

Human Subsistence and Environment during the Magdalenian at Langmahdhalde: Evidence from a new Rock Shelter in the Lone Valley, Southwest Germany

Gillian L. Wong¹, Britt M. Starkovich^{1,2} and Nicholas J. Conard^{2,3}

¹Eberhard Karls Universität Tübingen
Institut für Naturwissenschaftliche Archäologie
Rümelinstraße 23
72070 Tübingen, Germany
gillian.wong@uni-tuebingen.de
britt.starkovich@uni-tuebingen.de

²Senckenberg Centre for Human Evolution and Palaeoenvironment at Tübingen, Germany

³Eberhard Karls Universität Tübingen
Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters
Abteilung Ältere Urgeschichte und Quartärökologie
Schloss Hohentübingen
72070 Tübingen, Germany
nicholas.conard@uni-tuebingen.de

Abstract: *The Magdalenian assemblages of southwestern Germany offer insights into human behavior, subsistence, art, and mobility. Work at Langmahdhalde, a newly excavated Magdalenian rock shelter, has demonstrated the potential of its assemblages to continue this tradition using new tools and methods. Here, we present a preliminary study of the Magdalenian faunal assemblages from the site and discuss how these assemblages will contribute to our current understanding of human subsistence and environmental change at the end of the Pleistocene. We find that a significant portion of the macromammal assemblage at the site is a result of human activity. We also find that the large microvertebrate assemblage at the site is ideal for paleoenvironmental reconstruction and reflects large-scale environmental change from the late Pleistocene to early Holocene. These assemblages have the potential to address questions of Magdalenian settlement patterns in the Swabian Jura and to reconstruct the local paleoenvironment.*

Keywords: *Swabian Jura, rock shelter, Late Pleistocene, Holocene, Magdalenian, fauna, paleoenvironment*

Menschliche Subsistenz und Umwelt im Magdalénien der Langmahdhalde: Zeugnisse aus einem neuen Felsschuttdach im Lonetal, Südwestdeutschland

Zusammenfassung: Die Magdalénieninventare aus Südwestdeutschland gewähren Einblicke in Verhaltensweisen, Subsistenz, Kunst und Mobilität von Menschen. Arbeiten an der Langmahdhalde, einem neu entdeckten Felsschuttdach im Lonetal mit Funden und Befunden aus dem Magdalénien, erweitern das Potential der Fundstelle, diesen Sachverhalt unter Nutzung neuer Auswertungswerkzeuge und Methoden zu untermauern. Der Beitrag präsentiert eine vorläufige Untersuchung der magdalénienzeitlichen Fauneninventare aus der Fundstelle und legt dar, in welcher Weise diese Inventare zu unserem gegenwärtigen Verständnis der menschlichen Subsistenz und des Umweltwandels am Ende des Pleistozäns beitragen können. Es zeigt sich, dass ein nennenswerter Anteil des Großsäugerinventars aus der Fundstelle auf menschliche Aktivitäten zurückgeht. Es zeigt sich ebenso, dass das Inventar der größeren Kleinsäuger aus der Fundstelle ideal für Rekonstruktionen der Paläoumwelt ist, und dass die Vergesellschaftung dieser Tiere den großmaßstäblichen Umweltwandel vom späten Pleistozän zum frühen

Holozän widerspiegelt. Diese Fauneninventare besitzen das Potential, Fragen zu Siedlungsmustern im Magdalénien der Schwäbischen Alb anzugehen und die Paläoumwelt der Region zu rekonstruieren.

Schlagwörter: Schwäbische Alb, Felsschutzdach, Spätpleistozän, Holozän, Magdalénien, Fauna, Paläoumwelt

Introduction

The German Magdalenian is a dynamic cultural period characterized by the reintroduction of human populations to previously uninhabited regions and a subsistence focus on large game. This cultural period occurs after the Last Glacial Maximum (LGM), when climates are unstable and characterized by both warming and cooling events, a rapid retreat of glaciers just after the LGM, and eventual climatic amelioration that included a slow return of forests and the development of rich grasslands (Frenzel 1983; Weniger 1989; von Koenigswald 2003; Otte 2009; Maier 2015). Overall, these changes led to an increase in biodiversity across southern Germany that is reflected in the paleontological, paleobotanical, and archaeological records (von Koenigswald 2003; Maier 2015). Central European human subsistence strategies during this time are generally focused on reindeer (*Rangifer tarandus*) and horse (*Equus ferus*; Jochim et al. 1999; Maier 2015), but continue to broaden, with an increased intake of small game, plant, and fresh water resources (Weniger 1989; Stiner and Munro 2002; von Koenigswald 2003; Conard et al. 2013).

