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Middle Holocene rapid environmental changes and human adaptation in Greece

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ABSTRACT

Numerous researchers discuss of the collapse of civilizations in response to abrupt climate change in the Mediterranean region. The period between 6500 and 5000 cal yr BP is one of the least studied episodes of rapid climate change at the end of the Late Neolithic. This period is characterized by a dramatic decline in settlement and a cultural break in the Balkans. High-resolution paleoenvironmental proxy data obtained in the Lower Angitis Valley enables an examination of the societal responses to rapid climatic change in Greece. Development of a lasting fluvio-lacustrine environment followed by enhanced fluvial activity is evident from 6000 cal yr BP. Paleoecological data show a succession of dry events at 5800–5700, 5450 and 5000–4900 cal yr BP. These events correspond to incursion of cold air masses to the eastern Mediterranean, confirming the climatic instability of the middle Holocene climate transition. Two periods with farming and pastural activities (6300–5600 and 5100–4700 cal BP) are evident. The intervening period is marked by environmental changes, but the continuous occurrence of anthropogenic taxa suggests the persistence of human activities despite the absence of archaeological evidence. The environmental factors alone were not sufficient to trigger the observed societal changes.

Introduction

Over the past twenty years, palaeoenvironmental research in the eastern Mediterranean and Balkans has progressed significantly, mainly based on marine (e.g., Rohling et al., 2002; Kotthoff et al., 2008a,b; Triantaphyllou et al., 2009, 2014; Geraga et al., 2010; Kotthoff et al., 2011), lake and marsh (e.g. Digerfeldt et al., 2007; Pross et al., 2009; Peyron et al., 2011; Magny et al., 2012), peat bog (e.g. Bozilova and Tonkov, 2000; Stefanova and Ammann, 2003; Marinova et al., 2012), and more rarely fluvial (e.g. Benito et al., 2015) archives. These records provide evidence of significant climatic instability during the Holocene with notable periods of rapid climatic change (RCC) that are observed at the global scale (Bond et al., 2001; Mayewski et al., 2004; Wanner et al., 2011). At the same time, there has been an increase in numbers of scientific publications that connect cultural to environmental changes (e.g., Weiss et al., 1993; DeMenocal, 2001; Weninger et al., 2006; Büntgen et al., 2011; Drake, 2012; Kaniewski et al., 2013; Wiener, 2014). Such publications often propose a decisive role on modifications in biophysical factors in the emergence, decline or collapse of different societies, even if others suggest that these changes are more complex (Berglund, 2003) and propose non-deterministic explanations (e.g., Berger and Guilaine, 2009; Kuzucuoğlu, 2010, 2014; Mercuri et al., 2011; Roberts et al., 2011; Butzer, 2012; Lespez et al., 2014). Most of these studies have focused on the 8200 and 4200 cal yr BP events. For the first period, the main question concerns the consequences of RCC on human migration and the spread of Neolithic cultures from the Near East across Anatolia and Aegean towards Europe (e.g., Weninger et al., 2006, 2014; Berger and Guilaine, 2009; Lemmen and Wirtz, 2014). The second focuses on the effects of the 4200–4000 cal yr BP aridification on Middle Bronze Age societies in the Near East and eastern Mediterranean regions (e.g., Weiss et al., 1993; DeMenocal, 2001; Weninger et al., 2006, 2009; Weninger and Clare, 2011; Kaniewski et al., 2013; Wiener, 2014).

In this paper, we focus on the 6500–5000 cal yr BP period, which corresponds to one of the less studied RCC episodes in the Eastern Mediterranean and Balkans. This episode is evident at the global scale, but its timing is still unclear. Mayewski et al. (2004) provide evidence of a cool period from 6000 to 5000 cal yr BP, whilst Wanner et al. (2011) identify a cold spell between 6500 and 5900 cal yr BP. This uncertainty is related to the nature of RCC events that involve a combination of

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orbital, ice-sheet, ocean circulation, large tropical volcanic eruptions, and solar forcing factors (Finné et al., 2011; Wanner et al., 2011) and the complexity of the middle Holocene climate transition (Triantaphyllou et al., 2009; Magny et al., 2013). Indeed, the beginning of the climate reversal following the Holocene climate optimum is characterized by complex interactions between changes in orbital forcing, ocean circulation, and solar activity (Magny et al., 2006; 2013).

