Quaternary Research 84 (2015) 448–456

Contents lists available at ScienceDirect

Quaternary Research

journal homepage: www.elsevier.com/locate/yqres

Vegetation and climate changes during the late Pliocene and early Pleistocene in SW Anatolia, Turkey

Gonzalo Jiménez-Moreno [a,*], Hülya Alçiçek [b], M. Cihat Alçiçek [b], Lars van den Hoek Ostende [c], Frank P. Wesselingh [c]

[a] Departamento de Estratigrafía y Paleontología, Universidad de Granadan, Fuente Nueva s/, 18002 Granada, Spain
[b] Pamukkale University, Dept. of Geology, 20070 Denizli, Turkey
[c] Naturalis Biodiversity Center, P.O. Box 9517, 2300 RA Leiden, The Netherlands

ARTICLE INFO

Article history:
Received 7 May 2015
Available online 17 October 2015

Keywords:
Pollen analysis
Paleovegetation
Paleoclimate
Pliocene
Pleistocene
SW Anatolia

ABSTRACT

Pollen analysis was done on lacustrine sedimentary sequences dated by micromammals as late Pliocene–early Pleistocene that outcrop in two Neogene graben basins from SW Turkey. This study shows vegetation changes from steppe-like to more forested environments, very similar to the cyclic oscillations related to late Pleistocene glacial–interglacial climate changes. *Artemisia* was abundant during cold–arid periods, indicating that this species was already widespread in this area during the latest Pliocene and the beginning of the Pleistocene. A review of pollen records from Anatolia agrees with this study, suggesting that the spreading of this arid species occurred during a major climatic change: the beginning of the first glaciations and probably a change in seasonality towards summer aridity. *Artemisia* temporarily disappeared from the region during warm–wet periods and thus we suggest that glacial–interglacial-type oscillations already occurred in the area during the late Pliocene–early Pleistocene.

Introduction

Anatolia (Fig. 1A) is today a biodiversity hotspot and has been a refuge area for plants that were previously widespread in the European and Mediterranean regions (Biltekin et al., 2015 and references therein). Warm-temperate species, which have almost completely (*Zelkova*) or completely (*Pterocarya*, *Liquidambar*, *Parrotia persica*) disappeared from other European and peri-Mediterranean regions naturally occur in this region (Quézel and Médail, 2003). The Anatolian vegetation during the Miocene was mostly subtropical but many of those species declined through the Neogene due to climate cooling and enhanced aridity in the area and the establishment of the Mediterranean-type seasonal precipitation rhythm (summer drought since 3.4 Ma) (Suc, 1984; Jiménez-Moreno et al., 2005; Suc and Popescu, 2005; Jiménez-Moreno et al., 2010). This process was probably enhanced during the Pleistocene with glacial–interglacial cycles (Popescu et al., 2010) and the increase of magnitude of these cycles after the mid-Pleistocene transition, with the change from a 41 ka- to 100 ka-dominated climate (Lisiecki and Raymo, 2005). Aridity adapted species, such as *Artemisia*, colonized the region in such paleoclimatic conditions (Biltekin et al., 2015). However, the timing of the spreading of *Artemisia* in this area coming from Asia (Yunfa et al., 2011) is not accurately dated and happened sometime between the late Miocene and early Pliocene (Popescu, 2006; Biltekin, 2010). In addition, the main climatic or biogeographic factor forcing this widespread development of *Artemisia* steppes in the area is not fully deciphered yet.

The climatic patterns and vegetation history of late Neogene and Quaternary sediments from the western Anatolian basins (SW Turkey; Fig. 1B) have not been studied in sufficient detail to date (see below). However, Neogene sedimentary successions of western Anatolian basins are well exposed and slightly deformed, and are rich in fossil fauna and flora providing an important source of information on the paleogeographic evolution of the individual basins as well as on the regional paleoclimatic conditions. In addition, extensive coals and coal-bearing deposits in the SW Anatolia contain potential archives to recognize regional paleoclimatic and paleobotanical patterns. Pollen analysis, together with other paleontological and paleoenvironmental proxies, carried out on these organic lacustrine sediments could be a very valuable tool for deciphering paleoenvironmental conditions.

Recently, a number of studies have focused on the tectono-sedimentary development of the Çameli Basin and its surroundings, in an attempt to understand the tectonic and paleogeographic evolution of the eastern Mediterranean and Aegean regions. But so far little attempt has been made to draw vegetation patterns from the Çameli Basin as well as other western Anatolian basins. Besides, the only palynological studies on the western Anatolian basins concentrated in

* Corresponding author at: Avda. Fuentenueva S/N, 18002, Granada, Spain.
E-mail addresses: gonzaloj@ugr.es (G. Jiménez-Moreno), halcicek@pau.edu.tr (H. Alçiçek), alcicek@pau.edu.tr (M.C. Alçiçek), lars.vandenhoekostende@naturalis.nl (L. van den Hoek Ostende), frank.wesselingh@naturalis.nl (F.P. Wesselingh).