The Magdalenian of southwestern Germany has several well-studied sites, including those from Petersfels, Brillenhöhle, Schmiechenfels, Schussenquelle, and Hohle Fels. These assemblages are characterized by blade industries, bone tools, reindeer antler, art objects made of bone, antler, stone, and shell, and few ivory artifacts compared to earlier Upper Paleolithic assemblages (Schmidt 1912; Eriksen 1991; Maier 2015). Magdalenian archaeofaunal assemblages from this region demonstrate human subsistence strategies that fall in line with trends seen throughout Central Europe: reindeer- or horse-dominated diets with evidence of broadening (Schmidt 1912; Eriksen 1991; Napierala et al. 2014; Maier 2015). For example, Petersfels and Brillenhöhle have some of the largest Magdalenian faunal assemblages in southwestern Germany. Both large game assemblages are dominated by horse and reindeer specimens, and both assemblages have an abundance of hare (*Lepus* sp.) and ptarmigan (*Lagopus lagopus*) remains (Peters 1930; Boessneck and von den Driesch 1973, tables 1 and 2; Albrecht 1979; Albrecht and Hahn 1991).

The Paleolithic caves and rock shelters of the Swabian Jura of southwest Germany are some of the best studied archaeological sites in Europe and have been explored archaeologically since the 1860s (Schmidt 1912; Weniger 1989; Conard and Bolus 2006; Taller et al. 2014). Fraas' excavation of the late Magdalenian site Schussenquelle in 1866 (Fraas 1867; Schuler 1994) is largely considered the first systematic scientific Paleolithic excavation in Central Europe. Other Magdalenian sites in the region include Vogelherd, Hohlenstein, and Bockstein in the Lone Valley, Brillenhöhle, Geißenklösterle, Hohle Fels, and Helga Abri in the Ach Valley, and Schmiechenfels in the Schmiech (Fig. 1) Valley. Like most of Central Europe, after the LGM, humans did not repopulate the Swabian Jura until the later stage of the Magdalenian. The Magdalenian occupation of this region began before the late glacial interstadial, during cold and dry conditions (finds from

Hohle Fels have yielded a date of 16,300 cal BP; Taller et al. 2014) and continued until approximately 12,700 cal BP (Hahn 1995; Housley et al. 1997; Gaudzinski and Street 2003; Kind 2003). The sites in the Swabian Jura can therefore contribute to our understanding of why the number of Central European archaeological sites increases dramatically starting in the early late Magdalenian.

Several paleoenvironmental reconstructions have been conducted on Paleolithic time periods in the Swabian Jura using palynological (e.g., Firbas 1949; Bertsch 1961), archaeobotanical (e.g., Riehl et al. 2014), faunal (Krönnecke 2008, 2012), and geoarchaeological (e.g., Miller 2015) methodologies. These studies, though, focus primarily on periods pre-dating the Magdalenian. Further, although the power of microfaunal assemblages in paleontological and archaeological contexts to interpret past environments has long been acknowledged in Germany (e.g., Schmidt 1912; Ziegler and Dean 1998; Böhme 2007; Soergel-Rieth 2011[1924]), Magdalenian-aged microvertebrate assemblages in the Swabian Jura have not been the primary focus of research from this time period. New archaeofaunal datasets are therefore essential for reconstructing the environmental context of Magdalenian hunter-gatherers.

