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Human responses and non-responses to climatic variations during the last Glacial-Interglacial transition in the eastern Mediterranean

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A R T I C L E I N F O

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This paper is dedicated to the memory of Herb Wright (1917–2015), who made seminal and pioneering studies of environmental change and agricultural origins in southwest Asia.

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A B S T R A C T

We review and evaluate human adaptations during the last glacial-interglacial climatic transition in southwest Asia. Stable isotope data imply that climatic change was synchronous across the region within the limits of dating uncertainty. Changes in vegetation, as indicated from pollen and charcoal, mirror step-wise shifts between cold-dry and warm-wet climatic conditions, but with lag effects for woody vegetation in some upland and interior areas. Palaeoenvironmental data can be set against regional archaeological evidence for human occupancy and economy from the later Epipalaeolithic to the aceramic Neolithic. Demographic change is evaluated from summed radiocarbon date probability distributions, which indicating contrasting – and in some cases opposite - population trajectories in different regions. Abrupt warming transitions at ~14.5 and 11.7 ka BP may have acted as pacemakers for rapid cultural change in some areas, notably at the start of the Natufian and Pre-Pottery Neolithic cultures. However temporal synchroneity does not mean that climatic changes had the same environmental or societal consequences in different regions. During cold-dry time intervals, regions such as the Levant acted as refugia for plant and animal resources and human population. In areas where socio-ecological continuity was maintained through periods of adverse climate (e.g. Younger Dryas) human communities were able to respond rapidly to subsequent climatic improvement. By contrast, in areas where there was a break in settlement at these times (e.g. central Anatolia), populations were slower to react to the new opportunities provided by the interglacial world.

1. Introduction

Southwest Asia is one of the earliest and most important global centres of plant and animal domestication. From the Neolithic farmers of this region we have inherited cereal crops (wheat, barley, rye), pulses (pea, lentil), and domestic animals (sheep, goat, pig, cattle) (Zohary and Hopf, 2001; Colledge et al., 2004; Conolly et al., 2011). The increased economic productivity and new social organization associated with this 'Neolithic revolution' during the early Holocene were associated with population growth, increased sedentism and the beginnings of village life (Barker, 2006). It has long been hypothesized that the beginnings of Neolithic agriculture in southwest Asia were in some way connected to the major shift in global climate at the end of the last Ice Age (Bar-Yosef, 2017). In this paper we firstly review the historical development of ideas about human adaptations in the eastern Mediterranean during the last glacial-interglacial transition from ~16,000 to ~9000 Cal. yr BP. We then evaluate the current evidence for climatic and ecological change from both off-site and on-site contexts in the eastern Mediterranean region, including stable isotope geochemistry, fossil pollen and charcoals. These are compared against regional archaeological evidence for human occupancy and population change from the late Epi-Palaeolithic to the end of the aceramic Neolithic. Demographic evidence for cultural continuity or discontinuity is evaluated from summed radiocarbon date probability distributions. Finally, we critically compare the archaeological and palaeoenvironmental data sets in order to assess human responses and non-responses to changes in the natural environment.

Archaeological sites in the eastern Mediterranean region older than c. 12 ka BP (12,000 Cal. yr BP) belong to Epipalaeolithic

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cultures, such as the Natufian of the southern Levant. Sites were relatively small and most were only occupied seasonally. Many site economies included harvesting of wild cereal stands, while others involved exploitation of wild herds of sheep, goat and gazelle. In both cases these formed part of broadly based economies utilizing a wide range of resources (Hillman, 1996; Harris, 1998; Rosen and Rivera-Collazo, 2012). During the earliest aceramic Neolithic (Pre-Pottery Neolithic A or PPNA, ~11.7–10.5 ka BP) there are clear indications of cultivation of morphologically wild cereals, for example at the site of Jerf el Ahmar in the Euphrates valley (Willcox and Stordeur, 2012). By the later pre-pottery Neolithic (=PPNB, ~10.5–9.0 ka BP) fully-fledged farming villages had appeared widely throughout the so-called Fertile Crescent, and indeed beyond it into central Turkey. Sites were much larger, reflecting communities whose populations were numbered in hundreds or even thousands, and whose mode of production was rapidly becoming based on agriculture (Goring-Morris and Belfer-Cohen, 2008).

Sites of domestication for founder crops appear to have been restricted to the Fertile Crescent (Nesbitt, 2002). There is good biomolecular and archaeobotanical evidence that single-grained einkorn wheat was domesticated in the Karaca Dağ volcanic uplands of southeast Turkey during the first 1500 years of the Holocene (Heun et al., 1997; Willcox et al., 2009). However, bioarchaeological evidence indicates that the crop domestication process was not restricted to this core area (Fuller et al., 2011). For instance, morphologically-domestic emmer wheat appears early in the Damascus basin to the south and also further north near the middle reaches of the river Tigris at Çayönü, and the same is true for barley (Colledge et al., 2004). This suggests the possibility of multiple independent domestication events for cereal grasses. The first domestic sheep and goat appear at about the same time as these large-grained cereal crops (Conolly et al., 2011), with the earliest dated bio-archaeological evidence coming from the Zagros mountains of western Iran and northeastern Iraq (Zeder and Hesse, 2000; Riehl et al., 2013).

