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Prehistoric upland exploitation of the Central Alps – a case study from the Karwendel Mountains

ABSTRACT

The frequentation of the uplands and the origin of seasonal pastoralism in the Central Alps in prehistory are intensively discussed topics. This case study from the Karwendel Mountains, a mountain range situated between Tyrol (Austria) and Bavaria (Germany), illustrates on the basis of archaeological surveys and excavations as well as pollen analyses how groups of hunter-gatherers frequented and used a mountainous area since the Mesolithic. This traditional use continued well into the period that is in the more fertile lowlands characterized as Neolithic. The study also shows that the human impact on the natural vegetation in the heart of the mountain range was very modest until the Roman era, while other upland meadows of the Central Alps were used for livestock grazing since the Bronze Age. These pastoral practices deeply changed the landscape and the vegetation of the areas involved. The Karwendel, on the other hand, was at least sporadically visited but remained largely unaffected by human exploitation until modern times, as it is situated at the margin of the important communication routes and the main settlement areas.

KEYWORDS

Alpine pastoralism, Mesolithic, hunter-gatherers, neolithisation, pollen analyses, transhumance, Bronze Age, Central Alps

I. INTRODUCTION

The origin of seasonal pastoralism in the Alps

The period when Alpine dwellers first began to move their livestock to pastureland at higher elevations represents a debated and methodologically complex issue. While some researchers assume that seasonal pastoralism already began in the Neolithic (Walsh, Mocci 2011; Walsh *et al.* 2014), others date its origins to the Bronze Age (Reitmaier 2020), also depending on the region concerned. This debate is best represented by the Tyrolean Iceman, also known as Similaun Man (or Ötzi in German). His discovery in 1991 in the Ötztal Alps not only triggered the beginnings of glacial archaeology but also started the debate of the use of the higher altitudes. In the past, he was often thought to be a shepherd involved in early pastoralism (Spindler 1993; Spindler 2005) but despite extensive surveys and fieldwork over the past 30 years, no tangible archaeological evidence has been found to support this idea (Festi *et al.* 2014). So, this man from the Copper Age (dated to 5350-5100 bp) is now thought to be a hunter killed in an interpersonal conflict (Putzer, Festi 2014). His transitional status is best highlighted by the content of his stomach, containing both wild game (fat and meat of ibex and red deer) and cereals of einkorn, and traces of toxic bracken (Maixner *et al.* 2018).

Main goals and methods of the study

This paper summarizes the current state of research for the prehistoric upland colonization and exploitation processes in the Central Alps, focusing especially on new archaeological and palynological data from the Karwendel Mountains in Austria. Furthermore, it will also consider the settlement history of the surrounding areas to the north and to the south, i.e. Southern Bavaria and the Tyrolean Inn valley, in order to gain deeper insights into the colonisation processes, the human impact and transformations that faceted the landscape of this part of the Alps in prehistory. The case study presented in this paper is the survey and excavation project the author has conducted since 2015 in the Karwendel Mountains. In order to study the prehistoric settlement history of the area, the Institute of Prehistoric and Early Historic Archaeology and Provincial Roman Archaeology of Ludwig Maximilians University Munich has thus been conducting several survey and excavation campaigns in the Karwendel. These campaigns were so far focussed on the Eng valley, also

called Großer Ahornboden or Hinteres Risstal, and the surrounding plateaus in the east of the Karwendel. In 2016, two drill cores for pollen analysis were taken in the area of a former lake on the edge of a large sedimentation basin in the Eng valley and analysed at the Institute of Botany of the Leopold-Franzens University of Innsbruck (von Nicolai, Oeggl in preparation).

II. FIELD STUDY IN THE KARWENDEL MOUNTAINS

Description of the study area – state of the research

The Karwendel Mountains are the largest range of the Northern Limestone Alps. The major part belongs to the Austrian federal state of Tyrol, while the adjacent area in the north is part of Bavaria, Germany. The Karwendel is bounded by the rivers Isar and Walchen or Seeache in the north, the depression of the Achen Lake (Achensee) in the east and the mountain pass Seefelder Sattel (Seefeld Saddle) in the west (Fig. 1). In the south, the lower Inn Valley separates the Northern Alps from the Central Eastern Alps. To the north are the Bavarian Alpine foothills. The total area is about 950 km². The relief of the

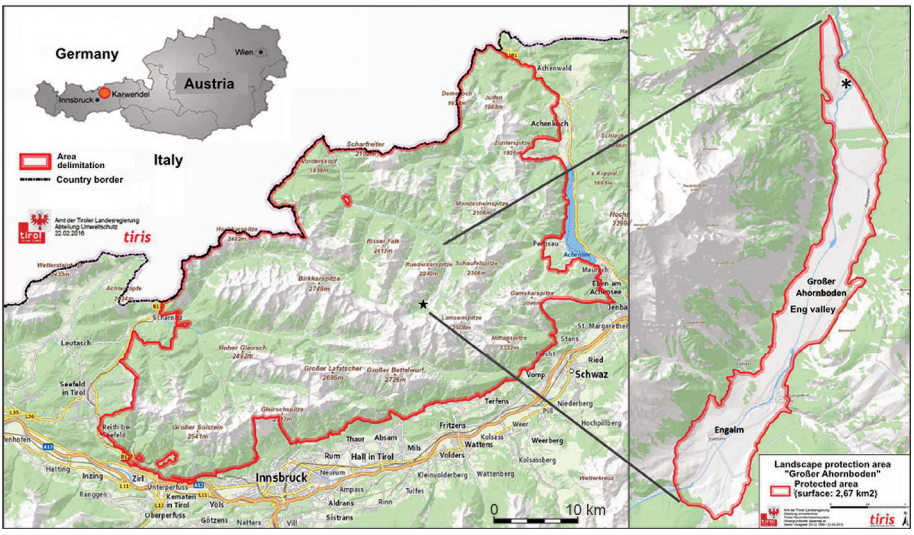

FIG. 1. Localisation and topography of the Karwendel Mountains. * drilling point for the pollen analysis; star: Lalidersalm-Hochleger (graph: K. Oeggl, C. von Nicolai; map base: TIRIS Tirol)

Karwendel was created by massive glaciation during the ice ages. There are 125 peaks in the Karwendel that reach heights of over 2,000 metres. The highest peak, the Birkkarspitze, has an altitude of 2749 m asl. Particularly distinctive are the steep rock faces, which drop up to 1000 m, and the U-shaped trough valleys, which are filled with Holocene and Quaternary loose sediments to a depth of more than 360 m (Fig. 2). The valley floors are also covered with late to postglacial alluvial and mud cones and moraines. The Karwendel is mainly drained to the north and west. The most important watercourse is the Isar, which rises in the Hinterau Valley. Climatically, it is today a moderately winter-cold location (measured at the Pertisau station in the Achental valley at 940 m asl) with precipitation maxima in the summer months and a significantly shortened growing season compared to the Inn valley, as snow must be expected from October to June (Böhm 2011).