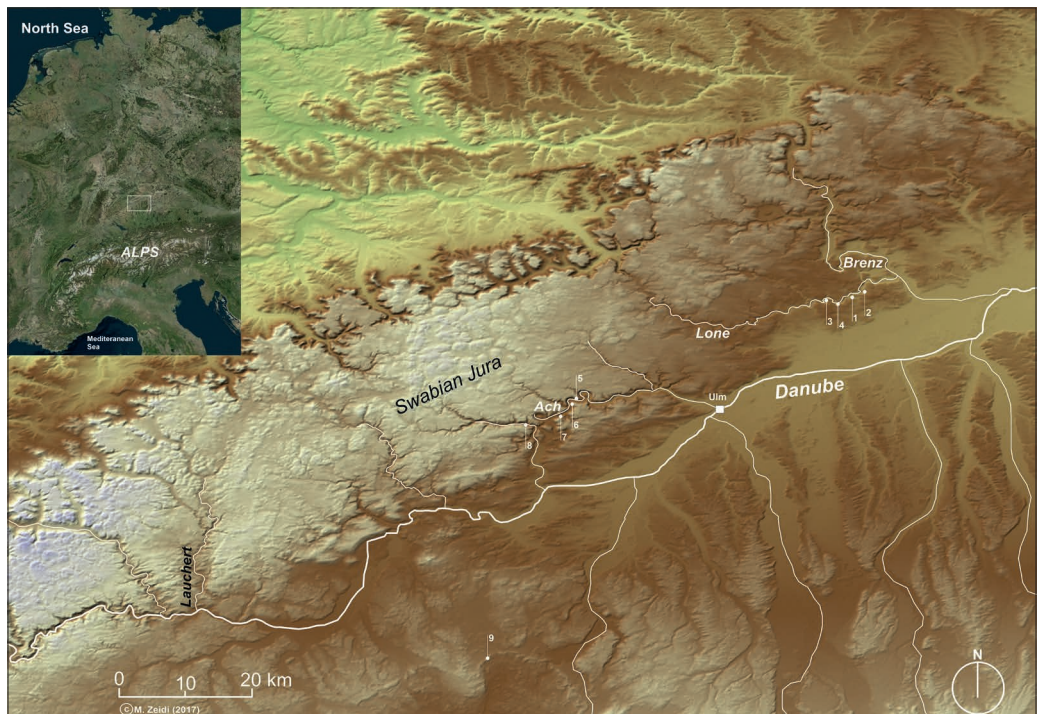


Fig. 1: Location of Langmahdhalde and other sites mentioned in the text. 1 = Vogelherd; 2 = Langmahdhalde; 3 = Bockstein; 4 = Hohlenstein; 5 = Brillenhöhle; 6 = Geißenklösterle; 7 = Hohle Fels and Helga Abri; 8 = Schmiechenfels; 9 = Schussenquelle. Map prepared by M. Zeidi.

Langmahdhalde is a newly excavated rockshelter in the Lone Valley with intact Magdalenian horizons. It is the first archaeological site from this time period to be identified in the Lone Valley for several decades, making it an ideal location to apply new techniques of excavation and analysis to a Magdalenian assemblage from the Swabian Jura. The site, which appears to be well-stratified, is still under excavation and has revealed an extensive Magdalenian horizon that consists of three combustion features, a significant stone tool assemblage, and several bone and antler artifacts. The archaeofaunal assemblage consists of macrovertebrate remains and a large microvertebrate assemblage. The site also has potential for the preservation of further Magdalenian remains and older Paleolithic deposits.



Fig. 2: Langmahdhalde. Overview of the excavation, May 2017. Photo: M. Zeidi.

In this paper, we present a preliminary analysis of the faunal remains from the Magdalenian occupation of Langmahdhalde, centered on both the micro- and macrovertebrates. Our goal is to determine whether the archaeofaunal assemblage from Langmahdhalde has the potential to address some of the gaps in our understanding of Magdalenian peoples of the Swabian Jura. We discuss whether the macrovertebrate remains from Langmahdhalde were deposited as a result of human activity and how taxonomic abundances compare to other Magdalenian assemblages from the Swabian Jura and general trends in Central European Magdalenian faunal data. We also evaluate the potential of

the microvertebrate assemblage to reconstruct regional paleoenvironmental conditions during the entire human occupation of the site, which includes specimens from the, primarily Holocene, horizons above the Magdalenian remains. We consider the sample size, taxonomic representation, and spatial distribution of the microvertebrate assemblage as factors indicative of this potential.

