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Mesolithic stone tool function and site types in Northern Bohemia, Czech Republic

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ABSTRACT

The sandstone plateaus cut by canyons with rockshelters in Luxembourg, Germany and the northern Czech Republic remain relatively unexplored archaeologically. In northern Bohemia, Czech Republic, these were mainly settled during the Mesolithic. Recent surveys have revealed a network of Mesolithic sites representing short and long-term occupations in canyon rockshelters. One long-term (Pod zubem) and one short-term site (Pod křídlem) were selected for functional analysis of stone tools, including microscopic use-wear and residues analyses, in order to investigate the uses of different site types in terms of subsistence, economic, and seasonal activities. Results indicate that stone tools were used on a variety of materials at the long-term occupation site of Pod zubem. At Pod křídlem, where the record is more sparse, the analyses suggest that plant processing was the primary activity. Faunal, macrobotanical, and lithic functional analyses suggests specialised use of tools and sites in the Mesolithic of Northern Bohemia.

KEYWORDS

Mesolithic, residue analysis, use-wear analysis, plant processing, hafting, northern Bohemia, Czech Republic

INTRODUCTION

The Mesolithic in the Czech Republic

One of the typical but still little explored landscape features in western Central Europe are the restricted areas of sandstone plateaus cut by canyons with rockshelters that are scattered from Luxembourg over western and central Germany to the northern part of the Czech Republic. Archaeological research within the sandstone rockshelters shows that the surrounding lands, being unattractive for agriculture, were mainly settled during the Mesolithic period. In this manner, these sites contribute substantially to the knowledge of a relatively little known period of central European prehistory (cf. Street *et al.* 2001).

In the Czech Republic (Northern Bohemia) this type of research is of a relatively recent date. Systematic survey and excavation projects, held between 1997-2005, and partly supported by National Geographic Society grant 98/6330 'Last Hunter-gatherers of Northern Bohemia',

revealed a network of key Mesolithic rockshelter sites across the landscape (Figure 1). Surveying the whole area followed several strategies. At the first stage, creating a geographic network of sites was the main aim, so that representative rockshelters in the various microregions, valleys and canyons were selected for exploration. At the second stage, we concentrated on the most promising areas where the individual sites created interrelated systems with internal hierarchy in size and function. One of them is the microregion on the Robecsky Brook, presented in this paper, another one is the Kamenice River canyon further north, explored later (Svoboda *et al.* 2007). During this project, the selected sites were approached in a complex manner, from viewpoints of geology and sedimentology, paleobotany, archaeozoology, archaeology, and anthropology (Svoboda 2003). At certain sites, special attention was paid to use-wear and residue analyses as well.

A closer look at the map that resulted from this survey and a comparative analysis of the individual sites reveal a certain hierarchy in the size and location of the rockshelters, complexity of archaeological features such as hearths and pits, and the quantity and variability of artefacts. In

Figure 1. Map of the North Bohemian rockshelter sites with Mesolithic occupations (points) and location of the North Bohemian region in Europe. The wide area corresponds to present-day national border against Germany and Poland. The main crossing river (from south to north) is Labe (Elbe); the plateau lies in elevations between 250–300 m a.s.l., with single elevations reaching to 500–750 m a.s.l., while highest elevations (over 1000 m a.s.l.) occur only in westernmost part of the area. - 1: Bezděz, 2: Vysoká Lešnice, 3: Nížká Lešnice, 4: Strážník, 5: Stará skála, 6: Máselník, 7: Černá Louže, 8: Pod Černou Louží, 9: Šídelník, 10: Heřmánky, 11: Hvězda, 12: Uhelná rokle, 13: U obory, 14: Donbas, 15: Pod zubem, 16: Pod křídlem, 17: Černá Novina, 18: Údolí Samoty, 19: Dolský Mlýn, 20: Okrouhlík and surrounding sites, 21: Arba, 22: Sojčí rockshelter, 23: Jezevčí rockshelter, 24: Nosatý kámen, 25: Švédův rockshelter. Triangle: open air sites of the Stvolínky – Holany area.

addition, potentials for preservation of organic materials, which naturally add more data on past activities performed at a site, vary from one site to another.

