

## CLIMATE, CRISES, AND THE »NEOLITHISATION« OF CENTRAL EUROPE BETWEEN IRD-EVENTS 6 AND 4

The concept of the »Neolithic« evolved in the middle of the nineteenth century in southern Scandinavia and was then introduced to a greater public by John Lubbock's (1865; 1874) classic publication »Pre-Historic Times as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages«. The term first and foremost denoted a typological distinction between the Palaeolithic and the »Age of the Ground Stone«. But right from the beginning it had also adopted an economic aspect: Lubbock (1874, 71) specifically mentions agriculture, including animal husbandry and settled villages of the Robenhausien. In other works of the later 19<sup>th</sup> century »Neolithic« also encompassed pastoralism as in Westropp's economic-typological table (Westropp 1872). Generally, 19<sup>th</sup> century thinkers did not greatly reflect on the vast economic and socio-political implications the transition to farming had on the history of humankind, however, it did play some role in evolutionary theories. Surprising, notably from a modern viewpoint, is that while scholars discussed the great variations of the possible origins of farming on a world-wide basis, they neglected questions around the actual spread of farming (Roth 1887).

With Gordon Childe the discussion became focussed on the economic and socio-political aspects of the process. In 1936 he coined the designation »Neolithic Revolution« to underline the immense economic and socio-political significance of this transition. With this term, Childe wanted to highlight the consequences brought about by the new economy and technology (Childe 1936, 66):

»Soon after the end of the Ice Age man's attitude (or rather that of a few communities) to his environment underwent a radical change fraught with revolutionary consequences for the whole species. [...] Man began to plant, cultivate, and improve by selection edible grasses, roots, and trees. And he succeeded in taming and firmly attaching to his person certain species of animal in return for the fodder he was able to offer, the protection he could afford, and the forethought he could exercise.«

Childe understood the »Neolithic Revolution« as »[...] a long process« (1936, 105) of cultural progression, and the Neolithic as an »age« which lasted, on a global scale, until modernity (ibid. 43p.).

In later years researchers focussed more on the actual spread of farming itself, and it became to be understood as a linear »shock wave« travelling through the landscape, changing societies from one aggregate state to another. This scenario was certainly also supported by the Systems Theory approach during processual archaeology; it was now that the term »neolithisation« (French »néolithisation« or German »Neolithisierung«) was introduced<sup>1</sup>. An iconographic image of this line of thought has been, and still is, the classic model of Ammerman and Cavalli-Sforza (1984, 195 fig. 6.10), often copied as for instance by Breunig (1987, 86 Abb. 14).

In the western scholarly tradition »Neolithic« was by now defined solely on economic terms: »neolithisation« denoted the process of becoming full-scale farmers; for Central Europe the classic image of the Neolithic had become the LBK village scene. Quite obviously, these conceptions were strongly influenced by 19<sup>th</sup> century views of European village farming, and when the reconstructions of the time are examined (examples in de Grooth 2005), the old German term »Landmann« (English: boor, peasant) comes to mind. The Neolithic farmer was the head of a core family composed of one – certainly – wife with children and grandparents, living in a farmstead (German: »Hof«), all this neatly fitted into the »farmstead model« (Ger-

man: »Hofplatzmodell«) (Boelicke 1982). Clearly, these conceptions were shrouded by a romanticising veil, and associated with these ideas – maybe sub-consciously – were tinges of a European-conquest-influenced »pioneer spirit« with hearty farmers clearing the primeval forests and bringing light to dim and shadowy Central Europe. In the European history of thought, such conceptions may be traced back to Greek historiography and ethnography (Müller 1972): *Ex oriente lux* came the farmers and brought the sparkle of civilisation to the European *barbaricum*, or to the »disgusting savages« to speak in Childe's (1929, 220) terms. Moreover, exchanges between farmers and local hunter-gatherers were often thought to have been minimal (Tringham 1968; Zvelebil 1986)<sup>2</sup>. Only occasionally, and mostly on the Central European side, did the local hunter-gatherer population play a more pronounced role in the scenarios proposed<sup>3</sup>.

Despite the acknowledgement of possible local contributions, »neolithisation« remained to be understood as essentially a process of migration also for Central European theorists. Up until the early 1980ies this monolithic concept of »Neolithic« and »neolithisation« was quite operable. Thereafter, however, it began to crumble. Jeunesse (1987) had discovered a new pottery tradition – stylistically clearly distinguishable from LBK – which nevertheless appeared on LBK sites. What was it? Accidental intrusions of an as yet unknown Middle Neolithic pottery style? Or was it a specific and unusual LBK ware? Or, was it an indication of different »people« in contact with LBK communities? Despite the somewhat simplistic and very traditional nature of the latter concept it still became the most widely accepted (Lüning / Kloos / Albert 1989; Jeunesse 2000; van Willigen / Jeunesse this volume), and in the following years it was supported by a number of other indications in the lithic industries found on earliest and later LBK sites where clear »non-LBK« types of local Mesolithic origin appeared (Gronenborn 1990; 1997).

Gradually, at least the western margins of the earliest LBK *oikumene* became conceived of as a multi-cultural »melting pot« where different cultural and economic traditions co-existed. Moreover, it appeared that the clear distinction between full-scale farmers and »pristine« – to borrow a term from the southern African »Bushman debate« (Sadr 1997) – hunter-gatherers was no more valid: People of the La Hoguette tradition seemed to have practised animal husbandry as indicated in Bavans in the Doubs Valley, eastern France, and Bad Cannstatt in Stuttgart, southwest Germany, and maybe also small scale farming (Aimé 1995; Kalis et al. 2001). These were no longer inferior, »disgusting savages« but societies with a certain social and political complexity, economically they could be classified as hunter/agro-pastoralists and might find their best ethnographic parallels in some of the Khoekhoe societies of the South African Cape Region (Fauvelle-Aymar 2002; Gronenborn 2004). Moreover, palaeobotanical evidence from southern Central and Western Europe is believed to indicate that cereals might have been experimented with as early as the seventh millennium cal BC (Erny-Rodmann et al. 1997; Lotter 1999; Beckmann 2004; van Willigen 2006; van Willigen / Jeunesse this volume). While these indications have been criticised continuously from a methodological botanical angle (Behre 2007) the debate on »pre-Neolithic« or »Initial Neolithic« farming does continue (Tinner / Nielsen / Lotter 2007). Even more so as the recent find of a clay token/seal (*pintadera*) of a southeastern European type at the rockshelter site of Arconciel/La Souche in the French Jura, dating to around 6200 cal BC (Mauvilly et al. 2007; Mauvilly / Jeunesse / Doppler 2008), does reaffirm previous archaeological indications of long-distance contacts between central European hunter-gatherers and southeastern European early farmers (Gronenborn 1999; Gehlen / Schön 2003), at least for the period around and after the so-called 6.2 ka-event.

Thus, sixth millennium »Contact Period archaeology« ventures on, and it becomes increasingly clear, that the distinction between Early Neolithic LBK farmers and Late Mesolithic hunter-gatherers has to be replaced by differentiated individual scenarios of fluidity and dynamic exchanges, with people switching their economies and likely also their cultural identities (see also Robb / Miracle 2007). All of the previously debated, and apparently mutually exclusive, models of neolithisation (e.g. Sangmeister 1983; Lüning 1988; Keefer 1993) seem to have taken place more or less contemporaneously and in various combinations.

