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The influence of refugial population on Lateglacial and early Holocene vegetational changes in Romania

Angelica Feurdean [a,*], Barbara Wohlfarth [b], Leif Björkman [c], Ioan Tantau [d], Ole Bennike [e], Katherine J. Willis [a], Sorina Farcas [f], Ann Marie Robertsson [g]

[a] *School of Geography, Centre for the Environment, University of Oxford, South Parks Road, OX1 3QY, Oxford, England; Quaternary Research Group, Department of Geology, Babes-Bolyai University, Kolgalniceanu 1 400084, Cluj Napoca, Romania*
[b] *Department of Geology and Geochemistry, Stockholm University, SE-106 91 Stockholm, Sweden*
[c] *GeoBiosphere Science Centre, Quaternary Sciences, Lund University, Sölvegatan 12, SE-223 62 Lund, Sweden*
[d] *Department of Geology, Babes-Bolyai University, Kogalniceanu 1, 400084, Cluj Napoca, Romania*
[e] *Geological Survey of Denmark and Greenland, Øster Voldgade 10, DK-1350 Copenhagen NV, Denmark*
[f] *Institute of Biological Research, Republici 48, 400015 Cluj Napoca, Romania*
[g] *Department of Physical Geography and Quaternary Geology, Stockholm University, SE-106 91 Stockholm, Sweden*

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Abstract

Romania has for a long time been lacking good palaeoenvironmental records, particularly for the Late Quaternary. A chronological framework had been nearly absent and the vegetation development had been reconstructed entirely from pollen data. Data sets from this part of Europe are important for assessing the spatial variability of past vegetation and climatic changes and to reconstruct tree migration routes at the end of the last glacial period. New palaeobotanical evidence has enabled us to address this gap and to provide a more comprehensive picture of the Lateglacial and early Holocene continental environment. This paper reviews results from radiocarbon dated sequences in Romania with the aim to place them in a larger perspective with regard to glacial refugia and tree immigration, and to asses the vegetation response to climatic oscillation from the end of the Last Glacial Maximum (LGM) to the early Holocene. This study documents that some coniferous and broad-leaved trees were present prior to 14,700 cal. yr BP in Romania, and thus it appears that this region may have been a refugial area for some tree species. During the Lateglacial, the vegetation shows a distinct response to climatic oscillations at all elevations, although the response is stronger at mid altitude (800–1100 m. a.s.l) than at high altitudes. Moreover, smaller climatic oscillations are only recorded at sites situated at mid altitudes, probably because these areas were located close to the tree line ecotone.

Keywords: glacial refugia; vegetation fluctuation; climate; pollen; plant macrofossils; Lateglacial; Romania

1. Introduction

The importance of palaeoecological studies as a way of placing contemporary environmental and climatic changes in a long-term perspective is increasingly recognized. Of particular interest are the millennial to

* Corresponding author. Tel.: +44 0 1865 285178.
E-mail addresses: angelica.feurdean@ouce.ox.ac.uk, angelica.feurdean@gmail.com (A. Feurdean).

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centennial climate fluctuations, which were characteristic of the Late Quaternary, and their impact on terrestrial ecosystems. By studying the biological response to these abrupt changes, it is possible to assess the sensitivity of vegetation to future climatic changes. Specifically, palaeoecological studies allow reconstructing shifts in the composition and abundance of plant communities, location of tree refugia and immigration routes. Palaeoecological research also becomes increasingly recognized as a tool for biodiversity evaluation and conservation management (Gillison and Willis, 2005; Willis et al., 2005). Because Romanian territory was not extensively glaciated during the full glacial, this region may have been glacial refugia for temperate trees and therefore may represent areas of special values for long-term persistence on biodiversity.

Numerous studies show a clear response of the vegetation to the distinct climatic fluctuations during the Lateglacial in Europe, but the amplitude of the response varied greatly across regions (Lotter et al., 1992; Ammann et al., 1993; Ralska-Jasiewiczowa et al., 1998; Birks and Ammann, 2000; Wick, 2000; Feurdean, 2004; Tzedakis et al., 2004). The observed differences may be due to spatial differences in temperature/precipitation changes, to different physiological tolerance of the species involved, to inter-species competition, life-history traits, location of refugia and migration speed.