This evidence shows that the change from a mobile, hunter-gatherer economy to sedentary agriculture in southwest Asia was not instantaneous, but involved a long transitional period that created new selection pressures on the crops concerned, leading to increased frequencies of domestication traits, and with considerable variation in individual site economies (Zeder, 2011). It may have been the greater commitment to farming indicated by the emergence of large nucleated communities in the later PPNB that led to the crop packages that are familiar to us, and which became linked to developing practices of animal husbandry (Asouti and Fuller, 2012). The package of livestock and grain crops was subsequently 'exported' from Southwest Asia into adjacent areas, especially north-westwards to form the basis of traditional European subsistence farming.

2. The role of climate change in the transition to agriculture in the eastern Mediterranean region: a brief historiography

The broad chronological coincidence between plant and animal domestication and the shift in global climate at the end of the last ice age has long offered a tempting explanatory framework for the emergence of agriculture. One of the first and best known theories relating climatic change to domestication for the eastern Mediterranean region was proposed by V.G. Childe in his book *The Most Ancient East* (1928). At that time it was believed that high latitude glacial periods were accompanied by lower latitude pluvials or wet phases (e.g. Brooks, 1926; see also Butzer, 1958; Horowitz, 1979). The Late Pleistocene Lisan Formation in the Dead Sea basin provided field evidence of former high lake levels that was used to support this glacial-pluvial correlation. Raphael Pumpelly had previously inferred that Old World landscapes had witnessed a progressive drying out, or desiccation, with water resources increasingly concentrated in locally favoured habitats in river valleys and around lakes (Goudie, 1973). In these few 'oases' Pumpelly (1908, pp.65–66) postulated that plants, animals and humans were forced to reside in close proximity on a reduced resource base, conditions that led to new relationships in the form of domestication. Pumpelly's oasis hypothesis was related to his archaeological and geological discoveries in central Asia rather than southwest Asia, and he offered no proper timescale for when cereal domestication might have begun. His ideas were clearly framed within an "environmental determinist" paradigm that was prevalent in Geography and other disciplines at the start of the twentieth century. Childe (1928), following Peake and Fleure (1927), transferred Pumpelly's oasis - or propinquity - hypothesis to the Near East, and added a clear archaeological chronology, in what he termed the 'Neolithic agricultural revolution'. On the other hand, Childe did not view the emergence of Neolithic farming in Southwest Asia and/or Egypt during the early post-glacial period as climatically predetermined. Rather he argued that it was one among several strategies adopted in the face of environmental change, in line with possibilist approaches to nature-culture relations that prevailed at that time.

Systematic archaeological field research into the origins of agriculture in southwest Asia only began in the late 1940s and 1950s with the work of R. Braidwood, K. Kenyon and others. Excavations of "tell" sites such as Jarmo and Jericho revealed Neolithic villages that were dated by the new radiocarbon method back to the very start of the Holocene. These excavations showed that whereas Childe had been correct in dating his Neolithic Revolution to near the beginning of the Holocene, he had been wrong to place it in Mesopotamia or the Lower Nile. Most early Neolithic sites such as Jarmo lie away from major alluvial river valleys, often in the hilly flanks of the Fertile Crescent (a term first proposed by J.H. Breasted in his book of the same name (1916)). Excavated mudbrick dwellings contained charred seeds, whose subsequent analysis, notably by archaeobotanist H. Helbaek, showed many of them to be early domestic cereals significantly different from naturally occurring wild varieties.

Braidwood was anxious to investigate the climatic background to the emergence of Neolithic farming, and as part of his field research in Iraqi Kurdistan invited American geologist H.E. Wright to accompany him in the field. Wright's fieldwork focussed initially on evidence for past glaciation in the Zagros mountains (Wright, 1962). At first Braidwood and his associates came to the conclusion that there had been no significant climatic changes in Southwest Asia during the last ~15 millennia that could explain the emergence of agriculture (Reed and Braidwood, 1960). However, as Wright (1980, p.145) later admitted, these initial conclusions were largely based on lack of hard evidence for the Late Glacial-early Holocene period, and that evidence was not long in coming. In 1960, Wright crossed from Iraqi to Iranian Kurdistan in order to core Zeribar, a small lake close to the frontier (Fig. 1). According to ^{14}C dating these sediment cores represented a continuous record of environmental change over more than 18 ka (i.e. since before the Last Glacial Maximum). Wright collaborated with Dutch palynologist/archaeobotanist W. van Zeist at Groningen, and also with limnologist G.E. Hutchinson at Yale for geochemical analyses. The results (van Zeist and Wright, 1963; Hutchinson and Cowgill, 1963; Wright, 1968) represented the first serious test of the hypothesized climatic explanation for Childe's 'Neolithic Revolution'. Pollen analysis showed that instead of the present-day oak parkland, the Zeribar region was a treeless chenopod-*Artemisia* steppe during the late Pleistocene, a flora typical of cold dry climatic conditions, not

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