Still, the idea of immigrating LBK farmers remains part of the concept, but now the number of immigrants is considered to be much less and interaction with local populations is understood to have been rather intense – not only on the western margins, but equally in eastern sites for instance in Bavaria (Gronenborn 1997; Zvelebil / Lukes / Pettitt this volume). However, some scholars continue to argue that no migration had ever taken place or if, only on a minimal scale (Kind this volume), and much of the newly arrived material culture would have been acquired through mere contacts – classic diffusionism. This extreme position today has only a few followers left, and most of the scholars working in Central Europe today would consider combined scenarios of migration and acculturation, partly assimilation with multicultural or multitrade societies resulting out of diverse and complex contact situations (Gronenborn 2007; Strien this volume; van Willigen / Jeunesse this volume; Zvelebil / Lukes / Pettitt this volume).

### **Problems unsolved**

Despite the level of agreement reached, there are problems yet unsolved, the major ones being the questions around the origins of LBK, the other one concerns the calculations about the rate of immigrants any of which are far from being robust.

The origins of LBK are currently being debated between Pavúk (2005) and Bánffy (2004; Bánffy / Oross this volume), both of which have produced apparently mutually exclusive scenarios. While Pavúk favours the idea of an emergence of LBK in southwest Slovakia and the adjacent regions during Middle and Late Starčevo with a southward spread from this core area, Bánffy proposes the LBK to have emerged around and west of Lake Balaton, after Late Starčevo. She bases her arguments against Pavúk on the shallow data base on which his ceramic chronology is built. Indeed, <sup>14</sup>C analyses appear to prove her right (Bánffy / Oross this volume) while traditional typo-chronological methods appeared to support Pavúk's scenario (Strien / Gronenborn 2005). The solution may lie in between both only apparently mutually exclusive scenarios in that two regional traditions would have composed the earliest LBK (Strien 2009).

The problems around the origins of LBK are also associated with the next field of uncertainty, namely the number of people migrating out of the core region: Analyses based on modern mtDNA and YDNA dispersions had resulted in the calculated rates of only 15 to 20 % of immigrants from South East Europe and ultimately Western Asia during the millennia of neolithisation (Richards 2003), but newer work on aDNA has disturbed these figures as apparently the Early Neolithic population throughout Central Europe was composed genetically in a different way than the present-day population (Haak et al. 2005; Bramanti et al. 2009; Burger / Haak this volume).

Moreover, it now appears that a hunter-gatherer subsistence strategy might have continued into the Early Neolithic as those groups became incorporated into what appears archaeologically as »LBK communities«. Here the former hunter-gatherers seem to have maintained their traditions, at least partly, in their respective material culture but also economically (e.g. Hachem 2000; Bentley et al. 2003; Strien 2005; Price / Wahl / Bentley 2006). Also, the spread of farming had only been limited to southern Central Europe; while the northern lowlands were in contact with the more southerly agriculturalised zones for over one thousand years the population there withstood the temptations of becoming farmers (Klassen 2004). This border appears to have been maintained by economic restrictions (Schier 2009) but also by different genetically composed populations (Bramanti et al. 2009). Animal husbandry and agriculture with farming was only adopted by 4000 cal BC (Behre 2007; Hartz / Lübke / Terberger 2007; Terberger / Kabacinski this volume). At that time, farmers had also reached the British Isles (Rowley-Conwy 2004; Sheridan 2007; Whittle 2007). Towards the west in the Dutch and Flemish lowlands, people became full scale farmers even later (Louwe Kooijmans 2007).

## Definition obscured

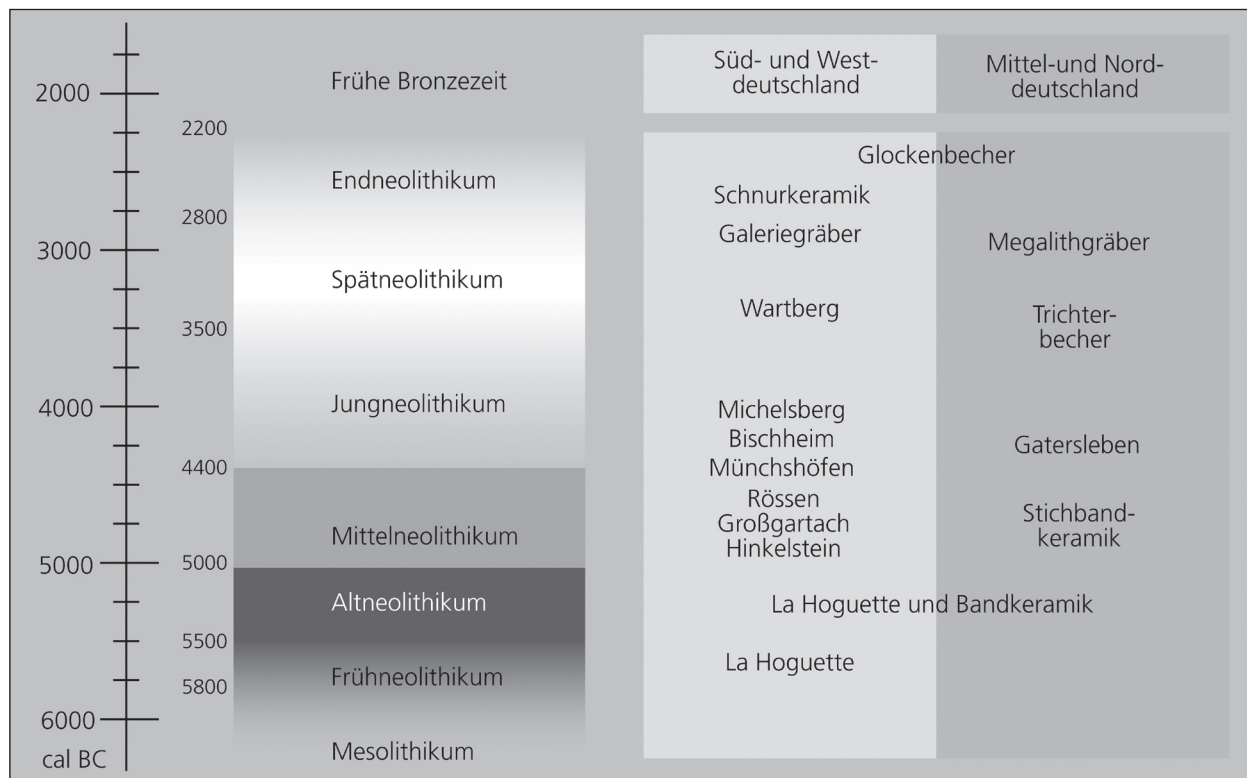
Taken this situation into consideration, it appears that the classic definition of the »Neolithic« has become somewhat obscure for Central Europe:

- There is no clear-cut distinction between immigrant farmers and local »pristine« hunter-gatherers, at least not for the west. On the contrary, societies along the Rhine might have practised a certain agro-pastoralism, and cereals might have been experimented with as early as the seventh millennium cal BC.
- Societies around the Mesolithic-Neolithic transitional »zone« were, as far as their cultural and biological identities are concerned, diverse; LBK villages were composed of individuals of many different cultural and ethnic backgrounds. And there are increasing indications that these community members pursued different subsistence strategies with some sub-groups practising hunting to a considerable degree.
- Politically these societies had different scales, and political complexity varied over time with an alleged tendency towards established and inherited positions towards the end of the 6<sup>th</sup> millennium, at least in some regions.
- Economically, distinctions are also difficult to draw: hunter-gatherers and/or hunter-agro-pastoralists coexisted with village based farmers, themselves economically diverse; all were in intensive contact with each other.