The Karwendel is rich in natural resources such as wood, hunting game, ores, salt and rocks. Nevertheless, until recently there were only a few sites and finds from the Karwendel that provided evidence of prehistoric settlement and use of the area. One reason for this is that large parts of the region have been protected as a nature park since 1928. With the exception of the construction of the Sylvenstein reservoir in the 1950s, no major construction work has

FIG. 2. View over the Großer Ahornboden/Eng valley to the south (photo: G. Haselwanter)

taken place in the Karwendel. Furthermore, forestry and pastoralism are the main economic branches practised in the region which result in fewer archaeological discoveries than is the case with intensive farming. Nevertheless, investigations in neighbouring areas, such as the Rofan Mountains located to the East (Bachnetzer, Leitner 2011) or the Fotscher Valley in the Stubai Alps to the South (Schäfer [ed.] 2011), suggest that the Karwendel was frequented in prehistoric times.

Survey and excavation results

During the survey campaign of 2016, a rectangular stone structure was discovered on the Lalidersalm-Hochleger at an altitude between 1826 and 1828 m asl on what is today an open alpine pasture. The following excavation between 2016 and 2018 revealed that the building consisted of three dry-stone walls and was built into the slope (Fig. 3). Its maximal length was 8.6 m, its maximal width 7.4 m. Several layers of the walls were still preserved in situ. The original width of the wall was probably 60 to 90 cm. However, it is difficult

FIG. 3. The modern dry-stone building, seen from the East. To the north, it was dug into the slope. Feature 7, which contained lithic artifacts, was discovered under the modern building (photo: C. von Nicolai)

to reliably estimate the width, as many stones have fallen down and have been displaced by slope erosion and avalanches. The soil of the building was made of clay on top of a layer of gravel. There was a fireplace in front of the entrance of the building. Inside the building, many hand-made nails and other iron fragments were found. Many of these probably belonged to the wooden roof that rested on the dry-stone walls. Glazed potsherds and fragments of a clay pipe allow to date the building to the 17th or 18th century AD. Considering the structure and the position of the building, it can be interpreted as a hut used for alpine dairy farming and hay harvesting during the summer months (von Nicolai 2020). Similar huts were still in use until the 1930s in parts of Austria (Hubatschek 1978).

Under the gravel layer situated underneath the modern building several features of irregular oval shape were excavated. They were embedded in hollows or gullies of the natural, irregularly weathered limestone bedrock filled with a loamy, medium brown sediment. Feature no. 7 was up to 1.53 m long, 0.85 cm wide and 0.27 m deep. The backfill of this pit was in places rather loamy, in places rather silty and of dark brown to black colour. The feature contained a lot of charcoal, as well as pieces of burnt clay, a piece of ochre and several lithic artefacts. The very irregularly shaped feature no. 18/19 contained a loamy sediment that was grey-brown to black in colour and a lot of charcoal (Fig. 4). It yielded even more lithic artefacts.

In total, approximately 560 lithic artefacts were discovered so far. Most of these are very small and were only recovered thanks to wet-sieving in the laboratory after the excavation was completed. The assemblage of feature no. 18/19 includes numerous flakes (Fig. 5: 1–2, 5, 7–10), microburins (Fig. 5: 4), small debitage and pieces of debris (more than 10 mm maximum length), as well as mini- or micro-debitage (up to 10 mm maximum length). These finds as well as several very small cores (Fig. 5: 6) indicate the production and the repair of stone tools at the site. Modified tools that can be typologically classified are relatively rare. One single microlith should be mentioned: an extreme scalene triangle, which, according to Taute (Taute 1971, fig. 37), represents an index type for the Beuronien C (type A 21). This type of artefact can generally be found in Southern Germany (Fig. 5: 3). In addition, there is a fragment of a scraper and a backed bladelet. Typologically, these artefacts can be attributed to the end of the early Mesolithic. Feature no. 7 contained a thumbnail scraper (Fig. 6: 3), a retouched bladelet with lateral retouche (Fig. 6: 1), the fragment of a bladelet (Fig. 6: 2), and several flakes (Fig. 6: 6-7). The typological attribution of these objects is less clear but it seems that they also belonged

FIG. 4. Feature 18/19 was embedded in a depression of the natural, irregularly weathered limestone bedrock and was filled with a loamy sediment, rich in charcoal (photo: C. von Nicolai)

to the Mesolithic. The radiocarbon-dating of charcoals from the two features, however, gives a different picture[1]: while the charcoals from feature 18/19 (7079–6830 BC cal 2σ and 6392-6243 BC cal 2σ) match the attribution of the