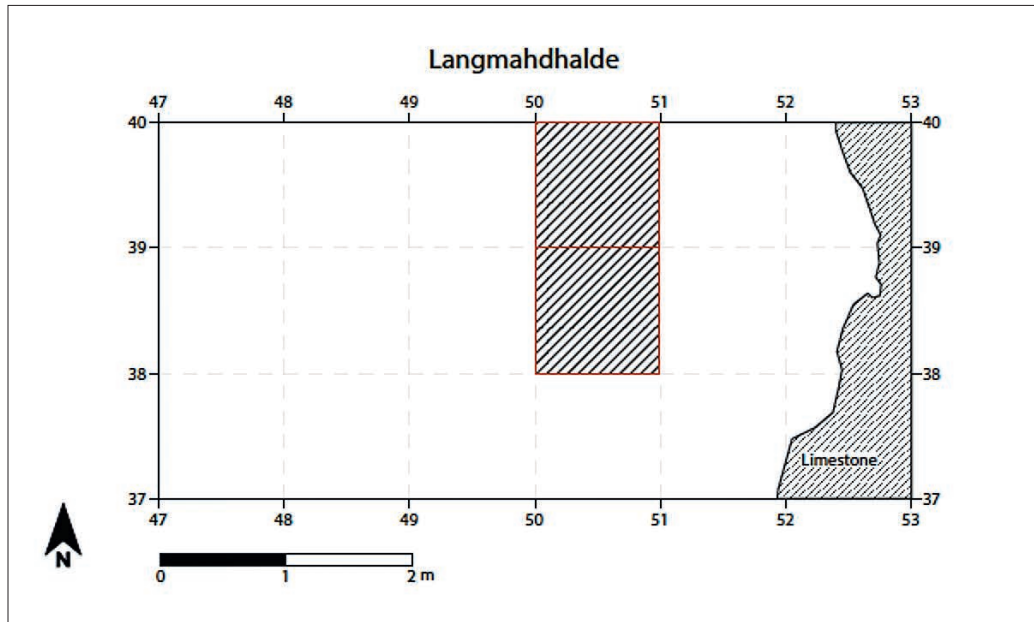


Fig. 3: Langmahdhalde. Excavation area one by one meter quadrant system. The rock face is indicated by the shaded portion on the right. The quadrants used for the microvertebrate analysis are highlighted (50/38 and 50/39). Illustration prepared by M. Zeidi and A. Janas.

Langmahdhalde

Langmahdhalde is a rock shelter in the Swabian Jura in southwest Germany. It is located in the Lone Valley, approximately 2 km northeast from the well-known archaeological site Vogelherd (Fig. 1). Test excavations began at the site in the late spring of 2016 and were conducted by the Institut für Ur- und Frühgeschichte und Archäologie des Mittelalters at the University of Tübingen under the direction of N. Conard. These excavations opened two trenches under the rock shelter. Only one of these excavation areas demonstrated clear potential for additional archaeological deposits and was thus expanded. In late spring of 2017, excavations continued and the excavation area was expanded and deepened (Fig. 2); it currently consists of 18 1 meter x 1 meter quadrants (Fig. 3). Excavation will continue in 2018.

The site has six geological (GH) and archaeological (AH) horizons: GH 1/AHI; GH2/AHII; GH2a/AHIIa; GH 3/AH III; GH 4/AH IV; GH 5/AH V (see Conard et al. 2017 for more details). GH1/AHI is a modern humus layer. GH2/AHII yielded a radiocarbon age of 2,465-2,361 cal BP and includes several Iron Age ceramic fragments (Conard et al.

2017). GH2a/AHIIa is a thin horizon compared to the others and has few faunal remains, but a lithic assemblage that likely belongs to the Mesolithic. GH3/AHIII has few anthropogenic remains but a date from the bottom of this layer places it in the late Paleolithic (14,379-14,088 cal BP; Conard et al. 2017). GH4/AHIV revealed a surface of several combustion features, antler, bone, and numerous lithic and microvertebrate remains, that was partially uncovered in 2016 and further explored in 2017. It has been dated to the Magdalenian (15,291-15,159 cal BP; Conard et al. 2017). Based on stratigraphy and artifact assemblages, these Magdalenian features and artifacts appear to continue into GH5/AHV (Fig. 4), which was first excavated in 2017 and has yet to be directly dated.

