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Where does the Iceman come from?

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ABSTRACT - Palaeoethnobotanical analyses of the wood remains and the mosses found with the Iceman as well as the food residues of his colon produce new evidence of his diet, environment and season of death. The dendroecological investigations of the wood species and the bryological investigations of the mosses of the Iceman show a clear trend that he lived in the valleys South of the main Alpine range.

Key words: Iceman, Palaeoethnobotanical analyses, Dendroecological investigations
Parole chiave: Uomo dei Ghiacci, Analisi paleoetnobotaniche, analisi dendroecologiche

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1. INTRODUCTION

The discovery of the Iceman in the snowy area of the Ötz Valley, far from human settlements, gave rise to many scientific queries including his vital space. The main Alpine range on which he was found suggests two theories: a) his settlement was to be located North of the range either in the Ötz Valley or in the Inn Valley; b) his settlement was to be located South in the Schnals Valley or in the Venosta Valley.

Both of these hypothesis are discussed as well as the respective findings. GROENMAN-VAN WATERINGE (1992) claims that, on the basis of the pollen spectrum on the remains of the clothing of the Iceman, he came from North because the pollen on the fur reflects the mountain vegetation North of the main Alpine range. On the other hand, the archaeological evaluation of the artefacts suggests that the man belonged to a South Alpine cultural group (PRINOTH-FORNWAGNER & NIKLAUS 1995).

The following archaeobotanical findings provide information in order to reconstruct and therefore localize the vital space of the Iceman.

2. METHODOLOGICAL ASPECTS

The reconstruction of the vital space is deducted on the basis of three sources of data from the finding place.

The first series of data consists of dendrological analysis of the wooden artefacts, wood and charcoal particles that were discovered during excavations or whilst cleaning the objects. The ecological assessment is based on the hypothesis that wood during the Neolithic phase was an important raw material for the production of every day objects. Great quantities of this raw material must have been available and therefore it must have been easily found in the neighbourhood. The wood species partially reflects the vegetation of his environment.

The second group of data consists of mosses that were found on the clothes of the Iceman. The third series of data were provided by the body of the Man and particularly from the analyses of the food remains found in his colon. These contained macro- and microfossils that provide information on his diet and the surrounding habitat immediately before his death.

3. RESULTS

3.1. *Dendrological analyses*

Thirteen different species were found uncarbonized. Nine of these were used for the production of weapons and other objects found. One was used for binding things and the purpose of the other three objects we do not know. All the types of timber found are obviously diffused in the investigated area (Tab.1). Montane species are predominant but there are also types of wood that are diffused in the subalpine and alpine areas. The classification of the timber analysis is summarized in Fig.1.

Other information is provided by the wood particles found in the residues obtained while cleaning the objects and from a leaf sample (n.91/139). There are eight different types of charcoal species (Fig.2): spruce *(Picea/Larix* type*)*, pine *(Pinus mugo* type*)*, maple tree *(Acer)*, green alder *(Alnus viridis)*,a Pomoideae, probably juneberry (cf. *Amelanchier ovalis)*, birch *(Betula)*, dwarf willow *(Salix reticulata*-type*)* and elm *(Ulmus)*. Quantitatively spruce *(Picea/Larix* type*)* is the most abundant species. Sorted by species occurrence there are the same amount of montane and subalpine species (Tab.1).

3.1.1. *Interpretation of the dendrological results*

The 13 taxa documented have a circumpolar or alpine distribution, which, on a larger scale, do not permit any conclusions about their origin to be drawn. The smaller-scale distributional spectra of the woody species, however, do reveal certain differences, since the individual species extend to the inner alpine region to different degrees. These local phytogeographic differences in the diffusion of the single species are documented (DALLA-TORRE & SARNTHEIN, 1900) and provide indications as to the origin of the Iceman.

The phytogeographical evaluation provides a heterogeneous picture. Species of all the vegetation zones are represented. Montane types are obviously predominant, while the alpine and subalpine species are less represented (Tab.1). Fragments of the snow bed communities characterized by the dwarf willows *(Salix reticulata-* type*)*, which are typical of the alpine and nival zone where the Iceman was found. The subalpine species including the dwarf mountain pine *(Pinus mugo)*, Swiss stone pine *(Pinus cembra)* and the green alder *(Alnus viridis)* as well as the montane species were probably brought there by the Iceman as these types of woods never reached the height of 3200m during the Holocene (BORTENSCHLAGER, 1992).

