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Trimlines and Fauna in the Eastern Alps during the Last Glacial Cycle

Zusammenfassung:

In der vorliegenden Arbeit werden die Rekonstruktionen der Eisausdehnung in den Ostalpen während des letzten Vereisungszyklus angesprochen. Die Möglichkeiten einer Einbeziehung direkter radiometrischer Daten von Höhlenbären zur Rekonstruktion von Aufbau und Abbau des Eises werden diskutiert.

Abstract:

The paper gives an insight into the reconstruction of ice extent in the Eastern Alps during the last glacial cycle. The possibility of correlation between direct radiometric data from cave bear remains and ice advance and retreat is discussed.

Résumé:

Le travail présent le résumé de la reconstruction de l'extension glaciale dans les Alpes de l'est pendant le dernier cycle glacial. Nous allons discuter la possibilité d'une corrélation des dates radiométriques directes des ours des cavernes pour reconstruire l'avancement et la diminution de la glace.

Key words: Ice extent, last glacial cycle, Eastern alps, cave bears

Introduction

Our knowledge of the Last Glacial Maximum (LGM)-ice surface in the Eastern Alps between 24 to 19 ka is based on the comprehensive work of VAN HUSEN (1987). He also provided a temporal development of the ice extent during the last glacial cycle (VAN HUSEN 2000). His reconstruction is detailed and very well supported by field evidence for the ice break down. On the other hand, information about the ice build up and the Wuermian fluctuations are sparse and less well supported.

The fluctuating global ice volume of the last glacial cycle is mirrored in a non-linear fashion by dated coral reef terraces and marine $\delta^{18}O$ (CHAPPELL

& Shackleton 1986, Linsley 1996). Bintanja et al. (2002) provided information about the Eurasian contribution to global ice-volume changes by sophisticated modelling.

The ice extent in the Eastern Alps during the last glacial cycle is not well known. Direct dated fauna elements may therefore serve as a proxy for the reconstruction of ice-free conditions.

Fauna evidence

Throughout the Alpine region, cave bears were the most abundant species during the Late Pleistocene. Up to now, about 40 major cave bear sites are known in the Eastern Alps and adjacent regions (see Döppes & Rabeder 1997, Pacher 2003).

Several sites lie within or at the margin of the maximum ice extent (Fig. 1). The majority of sites lie within the Northern Calcareous Alps. Only Conturines cave and Apollo cave lie more in the central part of ice-covered area. The distribution of the cave sites can be explained by the occurrence of karstic rocks but was also influenced by glacier advance and retreat through time.

More than hundred radiometric dates have already been obtained on Alpine cave bears. The bulk of data was possible due to financial support by the Austrian Academy of Sciences. Next to cave bears, direct radiometric evidences of „associated" fauna elements such as cave lion, wolf, and wolverine are available for the Eastern Alps. The dates range from beyond dating limits to the onset of the LGM (Pacher 2003).

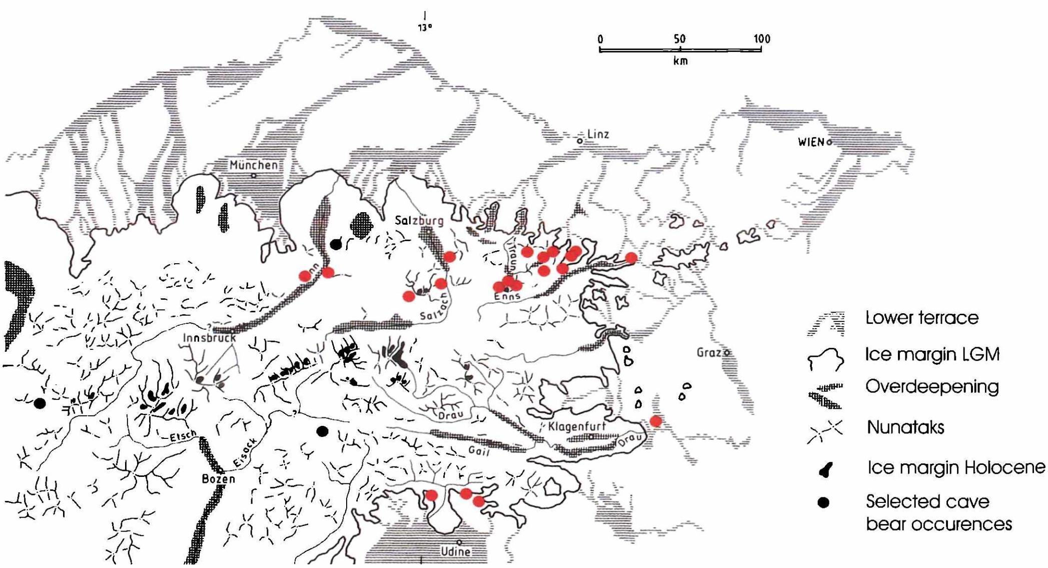
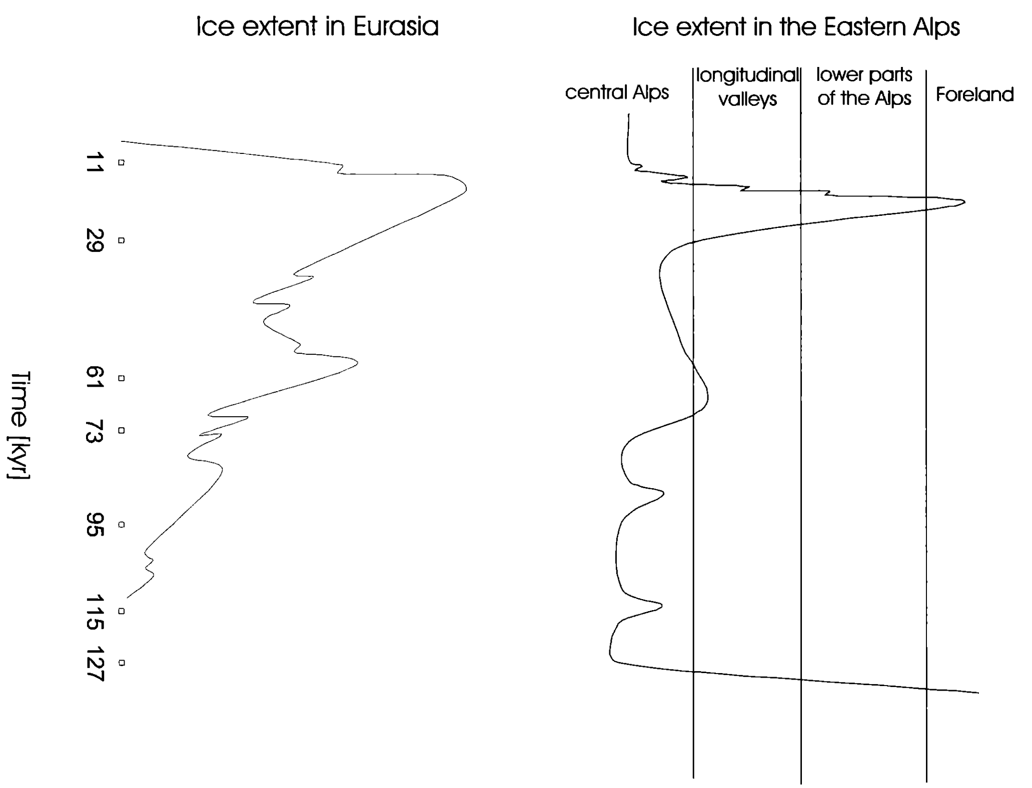