1 Calibration: BetaCal 3.18, IntCal13 atmospheric curve (Reimer *et al.* 2013).

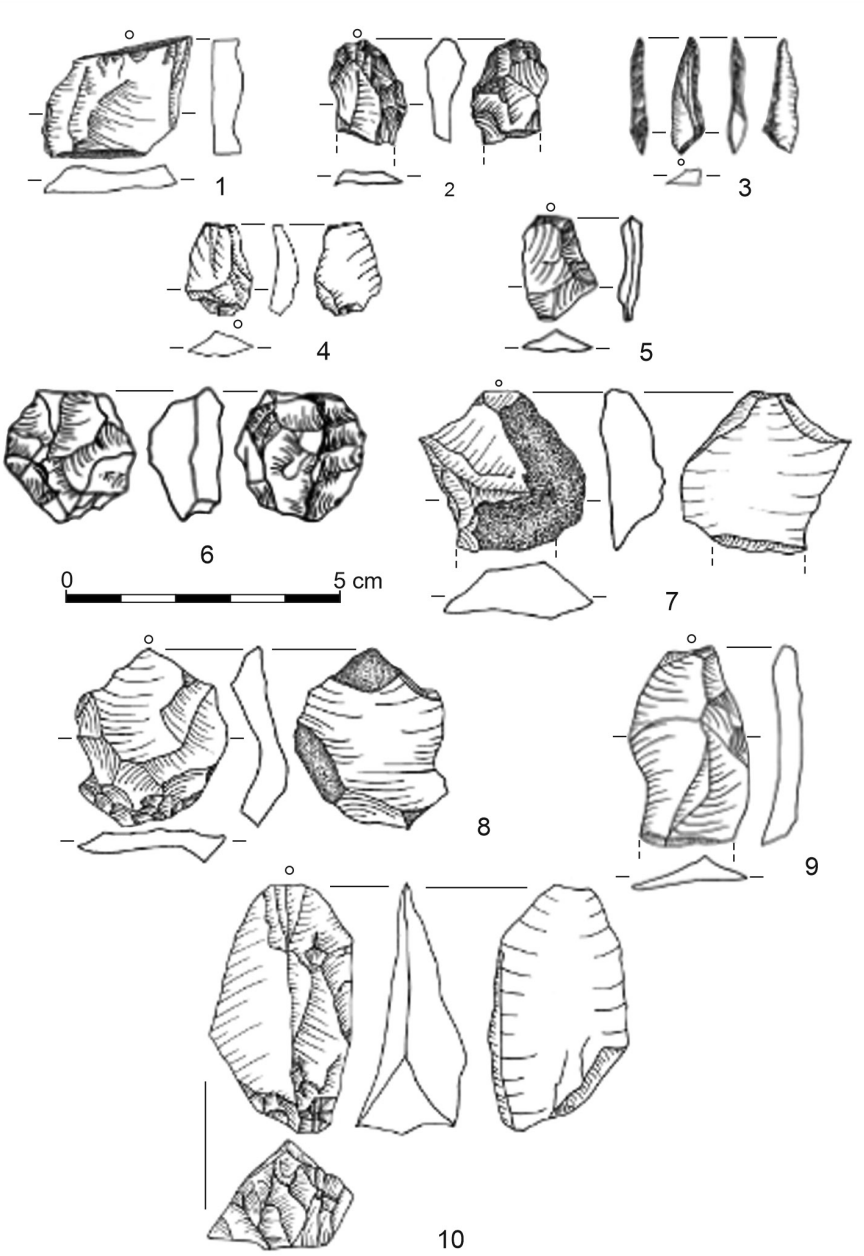

FIG. 5. Lithic artefacts. 1-2, 5, 7-10: flakes; 3: microlith, extreme scalene triangle; 4: microburin; 6: core (drawings: E. Maier)

microlith to the Mesolithic, the charcoals from feature 7 date to the Middle Neolithic (5025-4880 BC cal 2σ and 5044-4856 BC cal 2σ) according to the standard chronology of Central Europe (Table 1).

The raw materials used were mainly local, such as red, pink and grey radiolarite (Fig. 6: 3 and 6) and grey chert, siliceous limestones and quartz nodules (Fig. 6: 5), which are found in the Karwendel itself and in the neighbouring mountain range of Rofan. Tabular chert that comes from Southern Bavaria (Fig. 6: 1; among them, several pieces from the region around Abensberg-Arnhofen: Fig. 6: 2), radiolarites and cherts originating from the other side of the alpine main ridge - probably from the Val di Non

TABLE 1. Radiocarbon dates from the Lalidersalm-Hochleger site

Sample name	Material	Context	Find no.	^{14}C-age (a BP)	±	cal 2σ (95%)
Beta – 481722	charcoal	SE018	FN204	8050	30	7079-6830 BC
MAMS - 61963	charcoal	SE018		7450	22	6392-6243 BC
MAMS - 61962	charcoal	SE007	FN055	6071	21	5044-4856 BC
Beta – 455392	charcoal	SE007	FN395	6050	30	5025-4850 BC

FIG. 6. Lithic artefacts. 1-2: bladelets with lateral retouches; 3: thumbnail scraper; 4: debitage; 5: fragment of a bladelet; 6-7: flakes. Raw materials: 1: tabular chert from Bavaria (without more precise indication of origin); 2: tabular chert from Abensberg-Arnhofen; 3, 6: northern-alpine radiolarite; 4: rock crystal; 5: Hornsteinbrekzie; 7: radiolarite, typ Val di Non, Passo Predaia (photo: C. von Nicolai)

area (Fig. 6: 7) and the Monti Lessini - as well as rock crystal from the Central Alps (Fig. 6: 4) are also attested.[2] Numerous artefacts were lightly to moderately exposed to annealing, a heat treatment that improves the quality of the raw material. This technique was used above all from Southern Germany during the Early Mesolithic (Weiner 2012).

Prehistoric potsherds or archaeobotanical remains were not recovered, although the pit contents were wet-sieved. Tiny fragments of mostly burnt bones were found in large numbers. Unfortunately, it is impossible to know which animals were hunted because the collected faunal remains were too small to be determined by osteological analysis. A ZooMS analysis also failed for the same reason. Therefore, we can only guess that the same animals that are still present in the area today were hunted, namely ibex, chamois and red deer.