In the southeastern part of the Balkans and the Aegean (Bulgaria, Greece and Southern Romania), this middle Holocene climate transition corresponds to the transition from the Late–Final Neolithic or Chalcolithic (~6500–5300 cal yr BP, according to the Greek terminology) to the Bronze Age (~5300–3000 cal yr BP). Many signs of cultural breaks have been identified, with the disappearance of certain characteristic material and cultural features of the final phases of the Neolithic, including decorated ceramics (black-on-red, graphite-painted, incised and incrusted types), zoomorphic and anthropomorphic figurines, clay models, and ornaments (e.g. *Spondylus* bracelets and beads) (Anthony and Chi, 2009; Papadimitriou and Tsirtsoni, 2010). On the other hand, the persistence of some techniques (architecture, stone and metal tools) and the permanence in the location of certain settlements suggest that a degree of continuity existed or at least that there were some ties between the two periods (Tsirtsoni, 2010, 2014).

The radiocarbon ages obtained recently confirm the break between the Neolithic and the Bronze Age, because they show that, at sites where both periods are represented, several centuries separate the last levels of the Neolithic from the first levels of the Bronze Age. Depending on the site and the precision of the ages, the hiatus extends from ~6300–6000 to 5400–5000 cal yr BP (Maniatis and Kromer, 1990; Görsdorf and Bojadžiev, 1996; Tsirtsoni, 2014). Furthermore, very few sites have been dated within this interval (Boyadžiev, 1995; Maniatis et al., 2014; Tsirtsoni, 2014). A chronological gap of seven to eight centuries is apparent in the entire area. Interpretation of these data remains the focus of debate. Some researchers tend to underestimate the problem, pointing out the provisional nature of the radiocarbon ages and emphasising signs of continuity (Andreou et al., 1996; Demakopoulou, 1996; Treuil et al., 2008). But others, particularly in Bulgaria, propose a range of hypotheses to explain the causes of what is often perceived as the total collapse of Chalcolithic civilization. Some evoke human factors, in the form of invasions of people from the steppes north of the Black Sea (Boyadžiev, 1995, 1998), whilst others favour the role of environmental factors in relation to social changes: climate change resulting in a global rise of the water level and flood intensification (Todorova, 1978, 1995, 2007) or, on the contrary, a severe drought (Nikolov, 2012), has been suggested as a potential factor. Based on the available palaeoenvironmental data in the southeastern part of the Balkans, Weninger et al. (2009) put forward the role of overall cooling and the succession of catastrophic cold winters in the triggering of societal change. In these hypotheses, the gap in the 4th millennium BC may be the result of movement towards more favourable areas: in particular, the southern mountainous zones (Rhodope Mountains) that constitute one of the regions where the Chalcolithic seems to persist the longest in Bulgaria, until 5800–5700 cal yr BP, and more generally southwards to the Aegean.

