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Was the Neolithic Tyrolean Iceman "Ötzi" a shepherd?

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Abstract

The unique discovery of the glacier mummy on such a remote site in the Ötztal mountains is still an enigma. In the initial phase of the Iceman research, four hypotheses - the hunter, shaman, metal prospector and shepherd theories - were proposed to explain the find in its entirety. On the basis of detailed scientific investigations conducted in the meantime, the assumption that the Iceman was involved in an early form of transhumance has now gained general acceptance. Recently coprolite analysis was conducted on a hundred caprine dung pellets found at the Iceman's find spot and dated from 5400 to 2000 BC. The lack of caprine faeces from valley bottoms as well as the absence of dung pellets at the find spot between 3700 and 2900 BC questions the practice of transhumance in the area during the Iceman´slifetime and for this reason also his social status as a shepherd.

Introduction

The discovery of the Neolithic Iceman "Ötzi" at 3,200 meters above sea level in the Ötztal Alps (Fig. 1) raised a lot of questions about his origin and activities. "What was he doing at the high mountain pass, where he died?" The image of Ötzi encompass ideas that he was a shepherd, a hunter, a traveller, an outlaw, a trader of flint, a shaman, a miner or a warrior (Dickson et al., 2003). Now the hypothesis that the Iceman was a shepherd has gained general acceptance (Spindler, 1996) and is supported by pollen analyses (Bortenschlager, 2000) indicating that the alpine grasslands in the Ötztal have been pastured even 1,000 years before the Iceman's lifetime. Up to the present, flocks of sheep are driven up to these pastures during summer time, and even subfossil dung pellets of different ages from the Iceman's site indicate that caprines have frequented the area during prehistoric times (Kutschera & Müller, 2003).

At the Institute for Molecular Biosciences, University of Queensland/Australia DNA analyses of intestinal wall cells extracted from the coprolites were intended to indicate

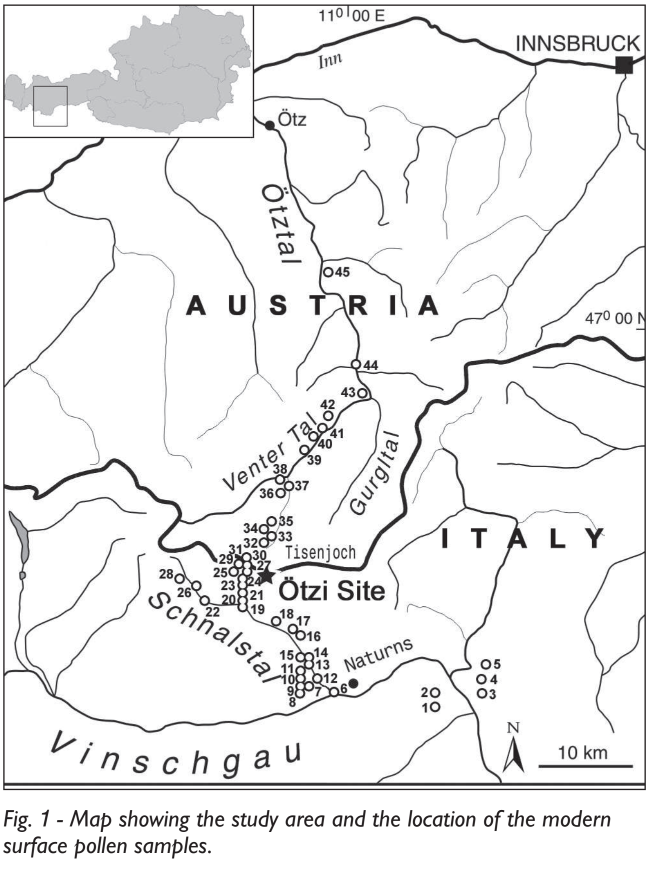

Fig. 1 - Map showing the study area and the location of the modern surface pollen samples.