Spruce *(Picea abies)*, which is typical of the woody area taken into consideration, is the most abundant species. With regard to the types of trees, the montane species are more common. The species that were used in making the artefacts all come from the montane forest environments. In particular woods of oak species *(Quercetalia pubescenti-petraeae)* (Tab.2) that live in warm environments prevail, along with broad-leaved trees and woods *(Fagetalia)* and above all types of wild plum trees and bushes *(Prunetalia)*.

The Norway maple *(Acer platanoides)*, the yew *(Taxus baccata)*, the ash *(Fraxinus excelsior)*, the lime *(Tilia)* and the elm *(Ulmus)* suggest woody slopes or gorges with a local humid climate and cool ground or variably humid grounds rich in nourishing elements. Thermophilous species like dawny oak *(Quercus pubescens)* or manna ash *(Fraxinus ornus)* are not present in the spectrum. Species that live in dry environments like the juneberry (*Amelanchier ovalis*), wayfaring tree *(Viburnum lantana)*, dogwood (*Cornus)* and possibly the bast-small-leaved-lime *(Tilia cordata)* along with the spruce *(Picea abies)*, the larch *(Larix decidua)* and pine *(Pinus)* recall the transition area between thermophilous oakwoods *(Quercetum pubescentis)* and the montane spruce forests *(Piceetum montanum)* (Tab.2).

Even the diffusion of these species in the forest North and South of the main Alpine range differs. Towards the North of the finding place in the Ötz Valley and the Inn Valley, the climate and soils are ideal for spruce *(Picea abies)* and pine *(Pinus)*. The more demanding type of deciduous forests *(Querco-Fagetea, Quercetea robori-petreae)* can only be found in limited areas and cannot spread because of the surrounding areas that are subject to frost. On the other hand the broadleafed trees *(Quercetalia pubescentis)* that prefer a warm habitat are well diffused in the valleys South of the main Alpine range. In the lower Venosta Valley and in the narrow entrances of the valleys and the gorges that stretch from North to South, these types of woods are found up to 1100m altitude (PEER, 1982). Considering this situation, the settlement of the Iceman was probably in the lower part of the Venosta Valley or at the beginning of the Schnals Valley.

These results are confirmed by the bryologic analysis of the mosses found with the Iceman. Even the phytogeographical evaluation of the mosses and in particular of the *Neckera* species suggests that the southern species are more common (DICKSON *et al.*, 1996).

3.2. *The colon sample*

The third series of data for the reconstruction of the vital space is provided by the body of the Iceman. Pollen and plant macrofossil analysis carried out on the food remains found in the colon of the mummy supply specific indications as to the habitat the Iceman lived in, immediately before his death. The vegetal remains of the faeces provide more reliable data than the artefacts, as the micro- and macrofossils were ingested a short while before the death. The remains of the colon sample (Fig.3) consist of cereals, charcoal and mineral particles, pollen, diatoms and whipworm eggs *(Trichuris trichiura).*

The macroremains (Fig.4) consist mainly of einkorn bran *(Triticum monococcum)* and chaff that can clearly be seen from the tubular cells of the seed hulls. Small testa remains (<125m) are predominant, which suggests the presence of a finely processed grain. As well as einkorn *(Triticum monococcum)*, there are also muscle fibres and parts of carbonized bones suggesting that meat was also eaten.

The pollen flora (Fig.5, spectrum 1) found in the food remains is much more divers than the macrofossils. Thirty types of pollen, two of spores and 16 diatoms are documented. It is surprising that the tree pollen represents 84% of the total amount and the non arboreal pollen adds up only to 16%, because it would seem obvious that herb pollen is more abundant than tree pollen considering of all the edible herbaceous plants. In order to understand this, it has to be considered, how the pollen flora in the intestines comes to existence. The taphonomy of the pollen spectrum of the intestines is complex and the pollen can derive from many sources. This is why the pollen has to be classified in artificial groups depending on how the body assimilates it (Bryant, 1974; Bryant & Holloway, 1983; Reinhard & Bryant, 1992). Two classes are distinguished: 1) economic pollen, that stick to edible plants and are intentionally ingested; 2) background pollen, that is airborne and is unintentional ingested when breathing or when drinking water.