From this viewpoint, the most complex site clusters excavated were in the deep canyons of larger brooks, such as the Kamenice river canyon in the very north (sites of Okrouhlík and Dolský Mlýn) and the Robečský Brook canyon ('Peklo' or 'Hellegrund' valley) in the center of the explored area (Svoboda *et al.* 1999). Because the Robečský brook canyon area offers the best conditions for organic preservation within the whole area, we have chosen the sites of Pod zubem ('under the tooth') and Pod křídlem ('under the wing') for the analysis presented in this paper (Figure 1).

The Pod zubem and Pod křídlem sites

The Pod zubem site, cadastre (county) of Česká Lípa, is located under a large, isolated rockhelter in a shallow side valley adjacent to the Robečský brook canyon, next to an active water spring, and 260 m a.s.l. This large but shallow rockshelter was explored in 1997 by three trenches adjacent to its northern wall, all of them 2 m wide and 2-3 m long. Trench A recorded a sequence of cultural layers not deeper than 1 m, whereas in trenches B and C we explored a large, oval-shaped depression reaching a total depth of 1.7 m (Figure 2).

Figure 2. The Pod zubem rockshelter, section in trench C. 1: grey, dusty layer; 2: brown-greyish, stripped layers of sand (both layers subrecent); 3: yellowish-grey, coarse-grained sand (Bronze Age, Neolithic); 4a-c: brownish-grey, fine-grained sand, with hearths and other anthropogenic features (Mesolithic); 5: yellow, coarse-grained sand, with silty bands (archaeologically sterile). Position of the ^{14}C samples from Layers 4a and 4b is indicated.

The upper three layers provided subrecent and Bronze Age occupations, especially Stroked pottery materials. Mesolithic Layer 4 was complex, with sandy-to-clayish layers interstratified by lenses of charcoal, burnt sand, and calcareous material. Thus, it was subdivided into stratigraphic units 4a-c, all providing Mesolithic lithic industries, with microlith types diagnostic for middle and late Mesolithic periods, bone tools (a chisel-shaped artifact and awls), associated faunal remains, and one human tooth. Charcoal for the ^{14}C dates (Table 1) was sampled from hearths in Layers 4a and 4b and yielded dates ranging from 7461 to 9025 cal B.P.

Table 1. ^{14}C dates for the Pod zubem and Pod křídlem rockshelters (all from charcoal). Calibration after the CALIB.REV.4.3. programme (Stuiver and Reimer 1993)

Rockshelter	Context	Depth (cm)	Layer	Sample #	Date (BP)	Interval (2 sigma)	Date (cal. BP)
Pod zubem	hearth	75	4a	GrN 23332	6790 $\pm$ 70	7510-7785	7656
Pod zubem	charcoal deposit	80	4a	GrN 23333	6580 $\pm$ 50	7421-7570	7461
Pod zubem	charcoal deposit	115-120	4b	GrN 23335	7660 $\pm$ 130	8182-8748	8412
Pod zubem	charcoal deposit	115	4b	GrN 23334	8110 $\pm$ 240	8408-9545	9025
Pod křídlem	charcoal deposit	50-70	4	GrN 23331	8160 $\pm$ 80	8815-9401	9124

Whereas the upper Mesolithic Layer 4a extended through all three trenches, and a remarkable circular hearth, plastered with sandstone blocks, was recovered in trench A, the middle and lower Mesolithic Layers (4b,c) were limited to filling of the depression in trenches B and C (Figure 3). In terms of paleobotany, this site yielded charcoal of pine, oak, and hazel, including hazelnut shells (Opravil 2003). The rich malacofauna (invertebrates with shells) corresponds to predominantly woodland communities, although a single find of Unionidae (freshwater mussels) may have been a contribution to the Mesolithic diet (Ložek 2003). The vertebrate fauna represents a wider variety of environments such as open habitats, woodland, and water environment of the nearby Robečský brook valley. Part of the faunal assemblage (Table 2) evidently results from hunting (hare, deer and red deer, elk, birds), and the relative abundance of certain species seems to reflect specialised hunting for fur animals (marten, squirrel, beaver, wild cat, fox; Horáček 2003).

Figure 3. The Pod zubem rockshelter, 1997 excavation, lowermost layer. a) white triangle – bone; b) diagonally hatched – sandstone blocks; c) charcoal; d) dotted - red-burnt sand; e) ‘brick-like’ hatched – calcareous deposits with organic material; f) limits of excavation.