With the weakening of the conceptual robustness of the term »Neolithic«, the process of »neolithisation« equally loses its firmness. Indeed, it has recently been suggested – outside Prehistoric Archaeology – to completely replace »neolithisation« with »agrarianisation«, defined as »[...] a process in the course of which humanity has extended the domain of agriculture and animal husbandry all over the world, and in doing so made itself increasingly more dependent upon this very mode of production« (de Vries / Goudsblom 2002, 34).

The »frontier concept« as part of the neolithisation process becomes equally obscured. Despite the continuous refinement by theoretical thinkers (Zvelebil 2004) the clear distinction between stages of availability, substitution, and consolidation may have to be given up, at least for studies on a chronologically refined level. Instead of having been spatiotemporally distinct entities these stages often co-existed, maybe even within one archaeological entity. In that sense, the »neolithisation« of the Balkans has been re-interpreted (Whittle et al. 2002; Budja this volume): The spread of farming into the northern Balkans is now seen as »a more complex and varied situation of limited colonisation and considerable indigenous acculturation and adjustment at a regional scale [...]« (Whittle et al. 2002, 93). The same has been suggested for Central Europe (Gronenborn 2007a; Zvelebil / Lukes / Pettitt this volume).

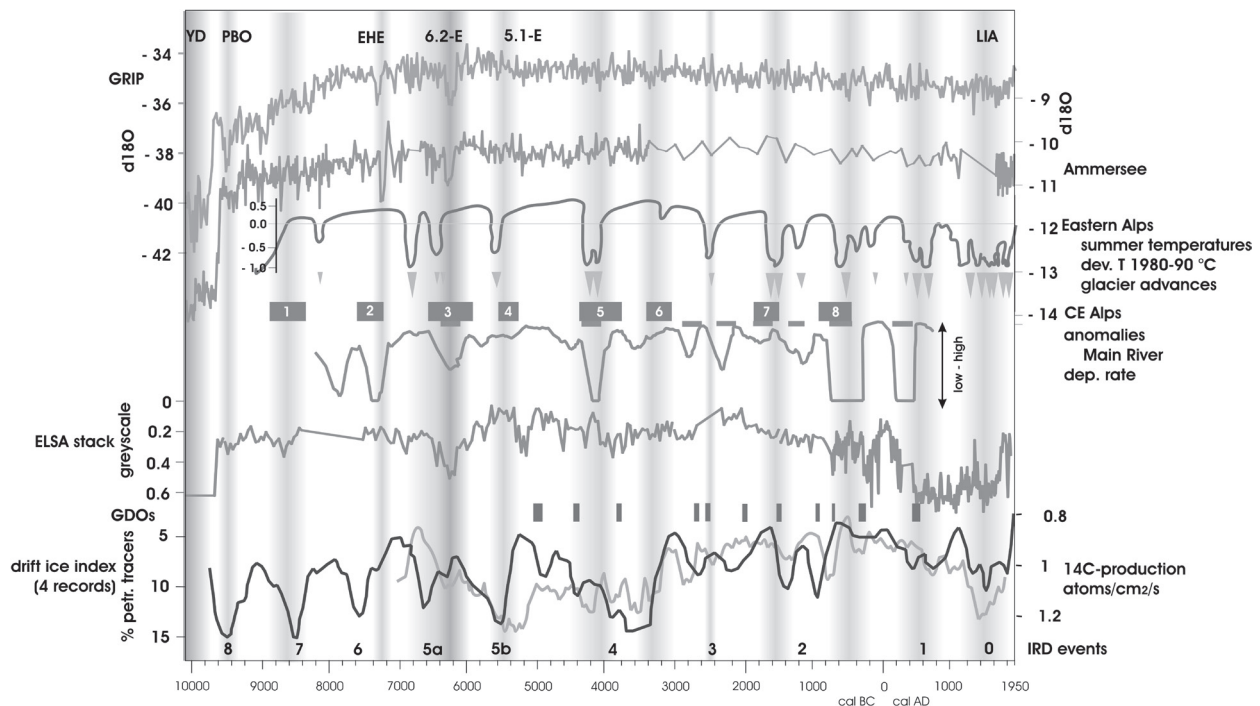
The traditional concept of »Neolithic« and »neolithisation« becomes even more unfit when we zoom out of Central Europe and look at neighbouring regions, at Eastern Europe (Russia / Ukraine) or at North Africa – regions which do play an increasingly acknowledged role in the process of the spread of farming to Europe. In Russia »Neolithic« meant and still means complex hunter-gatherer societies with pottery (Dolukhanov 1995; Parzinger 2006). In North Africa the term »Neolithic« is quite often applied to pottery using pastoralist societies, namely in the French and Italian research traditions (Barich 1980; Garcea 2006; Haaland 2007). Beyond these regions, in South Africa, »Neolithic« had been abandoned rather early since local culture history did not seem to fit the classic European definitions of the 1920ies and 1930ies (Sadr 2003). In the Americas the term »Neolithic« and »neolithisation« was never used widely and would have even been more difficult to define as a number of hunter-gatherer societies reached quite remarkable levels of socio-political complexity, indicated by monumental architecture (e.g. Saunders et al. 1997; Sassaman 2005).



**Fig. 1** Simplified chronological scheme for the Central European Neolithic (modified after Lüning 2002; Haak et al. 2006).

Summing up, the terms »Neolithic« and even more so »neolithisation« are only viable if looked at from a very broad and general perspective<sup>4</sup>. They do neither describe a clearly distinguishable period, nor a clearly defined type of society, nor a clearly circumscribed type of economy, nor a type of a mental state – they are merely vague generic terms which allow to move quickly in discussions. Equally, the terms »Eneolithic« or »Copper Age«, although of some technical applicability, are only coarsely defined and have little actual explanatory value<sup>5</sup>.