3.2.1. *Economic pollen*

This category includes pollen of cereals (*Cerealia* type) and legumes *(Papilionaceae)* that represent cultivated plants, as well as Chenopods (*Chenopodiaceae)*, greater plantain *(Plantago major* type*)*, Lady´s thumb (*Polygonum persicaria* type), sheep´s sorrel (*Rumex acetosella)* and nettles *(Urticaceae)* that grow like weeds in fields or rural areas near settlements. These pollen probably stuck to edible plants that were consequently eaten.

3.2.2. *Background pollen*

The remaining pollen is classified as background pollen. The criteria of this classification are: wind dispersal, their very small amount in the occurrence of honey in the Alpine area (Vorwohl, 1972) and the low pollen concentration.

The spectrum (Fig.5) represents a deciduous forest with hop-hornbeam *(Ostrya carpinifolia)* dominating and an admixture of birch *(Betula)*, hazel nut *(Corylus avellana)*, spruce *(Picea abies)*, and pine *(Pinus)*. As the hop-hornbeam *(Ostrya carpinifolia)* is distributed naturally only in the southern alpine valleys, this tree is a good indicator to the location of the settlement of the Iceman.

In order to compare this colon pollen sample with the inneralpine vegetation, it is compared to six other recent pollen surface spectra taken from a North-South transect of the research area (Fig.5, spectrum 2-7). As the pollen spectrum from the colon has a strong local component, it cannot be related directly to the recent pollen spectra. Nevertheless, some conclusions can be made:

- the pollen does not derive from the ice of the find spot, therefore melting water as a possible pollen source can be excluded;
- the pollen of the hop-hornbeam *(Ostrya carpinifolia)* is distributed only south of the main Alpine range and indicates the typical vegetation of the Venosta Valley and of the lower part of the Schnals Valley;
- the hop-hornbeam pollen *(Ostrya carpinifolia)* is not intentionally absorbed, because the use of hop-hornbeam pollen for dietary or medical purposes is unknown for Europe, contrary to America. Furthermore, the concentration of the pollen in the food residue (9,300 pollen grains per gram) is too low for an intentional consumption.

Therefore, the pollen of the hop-hornbeam *(Ostrya carpinifolia)* gives a strong suggestion that the Iceman stayed in the thermophilous deciduous forests of the Schnals or Venosta Valley immediately before his death.

The diatoms in the food residue provide information on how these pollen were ingested. All the types documented come from fresh water and suggest that most of the background pollen was swallowed with water (Rott, 2000).

4. CONCLUSIONS

Both the evaluation of the dendrological and bryological analyses and the coprolites contained in the intestines prove that the vital space of the Iceman was probably South of the main Alpine range. In particular the large quantity of the hop-hornbeam *(Ostrya carpinifolia)* pollen found in the food remains in the large intestine proves that the settlement of the Iceman is located in the lower Venosta or Schnals Valley, where he stayed immediately before dying. This can be determined because the microgametophyte was still preserved in the hop-hornbeam pollen. The exceptional preservation of the inner components of the pollen, which are usually easily disintegrated, provides further indications to the Iceman's life circumstances:

- the pollen was ingested by the Iceman during or very soon after the flowering season of the hop-hornbeam *(Ostrya carpinifolia)*;
- the *Ostrya* pollen did not remain in the intestine for a long time otherwise the cell contents would have been digested (LINSKENS & JORDI, 1997);
- it is therefore presumed that the Iceman died in spring or at the beginning of the summer. This is in accordance with the evaluation of the flowering seasons of the other arboreal pollen from the food residue. Furthermore, pollen of taxa, which flower in the autumn, are missing in the colon spectrum.