Table 2. Fauna potentially hunted by Mesolithic humans at the Pod zubem rockshelter (MNI). Data by I. Horáček (2003)

Fauna	Pod zubem, Layer 4
Eurasian red squirrel (<i>Sciurus vulgaris</i>)	3
European beaver (<i>Castor fiber</i>)	3
Brown hare (<i>Lepus europaeus</i>)	12
European roe deer (<i>Capreolus capreolus</i>)	2
Red deer (cf. <i>Cervus elaphus</i>)	2
Eurasian elk (<i>Alces alces</i>)	1
Wild boar (<i>Sus scrofa</i>)	3
Auroch/Bison (<i>Bos/Bison</i>)	1
Pine marten (<i>Martes martes</i>)	10
Wild cat (<i>Felis sylvestris</i>)	4
Red fox (cf. <i>Vulpes vulpe</i>)	5
Wolf (<i>Canis lupus</i>)	2
Perching birds (<i>Aves</i> , <i>Passeriformes</i>)	3
Non-perching birds (<i>Aves</i> , <i>non Passeriformes</i>)	3

The Pod křídlem site, cadastre (county) of Kvítkov, is located at the foot of the canyon about 3 m above the Robečský brook water level and 247 m a.s.l. A trench of 2 x 3 m was excavated to explore the sediments. In the uppermost part of the deposits, we revealed a sequence of several 20th century hearths, underlain by hearths with subrecent and medieval pottery. The underlying Mesolithic Layer 4 included charcoal layers with burnt stones from slightly redeposited hearths, the largest of which provided a ^{14}C date of 9124 cal B.P. (Table 1). The lithic industry comprised only 54 artefacts, one of which was a microlithic triangle diagnostic of early or middle Mesolithic, consistent with the ^{14}C date. This layer also provided charcoal of pine and fragments of hazelnut shells. The base of this sequence was formed by sterile sandy deposits (Figure 4).

Figure 4. The Pod křídlem rockshelter section showing location of the ^{14}C dated charcoal sample. 1: recent layer; 2: brownish, humus sand (subrecent); 3: light grey, clayish layer with spots of white sand (subrecent); 4: brown-reddish to brown-grayish sand (Mesolithic); 5: rusty sand horizon; 6: yellow-brownish sand; 7: basal, coarse-grained sand (Layers 5-7 archaeologically sterile). Position of the ^{14}C sample from Layer 4 is indicated.

In summary, the two sites excavated in the Robečský brook canyon are each of a different type. Pod zubem represents a large and complex settlement with elaborate hearths, pits, abundant artefacts of stone and bone, faunal remains, and a multi-layered stratigraphy documenting a sequence of long-term occupations. In contrast, Pod křídlem is a small satellite site with simple hearths accompanied by only a few artefacts, which (based on typology and ^{14}C date) may correspond to short episodes within the more complex settlement sequence documented at Pod zubem. Judging from the location just above the brook, Pod křídlem would be an ideal fishing post, even if no fish bones were recovered (in Northern Bohemia, fish bones are recorded only from the rockshelter of Dolský Mlýn on the Kamenice river).

These two sites were selected for detailed functional analyses of stone tools (both residue and use-wear analyses) because they represent cases of a large and long-term site and a small, rather episodic site that were partly contemporary. The excavations contribute to our understanding of hunting and other subsistence strategies, including aspects of seasonality. The faunal composition at Pod zubem shows a dominance of forest species, especially animals hunted for furs, whereas the morphology of bone industry suggests working with hides. The finds of hazelnuts complete the evidence on subsistence, but may also indicate a season of occupation during late summer and/or early fall. This observation would fit with the evidence of fur working, possibly in expectation of the approaching winter. With this in mind, we undertook functional analyses of a sample of stone tools from the upper and lower Mesolithic Layers (4a,b) of Pod zubem and a comparative sample from Mesolithic Layer 4 of Pod křídlem, where almost half of the small assemblage was examined, in order to gain a more complete picture of economic and subsistence activities.