The site of Lalidersalm-Hochleger has only been partially examined so far, but the excavated features and the find assemblage show that the site was probably used during the warm season as a temporary hunting stand or lookout. For this purpose, it was well positioned on a gentle descending, south-east oriented and sunlit slope at an altitude between 1826 and 1828 m asl. The area is today dominated by the mountain pine (*pinus mugo*) which grows at the natural subalpine tree line in what is called "Krummholzzone" in German ("area of crooked wood"). During the Middle Holocene climate optimum between 7000 to 3500 BC, a favourable phase with higher average temperatures in summer, the tree line was probably situated at an even higher altitude (Oeggl, Nicolussi 2009; Pechtl, Land 2019). Nonetheless, the site offers an excellent view to the east, south, and west where large grazing grounds for ibex and chamois are situated. In addition, several water sources are found nearby. The features presented above that were rich in charcoal can be interpreted as washed out remains of fireplaces belonging to the hunting stand. Stone settings enclosing these fireplaces or postholes are not yet documented. According to the radiocarbon dates, the site was used several times within two millennia.

The question who used the site is more difficult to answer. The find assemblage hints to the Mesolithic, whereas two of the radiocarbon dates also indicate an occupation during the Neolithic. The presence of hunter-gatherers in the area close to Lalidersalm-Hochleger, in and around the Eng

2 The raw materials were determined by Dr. M. Brandl, Austrian Academy of Sciences.

valley and in the wider surroundings is not surprising. In fact, several other Mesolithic sites were already known from the Eastern Karwendel Mountains and the Northern Chain of the Karwendel (adjacent to the Inn Valley) before the beginning of the project (Fig. 7). They are all located at an altitude of between 1500 and 2100 m asl above the tree line or in the transitional area between the coniferous forest and the area of crooked wood and all yielded lithic tools, cores, flakes, and debris from locally occurring rocks such as chert, radiolarite and quartzite (Broucek *et al.* 1998; Kompatscher, Kompatscher 1995; Kompatscher, Kompatscher 2000; Schäfer *et al.* 2006; Brunner, Müller 1998; Brunner 2007; Sölder 2007; Töchterle 2015a; Töchterle 2015b). Among them, the Pasillalm and Schleimssattel sites are particularly interesting because chert and radiolarite deposits of the Upper Jurassic are found here that were exploited during the older Mesolithic (Schäfer *et al.* 2006).

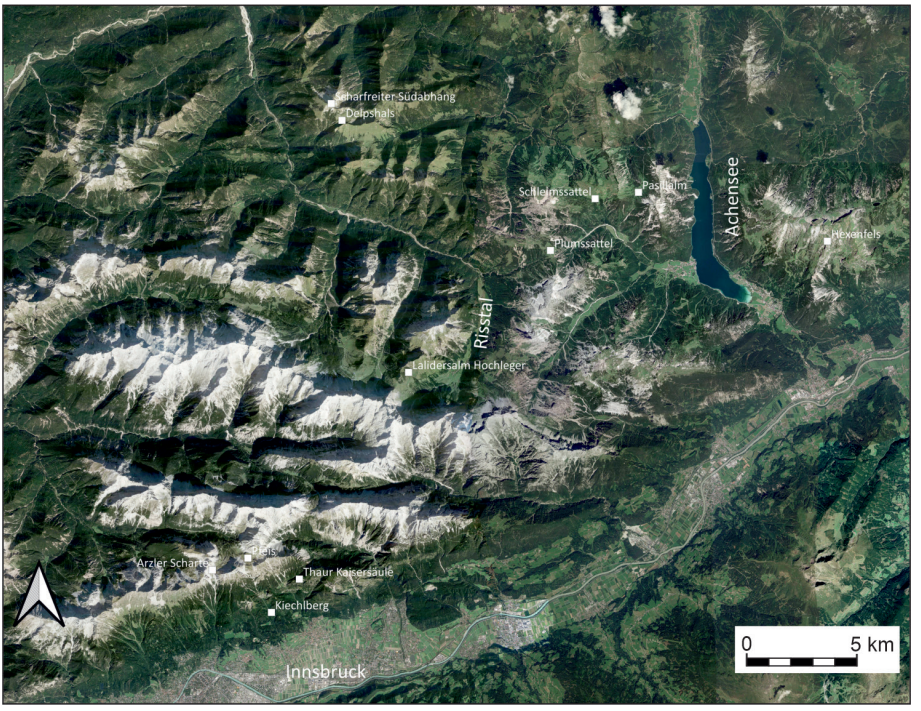

FIG. 7. Mesolithic sites in the study area (map: C. von Nicolai; map base: Google Satellite)

Palaeobotanical data and anthropogenic indicators

The presence of Neolithic herdsmen or even farmers, on the other hand, raises more questions. The pollen analysis carried out in the Eng valley at an altitude of 1115 m respectively 1116 m asl, situated 700 m lower than the excavated site of Lalidersalm-Hochleger and at a distance of approximately 5 km as the crow flies, did not reveal any larger human impact on the natural vegetation during the Mesolithic or the Neolithic (von Nicolai, Oeggl in preparation). Around 8000 BC, during the Boreal, pines (*pinus*) predominated in the forests. The spruce (*picea*) had already established itself. In addition, deciduous trees such as hazel (*corylus avellana*), maple (*acer*), ash (*fraxinus*), oak (*quercus*), lime (*tilia*) and elm (*ulmus*) occurred sporadically (Fig. 8). The spruce dominance from 7300 BC (Older Atlantic) onwards in the area may have been favoured by oceanic climatic conditions. This is also supported by coarse clastic deposits in drill core 1 of the Eng valley around this time. They indicate increased kinetic energy associated with increased discharge of lake water. Vegetation conditions remained more or less stable throughout the Mesolithic, with only minor disturbances. This includes the first occurrence of settlement indicators between 6000 and 6500 BC, associated with minimal declines of spruce and pine. This occurrence is located at a core impact and should therefore not be overestimated. The occurrence of the settlement indicators, which as apophytes belong to the indigenous flora, is never so strong that it would be above the natural distribution of these pollen types to infer an anthropogenic influence. There is also evidence of a disturbance around 4200 BC. The collapse of spruce is drastic, accompanied by relatively high levels of grasses (*poaceae*) and the first indicators of cultivation (*cerealia*), followed by settlement indicators. However, these signs of anthropogenic disturbance also occur at a core impact, and here, too, gravel deposits in the overlying strata indicate disturbed sedimentation conditions at the drilling point. Furthermore, the pollen concentration is low in the analysed strata, which also indicates persistent unfavourable climatic conditions. This event is dated with a radiocarbon date of 5265 + 27 uncal. BP (4228–3990 BC), and places it in a phase of climatic deterioration called Rotmoos I in the Alpine region characterised by glacial advances between 4600 and 4200 BC (Bortenschlager 1992; Nicolussi 2009). At higher altitudes, this climatic deterioration manifests itself in a lower pollen production of the local plants. Thus, pollen transported over long distances are more visible in the pollen spectrum. In the present case, a long-distance transport of pollen of settlement and cultivation indicators from the Alpine foothills is probable.

