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Vegetation and environmental changes in Northern Anatolia between 134 and 119 ka recorded in Black Sea sediments

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ABSTRACT

This multiproxy study on SE Black Sea sediments provides the first detailed reconstruction of vegetation and environmental history of Northern Anatolia between 134 and 119 ka. Here, the glacial–interglacial transition is characterized by several short-lived alternating cold and warm events preceding a meltwater pulse (~130.4–131.7 ka). The latter is reconstructed as a cold arid period correlated to Heinrich event 11. The initial warming is evidenced at ~130.4 ka by increased primary productivity in the Black Sea, disappearance of ice-rafted detritus, and spreading of oaks in Anatolia. A Younger Dryas-type event is not identifiable. The Eemian vegetation succession corresponds to the main climatic phases in Europe: i) the *Quercus–Juniperus* phase (128.7–126.4 ka) indicates a dry continental climate; ii) the *Ostrya–Corylus–Quercus–Carpinus* phase (126.4–122.9 ka) suggests warm summers, mild winters, and high year-round precipitation; iii) the *Fagus–Carpinus* phase (122.9–119.5 ka) indicates cooling and high precipitation; and iv) increasing *Pinus* at ~121 ka marks the onset of cooler/drier conditions. Generally, pollen reconstructions suggest altitudinal/latitudinal migrations of vegetation belts in Northern Anatolia during the Eemian caused by increased transport of moisture. The evidence for the wide distribution of *Fagus* around the Black Sea contrasts with the European records and is likely related to climatic and genetic factors.

Introduction

The last interglacial period (LI, or marine oxygen isotope stage (MIS) 5e, or Eemian) of vegetation history in Western Europe is relatively well studied and shows evidence for a uniform succession of vegetation across the region (e.g., Aalbersberg and Litt, 1998; Klotz et al., 2003; Sánchez Goñi et al., 1999, 2005; Tzedakis, 2000). Major changes in vegetation occurred during MIS 5e and 5d in Europe in tandem with major climatic events, associated with changes in North Atlantic currents and meridional sea-surface temperature (SST) gradients (Müller and Kukla, 2004). The lack of detailed pollen records for the Eemian interval east of 30°E (e.g., Urmia Lake in Iran (Djamali et al., 2008); Fig. 1) hinders correlations with the North Atlantic region, and both vegetation and climate history remain unclear for this period. Pollen and sedimentary records from and around the Black Sea basin can provide valuable information to contribute towards our understanding of the vegetation and climate history of the area.

Most paleoenvironmental studies on sediments from the Black Sea have been carried out for the late-glacial and the Holocene periods (Bahr et al., 2008; Filipova-Marinova et al., 2012; Kwiecien et al., 2009; Lamy et al., 2006; Shumilovskikh et al., 2012; Yanko-Hombach et al., 2007). Older sediments, covering the Quaternary and Pliocene intervals, were collected from the Black Sea during the R/V *Glomar Challenger* cruise in 1975 and studied at coarse resolution (Neprochnov, 1980; Ross et al., 1978). These studies revealed that glacial–interglacial cycles were characterized by changes between steppe and forest on adjacent land and conditions between lacustrine and marine in the Black Sea. Some details on the Eemian vegetation were provided by pollen records from the Black Sea cores (Koreneva and Kartashova, 1978) and terrestrial sediments from Bulgaria (Božilova and Djankova, 1976), Russia (Spiridonova, 1991), and Georgia (Shatilova, 1974) (Fig. 1, Table 1). These records reveal the presence of tree species such as *Fagus*, *Carpinus*, *Ostrya*, *Corylus*, *Quercus*, *Castanea*, *Pinus*, and *Picea* in the

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Figure 1. Location map of the study region: a) map of Europe with locations of core 22-GC3/8 (red star) and cores used for age-model construction (yellow stars) and supra-regional comparison (yellow circles); b) geographical map of the Black Sea region with location of core 22-GC3/8 (red star) and other regional pollen records, referenced and discussed in the text (yellow circles). Map was drawn with Quantum GIS (1.7.0) using data from www.bgr.de, www.nowcoast.noaa.gov, www2.demis.nl.

surrounding region. However, the low temporal resolution of the records and the absence of robust chronologies prevent a detailed reconstruction of the LI vegetation changes in the Black Sea region.

Vegetation changes and environmental conditions during the transition from the penultimate glacial to the Eemian and the onset of interglacial conditions for the Black Sea region have so far never been studied in detail. In general, the climate dynamics during the penultimate deglaciation remain obscure. For example, a number of pollen records demonstrate a Younger Dryas-type cooling event (Kattegat stadial) in Europe during the onset of the initial warming (Zeifen interstadial) (Sánchez Goñi et al., 1999, 2005; Seidenkrantz et al., 1996; Tzedakis, 2000), whereas other records do not support this cooling episode (Allen and Huntley, 2009; Brauer et al., 2007; Turner, 2000).

Here we present the first detailed pollen record based on sediment core 22-GC3/8 from the SE Black Sea (Fig. 1) covering ~134–119 ka, which was used for the reconstruction of vegetation and climate changes in Northern Anatolia during this interval. The assumed pollen source area for 22-GC3/8 includes the coastal areas nearest to the coring site, namely the central part of Northern Anatolia and especially the northern slopes of the Pontic Mountains (Shumilovskikh et al., 2012). The study also provides a comparison between pollen records from the Black Sea region and SW Europe. By using additional multi-proxy

Table 1
Site information for Mediterranean Eemian records discussed in the study.

Site	Lat, N	Long, E	Alt, m	Material	Reference
379A	43°00.29′	36°00.68′	−2173	Marine	Koreneva and Kartashova (1978)
Staro Orjachovo[a]	43°00′	27°48′	50	Lake/river	Božilova and Djankova (1976)
Nosovo-1[a]	47°18′	39°18′	6	Paleosol	Spiridonova (1991)
Horga[a]	42°00′	41°50′	8	Terrestrial	Shatilova (1974)
Kobuleti[a]	41°49′	41°46′	7	Terrestrial	Shatilova (1974)
Urmia	37°32′	45°05′	1315.9	Lake	Djamali et al. (2008)
Tenaghi Philippon	41°10′	24°20′	40	Peat	Wijmstra (1969)
Kopais	38°26.27′	23°03.02′	92.4	Lake	Tzedakis (1999)
Sofular	41°25′	31°56′	500	Speleothems	Badertscher et al. (2011)
Ioannina-284	39°45′	20°51′	473	Lake	Tzedakis et al. (2003)
Monticchio	40°56′40″	15°36′30″	656	Lake	Allen and Huntley (2009)
Valle di Castiglione	41°53′30″	12°45′35″	44	Lake	Follieri et al. (1988)
MD952042	37°48′	10°10′	−3148	Marine	Sánchez Goñi et al. (1999)

[a] Geographical coordinates of sites are not reported in the original publication and were georeferenced using gazetteers.