STONE TOOL FUNCTION IN THE MESOLITHIC: PREVIOUS RESEARCH

Just as excavations in the Czech Republic have been more focused on the Upper Paleolithic than the Mesolithic, so functional studies of stone tools in Europe have also tended to neglect the Mesolithic. The small number of studies that have been undertaken have primarily used the high-power method of use-wear analysis with magnifications up to 500x (Keeley 1980) although low-power magnification (50-200x) has also been used (e.g. K. Hardy 2004). The high-power method primarily relies on the recognition of polishes for identification of use-material, with supporting evidence provided by striations and edge damage. Microliths (including crescents, triangles, lunates, and backed bladelets) commonly show evidence of hafting and are generally assumed to have been part of composite tools with an emphasis on use as armatures or projectile points (Crombé *et al.* 2001; Dumont 1988). Other tool types, including blades, scrapers, denticulates, etc., are used for a variety of purposes such as wood, plant, hide, meat or antler/bone processing (e.g. Cahen *et al.* 1979; Dumont 1988; Finlayson 1990; Finlayson and Mithen 1997; K. Hardy 2004; Thorsberg 1983; Uwe-Heussner 1989).

The current study was described preliminarily by Hardy (1999) and has been updated subsequently with further microscopic analysis (including scanning electron microscopy, see below) and more specific identification of residues. Another type of analysis showing mechanical blow impacts on tips of microlithic projectiles is currently being undertaken by Yaroshevich (pers. comm. 2006) on materials from two Mesolithic sites (Okrouhlík and Dolský Mlýn) within the same region of northern Bohemia.

METHODS

Microscopic residue analysis attempts to elucidate stone tool function. In this case, function is a broad term encompassing a combination of how a tool was used (e.g. to cut or to scrape, also referred to as use-action) and the material on which a tool was used (e.g. hide, wood, etc.; also referred to as use-material). When it is possible to ascertain both use-action and use-material, it is possible to reconstruct tool function (e.g. whittling wood, scraping hide, etc.). Use-actions are inferred from the distribution of wear patterns (polishes, striations, edge rounding) and residues on tool's surface. Residues that show distinct patterning or co-occurrence with use-wear are referred to as use-related. Residues with no clear patterning (even distribution over the entire surface) and no associated wear patterns are not considered to be use-related.

A total of 70 artefacts (Pod zubem, n=46; Pod křídlem, n=24) were analysed microscopically for the presence of use-wear traces and use-related residues (Hardy 1999). Minimally handled, unwashed artefacts greater than 0.5 mm in size were placed in new resealable plastic bags as they were removed from the excavation in order to reduce the potential loss of residues through washing (Hardy and Garufi 1998; Hardy *et al.* 2001). The opportunistic sample included all artefacts removed from in situ excavations at either site during the two weeks of analysis. The

artefacts were examined using incident light microscopy at magnifications ranging from 50-500x using an Olympus BH microscope. Observed residues and use-wear were photographed and their locations recorded on line drawings of each artifact. Sediment samples taken from all levels at each site were also examined for the presence of residues.

Residues were identified based on comparison with published and comparative experimental material and included hair, feathers, plant and woody remains, resins, and starch grains (Anderson-Gerfaut 1990; Beyries 1988; Brom 1986; Brunner and Coman 1974; Catling and Grayson 1982; Fullagar 1991; Hardy 1994; Hardy and Garufi 1998; Hather 1993; Hoadley 1990; Kardulias and Yerkes 1996; Lombard 2004; Pearsall 2000; Teerink 1991; Williamson 1996). Residues were interpreted as use-related based on their patterning on the artifact surface, concordance with use-wear patterns, and their absence from sediment samples. Residues found on both artefacts and in the surrounding sediments were not classed as use-related (e.g. small rootlets). The typological categories represented in the sample included blades, bladelets, flakes, unifacial points and a crescent. Blades and bladelets are here defined as flakes twice as long as they are wide (Whittaker 1994) with blades having a breadth >0.7 cm. For the purposes of this analysis, the two categories are grouped together since they represent different sizes of the same artifact shape.

A small number of identifiable residues were removed from artifact surfaces for further analysis with scanning electron microscopy (SEM). These residues were removed by applying double-sided adhesive tape to the tool surface, then peeling the tape away and sticking the other side to an SEM stub. The stubs were sputter-coated with gold and examined with a JEOL 840a SEM at magnifications up to 2000x.

Use-wear observations included the assignation of polishes to two broad categories indicating the relative hardness of the use-material, hard/high silica or soft (B. Hardy 2004; Hardy *et al.* 2001). The hard/high silica category does not distinguish between hard materials such as bone, antler and wood from high silica materials such as grasses since high silica materials can produce polishes similar in nature to those produced by hard materials (Fullagar 1991). The direction and orientation of striations, edge damage, and edge rounding were also recorded.