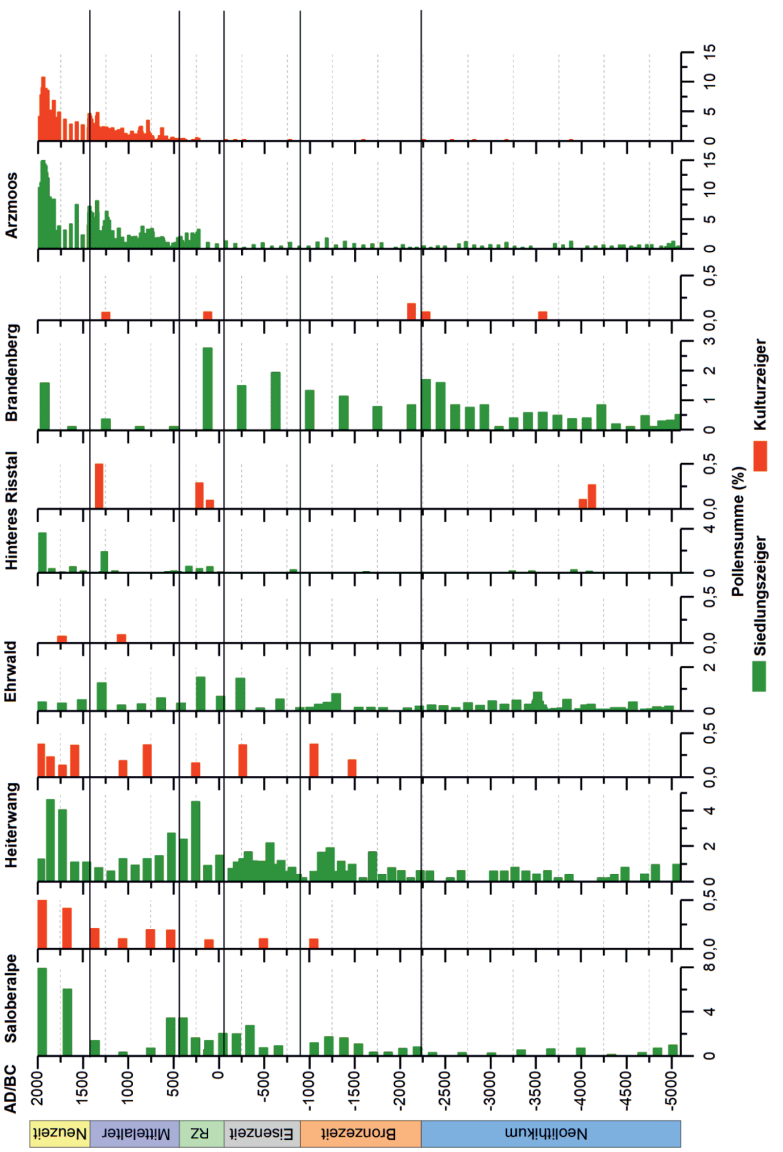

FIG. 8. Percentage values of anthropogenic and settlement indicators of pollen analytical studies of five neighbouring sites: Saloberalpe, Heiterwang, Ehrwalder Becken (Lermoos), Brandenberg (Oeggl, unpubl. data), Arzmoos (Peters 2012) in relationship to the pollen profile Eng valley (Ahornboden-Hinteres Risstal) in a west-east transect. Green: settlement indicators; red: anthropogenic indicators (graph: K. Oeggl)

The drill cores are interrupted in a depth from 286 cm for 60 cm. This hiatus can be traced over a large part of the lake basin in the Eng valley. After the 14C date of 3490 –3118 BC, sedimentation at the drilling point resumes in the Chalcolithic. Based on the present time-depth model, this hiatus falls into the time of the Chalcolithic Tyrolean Iceman. This period covers the second part of the Rotmoos climate oscillation in the Eastern Alps (Rotmoos II oscillation according to Bortenschlager 1992), which was also associated with hydrological fluctuations and glacier advances. After the hiatus, settlement indicators appear again at a depth of 201 cm (around 2500 BC). However, these are almost exclusively pollen from goosefoot plants (*chenopodiaceae*), which are dispersed far beyond their location and probably reflect increased settlement activities in the Alpine foothills. Their significance for local vegetation changes is therefore limited. There are no reactions of the tree species in the pollen diagram either.

We can thus assume that during the the early Holocene, dense, undisturbed forests existed in the Karwendel Mountains. The frequentation of the area by hunter-gatherers did not have a significant impact on the vegetation. No important increase in charcoal particles can be detected either, which could indicate the deliberate burning of vegetation to increase open areas for hunting. This was certainly not necessary in the region, as there were sufficient wood-free areas above the tree line and on the valley floor on the gravel surfaces of the Rißbach and other watercourses as well as close to the former lake in the Eng valley.