To assess the causal link between settlement decline and RCC periods, we need to examine more precisely the relationship between climate change and the paleoenvironmental conditions at archaeological sites. In the framework of the French project "Balkans 4000" that addresses climate–society interactions during the 4th millennium BC, we develop archaeological and palaeoenvironmental investigations to show that the hiatus is real and define its age based on numerous archaeological sites in the southeastern Balkans (Tsirtsoni, in press). To be able to detect the spatial organisation of the results, we studied sites distributed as equally as possible, taking into account the density of the archaeological sites and possibilities for sampling (Fig. 1). Broadening the framework of the study region was essential to be able to examine evidence for existence of specific sanctuary areas or the progression of site abandonment in the Balkans. Our study area extends from Attica to the lower Danube Valley, covering ~360,000 km^2. Observations were at the site scale within this vast area. The sites examined have different profiles, in terms of nature (habitats, cemeteries), installation type (flat site, tells, caves), location (plains, mountains, coastal), and duration of occupation. The results of the archaeological research are presented in Tsirtsoni (in press) and the aims of this paper are to identify and describe changes in the environment near archaeological sites occupied during the Late Neolithic and the Early Bronze Age to examine the nature of paleoenvironmental transformation and its potential effects on changes in settlement patterns and land use.

Previous research and study area

Research was conducted in the current floodplain of the Lower Angitis River near the confluence with the Strymon River (40°55′11″ N; 23°49′23″ E). This area is located 15 km from the Aegean Sea and the mouth of the Strymon River, and was chosen because of its archaeological and palaeoenvironmental potential as shown by previous investigations conducted in Greek eastern Macedonia (Lespez, 2003, 2007, 2011, Lespez et al., 2013). From an archaeological perspective, this area has the advantage of being situated at the outlet of a north–south axis that has repeatedly played a crucial role in the population dynamics of the Balkans and in exchanges between the Aegean world and southeast Europe (Todorova et al., 2007). The region is also in the middle of a zone where archaeological studies have been extensively developed and contains many sites occupied during the Late Neolithic and the Early Bronze Age. The well-known excavated sites of Dimitra (Grammenos, 1997), Sitagri (Renfrew et al., 1986; Fig. 1, site 9), and Dikili Tash (Darcque and Tsirtsoni, 2010) show a hiatus of 800–1000 yr during the 4th millennium BC in the settlement history, which according to the available archaeological information has been interpreted as an abandonment of the site by Late Neolithic people. In the lower Angitis valley, we focus our investigation at the bottom of the archaeological site of Fidokoryphi that is one of the four Late Neolithic and Early Bronze Age sites within a radius of 10 km (with Dimitra, AÏri Baïri and Kryoneri; Grammenos and Fotiadis, 1980; Fig. 2). Fidokoryphi is established on a small-elongated Neogene hill (330 × 100 m), which reaches 19 m above sea level (asl) and dominates the alluvial plain of the Angitis River (Fig. 2). The previous investigations conducted on the Holocene deposits show a thick fill of more than 10 m that is composed of alluvial and shallow lake deposits that reveal a significant potential for high resolution palaeoenvironmental studies (Lespez, 2007).

The lower Strymon Valley forms a subsiding basin along a Cenozoic detachment system (Dinter and Royden, 1993), situated between the Serbo–Macedonian massif to the west and the southern Rhodope Mountains to the east that rise to between 1300 and 2100 m asl. Tectonic activity was high during the middle Pleistocene and decreases during the late Pleistocene, with the studied area being relatively stable during the Holocene (Broussoulis et al., 1991; Lespez and Dalongeville, 1998). The valley bottom lies 5 to 100 m asl and is fringed by faulted Neogene hills with calcimagnesic soils and coalescing series of middle and upper Pleistocene alluvial fans composed of gravelly reddish-brown sediments (Psilovikos, 1986; Broussoulis et al., 1991; Lespez and Dalongeville, 1998). The distal parts of these alluvial fans are covered by vertic soils (Lespez, 2008). The Angitis River drains the Drama–Philippi basin. Given the karstic nature of the southern Rhodopes (marbles), stream flow is perennial and the monthly discharges vary between 6 and 29 m^3/s. In its lower course, the Angitis River has been extensively modified due to the complete drainage of the Achinos Lake which occupied the valley bottom until the early 20th century (Ancel, 1930). Travel accounts available from the 16th century highlight the large size of the lake and its marshy shores that were characterized by seasonal change (Fig. 2). The historical data for older periods suggests the continuance of the marshy lake landscapes