RESULTS

The combined sample from both sites consisted of 40 blades and bladelets, 28 flakes, one crescent and one unifacial point, for a total of 70 artefacts. Of these, 45 (64.3%) had some form of functional evidence (Table 3). Specific materials identified include plant, wood (particularly conifers/gymnosperms), feathers, hair, resin, and starch grains.

Pod Zubem

A total of 46 stone artefacts were analysed from the long-term occupation at Pod zubem including 30 blades/bladelets, 15 flakes, and a single unifacial point (Table 3). The residues observed include plant fragments, wood fragments, starch grains, feathers, hair and resin (mastic). In addition, use-wear polishes and edge damage contribute to our understanding of tool function and hafting.

Blades and Bladelets

Twenty-three of 30 blades and bladelets (76.7%) preserved some type of functional evidence. Residues included plant and wood tissue, and single instances of hair and feathers, suggesting use on a wide range of materials. The most common pattern of residue/use-wear includes combinations of plant/wood residues with hard/high silica polishes. In several cases, it was possible to identify the wood residue as gymnosperm (conifers) in origin due to the presence of bordered pits (Figure 5-6) (Hoadley 1990). In one case, tracheids are characterised by paired bordered pits indicating either larch (*Larix* sp.) or spruce (*Picea* sp.) as the source wood (Figure 5) (Hoadley 1990). Differentiation between larch and spruce is not possible based on the preserved anatomy. Furthermore, nearly half (14/30, 46.7%) of the blades/bladelets also show evidence for hafting. The distribution of functional evidence often suggests that a blade or bladelet was hafted

Table 3: Summary of functional evidence by tool type*

Pod zubem/Pod křídlem combined					
Evidence	Blades and Bladelets	Flakes	Crescent	Unifacial Pt.	Total
Plant	9/40	3/28	0/1	0/1	12/70
Wood	3/40	1/28	0/1	0/1	4/70
Starch grains	2/40	1/28	0/1	0/1	3/70
Feathers	1/40	1/28	0/1	0/1	2/70
Hair	1/40	1/28	0/1	0/1	2/70
Soft	4/40	1/28	0/1	0/1	5/70
Hard/high silica	12/40	4/28	0/1	0/1	16/70
Hafted	14/40	3/28	0/1	1/1	18/70
Striae only	2/40	1/28	0/1	0/1	3/70
None	9/40	16/28	0/1	0/1	27/70
Pod zubem					
Evidence	Blades and Bladelets	Flakes		Unifacial Pt.	Total
Plant	2/30	1/15		0/1	3/46
Wood	3/30	1/15		0/1	4/46
Starch grains	0/30	1/15		0/1	1/46
Feathers	1/30	1/15		0/1	2/46
Hair	1/30	1/15		0/1	2/46
Soft	4/30	1/15		0/1	5/46
Hard/high silica	9/30	2/15		0/1	11/46
Hafted	14/30	2/15		1/1	17/46
Striae only	2/30	1/15		0/1	3/46
None	7/30	7/15		0/1	14/46
Pod křídlem					
Evidence	Blades and Bladelets	Flakes	Crescent		Total
Plant	7/10	2/13	0/1		9/24
Wood	0/10	0/13	0/1		0/24
Starch grains	2/10	0/13	0/1		2/24
Feathers	0/10	0/13	0/1		0/24
Hair	0/10	0/13	0/1		0/24
Soft	0/10	0/13	0/1		0/24
Hard/high silica	3/10	2/13	0/1		5/24
Hafted	0/10	1/13	0/1		1/24
Striae only	0/10	0/13	0/1		0/24
None	2/10	9/13	0/1		11/24

Note: categories of evidence are not mutually exclusive. Totals in columns may exceed the number in the sample.

longitudinally. One half of the tool shows hafting evidence while the other half shows evidence for use. Hafting evidence includes striations confined to one area of an artifact as well as additive resin residue which may have served as a mastic (Figure 5).

Flakes

Eight of the 15 flakes (53%) analysed showed evidence of use. Flakes appear to have been used on a wide range of substrates with some flakes exhibiting use on multiple materials. PZ 824 (Figure 6) was used for cutting both gymnosperm wood and avian tissue. Feathers are potentially identifiable to Order level based on the patterning of nodes and internodes as well as the shape and arrangement of prongs at internodes (Brom 1986). The patterning on the feathers in Figure 6C-D is consistent with the Order Procellariiformes, which includes fulmars, shearwaters, and petrels. Given the fragmentary nature of the feather sample and the lack of certain diagnostic elements, however, this identification should be considered tentative, particularly since Procellariiformes are generally highly pelagic and Pod zubem is far from the ocean. Figure 7 shows a flake that was hafted using resin as a mastic. The worked edge shows numerous fragments of plant tissue (not specifically identifiable).