At the transition from the Neolithic to the Bronze Age, pines (*pinus*) and Swiss stone pines (*pinus cembra*) spread again, which indicate unfavourable climatic conditions. It was not until the turn of the Late Bronze Age to the Iron Age that grasses (*poaceae*) became more prominent, along with anthropogenic and grazing indicator species (of the *plantago lanceolata* type). From a palynological point of view, a human presence in the Eng valley at this time seems probable, although the anthropogenic indicators in the pollen record are not significantly elevated. Possibly, small-scale clearings in the wider surroundings are reflected in this data. At the beginning of the Iron Age (at a depth of 190 cm), anthropogenic pollen indicators (*artemisia, chenopodiaceae, rumex acetosella, plantago lanceolata* types) were increased. In the following period, the grasses (*poaceae*) and the pines (*pinus*) became more prominent. In the Roman period, grasses (*poaceae*), anthropogenic indicators and meadow herbs possess significantly higher values than in all sections before, to the disadvantage of the spruce (*picea*). Additionally, *cerealia*-type

pollen occurred. This reflects a local settlement phase with agriculture and a pastoral use of the area, which lasted until the 5th century AD. It was not until the 12th century AD that the Eng valley was recolonized. This colonisation phase continued until the 14th century AD, and was then interrupted by the onset of climate change during the Little Ice Age. In the 16th century AD, a new seasonal pasture use of the Eng valley took place, which was made possible by favorable summer temperatures around 1550 AD.

The vegetation history attested by the two cores from the Eng valley matches well with other pollen profiles of the Northern Limestone Alps available so far (Fig. 8), coming from Werdenfelser Land (Weber 1999), Murnauer Moor (Peters 2012), Zwischentoren (Walde 2010) and the Mangfall Mountains (Peters 2012; Gilck, Poschlod 2021). The results are also consistent with pollen profiles from more distant areas in the Northern Limestone Alps where grazing pointers and evidence of slash-and-burn events only appear from 4500 BC onwards, whereas pollen and erosion proxies indicate that large-scale deforestation and land use by agro-pastoralists only began from the mid to late Bronze Age. The human impact on the landscape was strongest in the Roman period and with interruptions in the Middle Ages (Friedmann, Stojakowits 2017; von Scheffer *et al*. 2019; Posch 2022).

III. NEOLITHIC PENETRATION OF THE CENTRAL ALPS. SOME CONSIDERATIONS

The archaeological data also suggests that the first Neolithic settlers arrived relatively late in the larger area and the Central Alps in general. The oldest Neolithic find in the Inn Valley and in the whole of Northern Tyrol so far is a sherd discovered during construction work in Ampass, east of Innsbruck (Töchterle 2001; Töchterle 2009; Töchterle 2015a). It probably belonged to the Gaban group, which was widespread between 5300 and 4900 BC in Trentino and South Tyrol, especially in the Adige Valley. The oldest radiocarbon dates from the Inn Valley are from Brixlegg-Mariahilfbergl and the Kiechlberg near Thaur. The Brixlegg-Mariahilfbergl site is located on an exposed hilltop above the bottom of the middle Inn Valley. The settlement layers of this site yielded mainly pottery of the late Rössen Culture, the Münchshöfen Culture, the Wauwil Culture, of the Vasi a bocca quadrata Culture (phase III), the Pollinger and the Cham Culture. The radiocarbon dates date the occupation between c. 4450 BC and 1920 BC, with several interruptions in settlement

activity (Huijsmans, Krauß 2015). The hilltop settlement of Kiechlberg, situated at an altitude of 1028 m asl at the southern foot of the Northern Chain of the Karwendel, was first settled about 300 years later. The pottery inventory is composed of finds from the Schwieberdingen Group, the Münchshöfen Culture, the Polling Culture, the Schussenried Culture and Phase III of the Vasi a bocca quadrata Culture. The oldest radiocarbon dating is assigned to the 43rd century BC (4230-3970 cal BC 2σ). The hilltop was occupied with interruptions up to the Middle Bronze Age. Here, as at Mariahilfbergl, there is evidence of settlement activities as well as the early processing of copper from the Late Neolithic onwards (Töchterle 2015a; Töchterle 2015b). Apart from these exceptions, the evidence for sites in the Inn valley before the later Early Bronze Age (phase Bz A2a/b/Fb IIb/IIIa) is sparse. The find material consists only of single stray finds of chert arrowheads, tools and flakes, stone axes and isolated pottery sherds that are difficult to date. Thus, the Inn valley was probably not permanently and densely settled during the earlier Neolithic (Töchterle 2012; Stöllner 2015).

In southern Bavaria, north of the Karwendel, the settlements of the Linear Pottery Culture, which appeared in southern Bavaria from about 5400 BC onwards, were restricted to the fertile loess areas with deep soils along the Danube and the upper course of the Isar river in the Gäuboden (Lower Bavaria). They are situated at altitudes below 500 m asl which have a relatively warm and dry climate. The southernmost extensions of the younger phase were located in the middle Lech Valley on the small loess terraces of moraines of the Riss glaciation. These settlements, which date to the 53rd century and around 5000 BC, however, lasted only a short time – presumably due to the high precipitation at the time (Pechtl 2015; Pechtl 2019). Farther south, in the area dominated by moraines of the Würm glaciation and in the foothills of the Alps, only isolated stray finds of the Older Neolithic are known so far, whereas Neolithic settlements are missing. A new research project with the title "Last hunters, firsts herdsmen and farmers. The origins of pastoralism in the area of Zugspitze – Wetterstein – Karwendel", undertaken by the universities of Munich and Innsbruck, has registered 14 stone adzes and axes that were found by chance in the districts of Garmisch-Partenkirchen (Germany) and Reutte (Austria), west of the Karwendel Mountains (von Nicolai *et al.* 2022). Typologically, the finds are similar to stone tools that were used between the 6th and the 3rd millennia BC by farmers in the Gäuboden. It can therefore be assumed that mainly people from the North frequented the area. Many of the finds are located along the routes that were important for transalpine transit,

often in particular topographical positions. This fact, as well as the unusual shapes suggest that these objects were not lost but deliberately deposited, perhaps as offerings. A good example is the D-shaped adze from Gerold near Klais (district of Garmisch-Partenkirchen), which was found during construction works in a garden at a depth of 0.5 m (Fig. 9). The location of the find site is interesting as it is situated on a route leading from the Loisach Valley west of the Karwendel over the Seefelder Sattel and the Zirler Berg to the Inn Valley. The adze was made of a fine-grained amphibolite, which probably originated from the Alps. It is very large with a length of 21.9 cm and a maximum width of 8.3 cm, carefully ground and shows only slight signs of use. It can most probably be dated to the time of the younger Linear Pottery Culture and the older Stroke-ornamented Pottery culture (ca. 5000 BC +/- 200-300 years) (Lang 2021).