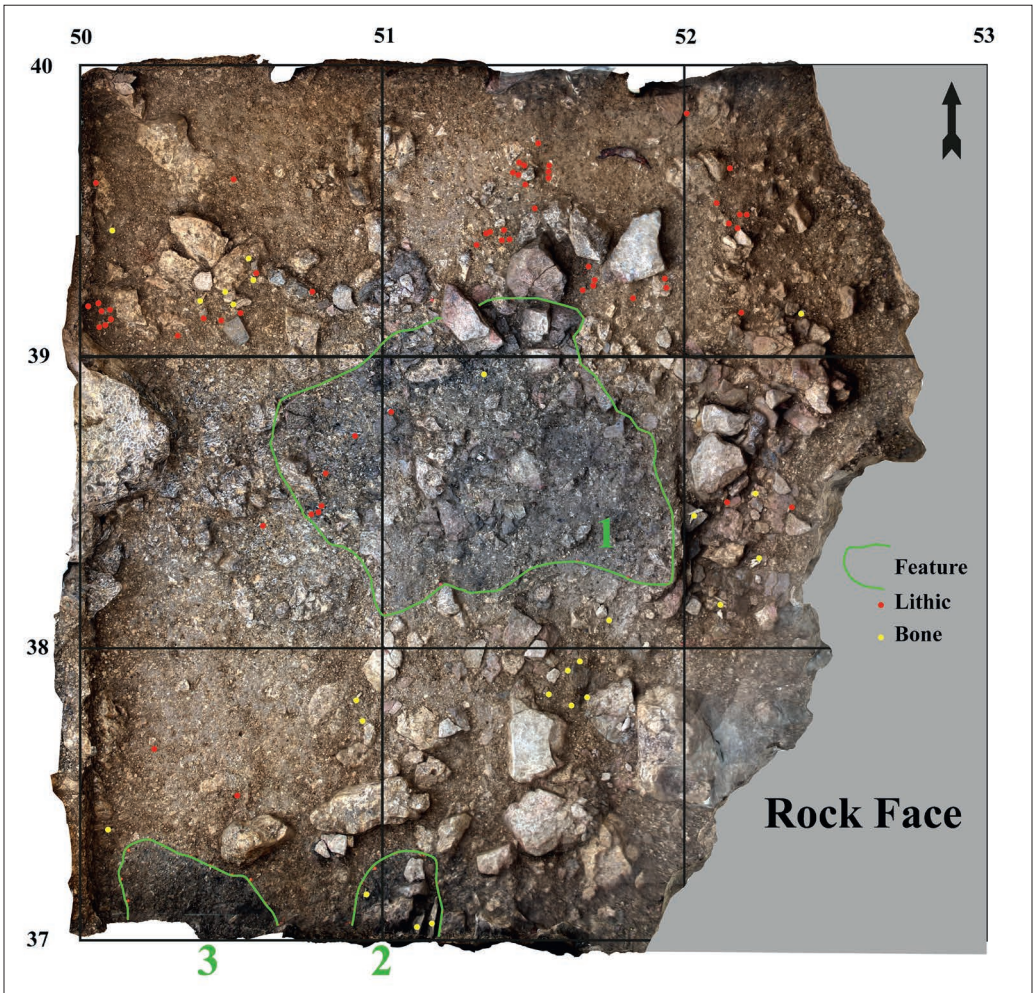


Fig. 4: Langmahdhalde. Overview of GH5 during excavation. The three combustion features are visible as well as lithic and bone artifacts and the numerous burned limestone pieces that characterize this horizon and GH4. Illustration prepared by A. Janas. Full color version available online: mgfuopenaccess.org.