Thus, it appears preferable to apply the designation »neolithisation« only in a very general sense. Indeed, some earlier applications of the term had already defined it as a long-ranging process with a duration of several millennia (e.g. Phillips / Aspinall / Feather 1977, 303). For Central Europe it may be operable between the 7<sup>th</sup> and 4<sup>th</sup> millennium cal BC: the onset would be with the changes occurring during the Late Mesolithic, and it would terminate with the arrival of farming in the northern lowlands (Fig. 1). Following this conception, in southern Central Europe »neolithisation« in its later stages also encompasses societies which had reached certain levels of socio-political complexity namely the chiefdoms and complex chiefdoms of the Middle Neolithic to earlier Aeneolithic Periods. This broad application of the term is justified geographically and historically as Central Europe in its entirety had become »agriculturalised« at that time, and, moreover, it does appear that Michelsberg Culture societies did have an influence on the spread of the Neolithic to the North (Hartz / Heinrich / Lübke 2000, 132-134; Jeunesse / Lefranc / Denaire 2004, 231-237). Going back to Childe (1936) such a broad concept would encompass the »Neolithic Revolution« and the »Prelude to the Second Revolution«, the emergence of urban structures. The »neolithisation« of Central Europe fades out with the onset of the remainders of Sherratt's (1981) »secondary products revolution« – the plough and



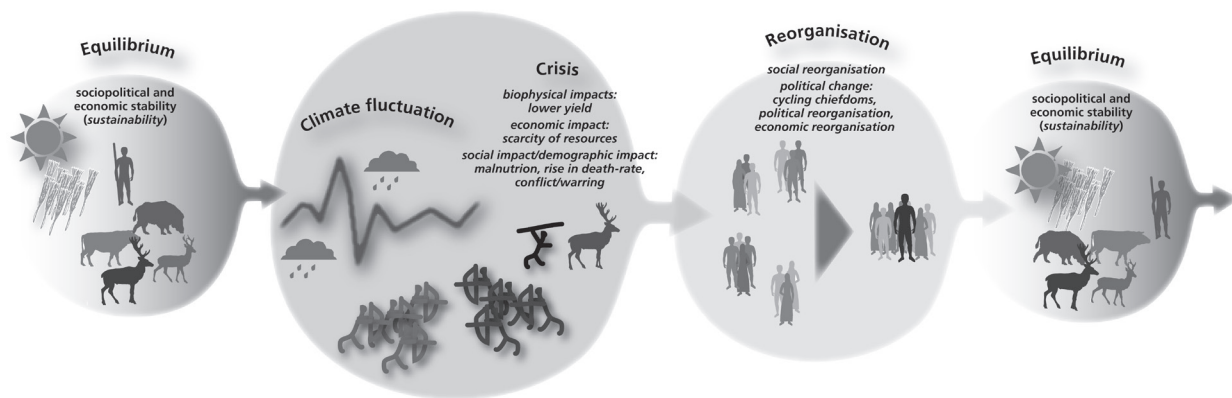
**Fig. 2** Selected marine and terrestrial palaeoclimate proxy-data for Central Europe. PBO – pre-Boreal oscillation; EHE – early Holocene event; CE – cold events; GDO – germination/dying-off events (modified after Gronenborn 2007 a; for sources see Appendix 2).

wheeled transport – and the socio-political changes they were embedded in (Müller 2004; Schlichtherle 2004; Johannsen 2006).

### Neolithisation sub-stages and IRD-Events

It has become clear in recent years that the spread of farming in western temperate Eurasia has not proceeded continuously and smoothly as for instance modelled by Ammerman and Cavalli-Sforza (1984) and again by Gkiasta et al. (2003) but that it happened in stages: Periods of rapid advance are intercalated by periods of stasis (Guilaine 2000-2001; 2003; Böhner / Schyle 2008). If these stages are compared to periods of climatic fluctuations and/or cooling phases it becomes apparent that certain expansion phases correlate with phases of climatic fluctuation – at the presented low level of resolution (**Farbtafel 1**). Indeed, increasingly are Holocene climate fluctuations being discussed as having had a considerable impact on expansion phases of the neolithisation process, most notably the 6.2-event (Weninger et al. 2005; Staubwasser / Weiss 2006; Weninger et al. 2006; Clare / Weninger / Jöris this volume). But as is suggested by **Farbtafel 1**, also other climate fluctuations might have had an impact on the process of neolithisation between the Near East and the British Isles (Bar-Yosef / Belfer-Cohen 2002; Bonsall et al. 2002; Strien / Gronenborn 2005; Cooney 2007; Gronenborn 2007b). These climate fluctuations punctuate the Holocene and may have been induced by meltwater pulses from the Laurentian Ice Sheet and by variously so-called ice-rafting detritus or ice-rafted debris events (IRD-events) which had an impetus on the North Atlantic thermohaline circulation (Bond et al. 2001; Heiri / Tinner / Lotter 2004; Kubatzki this volume). If plotted against each other, IRD-events and a number of anomalies registered in terrestrial proxy data show a remarkable contemporaneity (**fig. 2**),





**Fig. 3** Simplified scenario of climate-induced culture change in pre-state societies (modified after Pfister / Brázdil 2006, 118 fig. 2).

which indicates that for Europe fluctuations of the North Atlantic thermohaline circulation might have been responsible not only for abrupt cool and/or wet phases but also a general increase in weather anomalies (Lund / Lynch-Stieglitz / Curry 2006). At least this is suggested by the data available from the last of the IRD-events (IRD 0), the Little Ice Age (LIA), during which the most intensive periods are characterised by an increase in extreme weather situations such as unusually cold winters, hot and dry summers, wet summers, or hail storms (Pfister / Brázdil / Glaser 1999; Glaser 2001; Huntley et al. 2002; Behringer 2007). For the Near East early Holocene climate appears to have been influenced by shifts in the monsoonal patterns (Migowski et al. 2006; Staubwasser / Weiss 2006) which might have been linked to the fluctuations in the North Atlantic (Gupta / Anderson / Overpeck 2003). Lastly, there are indications that solar variability could have been a triggering force for the North Atlantic / Northwestern Afro-Eurasia Holocene climate fluctuations (Bond et al. 2001; Mayewski et al. 2004; Bard / Frank 2006; Lund / Lynch-Stieglitz / Curry 2006; Debret et al. 2007). How would climate fluctuations have influenced Mesolithic and Neolithic societies on the ground? Unfortunately, theoretical studies on this rather important topic are anything but numerous. In any case, they should be based on historical or ethnohistorical analogies, a new discipline which came to be called »Historical Climatology« (Brázdil et al. 2005). A number of studies are based on the effects of the Little Ice Age (e.g. Pfister / Brázdil / Glaser 1999). All of these studies show that the effects of climate fluctuations varied considerably across Europe and that while one region suffered severely another might not have been affected at all or might have even flourished under favourable conditions. This demonstrates that any analytical approach must essentially be a regional one (Pfister / Brázdil 2006, 126).

While mediaeval and post-mediaeval analogies may be helpful in a general understanding of climate-induced vulnerability they may only be of limited explanatory power for Stone Age agricultural societies where transport technology was even less developed and the economy could not rely on long-distance food-stuff transport to minimise effects of harvest failures. Much less than any mediaeval or early modern society were Stone Age communities able to rely on food shipments from distant, less affected regions. Also, we may assume that prehistoric agricultural societies were more severely affected by series of rapid and abrupt extreme anomalies than by any gradual cooling or warming trend, as planning became unpredictable.

These circumstances make their detection in the archaeological but also in the proxy-records extremely difficult. It would require high-resolution palaeo-climatological as well as archaeological data (Jones et al. 1999; Gronenborn 2005b) which can only be acquired by rigid and tight regional studies. We may, however, at this point model how climate-induced culture change might have operated. Interesting case studies are the

effects of famine years in Bohemia and Switzerland after 1770 (Pfister / Brázdil 2006): a series of adverse weather conditions resulted in harvest failures for two summers in a row in southern Central Europe. However, while social and political measures ameliorated the effects for Switzerland, oppressive government and a third year of famine had devastating effects in Bohemia which led to an impoverishment of the rural population and the lower classes in urban areas, to considerable population loss, to the outbreak of diseases, and finally all this resulted in a serf revolt. After the famines the potato was widely accepted as an alternative food resource. This series of events – albeit presented in a simplified version<sup>6</sup> – can be taken as an exemplary situation (**fig. 3**). After a hypothetical phase of economic stability (here provokingly termed »equilibrium« characterised by »sustainability«) during which agricultural systems operated relatively effectively climate fluctuations would have brought about a number of consequences: harvest failures and scarcity of resources would result in malnutrition, a rise in death-rate and conflict and warring<sup>7</sup>. These periods of increased socio-political tension would eventually lead to social, political, and economic reorganisation (Ember / Ember 1992). Finally, societies would find a new aggregate state and flourish again.