which kind of animal had produced the subfossil faeces. These molecular biological investigations produced no results. Thus, recent pollen and macrofossil analysis of these subfossil dung pellets should crutinise whether the dung derives from livestock - sheep (*Ovis orientalis* f. *aries*)/goat (*Capra aegragrus* f. *hircus*) - or game – ibex (*Capra ibex*)/chamois (*Rupicapra rupicapra*). In general, studies by Akeret and Jacomet (1997), Carrion (2002), Moe (1983), Vermeeren and Kuijper (1996) and Vermeeren (1998) assumed that pollen and seed content of preserved excrement reflects the habitat and season of consumption of the animals. Therefore, dung pellets derived from zoo-anthropogenic habitats would suggest prehistoric transhumance in the Ötztal Alps.

nr	locality	altitude m a.s.l.	vegetation type
1	Marling	400	Orno-Ostryetum
2	Marling	400	Orno-Ostryetum
3	Meran	600	Quercetum pubescentis
4	Meran	600	Orno-Ostryetum
5	Meran	600	Orno-Ostryetum
6	Juval castle	800	Quercetum pubescentis
7	Juval castle	850	Piceetum montanum
8	Juval castle	850	Piceetum montanum
9	Juval castle	850	Piceetum montanum
10	Irrigation canal vis-à-vis Ladurn	900	Piceetum montanum
11	Walchhof	950	Corylo-Populetum
12	Ladurn	800	Quercetum pubescentis
13	Katharinaberg	1100	Arrhenateretum
14	Katharinaberg	1400	Festuco-Laricetum
15	Barracks below Katharinaberg	1050	Corylo-Populetum
16	Entrance of the Pfossen vallex	1300	Piceetum montanum
17	Brugghof	1400	Trisetetum flavescentis
18	Unser Frau	1500	Festuco-Laricetum
19	Vernagt	1700	Trisetetum flavescentis
20	Tisenhof	1750	Trisetetum flavescentis
21	Tisenhof	1800	Trisetetum flavescentis
22	Gerstgräser forest	1800	Larici-Pinetum cembrae
23	Tisental	1900	Larici-vaccinietosum
24	Tisental	2000	Larici-vaccinietosum
25	Tisental	2100	Rhododendretum-extrasylvaticum
26	Kurzras	2150	Larici-Pinetum cembrae
27	Tisental	2200	Rhododendretum ferruginei
28	Langgrubtal	2100	Larici-Pinetum cembrae
29	Tisental	2400	Rhododendretum ferruginei
30	Tisental	2500	Caricetum curvulae
31	Tisental, at the moraine of the rock glacier	2600	Caricetum curvulae
32	Am Soom	2400	Caricetum curvulae
33	Martin Busch hut	2510	Caricetum curvulae
34	Martin Busch hut	2400	Caricetum curvulae
35	Alp on the path to the Martin Busch hut	2250	Nardetum
36	Path to the Martin Busch hut	2150	Pinetum mughi
37	Path to the Martin Busch hut	2000	Pinetum mughi
38	Vent	1900	Rhododendretum ferruginei
39	Winterstall	1800	Trisetetum
40	Winterstall	1700	Piceetum subalpinum
41	Heiligkreuz	1700	Piceetum subalpinum
42	Lehenwald	1600	Piceetum subalpinum
43	Zwieselstein	1500	Piceetum subalpinum
44	Sölden	1350	Piceetum montanum
45	Huben	1200	Festuco-Cynosuretum

Table 1 - Modern surface pollen samples along the South-North transect from the Etsch valley across the alpine Main range to the Ötz valley. Location of the sites see Fig. 1.

Material and methods

Pollen and macrofossil analyses of 103 subfossil coprolites from Ötzi's site were conducted to identify if some derived from animals grazing in anthropogenic habitats of low altitudes (livestock) or only in the alpine grasslands (game). After freeze-drying (Steris Lyovac GT-2) the coprolites were weighed for calculation of the pollen concentration. The material was treated 72 h with 0.5% tri-Sodium phosphate dodecahydrate and subsequently washed with distilled water through sieves with mesh sizes of 0.5 mm, 0.25 mm, 0.15 mm and 0.063 mm. The residues of the sieves (0.5 mm, 0.25 mm, and 0.15 mm) were sorted for macro botanical analyses under a binocular microscope. The material <0.15mm was selected for pollen analyses. All pollen samples were prepared according to Erdtmann (1969) with acetolysis and the preparation of the stained microscopic slides followed standardized methods used at the Botanical Institute, Innsbruck (Seiwald, 1980).

