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SHORT COMMUNICATION

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Late-glacial fluctuations of timberline in the Black Forest (SW Germany)

A revised approach to a climatic reconstruction

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Abstract Based on pollen diagrams from nine sites at altitudes between 654 and 1280 m a.s.l. the Late-glacial fluctuations of the timberline are reconstructed and interpreted in terms of summer temperature.

Keywords Southern Germany · Late-glacial · Climatic fluctuations · Timberline reconstruction

New pollen diagrams from lake sediments from sites at different altitudes (654–1280 m a.s.l.) in the Black Forest (Fig. 1, Table 1) allow an improved reconstruction of vegetation dynamics for the period between the retreat of ice at the beginning of the Late-glacial and the onset of final afforestation in the early Holocene (Fig. 2). The new, more precise reconstruction can now replace a former approach (Lang 1952). The diagrams used for the reconstruction also cover the Holocene and are presented and discussed in detail by Lang (2005). The present paper deals only with some aspects concerning the Late-glacial. Until the present no radiocarbon data have been available for that period in the Black Forest. Hence the only reliable time marker is the Laacher See Tephra (LST), which is present in all diagrams used for the reconstruction (2–9), with the exception of diagram 1, where sedimentation started after the end of the Younger Dryas (DR 3). The LST marks the time horizon of 11 ka B.C. (13 ka cal B.P.) and is taken as the boundary between the Alleröd (AL) and Younger Dryas (DR 3) chronozones.

In view of the total lack of radiocarbon data older than 11 ka B.C. the start of the timberline curve could not be placed precisely on the time scale (Fig. 2) and will possibly be corrected in the future. The intention of the curve is rather to show a first rise of the timberline around 13 ka B.C. with a peak around 12.5 ka B.C., in accordance with the chronological fixing of the first afforestation in surrounding regions, for example in the Swiss alpine foreland, where the first spread of trees (*Betula*) was dated between 12.9 and 12.6 ka B.C. (Ammann 1989; Lotter et al. 1999).

During the early Late-glacial, i.e. during the Oldest Dryas (DR 1), the vegetation of the mountain area consisted of open treeless “steppe tundra”, a more or less dense plant cover dominated by Poaceae and *Artemisia*, together with Chenopodiaceae, Caryophyllaceae, *Rumex*, *Thalictrum*, *Helianthemum*, *Dryas octopetela* and other taxa. During the Bölling (BÖ) birch park tundra spread up to an altitude of 1000–1100 m a.s.l., with a preceding

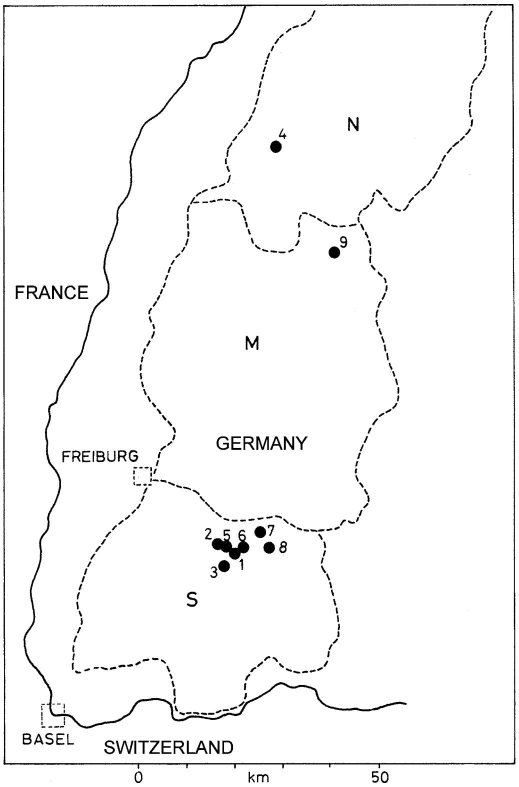

Fig. 1 Location of sites used for reconstruction of the timberline in the Black Forest. Numbers refer to Table 1. M: Middle Black Forest. N: Northern Black Forest. S: Southern Black Forest

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Table 1 Pollen diagrams used for reconstruction of Late-glacial timberline

No	Site	m a.s.l	Region	Reference
1	Zweiseenblickmoor near Neuglashütten	1280	S	Lang (2005)
2	Feldseemoor at the Feldberg	1100	S	Lang (2005)
3	Scheibenlechtenmoos near Menzenschwand	1098	S	Lang (2005)
4	Mummelsee at the Hornisgrinde	1027	N	Lang (2005)
5	Waldhofmoor in the Bärental	1000	S	Lang (2005)
6	Rotmeer near Altglashütten	962	S	Lotter and Hölzer (1994)
7	Titisee	845	S	Lang (2005)
8	Urseemoor near Lenzkirch	835	S	Lang (1971, 2005)
9	Alter Weiher near Freudenstadt	654	M	Lang (2005)

Numbers refer to Figs. 1 and 2. M: Middle Black Forest. N: Northern Black Forest. S: Southern Black Forest

short stage of dwarf shrub vegetation with *Salix*, *Juniperus* and *Hippophaë*. A subsequent lowering of the timberline, revealed only in some of the pollen diagrams from above 950 m a.s.l., corresponds very probably to the Elder Dryas (DR 2) around 12,000 B.C. After the immigration of pine (mainly *Pinus sylvestris*, however *P. mugo* was also present) pine birch forests occupied the mountains up to an altitude of at least 1100 m a.s.l. This period, the end of which is stratigraphically well marked by the LST, corresponds to the Alleröd (AL). Later, during the Younger Dryas (DR 3), a pronounced lowering of the timberline, down to at least 750 m a.s.l., took place, resulting in a renewed spread of steppe tundra above that level. Finally, at the beginning of the Holocene, forests covered the mountains to the top, i.e. up to 1493 m a.s.l. (Fig. 2).