Figure 1: Map of glacier extent in the Eastern Alps during the LGM after van Husen (1987). Dated cave bear remains (red dots) document animals inside of the maximum glacier extent. The knowledge about the fluctuations of the ice margin during the glacial cycle and the distribution of the fauna in the area is still very incomplete.

Discussion and implications

Ursus spelaeus was mainly herbivorous and used caves to hibernate (RABEDER et al. 2000, LIDÉN & ANGERBJÖRN 1999). Thus, evidence of cave bears in Alpine regions requires glacier-free conditions at a certain time. The bears must have been able to reach the cave entrances (e.g. Potočka zijalka, PACHER et al. 2004). Similar arguments are used for the human occupation of the Alpine region. This basic assumption runs through the history of palaeontological investigations of the Alps, although our knowledge about the glacial cycle changed considerably through times.
PENCK & BRÜCKNER (1909) found evidences of four ice ages interspersed by three interglacial periods. Certain faunal and archaeological remains in the Alpine region combined with an evolutionary concept of cultures made it necessary to think of at least one warmer period within the last glacial cycle. The next major step in the investigation of the glacial cycles came from Milankovitch, who first introduced the ideas of several phases of climatic changes based on astronomical parameters (RABEDER et al. 2000). Today, the investigation of the „ice-ages" is strongly based on the results from the ice core drillings and marine sediments from the ocean floor. The ice cores show a high frequency of cold and warm oscillations called Dansgaard-Oeschger events (see WEISSMÜLLER 1997; VAN ANDEL 2002).
Our knowledge of climatic changes and ice build up and down is far less detailed in the Eastern Alps. Evidence of significant ice advances in the

Figure 2: With sophisticated calculations BITANJA et al. (2002) modelled the ice storage on the Eurasian continent during the last glacial cycle (left diagram). On the base of few local information points VAN HUSEN (2000) developed a first approach to the ice fluctuations in the Eastern Alps (right diagram). The general ice increase on the continent displayed in the left diagram is not mirrored in the right diagram. Differences in behaviour of the small Alpine ice cap and large inland ice accumulations are likely.



Alps during the early part of the last glacial cycle is reported (e.g. PREUSSER 2002, FIEBIG & PREUSSER 2003, PREUSSER & SCHLÜCHTER 2004). The extent of these advances has been reconstructed at only very few places and an attempt to model the variation is missing.

The evidence of cave bears at higher altitudes documents interstadial phases of climatic amelioration with glacier retreat during the last glaciation. Based on results from the Ramesch-Knochenhöhle in Upper Austria even interglacial conditions between 64,000 and 31,000 years BP have been assumed (RABEDER et al. 2000). As only another report for such warm conditions exists (SPÖTL et al. 2002), the interglacial conditions are still questioned (e.g. PREUSSER 2004). After VAN HUSEN (2000), the ice extent was confined to the Central Alps during this period.

BINTANJA et al. (2002) suggested extensive glaciation in Eurasia (between 25 and 43 m sea level equivalent) but it is unknown how much of this calculated Eurasian ice volume was stored in the Alps (compare Fig. 2).

Additionally, periods of flowstone growth are another climatic proxy in the Alpine region (ROSENDAHL et al. 1998, SPÖTL et al. 2000). Formation of dripstone is dependant on milder and more humid conditions allowing an increase in dissolution of calcite rocks and a higher density of vegetation cover on top of the caves.

A correlation between human and faunal occupation of the Alpine region, climatic conditions and ice extent is evident. The youngest dates produced by cave bear bones from the Alpine region are from the onset of the LGM (see PACHER 2003, MOREL et al. 1997) while the species survived longer in lower regions. Nonetheless, a compilation and detailed analysis of all data is still missing. Radiometric data need a critical revision of their reliability and the position of each cave in relation to ice surface elevation needs to be analysed.

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