Obviously, this scenario is oversimplified and strongly influenced by 1960ies system-theory approaches. Nevertheless, it is not inoperable as a basic template, only that individual situations would differ in time and space. Also, internal dynamics of Neolithic – or any prehistoric – societies have been omitted. These would need to be taken into account when specific historic situations are to be examined.

It also needs to be taken into account that climate-induced economic and socio-political effects during the Neolithic would have been only of regional immediate consequences as most anomalies will have only regional impacts. However, once societies in a certain area were affected and de-stabilised – through an increase in warfare and political turmoil – they could well have affected surrounding groups through an increase in outward raiding (to meet supply), and/or migration caused by group fissioning in the course of internal economic and socio-political destabilisation. Even if the immediate effects of a climate anomaly have only been regional and short-lived the resulting turmoils could radiate out from the point of impact and result in prolonged periods of warring and general uncertainty for an extensive region, lasting sometimes decades if not centuries.

Socio-politically any period of destabilisation can result in a change of political organisation – the established elite will loose its support by the commoners, even more so if political authority and power is based on harvest success which often is the case in agricultural societies (Ember / Ember 1992). Particularly Early Neolithic societies in Europe seem to have relied on a harvest-related ideology as may be read from certain figurine types (e.g. Höckmann 2000/2001; Lüning 2005; Hansen 2007). Once these believe systems proved ineffective, their political protagonists would loose public support, the result would be political fluctuations, cycling, during which old systems were abandoned and new ones emerged. Such cycling had been observed in a number of archaeological case studies and theoretical works (e.g. Renfrew 1974; Anderson 1994; Blanton et al. 1996).

Certainly, as particularly Durkheimian, Marxist, and generally post-processual theorists propose, political cycling may be based entirely on internal social disintegration of communities. However, an increasing body of evidence demonstrates that external threads with prolonged effects may initiate or amplify such changes (e.g. Fiedel 2001; Bamforth 2006; Kidder 2006). Hence, if the IRD-events are understood as periods of increased numbers of anomalies, they may also be understood as periods of potentially increased socio-political and economic vulnerability<sup>8</sup>.

Such an approach cannot derogatively be called climate determinism. It goes far beyond the classic theories of alleged static climate-culture interrelationships<sup>9</sup> and integrates recent studies on palaeoclimate fluctuations with theoretical approaches focussing on socio-political and economic dynamics.



The possible indications for cereal horticulture around the Alps and in southern France (see discussion above) can be taken as the somewhat diffuse onset of neolithisation in Central Europe. These possible early traces fall within a period traditionally called the »Late Mesolithic«. »Late Mesolithic« is defined by the appearance of trapezoidal arrowheads and regular blades across Western Eurasia with regional temporal discontinuities but certainly southern Central Europe trapezes do appear contemporaneously between 7000 and 6700 cal BC (Gronenborn 1997; Tinner / Nielsen / Lotter 2007; Gehlen this volume). The appearance of these »blade-and-trapeze« industries has been associated with the spread of the earliest Neolithic to Greece and indeed both phenomena are coarsely coincident as indicated by recent  $^{14}\text{C}$ -dates from Early Neolithic Knossos (Efstratiou et al. 2004). However, while the advent of farming societies to Crete and maybe the Greek mainland<sup>10</sup> could be attributed to settlers from Asia Minor, the »blade-and-trapeze« industries should have arrived via the Russian steppe and forest-steppe zone and should ultimately have emerged in Central Asia together with the regular blades technology probably based on a pressure technique (Gronenborn 1997)<sup>11</sup>. Around 7000 cal BC hunter-gatherer pottery traditions seem to appear in the south-eastern Russian steppe zones (Mamonov 2000)<sup>12</sup>.

These broad-scale cultural changes are preceded by IRD-event 6 (**fig. 2**) as numbered in the original publications by Bond et al. (2001). According to the published age model this phase should date to the second half of the 8<sup>th</sup> millennium cal BC. IRD-event 6 might be reflected in a number of proxy-data: in the stable isotopes from Greenland, but also in the Ammersee  $\delta^{18}\text{O}$ -curve from southern Germany, it might also be reflected in the deposition rate of oak trees in the River Main (Spurk et al. 2002) and in Cold Event 2 (CE 2) in the Alpine region (Haas et al. 1998). In the Levant this event does not appear to have had a significant effect but it is paralleled by a signal in the Southwest monsoon proxy record from the Arabian Sea (Gupta / Anderson / Overpeck 2003); the Dead Sea experiences a slight lowering of the water table (Migowski et al. 2006). The temporal proximity of these possibly interrelated fluctuations in climate proxies to the considerable culture change across many parts of temperate western Eurasia is noteworthy. This period of intensified anomalies and rapidly changing climatic conditions might have been drastic enough to result in various population displacements. In this way, the early farming sites in South East Europe might be interpreted as the remains of migrants who had been forced out of their homelands just as it has been suggested for later movements during the 6.2-event. Admittedly, at this point, it is entirely unclear why a climatic fluctuation would also result in a change in lithic technology, namely the above mentioned appearance of the blade-and-trapeze industries, but equally in this case may the reason be sought in east-west population displacements in the south-eastern European and Central Asian steppe zones.

## Neolithisation stage II / IRD 5a

The following IRD event (5a) has been discussed as part of the 6.2-event, which is treated extensively in a number of publications (Gehlen / Schön 2005; Weninger et al. 2005; 2006; Clare / Weninger / Jöris this volume) and thus shall not be dealt with here extensively. It may only be noted, that its effects appear to have been considerable in the Near East as well as in wider Central Europe (Tinner / Lotter 2001; Alley / Ágústssdóttir 2005). During and after this period Neolithic farmsteads spread as far north as the Carpathian Basin (Whittle et al. 2002; Budja 2007). Not only are the Ofnet skull nests with their indications of violence-inflicted trauma chronologically associated with the event (Gronenborn 2007b), but we also see indications of cultural intensification in the Danube Gorges at Lepenski Vir around this period (Bonsall

2008). Curiously, most Late Mesolithic burials from southern Central Europe and the Alps date during the 6.2-event (Gehlen / Schön 2005). Apparently also other regions experienced population movements during and after this period, for instance with the appearance of aceramic farmers in the plains of Georgia (Chataigner / Arimura / Gasparyan 2007) or the establishment of farming villages in Central Asia north of the Kopet Dağ mountains (Harris et al. 1993; Harris / Gosden / Charles 1996).

