



Last remains of fauna and flora shortly before the onset of the Last Glacial Maximum in the Alpine area



Martina Pacher¹, Markus Fiebig² & Anne Hormes³

¹Institut für Paläontologie, Universität Wien, Althanstraße 14, A-1090 Wien, martina.pacher@univie.ac.at

²Institut für Angewandte Geologie, Universität für Bodenkultur Wien, Peter Jordan Straße 70, A-1190 Wien, markus.fiebig@boku.ac.at

³Angströmlaboratory Uppsala University, Box 534, 7511 Uppsala, Sweden, anne.hormes@unis.no

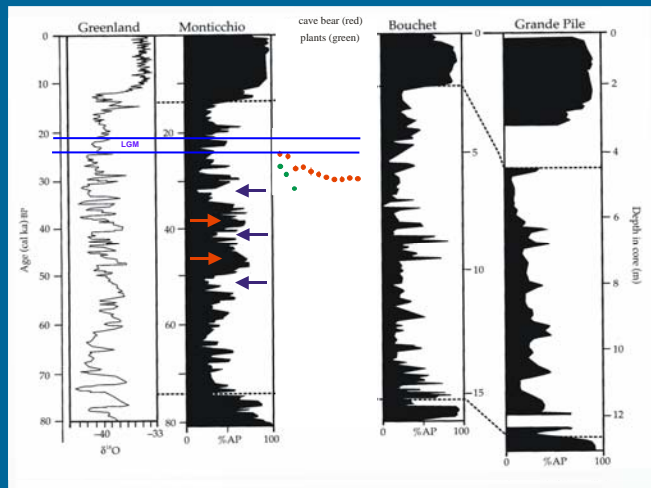
Problem: During the Last Glacial Maximum (LGM) large parts of the Alps were covered by ice and living conditions were dominated by this ice stream net and cold conditions. The local maximum ice extension during the last glacial cycle in the northern Alpine foreland was from 24,000-21,500 a cal. (after Preusser 2004) and correlates to the onset of Marine Isotope Stage 2 (MIS 24,000-11,500 a). Cave bear sites of the Alps mainly date into MIS 3 (65,000 – 24,000 a) but a few dates seem to be very close to the maximum extension of ice and hence would coincident with the growth of the glaciers. Dates from selected sites with bone or plant remains younger than 30 ka cal. are presented and shortly discussed.

Table 1 with map: Direct radiocarbon dates of cave bear samples and plant remains from the Alpine area closest to the onset of the LGM compared to Stadials (GS), Interstadials (GIS) and Heinrich-events (H). Dates after Blant et al. (2004), Morel & Schifferdecker (1997), Pacher (2003), Pacher et al. (2004), Perego et al. (2001), Perego (200), Preusser (2004), van Husen (2000).

Site	No. in map	a.s.l.	Lab.no	Dates (BP)	CalPal	paleoclimate
cave bear sites:						
Fontana Marella	(1)	1050	UZ-2512/ETH-5198	21810+/-200	24418+/-535	GS2 H2
Fontana Marella	(1)	1040	UZ-2513/ETH-5199	22310+/-300	24918+/-544	GS2
Grotta dei Pipistrelli	(2)	1040	ETH-18624	24340+/-200	27331+/-453	GS2 GIS3
Baume a Pirotas	(3)	680		24170+/-230	27117+/-408	GS2 GIS3
Gamsulzenhöhle	(4)	1300	VRI-1159	25090+/-640	27937+/-675	GIS3 GS3 GIS 4
Gamsulzenhöhle	(4)	1300	Hv-16893	25985+/-780	28602+/-605	GIS4 GS4 H3
Liegloch	(5)	1290	VERA-2184	26390+/-110	29067+/-141	GS4 H3
Bärenloch	(6)	1645	ETH	26520+/-240	29107+/-169	GS4 H3
Paradieshöhle	(7)	2200	Ua-16529	26850+/-500	29503+/-478	GS4 H3
Potocka zijalka	(8)	1700	Beta-143240	26900+/-110	29307+/-102	GS 4
Bame Roche Tiiloo	(9)	485	ETH-14919	26980+/-260	29381+/-172	GS4 H3
open sites with plant remains:						
Baumkirchen	(B)	681	VRI-16	26800+/-1300	29952+/-1475	GIS 3 GS 3
Baumkirchen	(B)	661	VRI-273	25500+/-600	28315+/-563	GS 3 GIS 4 GS 4
Albeins	(A)	800	Hv-1544	24000+/-210	26971+/-385	GIS 4 GS 4 H3



View of the Steinernes Meer from Saalfelden to the north (source: http://de.wikipedia.org/wiki/Bild:Saalfelden_Steinernes_Meer.jpg). Cave Bear remains were found just below the highest peaks at 2200 m of Steinernes Meer and dated at 29,500 a cal. In order to reach the site, the area must have been mainly ice-free. The local ice stream net reached a height of about 2000 m during MIS 2 (24,000-21,500 a).