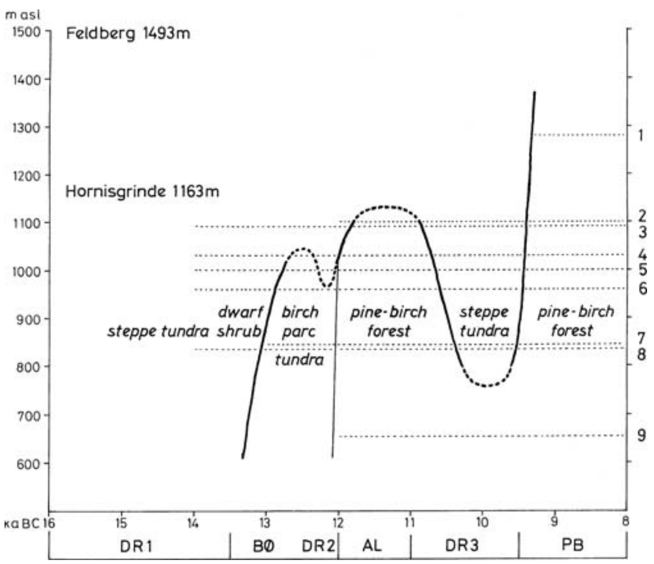

Fig. 2 Presumed fluctuations of the timberline in the Black Forest during the Late-glacial and early Holocene. Numbers on the right hand side refer to Table 1 and Fig. 1. Note that no radiocarbon dates are available for any of the pollen diagrams employed, yet all of them - with exception of no. 1- contain the LST as a time marker for the horizon 11 ka B.C.

The fluctuations of the timberline during the Late-glacial are clear indications of repeated changes of climate, particularly of summer temperature, because the timberline (in Europe) is mainly determined by summer temperature. Today the distribution limit of *Pinus sylvestris* in the European north as well as in the Alps seems to be correlated with the 12 °C-July isotherm (Firbas 1947; Dahl 1998). Hence an upper limit of pine in the Black Forest during the Alleröd at about 1100 m a.s.l., an altitude with a present July mean temperature of about 13 °C, indicates a depression of 1 °C during the Alleröd as compared with today. The pronounced lowering of the treeline during the following Younger Dryas down to about 750 m a.s.l., an altitude with a present July mean temperature of about 15 °C, indicates a depression of the July mean temperature of 3 °C compared to the present and a difference of about 2 °C between Alleröd and Younger Dryas.

How do these reconstructions of Late-glacial summer temperatures in the Black Forest correspond to others in neighbouring regions? Lotter et al. (2000), using transfer functions derived from pollen and cladocera, reconstructed for Gerzensee at the northern border of the Swiss Alps (603 m a.s.l., mean summer temperature at present 16.6 °C) a summer temperature (June/July/August) of 11–13 °C for the Alleröd and 9–10 °C for the Younger Dryas and thus a lowering of 3.6–5.6 °C for the Alleröd and 6.6–7.6 °C for the Younger Dryas as compared with today. Thus the difference between Alleröd and Younger Dryas is in the range of 1–4 °C. Lemdahl (2000), using the MCR method (Mutual Climatic Range) based on coleopteran assemblages from three sites at different altitudes in the Swiss Alps (Gerzensee 603 m, Leysin 1230 m, Zeneggen 1510 m) reconstructed a mean July temperature for (the end of) the Alleröd close to that of today and a lowering of 5–8 °C for the Younger Dryas. Heiri and Millet (2005), using transfer functions based on chironomid assemblages in Swiss lakes reconstructed from Late-glacial sediments of Lake Lautrey in the French Jura (788 m, mean July temperature 15 °C) a mean July temperature of 16.5–17 °C for the Alleröd and 14 °C for the Younger Dryas, hence warmer summers during the Alleröd than today. According to that reconstruction the difference between the Alleröd and the Younger Dryas amounts to 2.5–3.6 °C. von Grafenstein et al. (1999) analysed oxygen-isotope values of ostracod shells from sediments of the Ammersee in the northern alpine foreland southwest of Munich and reconstructed an annual temperature only slightly lower than today for the Alleröd (on the assumption that 1.7 °C corresponds to 1‰ $\delta^{18}O$) and a cooling of ca. 6 °C compared with today for the Younger Dryas.

Although some of these reconstructions differ considerably from each other - probably depending on the different indicators and methods - they all show a cooling during the Younger Dryas, however in the broad range of 1–8 °C compared with the preceding Alleröd. The reconstructed value of 2 °C cooling, based on the change in the timberline as presented in this paper, seems to fit adequately within this range.

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