#### Neolithisation stage III / IRD 5b

The following IRD-event 5b is currently not very precisely dated, but given the possible correlation with the  $^{14}\text{C}$ -production rate (fig. 2), it may have influenced the mid to latter part of the sixth millennium cal BC. However, evidence from terrestrial climate proxies from Central Europe is contradictory: while Kalis, Merkt, and Wunderlich (2003) propose a cooler and more humid phase for the earlier centuries, Kreuz (2007, 260) argues for cooler and more humid conditions towards the mid-sixth millennium. The chronologically only coarsely resolved ELSA greyscale curve (Sirocko et al. 2005) indicates an increasing humidity rate after the end of the effects of the 6.2-event and a return to dryer conditions around and after 5100 cal BC. Equally cold/humid-event 4 (CE 4) of the Alps (Haas et al. 1998) would date to this period (fig. 2).

Given the hypothesis proposed in this article – IRD-events being linked to advances in the spread of the Neolithic – it is striking, that the expansion of the Central European Early Neolithic Linear Pottery Culture (*Linienbandkeramik* - LBK) is associated with the IRD 5a-event. However, due to the currently rather imprecise dates of the various 6<sup>th</sup> millennium proxy-data but also uncertainties within the chronology of the Linear Pottery Culture, robust conclusions about detailed interrelationships are currently impossible (Strien / Gronenborn 2005).

A bit clearer is the situation for the end of the sixth millennium cal BC. This is characterised by an oscillation around 5100 cal BC and a trend to generally dryer conditions. The oscillation is visible in the stable isotopes from Greenland and Southern German sources but also in a dendro-dated stable isotope proxy from the Kückhoven well: the anomaly sets in around 5145 den BC<sup>13</sup> with strong negative amplitudes at 5112 and 5098 den BC (Helle / Schleser 1998; Strien / Gronenborn 2005, 133). The trend towards dryer conditions is currently most visible in the ELSA curve (fig. 2) and seems to continue for about a century; dryer conditions towards the end of the LBK had previously already been proposed by a number of authors (e.g. Quitta 1969; Pavúk 1986; Jäger / Kaufmann 1989; Schmidt / Gruhle 2005).

In this connection it is interesting to note that Leuschner et al. (2002, 700) were able to work out phases of changes in bog oak population dynamics («germination and dying-off events – GDO») in north-west German and Dutch mean-age chronologies of which one dates to around 5040 den BC. These GDOs are interpreted as having been caused by changes in the hydrology when the rising groundwater table would cause oxygen shortages which would eventually lead to tree death. A lowering of the groundwater table will then allow trees to germinate and/or grow again. GDOs cannot be taken as single, drastic events but rather as an accumulation of unfavourable conditions lasting for years, even decades (ibid. 697); GDO 5040 den BC is a period of growth depressions lasting from 5040 to 4850 den BC (ibid. 698 fig. 3). GDO 5040 might be interpreted as a return to wetter conditions after a preceding dry period from 5145 cal BC to about 5040 cal BC.

Regardless of whether a connection to the late sixth millennium fluctuations in the terrestrial proxy data actually may be attributed to the effects of the terminating IRD 5a, Schmidt, Gruhle, and Rück (2004) as well as Strien and Gronenborn (2005) have argued that these climatic uncertainties might have resulted in the final collapse of LBK and ultimately in the change towards the Middle Neolithic societies e.g. Hinkelstein

in the Rheinhessen loess area or the Stichbandkeramik in Eastern Central Europe and Lengyel in South East Central Europe.

#### Neolithisation stage IV / IRD 4

The earlier part of the fifth millennium seems to have been climatically calm and relatively dry which may also be linked to a spread of the Neolithic to Cantabria and towards the French Atlantic coast, both rain-logged areas (Arias 1999; 2007; Marchand 2007; Jeunesse / van Willigen this volume). Only towards the middle of the fifth millennium do more turbulent times return. In the north-west European bog oak chronology a GDO occurs around 4350 den BC, preceded by a period of growth depression between 4420 and 4405 den BC, and another GDO around 3970 den BC with the growth depression between 3970 den BC and 3865 den BC (Leuschner et al. 2002, 698 fig. 3). The Main-deposition curve (Spurk et al. 2002) shows an anomaly at 4160 den BC ending at 3870 den BC. These fluctuations are again correlated with an ice-berg-discharge, namely IRD-event 4 (fig. 2), which lasts for several hundred years with several peaks, the last occurring in the earlier third millennium.

Spurk et al. (2002) interpret the anomaly in the Main-chronology around 4000 den BC as dry conditions on the continent, but Leuschner et al. (2002, 703), possibly following Baillie (1995), would see a humid phase between 4000 and 3900 den BC for northwestern Europe. Bonsall et al. (2002) conclude that – in Scotland – actually dryer conditions prevailed between 4100 and 3200 cal BC, the driest conditions would have centred around 3800 cal BC. They argue that these specific dry conditions would have been inviting for a shift to agriculture by the local hunter-gatherer population. This diffusionist model was prevalent at the time of the publication. Recently, however, it has been discussed again by a number of scholars (Rowley-Conwy 2004; Sheridan 2007) whether the Neolithic might not have been introduced to the British Isles by settlers from France and/or the Netherlands.

Also, it appears that the »colonisation« of the British Isles by farmers occurred in several shifts with early advents – at least of cattle – from Brittany to Ireland arriving towards the latter 5<sup>th</sup> millennium (Tresset 2003); a linkage with GDO 4350 den BC is suggestive and seems to be worthwhile to investigate closer. More massive (migration) events took place after 4000 cal BC with the sudden upspring of Early Neolithic sites across the British Isles, and by 3700 cal BC monumental architecture springs up all across southern England (Cooney 2007; Sheridan 2007; Whittle 2007). In this connection it should be noted, that the 37<sup>th</sup> and 36<sup>th</sup> centuries cal BC in Switzerland and South-West Germany are considered as a period of climate-induced »crises« (Schibler et al. 1997; Schibler 2004).

Also northern Europe experiences a spread of the Neolithic. Current dates see the advent of the earliest indications of farming around and after 4100 cal BC (Hartz / Lübke / Terberger 2007; Terberger / Kabaczinski this volume). Increasingly are migrations being discussed again in connection with this spread of technology (Hartz / Heinrich / Lübke 2000, 132-134; Jeunesse / Lefranc / Denaire 2004, 231-237). With the spread of farming to the northern lowlands the process of neolithisation terminates for Central Europe. At the same time socio-political trajectories seem to have reached a new aggregate state with the emergence of proto-urban structures as they may be claimed for at least some of the larger Michelsberg and other Aeneolithic sites.

Summing up, after a period of relatively calm climate during the earlier fifth millennium the period between 4400 and 3600 cal BC in northwestern, west-central, central, and northern Europe seems to be a period of considerable socio-political turmoil, expansion, conquest, and violence (Gronenborn 2007b).

## Conclusion

The Neolithic expansion occurred in phases of rapid advance and subsequent phases of stasis. Guilaine (2000-2001, 272) ascribes these phases of stasis («pauses») to the need of societies to cope with new environments, economically and socio-politically:

»Ces essoufflements signifient que les cultures sont alors parvenues aux limites de leur adaptation écologique et structurelle. Un temps de «fermentation» est donc à nouveau nécessaire sur ces frontières culturelles: [...]«

This is certainly a valid hypothesis and has recently been reapplied by archaeobotanical (Colledge / Connolly / Shennan 2004; Kreuz et al. 2005) and also archaeological culture history (Schier 2009). It has, however, a deterministic tinge in that Guilaine presupposes that the Neolithic had an inherent expansionist character. This alleged inherent expansionist character seems to underlie the greater number of earlier neolithisation models and may have been fed by the Childean – or traditional Old European – evolutionist *ex oriente lux*-paradigm.