FIG. 9. Adze from Gerold, made of amphibolite. Length. 21,9 cm, maximal width B. 8,3 cm (photo: M. Fesq-Martin)

It was not until the Middle Neolithic that a slow expansion towards the south took place. For example, a potsherd from the Southeast Bavarian Middle Neolithic (SOB) was recently found on Roseninsel in Lake Starnberg, which can be assigned typologically to the stages SOB II d to e. In absolute dates, this corresponds to the period between ca. 4730 and 4640 cal. BC (Riedhammer 2018). This is again a stray find outside of the settlement area of this cultural group which does not attest the existence of permanent settlements in the Alpine foothills (Fesq-Martin *et al.* 2019; von Nicolai, Fesq-Martin 2022). The situation observed in the Inn valley and the Southern Bavaria corresponds well to what is attested only in the Swiss Midlands and Upper Swabia where the shorelines of the lakes are slowly settled from 4400 BC (Schier 2017).

We can thus ascertain that no Neolithic settlements are known in the surroundings of Lalidersalm-Hochleger that are contemporary to the younger radiocarbon dates. All known sites are younger; besides, there are only stray finds. The first farmers who settled in the Alpine foothills or in the Inn Valley did presumably only sporadically venture into the mountains. Changes of the natural vegetation are not recognizable. It was not until around 3000 BC that the number of settlements in the Tyrolean Inn valley and in the Bavarian Alpine foothills slowly increased (Oeggl, Nicolussi 2009).

IV. THE BRONZE AGE ECONOMIC EXPANSION IN THE CENTRAL ALPS

Throughout the Alps, the permanent settlements extended and then densified during the Late Neolithic and the Early Bronze Age, i.e. at the turn of the 3rd and 2nd millennium BC. This development is documented for example in the Silvretta mountains in Switzerland (Reitmaier 2017; Reitmaier, Kruse 2018; Reitmaier 2021), in Montafon (Bringemeier 2015; Bringemeier *et al.* 2015), in the Kleinwalser Valley (von Scheffer *et al.* 2019; Posch 2022) and the Dachstein region (Mandl 2007) in Austria, and in the Schnals Valley in Northern Italy (Putzer, Festi 2014; Festi *et al.* 2014). It is probable that this large-scale settlement expansion was related to new commercial activities, especially mining of ore and salt as new key economic processes, in addition to climatic and demographic causes. An increased demand of land for farming probably included from the very beginning the high-altitude areas. The practice of vertical transhumance, however, does not necessarily involve the presence of permanent and stone-built structures. It means that small livestock (especially sheep and goats) was driven to high altitude pastures in summer. In winter, it was moved back to the valley bottoms but not kept in stables. Meat, leather, and wool were the main products of this economy; the milk was mainly used for the young animals. Fix dwellings were not necessary for this form of pastoralism (Reitmaier 2010; Reitmaier 2017; Dietre *et al.* 2020). In contrast, if dairy products, especially cheese, were the main product of the pastoral activities, more infrastructure was needed. This type of economy is called "Almwirtschaft" or "Alpwirtschaft" in German. It is characterized by the use of high-altitude pastures in summer, stables in the valleys in winter and intermediate stages in early summer and autumn. The movement of livestock, especially cattle, took place in stages over relatively

short and fixed distances. To produce cheese during the summer months in the mountains, huts for the dairymen, simple stables or enclosures for the livestock, installations for the processing of milk, storage areas for the cheese produced, as well as access to water and firewood were required (Reitmaier 2010; Reitmaier 2017; Reitmaier 2021). This type of economy seems to have developed in the Early or Middle Bronze Age on the southern edge of the Alps, from where it spread northwards from the Late Bronze Age onwards (Reitmaier 2020). In the Central and Eastern Alps, the structures described above have been documented since the Late Bronze Age and mostly during the Early Iron Age (Carrer *et al.* 2016; Reitmaier 2017; Moe, Fedele 2019; Reitmaier 2020; Dietre *et al.* 2020). The first direct evidence of Alpine dairying was identified on prehistoric potsherds from Late Bronze and Iron Age stone-built constructions in the Silvretta mountain range (Lower Engadin, Switzerland), situated at an altitude of more than 1800 m asl. Biochemical analyses of lipids confirmed that domestic animals had been milked in those structures and that the milk had then been processed there. One can therefore assume that nutritious, durable and storable goods such as cheese, butter and lard were produced and distributed in the Alps during the Bronze and Iron Age (Carrer *et al.* 2016; Reitmaier 2017; Dietre *et al.* 2020; Reitmaier 2021).

In and around the Karwendel, a similar development can be observed. Both north (Koschik 1981; Möslein 2001) and south of the mountain range, settlement became increasingly dense from the Early Bronze Age onwards. In the Inn Valley, this population growth was probably due to the exploitation of the copper deposits in the greywacke zone on the southern side of the valley (Höppner *et al.* 2005; Huijsmans, Krauß 2015; Töchterle 2015a; Töchterle 2015b). In the Middle Bronze Age, the settlement growth on both sides of the Karwendel continued, although the use of the fahlerz copper from Schwaz-Brixlegg already declined sharply in the late Early Bronze Age (BzA2a/FB IIb) in favour of the chalcopyrite deposits in the Mitterberg-Bischofshofen area near Salzburg and was finally abandoned altogether (Töchterle 2015b). It is also from the Early to the Middle Bronze Age onwards that we can note an increasing periodical use of the high-altitude grazing areas by shepherds in Northern Tyrol (Patzelt 2013). As elsewhere, this land use is documented by dry-stone buildings and enclosures in high altitude areas, shelters under overhanging rocks, fireplaces and ash layers.