As analogues for the subfossil pollen spectra modern reference data sets were established: The first one consists of 56 modern pollen surface samples from different vegetation types along an altitudinal south to north transect from the valley bottoms of the Etschtal (Vinschgau), along the Schnalstal up to the Tisenjoch (Ötzi site) and down to the Ötztal bottoms again (Tab. 1). The second analogue consists from just expelled droppings, collected near the Tisenjoch in June 2002 when flocks of sheep were being driven up to the high altitudinal pastures of the Ötztal. Thirteen such caprine faeces (n=13) were picked up, and additionally 37 faeces of sheep and goats were sampled from the high altitude pastures each week during the whole summer season.

Ordination by prinicipal component analysis (PCA) and detrended correspondence analysis (DCA) (Ter Braak, 1987) was used to differentiate between the subfossil and recent pollen data sets. No environmental variables were measured, and the dataset resulted in different gradient lengths (Tabs. 2-4) which indicates linear response curves (PCA) or unimodal response model (DCA) (Ter Braak & Prentice, 1988). Standard settings in the program CANOCO ver. 3.12 (Ter Braak, 1991) were used with square root transformation (Overpeck et al., 1985) of pollen data to reduce differences between percentage values. Ordination was plotted using CANODRAW 3.0 (šmilauer, 1992).

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Eigenvalues	0.324	0.166	0.127	0.091
Lengths of gradient (SD = Standard deviation)	2.242	1.394	1.325	1.229
Cumulative percentage of variance of species data	32.4	49.0	61.7	70.8

Table 2 - The results of principal component analysis (PCA) including pollen percentage values of modern reference faeces from valley and alpine pasture.

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Eigenvalues	0.329	0.177	0.127	0.093
Lengths of gradient (SD = Standard deviation)	2.187	1.591	1.371	1.275
Cumulative percentage of variance of species data	32.9	50.6	63.3	72.6

Table 3 - The results of principal component analysis (PCA) including pollen percentage values of modern reference faeces from valley and alpine pasture in comparison to the subfossil faeces.

	Axis 1	**Axis 2**	**Axis 3**	**Axis 4**
Eigenvalues	0.508	0.177	0.118	0.064
Lengths of gradient (SD = Standard deviation)	3.198	1.850	1.662	1.765
Cumulative percentage of variance of species data	28.4	38.4	45.0	48.5

Table 4 - The results of detrended correspondence analysis (DCA) including pollen percentage values of the subfossil faeces in comparison to the modern surface (moss) pollen samples.

Results and conclusion

The PCA plot (Fig. 2) of the pollen percentage data from the modern reference faecal samples shows that the dung pellets from sheep grazing on valley pastures is distinctly separated from those deriving from grazing in alpine pastures. Droppings from the valley pastures are characterised by pollen of thermophilous deciduous forest (*Quercus robur*-Typ, *Fraxinus ornus*, *Ostrya carpinifolia*) and pollen of herbs such as *Plantago serpentina*, *Helianthemum* sp., *Rumex acetosella* and *Rumex acetosa*-type. Those from alpine pastures contained non-arboreal pollen such as *Achillea*-type, *Saxifraga oppositifolia*, Campanulaceae, *Trifolium*-type, Cyperaceae and less arboreal pollen (mainly *Pinus cembra*).