If the spread of the Neolithic is considered to have been driven by periods of (climatically induced) crises, then the entire forcing of the neolithisation is turned around: the spread was not fuelled by an alleged cultural superiority of Near Eastern societies but rather by unfavourable circumstances which pushed societies to new solutions<sup>14</sup>. Under such a light the coarse-level resolution chronological correlation between periods of increased anomalies (IRD 6, 5a, 5b, and 4) and the spread of farming is striking. Rapid and drastic climate change which altered living conditions within a few years, as might certainly have been the effects of the IRD-events, would have had immediate consequences for the economy of farming societies: Not only did they affect harvests but due to the changing environmental conditions (shift/reduction of growing season) traditional knowledge of farming practices will also have become meaningless – the social and political roles of titleholders controlling this knowledge would have been challenged. Societies were not only threatened in their economic, but also their social, ritual, and political stability.

These climate-induced crises called for re-arrangements, societies fissioned and re-ordered. Along with economic, social, and political »re-negotiations« material culture changed as old traditions broke apart and new ones emerged<sup>15</sup>. It may be particularly those changes and breaks which actually lay behind the boundaries of the classical chrono-typological archaeological entities.

I will end this paper with a postulate which will need to be scrutinised in the course of further research: The Neolithic Expansion (and, associated with it, also culture change within Neolithic societies) was paced by climatic fluctuations; in this long-term process IRD-events 6 and 4 mark the outer chronological margins of the »neolithisation« in Central Europe.

## Appendix 1

### Sources for Farbtafel 1

#### Climate proxies

GRIP  $\delta^{18}O$ : Shackleton et al. 2004; GDO: Leuschner et al. 2002; Cold events Alps: Haas et al. 1998; Main River oak anomalies: Spurk et al. 2002; IRD events: Bond et al. 2001; Monsoon proxy Arabian Sea: Overpeck et al. 1996; Dead Sea level: Migowski et al. 2006.

#### Farming-spread chronozones / archaeological cultures

British Isles: A. Whittle, pers. information; interpolation by author; early Funnel Beaker Culture: Midgley 1992; later LBK / Villeneuve-Saint-Germain / Augy-Sainte-Pallaye: Lüning 1988; Jeunesse 1998-99; earliest LBK / La Hoguette:

Gronenborn 1997; early cereal horticulture: Erny-Rodmann et al. 1997; Jeunesse 2003; Beckmann 2004; Cucuteni-Tripolye / Bug-Dnestr: Kozłowski 1993; Impresa / Cardial: van Willigen 2006; Jeunesse / van Willigen this volume; Italian Impresa: Fugazzola Delpino / Pessina / Tiné 2002; Balkanic Early Neolithic (Starcevo-Körös-Cris; Greek Middle Neolithic): Kalicz / Virág / Biró 1998; Greek / Bulgarian Early Neolithic: Böhner / Schyle 2008; Djeitun: Harris / Gosden / Charles 1996; Georgian Neolithic: Chataigner / Arimura / Gasparyan 2007; West Anatolian Early Neolithic / PPNA / Incipient Neolithic / Neolithic core zones: Böhner / Schyle 2008; Willcox 2005.

## Appendix 2

### Sources for figure 2

GRIP: Shackleton et al. 2004; Ammersee: von Grafenstein et al. 1999; Eastern Alps temperature/glaciers: Nicolussi / Patzelt 2006; Cold events Alps: Haas et al. 1998; Main River anomalies/deposition rate: Spurk et al. 2002; ELSA stack greyscale: Sirocko et al. 2005; GDOs: Leuschner et al. 2002; IRD events: Bond et al. 2001; <sup>14</sup>C-production rate: Kromer / Friedrich 2007.

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### Annotations

- 1) Apparently a research history of the term has not yet been written. A search in JSTOR <http://www.jstor.org> produced Nougier (1954) as the earliest result – he (ibid. 254) describes »néolithisation« as a »révolution économique«. This early appearance indicates a French origin of the term. In the Anglo-American literature »neolithisation/neolithization« had not been used more widely before the end of the 1970ies, and only during the 1980ies it became broadly applied. In Germany Narr (1975, 18) seems to be one of the early users and includes also a definition: »Wichtiger ist die Erfassung von Prozessen bei vergleichbaren Völkern späterer Zeit. Das, was wir archäologisch schlagwortartig als den Ablauf der »Neolithisierung« bezeichnen, d.h. die Einführung der neuen Lebens- und Wirtschaftsweise durch »Erfindung« oder »Akkulturation« ist ebenso ein höchst komplizierter Vorgang wie die Übernahme und Entlehnung zwischen neolithischen Gruppen.«
- 2) For further research histories see also Zvelebil / Lukes / Pettitt (this volume) and Budja (this volume).
- 3) A discussion on these changing thoughts is provided in Gronenborn (2007a).
- 4) For an earlier terminological debate see also Klejn (1972).
- 5) Definitions are e.g. provided by Müller-Karpe (1974), Lichardus (1991), Sherratt (1994) or Strahm (1994).
- 6) For more information consult Pfister / Brázdil (2006).
- 7) Recent medical research is more concerned with the consequences of future climate change in connection with the global warming process (Patz et al. 2005). However, analyses of historical accounts and archaeological data from recent periods for hunter-gatherer and early agricultural societies do give insights into the effects of an increase in climate anomalies (e.g. Anderson / Stahle / Cleaveland 1995; Jones et al. 1999; Milner 1999; Lekson 2002; Bamforth 2006).
- 8) Following this Lemmen / Wirtz (this volume) simulate climate fluctuations by a reduction of their parameter »food extraction potential«.
- 9) Brief summaries of climate-related historical thinking may be found in von Storch / Stehr (2002) and Gronenborn (2005a).
- 10) For the controversial discussion of the earliest advent of farming to the Greek mainland see Perlès (2001), Gehlen / Schön (2003), Reingruber / Rösch (2005), Schön / Gehlen (2006).
- 11) It needs, however, to be stressed that this hypothesis will remain speculative due to the lack of firmly dated sites from the south-eastern European steppe zones and their neighbouring Asian regions (Gehlen this volume).
- 12) These early dates have become questionable recently (personal electronic communication A. E. Mamontov, 12 July 2008).
- 13) den BC= dendrochronologically-dated Before Christ.
- 14) For a discussion of push-and-pull hypotheses in climate-related Early Neolithic archaeology see Strien and Gronenborn (2005).
- 15) Very little ethno-archaeological work has gone into the study of ruptures and changes in material culture and their possible socio-economic backgrounds. However, examples from societies on a »Neolithic« socio-technological level are available from Historical or Contact Period Archaeology in North America: Through increasing contact with and dependence on Europeans the traditional material culture of the Mandan and Hidatsa on the Upper Missouri changed greatly and was ultimately destroyed (Wood / Thiessen 1985).