http://dx.doi.org/10.1016/j.yqres.2015.09.005
0033-5894/

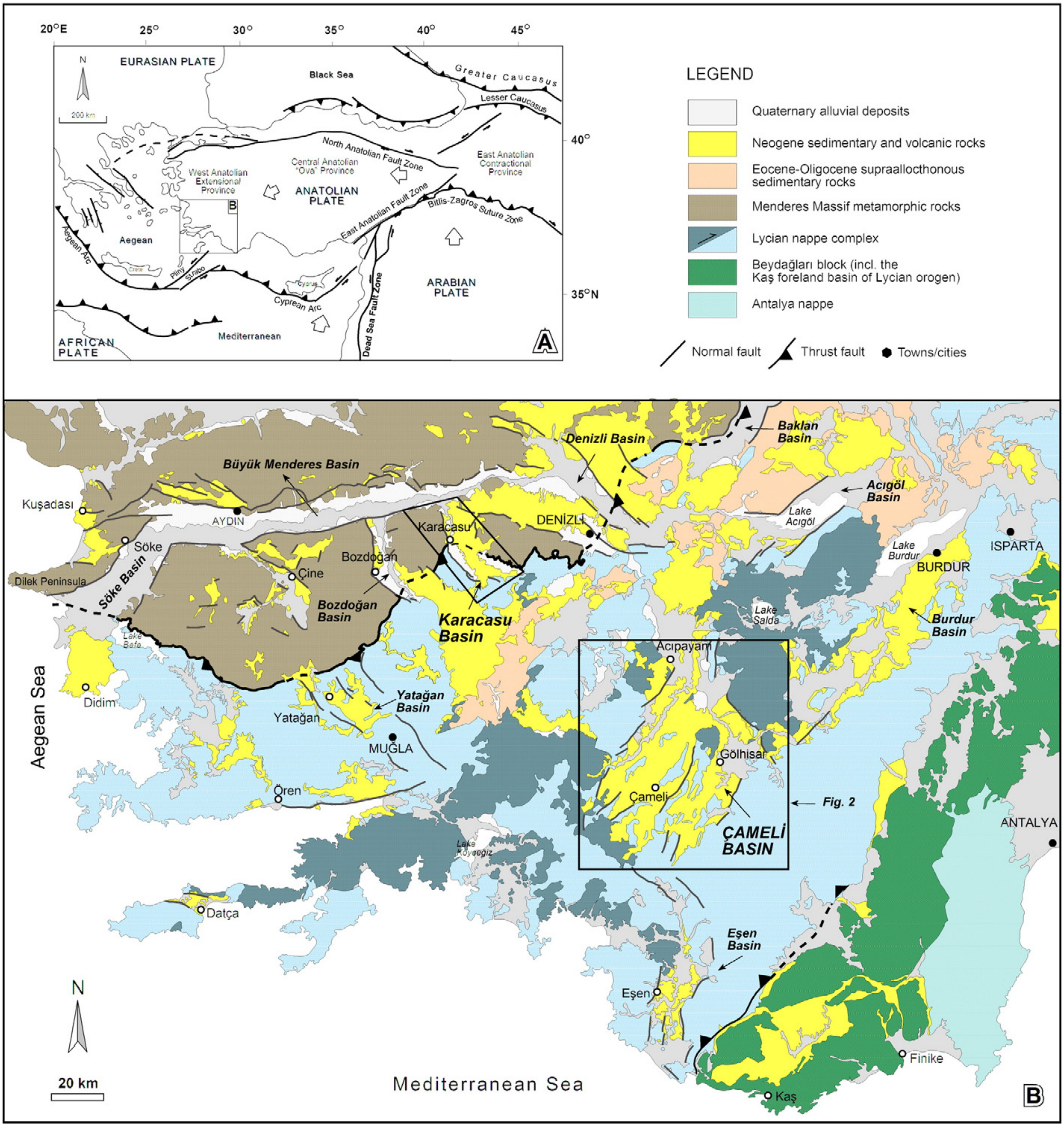

Figure 1. (A) Tectonic map of the Aegean Sea and western Turkey showing the major tectonic structures (modified from Bozkurt, 2003); and (B) overview of the prominent extensional basins of western Anatolia surrounding the Çameli Basin (based on Konak, 2002; Konak and Şenel, 2002; Şenel, 2002; Turan, 2002).

the Oligocene and Miocene coal-bearing deposits (e.g., Benda, 1971; Becker-Platen et al., 1974, 1977; Akgün and Akyol, 1999; Akgün et al., 2007; Biltekin, 2010; Akkiraz et al., 2011; Kayseri-Özer, 2014; Biltekin et al., 2015) and little attempt was made to undertake any detailed palynology of the Pliocene and early Pleistocene deposits (Alçiçek and Jiménez-Moreno, 2013). Recently, an abundance of vertebrate and invertebrate fossil assemblages in the Çameli basin-fill have attracted researchers (Diepeveen, 2012; van Bennekom, 2013; Van den Hoek Ostende et al., 2015a, b), yet a study of the pollen assemblages as a climate proxy is lacking.

In this study, pollen analysis has been carried out on two sedimentary sequences of late Pliocene and early Pleistocene ages that outcrop in the Çameli Basin, SW Turkey (Fig. 2). These data have been compared with previously published pollen records from another site from the nearby Karacasu basin and with regional pollen data (Alçiçek and Jiménez-Moreno, 2013; Fig. 1B). These records demonstrate cyclic and paired changes in vegetation, lake level and sedimentation that appear to be linked to orbital-scale climate variability (i.e., "glacial–interglacial" cycles). Vegetation, climate and age implications are discussed within the context of the Neogene Northern Hemisphere glacial intensification.