Figure 5. PZ 503: Bladelet with evidence of hafting and woodworking, A) SEM photo of softwood tracheid with paired bordered pits indicated by arrows, B) resin. Shading indicates area under the haft.

Unifacial Point

The one unifacial point in the sample shows evidence for hafting in the form of striations on the proximal portion of the tool caused by movement of the artifact in the haft. No evidence was found on the distal end to indicate the material on which the tool was used.

Pod křídlem

Twenty-four artefacts were examined from the short-term occupation site of Pod křídlem, 12 (50%) of which showed functional traces (Table 3). Eight of ten blades and bladelets had signs of use, all with evidence of plant or hard/high silica material. The remaining two showed no evidence of use. Of the 13 flakes examined, only four (30.7%) showed signs of use, all on plant or hard/high silica material. One microlithic crescent examined preserved no evidence of use.

Figure 8 shows a bladelet that has been used for processing a starchy plant material. The plant tissue on the bladelet's margin consists of storied parenchyma (energy storage tissue) with numerous starch grains within it, identifiable by a characteristic extinction cross visible under cross-polarised light (Haslam 2004). This type of tissue is typically found in storage organs such as roots and tubers (Hather 1993). Nuts are also high in starch and contain storage (parenchyma) tissue (Decke 1982). Hazelnut remains were found at both Pod zubem and Pod křídlem. If this tissue does represent hazelnut, then the bladelet may have been used to peel the outer skin. However, once the hard outer shell has been removed, the skin on hazelnuts is soft, thin and edible, making this type of processing unnecessary. A more likely scenario would involve using a stone tool to pry open the hard outer shell. Paz (2001) documented this process on *Beilschmiedia* nuts from archaeological deposits in Sulawesi. In the process of prying open the shell of the nut with a stone tool, the underlying flesh of the nut was cut. This process would potentially produce a residue similar to that in Figure 7. Unfortunately, no further diagnostic anatomy was found to distinguish between nuts and roots or tubers.

DISCUSSION

Pod zubem and Pod křídlem were chosen for analysis because they represent two distinct types of occupation (long-term and short-term) and are in close proximity to one another. Thus, they have the potential to provide information about differences in activities at different site types, at least in terms of stone tool function. Based on the current analysis, the two sites show marked differences in terms of tool use.

Figure 6. PZ 824: Flake used for woodworking and cutting avian tissue, A) wood cells in oblique section, B) SEM photo of softwood tracheids with bordered pits indicated by arrow, C) feather barbule, D) SEM photo of feather barbule with two projecting prongs.

On the basis of the environmental and faunal analyses, Pod zubem, the larger settlement, was within a predominantly woodland environment with pine, oak, and hazel, not far from a larger brook. The Mesolithic inhabitants concentrated on collecting hazelnuts and hunting hares, deer, elks and birds, with special emphasis on fur animals such as squirrel, marten, wild cat, beaver, and fox. Hazelnuts are available seasonally in late summer and early fall. The evidence for skin-working and the presence of fur-bearing animals suggests a late fall or winter occupation. In contrast, the Pod křídlem site represents short-term and probably task-specific stays deeper inside the valley, directly above the brook.

Parallel to the longer occupation with numerous hearths, faunal remains, and macrobotanical remains, stone tool use at Pod zubem is more varied than that at Pod křídlem. Stone tools were used on a wide range of materials including plant, wood, mammals, and birds. In some cases, a single tool was used on many different materials. Hafting is common at Pod zubem and was often accomplished by the use of a resin as a mastic. While it has not been possible to specifically

Figure 7. PZ 475: Hafted flake used for plant processing, A) resin, B and C) plant tissue on edge. Shading indicates area under the haft.

identify the source of the resin, the evidence for processing of gymnosperms suggests various conifers (juniper, pine, spruce, larch, etc.) as possibilities. These findings are consistent with archaeological data that suggest that the site represents a longer term, repeated occupation.