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## *Zusammenfassung/Abstract/Résumé*

### **Klima, Krisen und die »Neolithisierung« Mitteleuropas zwischen den IRD-Ereignissen 6 und 4**

Vielfach wird der Prozess der »Neolithisierung« im mitteleuropäischen Bereich als ein zeitlich eng begrenzter Vorgang verstanden, der in unmittelbarem Umfeld der expansiven bäuerlichen Siedlungen (»Frontier«-Konzept) stattgefunden habe. Ein solches reduktionistisches Verständnis ist allerdings aus überregionaler und mehr noch aus globaler Perspektive unproduktiv. Angesichts der ungeheuren Bedeutung des soziopolitischen und ökonomischen Wandels, den die »Neolithisierung« für die Geschichte der Menschheit hat, ist es auch in Mitteleuropa sinnvoll, eine breiter gefasste Konzeption zu entwickeln.

Es wird daher vorgeschlagen, die Neolithisierung als einen langen, fast zweitausend Jahre währenden Prozess fluktuierenden und differenzierten Kulturwandels zu verstehen, der bereits zum Ende des 8. Jahrtausends einsetzt und im südlichen Mitteleuropa bis zum Übergang Mittel-/Jungneolithikum andauert. Dieser Prozess war bestimmt von Klimaereignissen, verbunden mit den Eisdriftereignissen (IRD-events) des nordatlantischen Raumes, die einen Faktor bei der Ausbreitung der bäuerlichen Wirtschaft gespielt zu haben scheinen.

### **Climate, crises, and the »neolithisation« of Central Europe between IRD-events 6 and 4**

In Central European prehistoric archaeology the process of »neolithisation« is often understood as a short-term rupture occurring around the expanding agricultural frontier. From a broader, if not global perspective, this reductionist viewpoint is somewhat unproductive.

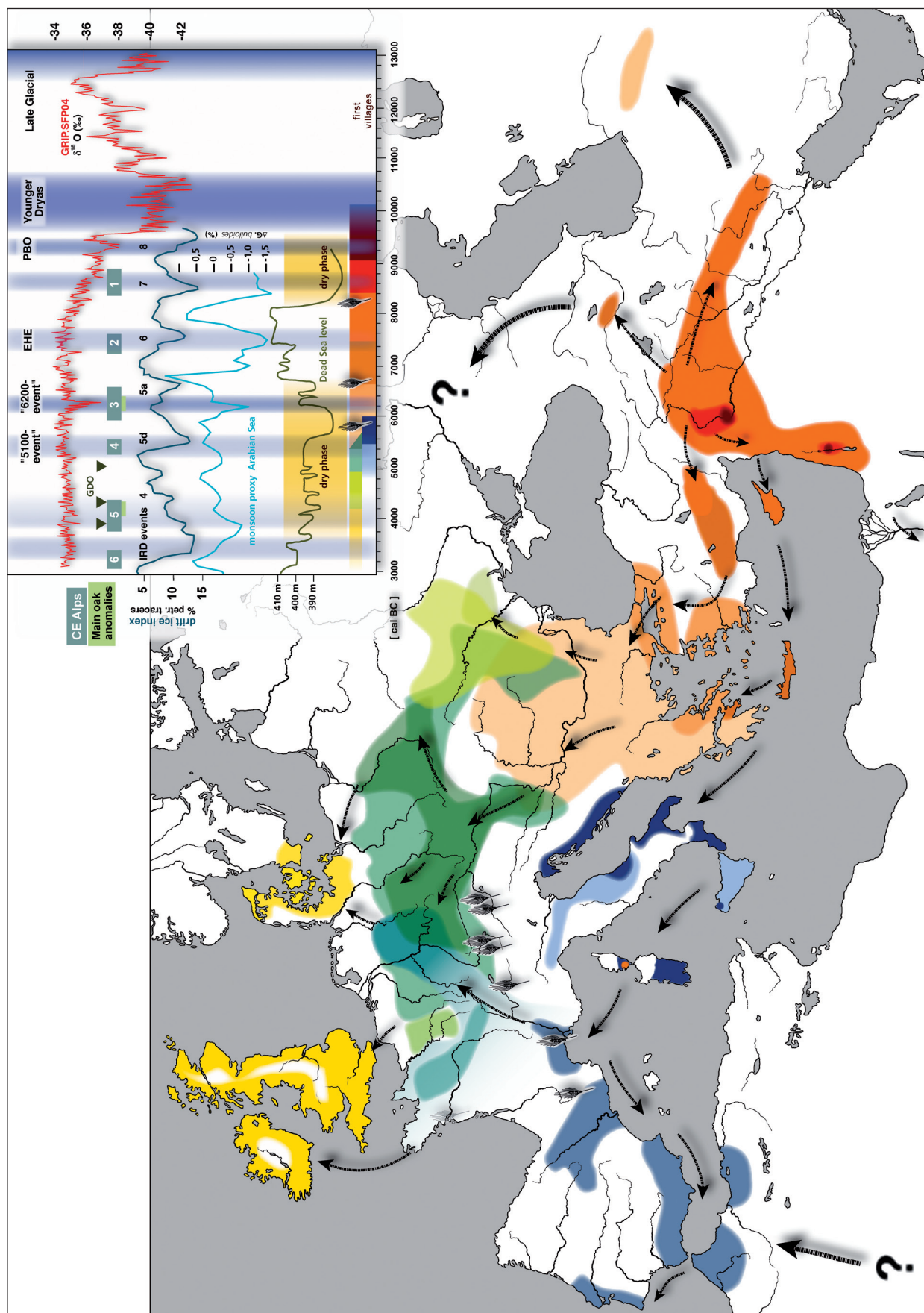
It is therefore suggested to conceptualise »neolithisation« as a long-term two thousand years lasting fluctuating process of culture change which sets in by the end of the eighth millennium cal BC and lasts until the Aeneolithic/Jungneolithikum in southern Central Europe or the Early Neolithic/Frühneolithikum in the North. This process appears to have been forced by climate events which are connected to the ice rafting episodes (IRD-events) of the North Atlantic realm.

### **Climat, crises, et la »néolithisation« de l'Europe centrale entre les événements IRD-6 et IRD-4**

Le processus de néolithisation en Europe centrale est souvent interprété comme un événement de courte durée qui s'est déroulé dans l'environnement immédiat des communautés agropastorales en expansion (concept de frontière). Dans une perspective extrarégionale, voire globale, cette vision réductrice est en quelque sorte non productive.

Compte tenu de l'importance fondamentale de ce processus de transformations sociopolitiques et économiques que représente la néolithisation pour l'histoire de l'humanité, il nous a paru judicieux de développer un concept plus large pour l'Europe centrale. Par conséquent, on propose d'interpréter la »néolithisation« comme un processus oscillant et différencié de longue durée, englobant environ 2000 ans de changements culturels qui débute à la fin du 8<sup>ème</sup> millénaire BC et perdure jusqu'à l'Énéolithique/Néolithique moyen II dans le sud de l'Europe centrale ou jusqu'au Néolithique ancien dans le Nord de l'Europe. Ce processus a été déclenché par des événements climatiques, liés à des épisodes de débris transportés par la glace (IRD-events) dans le domaine nord-atlantique, qui semblent constituer un facteur lors de l'expansion de l'économie agropastorale.

(traduit de l'allemand par Karoline Mazurié de Keroualin)



Culture history informed interpretative chronozone model of the spread of farming across western Eurasia (telescoped time slice layers, non-go-referenced). YD – Younger Dryas; PBO – 2002; Gronenborn 2003; for sources see Appendix 1).