006. Past hydrological events reflected in the Holocene fluvial record of Europe. *Catena* 66(1–2): 145–154.
- MAGNY M. and SCHOELLAMMER P. 1999. Lake-level fluctuations at Le Locle, Swiss Jura, from the Younger Dryas to the Mid-Holocene: a high-resolution record of climate oscillations during the final deglaciation. *Géographie physique et Quaternaire* 53(2): 183–197.
- MAGNY M., BÉGEOT C., GUIOT J., PEYRON O. 2003. Contrasting patterns of hydrological changes in Europe in response to Holocene climate cooling phases. *Quaternary Science Reviews* 22(15–17): 1589–1596.
- 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.
- MIGOWSKI C., STEIN M., PRASAD S., NEGENDANK J. F.W., AGNON A. 2006. Holocene climate variability and cultural evolution in the Near East from the Dead Sea sedimentary record. *Quaternary Research* 66(3): 421–431.
- NOVELLETTO A. 2007. Y chromosome variation in Europe: Continental and local processes in the formation of the extant gene pool. *Annals of Human Biology* 34(2): 139–172.
- PERIĆ S. 2004. Problem of Neolithization in Central Pomoravlje. In M. Vasić, P. Vučković, B. Cvetković (eds.), *The Neolithic in the Middle Morava Valley*. Archaeological Institute, Belgrade: 11–34.
- REINGRUBER A. and THISEN L. on-line 2005. CANew ¹⁴C databases and ¹⁴C charts. Aegean Catchment. (E. Greece, S. Balkans and W. Turkey) 10,000–5,500 cal BC. on-line <http://www.canew.org/data.html>
- ROHLING E. J. & PÁLIKE H. 2005. Centennial-scale climate cooling with a sudden cold event around 8,200 years ago. *Nature* 434(7036): 975–979.
- SARMAJA-KORJONEN K. and SEPPÄ H. 2007. Abrupt and consistent responses of aquatic and terrestrial ecosystems to the 8200 cal. yr cold event: a lacustrine record from Lake Arapisto, Finland. *The Holocene* 17(4): 457–467.
- SCHMIDT R., KAMENIK C., TESSADRI R. and KOINIG K. A. 2006. Climatic changes from 12,000 to 4,000 years ago in the Austrian Central Alps tracked by sedimentological and biological proxies of a lake sediment core. *Journal of Paleolimnology* 35(3): 491–505.
- SEPPÄ H., BIRKS H. J. B., GIESECKE T., HAMMARLUND D., ALENIUS T., ANTONSSON K., BJUNE A. E., HEIKKILÄ M., MACDONALD G. M., JALAA. E. K. O, TELFORD R. J. and VESKI S. 2007. Spatial structure of the 8200 cal yr BP event in Northern Europe. *Climate of the Past Discussions* 3(1): 165–195.
- SPURK M., LEUSCHNER H. H., BAILLIE M. G. L., BRIFFA K. R. and FRIEDRICH M. 2002. Depositional frequency of German subfossil oaks: climatically and non-climatically induced fluctuations in the Holocene. *The Holocene* 12 (6): 707–715.
- STARKEL L., SOJA R., MICHCZYŃSKA D. J. 2006. Past hydrological events reflected in Holocene history of Polish rivers. *Catena* 66(1–2): 24–33.
- STAUBWASSER M., WEISS H. 2006. Holocene climate and cultural evolution in late prehistoric-early historic West Asia. *Quaternary Research* 66(3): 372–387.
- SÜMEGI P. and KERTÉSZ R. 2001. Paleogeographic Characteristics of the Carpathian Basin: an Ecological Trap During the Early Neolithic? In R. Kertész 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* 11: 405–415.
- SZLAVIK L. and RÁTKY I. 2001. Typical Flood Patterns on the Fekete Körös and Fehér Körös Rivers and the Potential Flood Control Developments. *Periodica Polytechnica Ser. Civ. Eng.* 45(1): 121–140.
- 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 ka event from Greenland ice cores. *Quaternary Science Reviews* 26(1–2): 70–81.

- THORNDYCRAFT V. R., BENITO G. 2006. Late Holocene fluvial chronology of Spain: The role of climatic variability and human impact. *Catena* 66(1-2): 34-41.
- TINNER W., LOTTER A. F. 2006. Holocene expansions of *Fagus silvatica* and *Abies alba* in Central Europe: where are we after eight decades of debate? *Quaternary Science Reviews* 25(5-6): 526-549.
- TODOROVA H., VAJSOV I. 1993. *Novo Kamennata epoha v Blgarija*. Izdatelstvo Nauka i Izkustvo. Sofija.
- TODOROVA H. 2003. Prehistory of Bulgaria. In D. V. Grammenos (ed.), *Recent Research in Prehistory of Balkans. Publications of the Archaeological Institute of Northern Greece* 3. Thessaloniki: 275-328.
- TRINCARDI F., CATTANEO A., ASIOLI A., CORREGGIARI A. and LANGONE L. 1996. Stratigraphy of the late-Quaternary deposits in the central Adriatic basin and the record of short-term climatic events. In P. Guilizzoni and F. Oldfield (eds.), *Palaeoenvironmental Analysis of Italian Crater Lake and Adriatic Sediments. Memorie dell'Istituto Italiano di Idrobiologia* 55: 39-70.
- VAN ANDEL H. T., RUNNELS N. C. 1995. The earliest farmers in Europe. *Antiquity* 69(264): 481-500.
- VETNIĆ S. 1998. O preklju starčevačke kulture u bazenu Velike Morave. In N. Tasić (ed.), *Rad Dragoslava Srejića na istraživanju praistorija Centralnog Balkana. Memorial Dragoslava Srejića. Zbornik radova 1*. Kragujevac: 75-96.
- WENINGER B., ALRAM-STERN E., BAUER E., CLARE L., DANZEGLOCKE U., JÖRIS O., KUBATZKI C., ROLLEFSON G., TODOROVA H., VAN ANDEL T. 2005. Die Neolithisierung von Südosteuropa als Folge des abrupten Klimawandels um 8200 calBP. In D. Gronenborn (ed.), *Klimaveränderung und Kulturwandel in neolithischen Gesellschaften Mitteleuropas 6700-22 v. Chr. RGZM Tagungen 1*: 75-117.
- 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 Research* 66(3): 401-420.
- WHITTLE A., BARTOSIEWICZ L., BORIĆ D., PETTIT P., RICHARDS M. 2002. In the beginning: new radiocarbon dates for the Early Neolithic in northern Serbia and south-east Hungary. In E. Bánffy (ed.), *Prehistoric Studies in Memoriam Ida Bognar-Kutzian. Antaeus* 25: 15-62.