By contrast, the more ephemeral site of Pod křídlem demonstrates a more specialised use of tools. All artefacts with signs of use were utilised on plants or hard/high silica material. Furthermore, there is little evidence of hafting. These data fit a pattern of hand-held tool use focused on plant material. The starchy storage tissue found on PK 251 can be interpreted as evidence of food processing, either of nuts or roots and tubers. If this is indeed nut processing, this may suggest a late summer/early fall occupation similar to Pod zubem. If instead this tissue derives from roots or tubers, it does not provide insight into seasonality.

Figure 8. PK 251: Bladelet used for processing starchy plant material. A) stored parenchyma cells, B and C) parenchyma cells with starch grains, arrow indicates characteristic extinction cross, D) hard/high silica polish, E) SEM photo of stored parenchyma.

Another possible explanation for the differences between these two sites is differential residue preservation. Often, it appears that animal residues are underrepresented, at least in comparison with the archaeozoological assemblages (Hardy *et al.* 2001; Hardy, 2004). Microscopic residue analysis can, however, detect animal residues when they are present (e.g. Hardy *et al.* 2001; Lombard 2004; Loy and Dixon 1998; Williamson 1996). Furthermore, when preservation conditions are favourable, animal residues may be found in large amounts on numerous artefacts as has been demonstrated on Aurignacian artefacts from southwestern Germany (Hardy *et al.* in press). In this case, the sites are very similar in geological makeup (sediment, depositional environment) and differential preservation between the two is unlikely. Therefore, the lack of animal residues at Pod křídlem is not likely due to taphonomic bias.

Plants processed at Pod zubem and Pod křídlem include wood (specifically softwood/gymnosperm) and possibly roots, tubers or nuts. Evidence for root or tuber exploitation has been documented at numerous Mesolithic sites across Europe. Root and tuber remains include arrowhead, knotweed (Calowanie, Poland: Kubiak-Martens 1996), cattail, wild beet, bulrush, wood fern (NP3 and S51, Northern Netherlands: Perry 1999), wild garlic, pignut (Halsskov, Denmark: Kubiak-Martens 2002), and non-specific vegetative storage tissue (Roc del Migdia, Catalonia: Holden *et al.* 1995). Hazelnuts are quite common at many Mesolithic sites (see Regnell *et al.* 1995; Zvelebil 1994; among others), although it is difficult to estimate exactly how important they were in the Mesolithic diet (Mithen *et al.* 2001).

Wood processing definitely occurred at Pod zubem, particularly of gymnosperms and in one case larch or spruce. However, what the wood was being used for is unclear. There is evidence that conforms to hafting traces (striations, bright spots, resin) seen on experimental and archaeological material (e.g. Crombé *et al.* 2001; Rots 2005) and hafting requires the preparation of a handle. Thus, the woodworking could relate to the preparation of a haft. Other uses are certainly possible but lack any supporting evidence on which to form a hypothesis.

CONCLUSIONS

Clarke (1976) anticipated the importance of plant use in the Mesolithic many years ago and subsequent research has confirmed his hypothesis (e.g. Mason 2000; Mithen *et al.* 2001; Zvelebil 1994). While macrobotanical remains were found at the long-term occupation site of Pod zubem, the application of microscopic residue analysis has yielded additional evidence for plant processing. At the short-term occupation of Pod křídlem, few macrobotanical remains were recovered; thus, residue analysis has demonstrated an activity that was otherwise hardly visible archaeologically. The evidence for processing of wood at Pod zubem fits well with the faunal assemblage which is dominated by forest species. The macrobotanical identification of hazelnuts along with the microscopic identification of roots, tubers, or nuts adds to the growing body of literature demonstrating the importance of plant foods in the Mesolithic.

The evidence presented here also points to the exploitation of mammals and birds at Pod zubem, especially the smaller fur animals (cf. Charles 1997). Evidence for frequent hafting at the site may relate to the construction of composite points or barbs similar to those recreated experimentally (Crombé *et al.* 2001), whereas the impact blows identified by Yaroshevich (pers. comm. 2006) on some of the geometric projectiles complete the picture of hunting by projectiles.

In addition to providing information about subsistence and economic activities, we can see a clear distinction in site function. Stone tools were used on a wide variety of materials at Pod zubem, reflecting the longer-term occupation and the richer archaeological assemblage. The archaeological record at Pod křídlem is sparser, but can be supplemented by the functional analyses that point to plant processing as an important activity. The combination of faunal, macrobotanical, and stone tool functional analyses suggests specialised use of tools and sites in the Mesolithic of Northern Bohemia.

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