The diagram (left) shows a comparison between calibrated cave bear and flora dates from Table 1 and arboreal pollen distribution in the profiles Monticchio and Bouchet (modified after van Andel, 2003:13) and GRIP ice-core data (red arrows – increase, blue arrows – decrease in arboreal pollen at Monticchio; red dots: cave bear sites (1-9 of Table 1) green dots: open sites with plant remains (A+B of Table1).

Discussion: While data for the last deglaciation are available for many sites, only few data exist for the onset of the LGM. Baumkirchen (B) and Albeins (A) point to ice free conditions in the Inn and Eisack valleys about 5000 a before the onset of the LGM. The same holds true for the youngest cave bear dates in high Alpine areas (e.g. Paradieshöhle, Steinernes Meer). The two cave bear dates closest to the LGM are from sites on the southern border of the Alps and thus not directly influenced by the ice build-up.

So far, there are two explanations of the available dates: 1) The dates argue for a rapid ice build-up from the inner Alpine area towards the Alpine foreland within about 2,500 a. Even the high Alpine areas were ice-free about 5000 a before the LGM with favourable climatic conditions for cave bears in high Alpine areas.

2) Limited calibration procedures for radiocarbon dates older than 24 ka advises caution using a single date for glacial and paleoclimatic reconstruction. Therefore, at least for Paradieshöhle new radiometric data are in progress (together with Gernot Rabeder & Doris Döppes).

Conclusion: The number of dates so far is too small to achieve a conclusive pattern of cave bear disappearance in the Alpine area. New dates are necessary in order to test the results of the partly old dated materials and the climatic situation during the ice build-up needs further investigation.

References:
Blant, M., Brallard, L. & B. Magnin 2004. Bärenloch (Jura, FR) Der letzte Schlupfwinkel der Höhlenbären in den schweizerischen Alpen? *Stalactite* 54(1): 30-47.
Morel, Ph. & F. Schifferdecker, 1997. Homme et ours des cavernes (*Ursus spelaeus*) au Pléistocène supérieur dans les grottes de l'Arc jurassien de Suisse occidentale: bilan et nouvelles données chronologiques. *Proceedings of the 12th International Congress of Speleology*, 1997, Switzerland, Volume 3:137-140, La Chaux-de-Fonds.
Pacher, M. 2003. Upper Pleistocene Cave Assemblages at Alpine Sites in Austria and adjacent regions. *Praistoria Alpina* 39: 115-118.
Pacher, M., Pohar, V. & G. Rabeder (eds.), 2004. Potocka zijalka – paleontological and archaeological results of the excavation campaigns 1997-2000. *Mitteilungen der Kommission für Quartärforschung der Österreichischen Akademie der Wissenschaften* 13, Wien.
Perego, R. 2003. Macromammiferi fossili rinvenuti nella Grotta dei Pipistrelli, Monte Baldo (Comune di Avio, Trento). Dati preliminari. *Ann. Mus. Civ. Rovereto* 18(2002): 153-170.
Perego, R., Zanatta, E. & A. Tintori 2001. *Ursus spelaeus* from Grotta di Fontana Marella, Campo di Fiori Massif (Varese, Italy): Morphometry and paleoecology. *Rivista Italiana di Paleontologia e Stratigrafia* 107(3): 451-462.
Preusser, F. 2004. Towards a chronology of the Late Pleistocene in the northern Alpine Foreland. *Boreas* 33: 195-210.
Van Andel, T.H. 2003. Glacial Environments I: the Weichselian Climate in Europe between the end of the OIS-5 Interglacial and the Last Glacial Maximum. In: van Andel, T.H. & W. Davies (eds.), *Neanderthals and modern humans in the European landscape during the last glaciation*. McDonald Institute Monographs, 265 p., Oxford.
Van Husen, D. 2000. Geological processes during the Quaternary. *Mitteilungen der Österreichischen Geologischen Gesellschaft* 92: 135-156.



Acknowledgements: The authors are especially indebted to Stefan Vogt, Carsten Ebenau and the members of the AK Kluterthöhle (www.kluterthoehle.de) for help and support.