SUMMARY - Palaeoethnobotanical analyses of the wood remains and the mosses found with the Iceman as well as the food residues of his colon produce new evidence of his diet, environment and season of death. The dendroecological investigations of the wood species and the bryological investigations of the mosses of the Iceman show a clear trend that he lived in the valleys South of the main Alpine range. The best indication of the Iceman´s provenance deliver the coprolite analyses of the food remains from his colon. The most registered species in this pollen spectrum belongs to the hop-hornbeam (*Ostrya carpinifolia*), which has a restricted distribution to the valley bottoms South of the main Alpine range. The more so, that the microgametophyte was still preserved within these pollen grains, it proofs, that the pollen became incorporated in the intestines within a short time after being released from the inflorescences. The flowering season of the hop-hornbeam (*Ostrya carpinifolia)* and of the residual pollen taxa in his colon indicate that the Iceman died in early summer at the latest.

RIASSUNTO - Le analisi paleoetnobotaniche dei resti lignei e dei muschi trovati insieme al corpo dell'uomo del Similaun così come dei resti di cibo presenti nell'intestino colon, forniscono nuove indicazioni sulla dieta, ambiente e stagione della morte dell'individuo. Le ricerche dendroecologiche delle specie lignee e le ricerche briologiche dei muschi mostrano che l'uomo visse nelle valli a sud del principale arco alpino. La indicazione migliore è data dall'analisi dei resti di cibo presenti nell'intestino colon. Le specie di pollini maggiormente presenti appartengono a *Ostrya carpinifolia* che ha una distribuzione ristretta alle valli meridionali dell'arco alpino. Inoltre, risulta evidente che il polline rimase nell'intestino per un breve periodo di tempo. La stagione della fioritura e la percentuale di polline residuo nel colon indicano che l'uomo del Similaun morì non oltre l'inizio dell'estate.

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Woody plant species	Distributional area	Altitudinal zone	Venosta Valley	Ötz Valley
European Yew, *Taxus baccata*	central European	montane	-	-
Norway Maple, *Acer platanoides*	central European	montane	+	-
Common Ash, *Fraxinus excelsior*	central European, submediterranean	montane	+	+? introduced
Juneberry, *Amelanchier ovalis*	central European, Alps	montane	+	+
Dogwood, *Cornus*	central European, submediterranean	montane	+	+
Hazel, *Corylus avellana*	central European	montane	+	+
Lime, *Tilia*	central European	montane	+	+
Elm, *Ulmus*	central European	montane	+	+
Wayfaring Tree, *Viburnum lantana*	submediterranean	montane	+	+
Scotts Pine, *Pinus sylvestris*	subboreal	montane	+	+
Larch, *Larix decidua*	boreal	(montane), subalpine	+	+
Norway Spruce, *Picea abies*	boreal	montane - subalpine	+	+
Swiss Stone Pine, *Pinus cembra*	boreal	subalpine	+	+
Dwarf Mountain Pine, *Pinus mugo*	central European - alpine	subalpine, alpine	+	+
Birch, *Betula sect. albae*	boreal	montane - subalpine	+	+
Green Alder, *Alnus viridis*	boreal-subalpine	subalpine	+	+
Dwarf Willow, *Salix reticulata*-Type	arctic-alpine	alpine	+	+

Tab.1 - Inneralpine distribution of the wood species found in the Venosta Valley and the Ötz Valley

Table 2:

	Dawny Oak forests	Oak forests	Pine forests	Spruce forests	Gorges	Alluvial forests	Hedges, Forest fringes	Timberline	Krummholz	Snow bed communi-ties
Ötztal <100km	①	◆	◆	◆	①	◆	◆	◆	◆	◆
Vinschgau <25km	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Taxus baccata	②				②					
Picea abies				◆		◆				
Larix decidua				◆				◆		
Pinus cembra								◆		
Pinus mugo/sylvestris	◆	◆	◆	◆					◆	
Salix reticulata										◆
Alnus viridis					◆				◆	
Betula sect.Albae		◆	◆	◆				◆		
Corylus avellana	◆				◆	◆	◆			
Ulmus	◆				◆	◆	◆			
Amelanchier ovalis	◆	◆	◆				◆			
Acer platanoides					②	②				
Cornus	◆	◆				◆	◆			
Fraxinus excelsior	◆				◆	◆				
Viburnum lantana	◆		◆				◆			
Tilia	◆	◆			◆	◆				