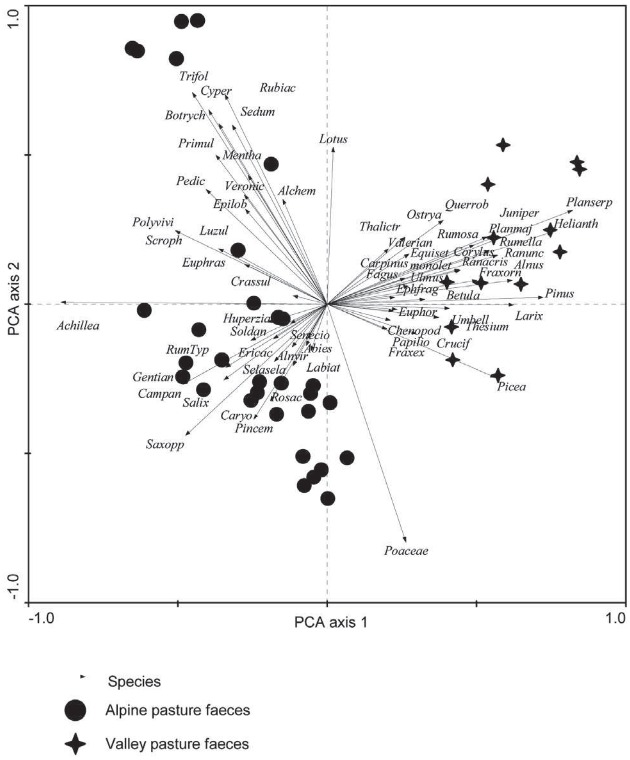

Fig. 2 - PCA plot (axis 1 and 2) of the modern reference faeces from valley (n = 13) and alpine pasture (n = 31). To avoid crowding on the plot, the names of important taxa are shown. Comparison of pollen percentage values (79 species) separates the valley pasture faeces distinctly from the alpine pasture ones.

In Figure 3 the subfossil coprolites are compared with the modern reference faeces data set: The subfossil faeces group together with the alpine pasture faeces, indicating that all animals have grazed in high altitudes. Additionally, the plant macro remain analysis of the subfossil coprolites proves their subalpine and alpine origin by the high frequencies of *Ranunculus glacialis* fruits and *Saxifraga oppositifolia* leaf fragments in the faeces (Tab. 5). Additionally, occurrence of *Arabis alpina*, Brassicaceae, *Campanula scheuchzeri/Phyteuma spicatum*, *Leucanthemopsis alpina*, *Salix herbacea* and *Potentilla aurea* and small epiderm fragments of Poaceae indicate open vegetation above the timberline at subalpine and alpine altitudinal zones (Tab. 5). Furthermore, this hypothesis is re-examinated by the comparison (DCA) of the modern surface (moss) pollen samples from the altitudinal transect with the subfossil coprolites (Fig. 4). This approach yields the same results – the subfossil droppings from the Ötzi site derived from animals grazing at an altitude higher than 1,500 m a.s.l. - which questions the existence of Neolithic transhumance in the area.
Conclusions of seasonality deduced from pollen analytical

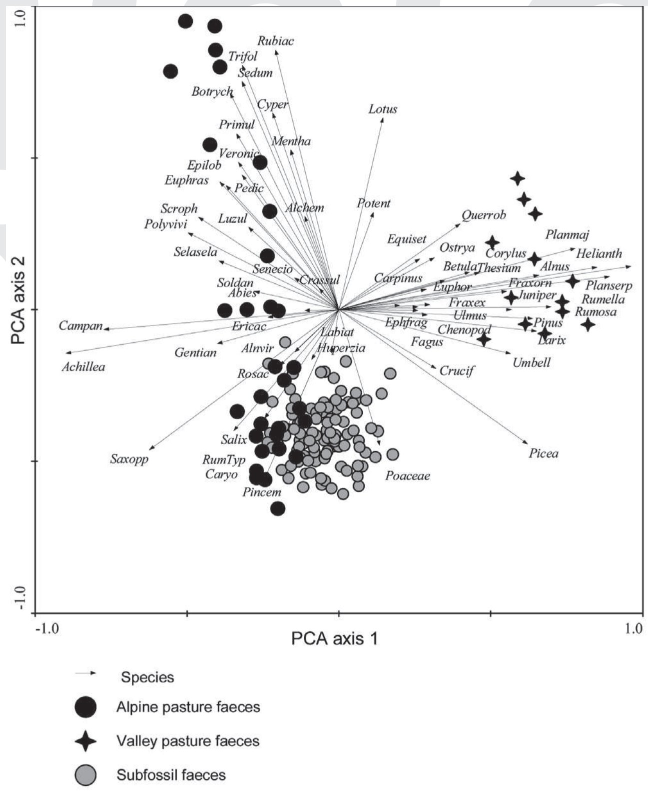

Fig. 3 - PCA plot (axis 1 and 2) of the modern reference faeces valley (n = 13) and alpine pasture (n = 31) in comparison to the subfossil caprine faeces (n = 103) by using pollen percentage values of 79 species. To avoid crowding on the plot, the names of important taxa are shown. The subfossil faeces cluster well with the modern alpine pasture faeces.