Palaeovegetational investigations in Romania have a long tradition (Pop, 1929, 1932, 1942, 1957, 1960; Diaconeasea, 1969, 1977; Lupsa, 1977, 1980; Boscaiu et al., 1983; Farcas, 1995, 1996; Buz, 1999). Only very recent studies, however, provide radiocarbon chronologies for Lateglacial fluctuation in vegetation dynamics (Farcas, 2001; Farcas et al., 1999; Feurdean et al., 2001; Wohlfarth et al., 2001; Björkman et al., 2002, 2003; Tantau, 2003; Tantau et al., 2003; Feurdean, 2004, Feurdean and Bennike, 2004; Tantau et al., 2006). These studies show that steppe environments with *Pinus* and *Betula* developed before 14,700 cal. yr BP. During the Lateglacial, herbs and open woodlands with *Pinus*, *Betula* and some *Larix*, *Salix* and *Alnus*, alternated with expansion of woodlands that also included *Picea*, *Ulmus* and *Populus*. At the Lateglacial–Holocene transition at 11,500 cal. yr BP, *Pinus*, *Betula*, *Larix* woodlands spread, followed rapidly by the expansion of *Ulmus* and *Picea*, and the arrival of *Quercus*, *Tilia*, *Fraxinus*, *Acer* and *Corylus*.

The sites Avrig, Preluca Tiganului, Steregoiu, Mohos, Luci, Iezerul Calimani and Taul Zanogutii are the only available Lateglacial radiocarbon dated sequences in Romania (Figs. 1, 3–9). The aim of this paper is to summarize results from these sites and (i) to place them in a regional context with regard to glacial refugia and tree immigration, (ii) to discuss the vegetation response to the climatic oscillations during the Lateglacial and early Holocene, (iii) to examine the sensitivity of vegetation to climate change and (iv) to examine the refugial role of Romania for temperate vegetation and highlight the potential of this region in terms of its genetic diversity and conservation implication.

2. Geographic setting and methodology

Romania is characterized by a high degree of topographical variation, which leads to steep climatic gradients that are sensitive indicators for climatic changes. The modern vegetation shows clear latitudinal zonation: the steppe zone, the forest-steppe zone and the nemoral zone, the latter being the most extensive vegetation type (Donita, 1962; Csurös and Vegetatia, 1976; Cristea, 1993). The vegetation is also arranged in altitudinal belts according to climatic, topographic and edaphic conditions (Fig. 2). The limits of the altitudinal belts vary in the Carpathians with latitude, distribution of air masses and orientation of the mountains. Four altitudinal belts can be distinguished: (1) the foothill woodland belt (300–600 m a.s.l.), which includes several oak species (the most common is *Quercus petraea*), *Tilia cordata*, *Corylus avellana*, *Carpinus betulus*, *Fagus sylvatica*; (2) the montane belt can be subdivided into three sub-belts: *F. sylvatica* woodlands between 600 and 1000 m a.s.l., *F. sylvatica–Picea abies* or *F. sylvatica–Abies alba* woodlands between 1000 and 1200 m a.s.l. and *P. abies* woodlands between 1200 and 1800 m a.s.l. Small stands of *Larix decidua*, *Pinus* sp. (most common *P. sylvestris* and *P. cembra*) also occur; (3) the subalpine belt (1800–2000 m a.s.l.) is dominated by mixtures of *Pinus mugo* ssp. *mugo*, *Juniperus communis* and *Rhododendron kotschyi*; (4) the alpine belt occurs above 2000 m a.s.l. and is characterized by communities dominated by *Salix* spp. and herbaceous plants such as *Silene acaulis*, *Saxifraga bryoides*, *Festuca glacialis*, *Sesleria coerulea*, *Carex curvula*, etc.

Only seven Lateglacial sites from Romania, situated in or close to the Carpathian Mountains, at altitudes ranging from 400 to 1840 m a.s.l. (Fig. 1, Table 1), provide absolute chronologies. The present discussion is therefore based on pollen stratigraphies established at these localities. Avrig is situated in the southern part of the Transylvanian Depression, close to the southern Carpathians and is influenced by a montane climate (Tantau et al., 2006). Preluca Tiganului and Steregoiu are located on the western flank of the Gutaiului Mountains (Wohlfarth et al., 2001; Björkman et al., 2002, 2003; Feurdean, 2004;