As concerns the Karwendel Mountains, there are several hints for the beginning of pastoralism in the Bronze Age. The pollen diagram shows that the first settlement or pastoral activities in the valley might have taken place at

the beginning of the middle Bronze Age from 1500 BC onwards, although the increase in grazing and settlement indicators could also be connected with long-distance pollen flight (von Nicolai, Oeggl in preparation). The diagram also reveals a high number of charcoals during this period, which could be related to systematic burning to produce pastures. This assumption is confirmed by the radiocarbon dating of a charcoal sample that was recovered in a rock shelter situated at an altitude of 1350 m asl, close to the pathway that led from the valley bottom to the Laliders pasture (von Nicolai 2017). This sample was dated to the 16th century BC (1606-1506 (Cal 1 σ) or cal BC 1622-1466 (cal 2 σ), i.e. the end of the Early Bronze Age or the beginning of the Middle Bronze Age. As this sample comes from a redeposited mud flow, it is not possible to use it to date the layers in the rock shelter but several other charcoal layers have been documented in the surroundings of the rock shelter. This indicates that one or more large forest fires happened in the area. The Karwendel Mountains are a region with a lot of precipitation, so it is unlikely that large natural forest fires were provoked by lightning strokes (Bringemeier *et al.* 2015; Heel 2015). So maybe the charcoal sample from the rock shelter in the Karwendel Mountains can be connected with first pastoral activities or with prospectors venturing into the mountains in search for raw materials. In fact, several stray finds from the Urnfield period, such as a Bronze sword and a Bronze spearhead (Franz 1956), show that the area was frequented in this period. Thus, the pollen analysis, the charcoal sample from the rock shelter and the stray finds might indicate seasonal mobility related to transhumance in the Karwendel Mountains during the Bronze Age. Access to the Eng valley was possible either from the increasingly densely populated Inntal or from the Bavarian foothills of the Alps.

V. CONCLUSION: A (POST-) MESOLITHIC LIFESTYLE IN THE ALPS DURING THE NEOLITHIC

Considering the evidence from the Karwendel Mountains, we can assume that this site of Lalidersalm-Hochleger was frequented by hunters and gatherers, who practiced a Mesolithic lifestyle and followed the traditional trails across the mountains, not only in the 7th but also at the transition of the 5th to the 4th millennium BC. The stone artefacts hint to the Mesolithic. Furthermore, there is no evidence from the site so far of the use of pottery, the presence of grazing animals and the consumption of cultivated plants, although the pit contents

were almost completely wet-sieved. Other regions in the Northern Limestone Alps, for example the Kleinwalsertal in Vorarlberg/Western Austria (Posch 2022), reveal the same pattern: while some groups in the fertile lowlands along the rivers Danube, Isar and Lech, only a few hundred kilometers away, already lived as sedentary farmers since the middle of the 6th millennium BC, people in the Northern Limestone Alps as well as in the young moraine landscape of the Bavarian Alpine foothills maintained a nomadic and hunting-oriented way of life well into the 5th millennium BC. Such "parallel societies" are found all over Europe in marginal natural areas during the 6th and 5th millennium, where the environmental conditions were not favorable for early farming communities and not well suited to early agricultural methods and implements (Stäuble *et al.* 2021): for example, in Upper Swabia in the Federsee basin (Kind 1992; Kind 1997), in North Rhine-Westphalia (Bollongino *et al.* 2013; Orschiedt *et al.* 2021), in Eastern Saxonia/Oberlausitz (Liebermann 2021), and in the North German Plain (Schier 2017). With a few exceptions, such as Zizers-Fridau located in the Alpine Rhine Valley in the Grisons, Switzerland, where a settlement of the Middle Neolithic Hinkelstein Culture is attested (Seifert 2012), agriculture reached the Central Alps, and initially the big river valleys, only in the middle of the 5th millennium BC and later. Settlements such as the Kiechlberg in the Inn Valley bear witness to this. But in addition, there were also sites such as the rock shelter and several smaller rock boulders in the Urschai Valley, in the Lower Engadine, Switzerland, situated at an altitude of about 2200 m asl, where a sequence of fireplaces was excavated. It revealed large quantities of simple and unspecific pottery, well-preserved bones of alpine wild animals (ibex, chamois), flint arrowheads, as well as charred remains of collected plants or staple food like nuts and acorns, both from local trees and from species growing farer away today. The site was occupied several times between the 5th to the 3rd millennium BC, with two main phases dating from 4800 to 4500 BC and a slightly younger phase dating from 4500 to 4000 BC. The finds suggest a periodically camp used by hunter-gatherers during the Neolithic (Dietre *et al.* 2020). This indicates the continuation of dynamic and significant hunting activities in the Alpine region for the major part of the Neolithic. Especially during periods of climatic deterioration, for example the Chalcolithic, hunting played an important role for the nutrition of the population (Putzer, Festi 2014; Schibler 2008). Neolithic people in the Alps were also more mobile and their settlements smaller and more elusive than those in other regions. Pastoral use of the uplands began in the Central Alps only in the Bronze Age, especially during the Late Bronze Age, sometimes

even later. The inner valleys of the Karwendel Mountains were situated far from the main settlement areas and the important communication routes; on foot, the Eng valley can be reached from the Inn valley in at least six hours. The farmers today need 18 hours, i.e. two days, to drive their cattle from there to the Inn valley. Therefore, the colonization and exploitation of the Karwendel started with a delay in comparison with other, more accessible regions. Although the archaeological finds attest that the area was frequented at least sporadically in prehistory, neither pollen analysis nor archaeology can provide clear evidence of prehistoric pastoralism. At best, pastoral activities that left no traces in the pollen profile can be expected, due to the small number of animals and people involved. Only for the Roman period the pollen analyses document seasonal grazing in the Eng valley, however, there is no archaeological evidence for this. The persistence of a natural landscape largely untouched by humans is all the more astonishing when one considers how densely populated the adjacent Inn valley to the south was from the Bronze Age onwards. Only in the modern era it is possible to reconcile the pollen analyses with the archaeological evidence. All in all, the Karwendel project shows how systematic prospection can succeed in shedding new light on a region largely unexplored by archaeologists until now. Furthermore, it also contributes to the understanding of the coexistence of hunter-gatherers and agro-pastoralists in neighbouring regions over centuries, illustrating the complex and long-lasting process of neolithisation in Central Europe.

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