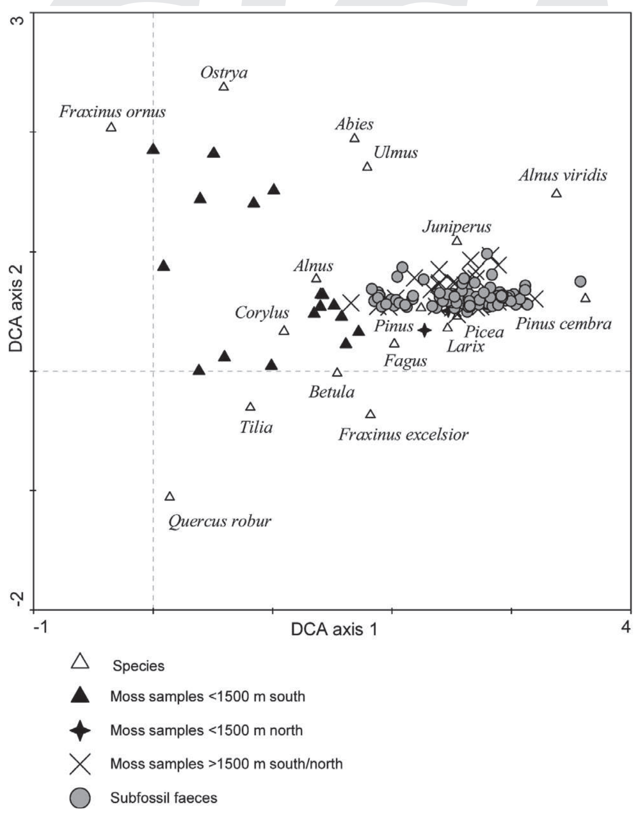

Fig. 4 - DCA plot (axis 1 and 2). Pollen percentage values (17 tree species) of the subfossil coprolites (n = 103) in comparison to the modern surface (moss) pollen samples (n = 45). The subfossil faeces match well with the high altitudinal moss samples.

species	upper limit of vegetation	preservation type	sum	freque ncy
Arabis alpina	2700 m	fruits	1	1,2
Campanula scheuchzeri/Phyteuma spicatum	2600 m	seeds	110	23,8
Leucanthemopsis alpina	2500 m	fruits	2	2,4
Potentilla aurea	2500 m	fruits	1	1,2
Potentilla sp.		fruits	1	1,2
Ranunculus glacialis	3200 m	fruits	86	23,8
Ranunculaceae		fruit fragments	101	35,7
Rumex cf. scutatus	2500 m	fruits	1	1,2
cf. Salix herbacea	2900 m	leaf fragments	8	6,0
Saxifraga oppositifolia	2500 m	leaf fragments	120	13,1
Urtica dioica	2500 m	fruits	1	1,2
cf. Brassicaceae		fruits	1	1,2
cf. Caryophyllaceae		seeds	1	1,2
Cyperaceae		epidermis	82	27,4
Luzula sp./Juncus sp.		seeds	24	11,9
Luzula sp./Juncus sp.		perigone leafs	1	1,2
Poaceae		fruits	1	1,2
Poaceae		epidermis	864	91,7
Poaceae		glumes	73	29,9
Poa pratensis/annua, Deschampsia caespitosa		fruits	1	1,2

Table 5 - Uncharred botanical macroremains of 84 subfossil caprine faeces.

investigations are problematic (Moe, 1983). Whereas, detailed information about the season of consumption were provided by the regular occurrence of *Ranunculus glacialis*-fruits. According to Wagner et al. (2005) the period of seed development of *Ranunculus glacialis* ranged between 28 and 36 days after anthesis, which started 10 to 14 days after snow melt. This study indicates that the subfossil coprolites derived from summertime.

There are radiocarbon data from twelve subfossil dung samples from the discovery site and these dates support the conclusions drawn from the pollen analyses. The dates cover a period from 4,800 – 2,000 BC, but during Ötzi's time in the late Neolithic there is an absence of dung at the site (Kutscher and Müller, 2003). To conclude, these latest results cast serious doubts on the explanation of Ötzi having been a shepherd.

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