Tab.2 - Dendroecological results of the wood analyses: ① woodlands which do not occur in the Ötz Valley, ◆ woodlands and species distributed on both sides of the main Alpine range, ②, species which occur only in the valley bottoms south of the main Alpine range

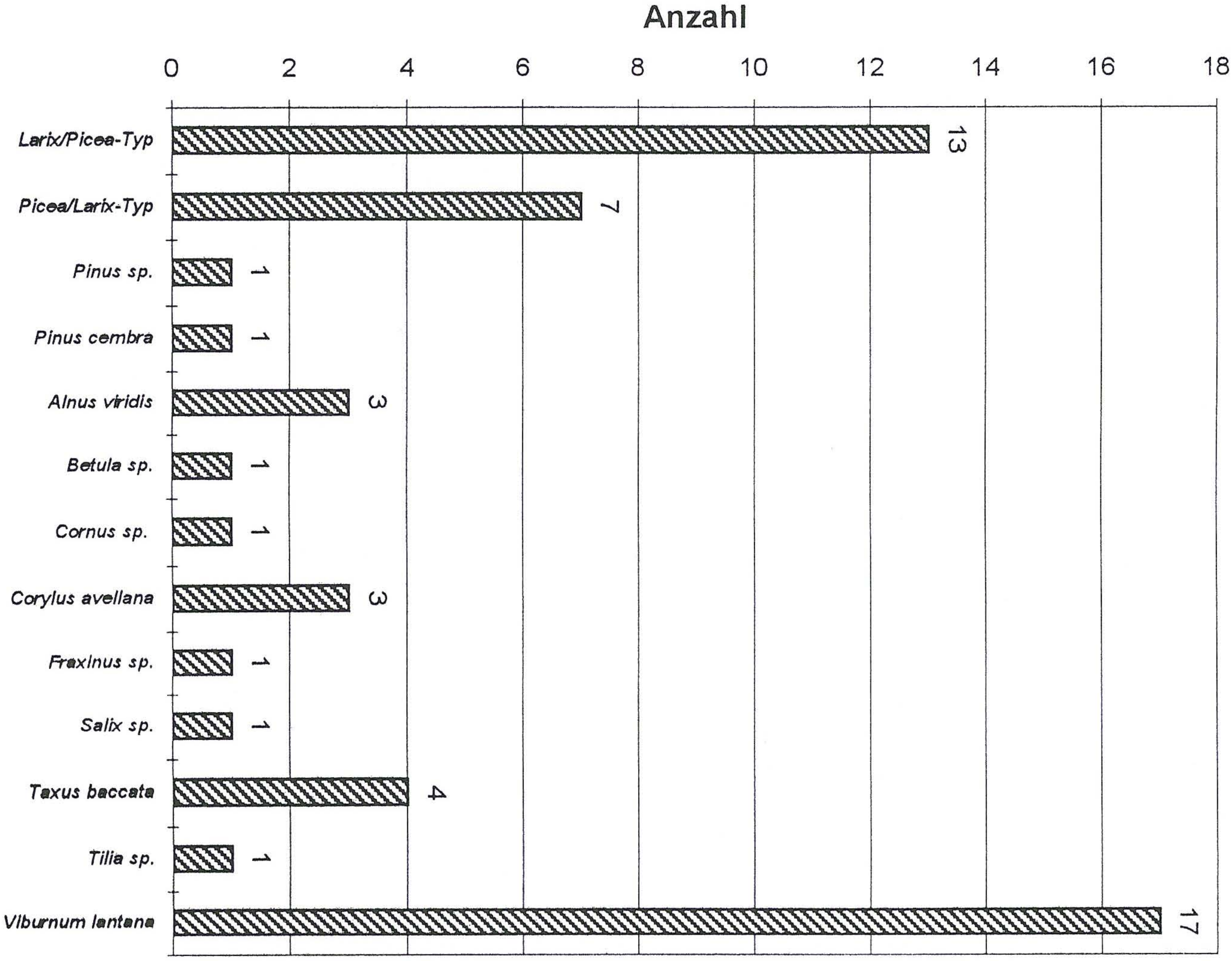

Fig. 1 - Results of the wood analyses: spectrum of the uncharred wood species (artefacts and other wood found at the site)

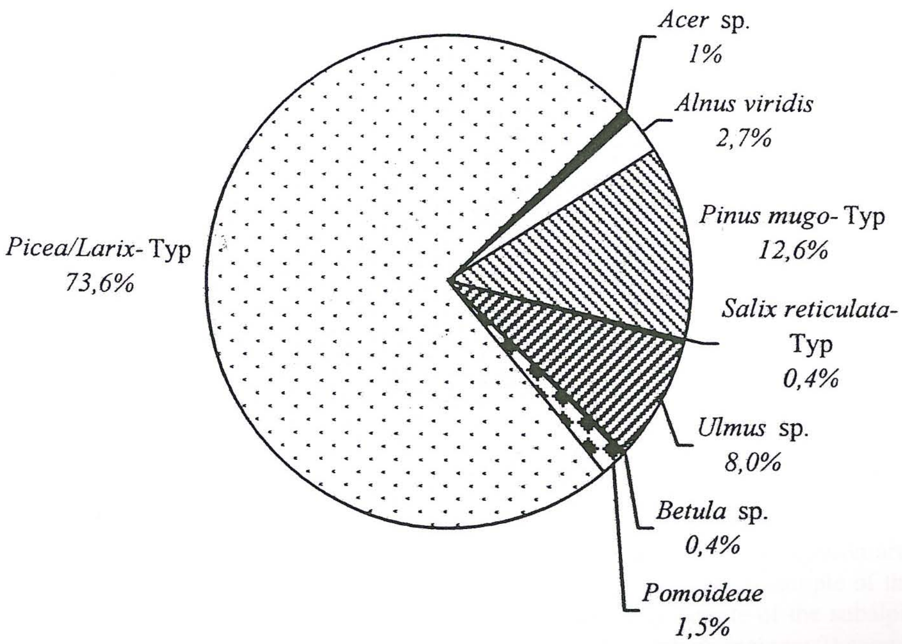

Fig. 2 - Results of the charcoal analysis

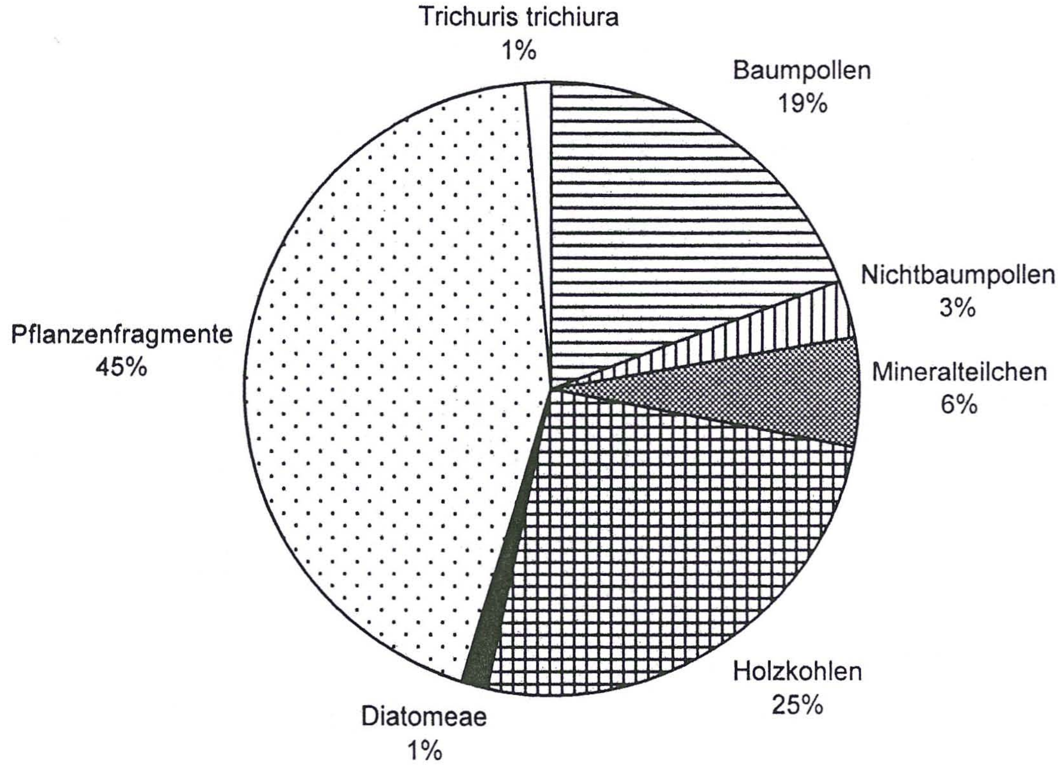

Fig. 3 - Colon content

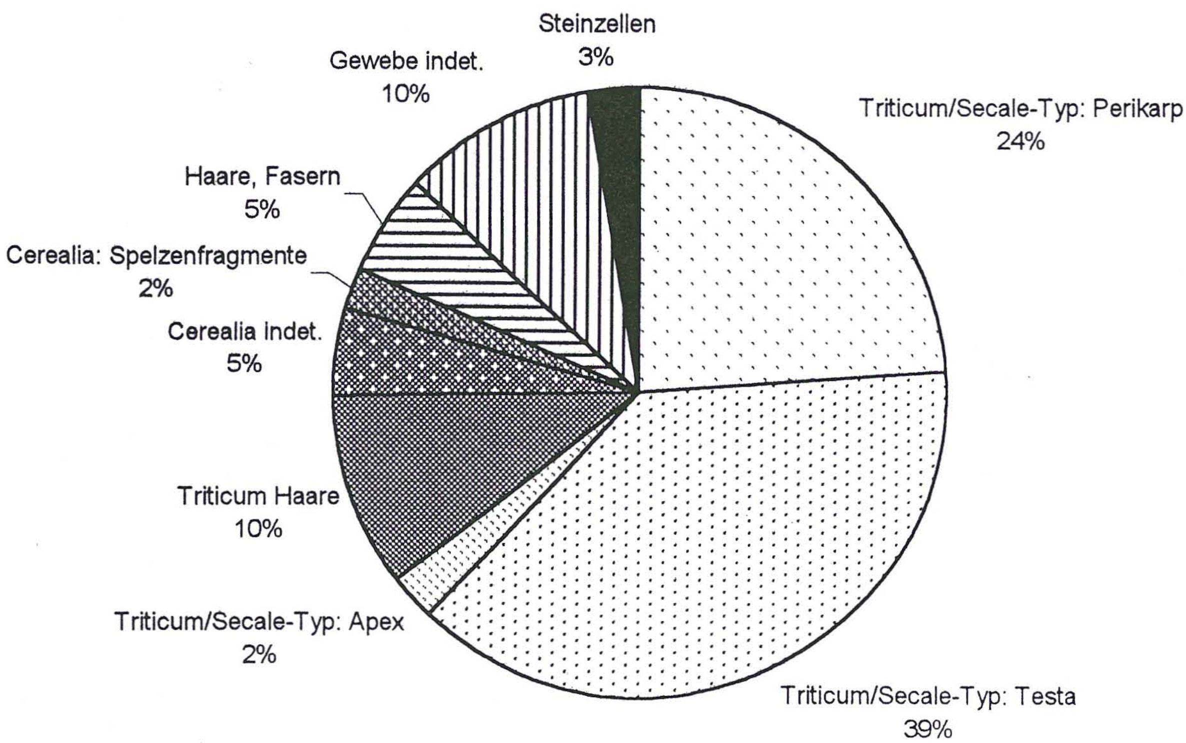

Fig. 4 - Plant remains of the food residue from the colon

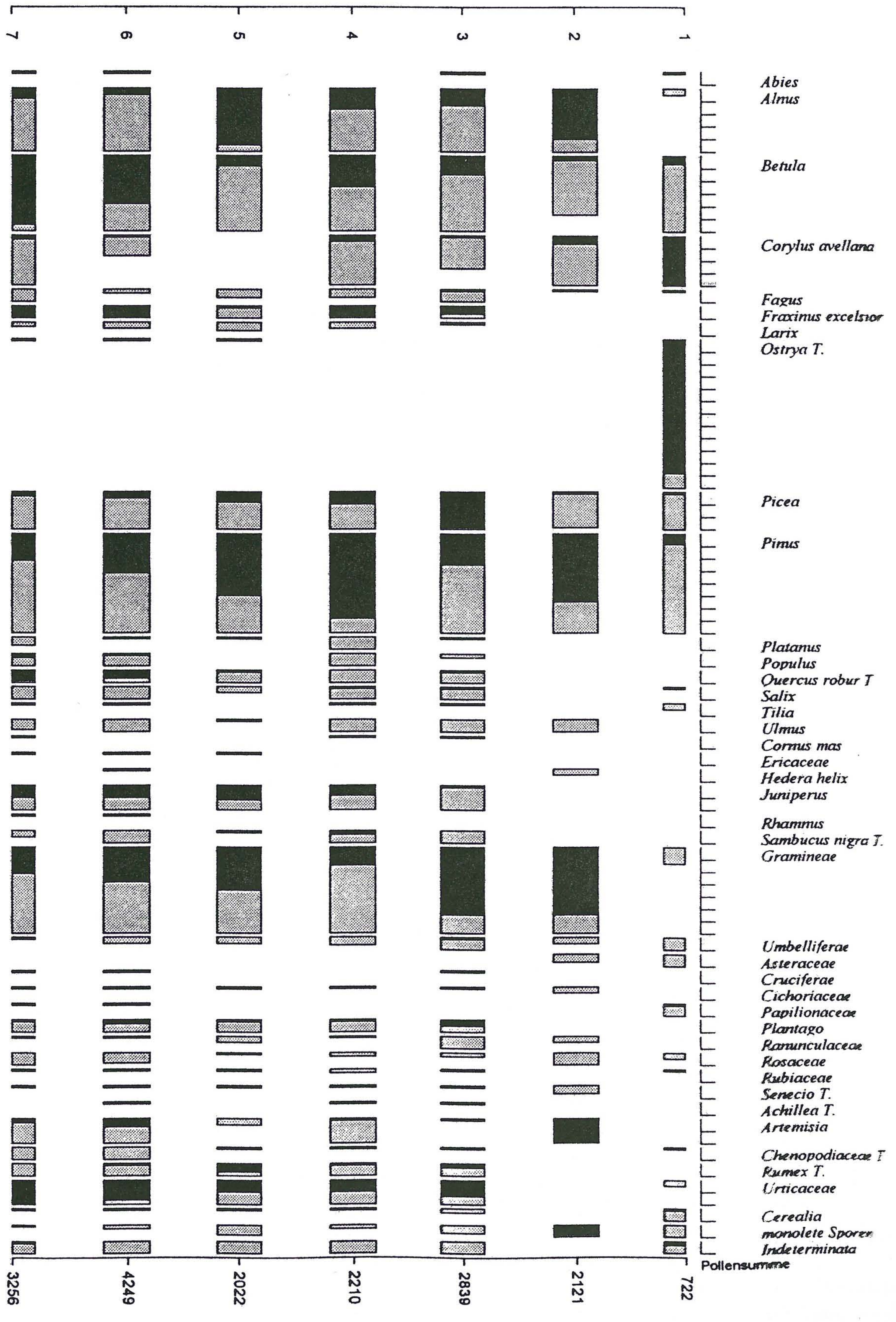

Fig. 5 - Comparison of the colon pollen spectrum with recent pollen spectra from the investigation area along a North-South transect of the Eastern Alps: 1) colon sample; 2) ice sample from the find spot; 3) sample of the northern alpine border zone: montane regions; 4) sample of the montane regions in the Inntal; 5) sample of the subalpine regions in the Ötz Valley; 6) sample of the southern inneralpine zone (Venosta Valley, Italy): montane regions; 7) sample of the southern inneralpine zone (Bozen, Italy): montane regions. (scale reading: 1 graduation mark means 5%)