In this paper, we focus on the Magdalenian deposits at the site. We include all macrofaunal remains from GH4/AHIV from the 2016 excavation and all macrofaunal remains from GH4/AHIV and GH5/AHV from 2017 that were observed during excavation and measured individually. Remains from the 2017 excavations that were recovered as collected finds or recovered during water screening and sorting were not yet available for study at the time of this analysis. The microvertebrate assemblage at this site is quite large ($n > 200,000$ specimens); as a result, we include only the microvertebrate remains from quadrants 50/38 and 50/39 from the 2016 excavations in this analysis. These quadrants have some of the largest microvertebrate assemblages at the site and they are highlighted in Fig. 3. In order to fully evaluate Late Pleistocene environments at the site, we conducted microvertebrate analyses on all geological and archaeological horizons except GH1/AHI, as it is modern. The Holocene horizons (GH2/AHII and GH2a/AHIIa) provide much needed context for the implications of the Pleistocene remains (GH3/AHIII and GH4/AHIV).

Methods

In this study, we define macrovertebrates as those species likely reflecting human consumption, such as reindeer, horse, medium-sized birds, and hare. Moreover, we define microvertebrates as specimens belonging to taxonomic groups that have strong potential to reconstruct regional Pleistocene environments and climates. For this study, these taxonomic groups are Rodentia (rodents) and Insectivora (i.e., shrews and moles). Rodents and insectivores have relatively short lifespans, reproduce quickly, and have large litter sizes, allowing them to respond quickly to climatic and environmental changes. This life history makes members of these taxonomic groups particularly appropriate for environmental and climatic reconstructions (Grayson 1981, 1984; Terry 2010; Broughton and Miller 2016, 95) and gives rise to larger sample sizes in the fossil record. Amphibian and reptile remains are also very useful in this respect as they are often adapted to specific habitats (Blain et al. 2009), but these taxa are represented by less than 10 specimens in this assemblage and are therefore not included. Fish remains are similarly useful and are represented at the site but these are primarily from the 2017 excavation and are not yet available for analysis. We do not include specimens belonging to the genus *Microtus* that could not be identified to the species-level because they cannot provide specific environmental information.

These definitions of micro- and macrovertebrates can, of course, have some overlap. Birds and hares, for example, often fall into both categories of classification. Medium-sized birds such as ptarmigan and grouse are common prey for humans and often also have specific environmental requirements. It is therefore important that we understand the taphonomic history and depositional context of these taxa and integrate micro- and macrovertebrate remains when we interpret past human behavior.

It should be noted that microvertebrate assemblages are rarely deposited by humans and are much more likely to be the result of mammalian carnivore or predatory bird activity (Andrews 1990; Fernández-Jalvo et al. 2016). Thus this portion of the assemblage is indicative, not of human consumption, but of non-human predator prey choice and, in turn, the habitats of those predators and their prey (Andrews 1990; Fernández-Jalvo et al. 2016).

We recorded all faunal remains using Stiner's (2005) coding system, modified for the specific taxa found in the German Late Pleistocene and early Holocene. We identified faunal remains to the lowest possible taxonomic level using modern zooarchaeological methods and references (Pales and Lambert 1971; Schmid 1972; Grayson 1984; Gilbert 1990; Lyman 1994, 2008; Hillson 2005; Gilbert et al. 2006; Reitz and Wing 2008) and the University of Tübingen's comparative vertebrate collection housed in the Institut für Naturwissenschaftliche Archäologie. We recorded evidence of taphonomic processes, such as burning (Stiner et al. 1995), weathering (Behrensmeier 1978), mineral staining, breakage, and human-made cutmarks for all specimens (Lyman 1994; Fernández-Jalvo and Andrews 2016). We calculated the Number of Identified Specimens (NISP) and %NISP for each taxonomic category of macrovertebrates (Grayson 1984; Lyman 2008) using Stiner's (2005) landmark system. We calculated NISP and Minimum Number of Individuals (MNI; Grayson 1984; Lyman 2008) using Stiner's (2005) landmark system for each microvertebrate taxonomic category. Our calculations of MNI use the most commonly occurring element and, when applicable, take side into account. We have not yet refit the assemblage, but Stiner's (2005) system largely bypasses this, at least in a statistical sense, for calculating MNI.

Several unidentified horse tooth fragments are present in the sample. We did not include these specimens in NISP calculations as they would have greatly overestimated horse remains at the site compared to other taxa. Mammoth is represented by one piece of ivory that measures approximately 7 cm in length. We assigned specimens that could not be identified to a specific taxon to body-size groups.

A discussion of the calculation of MNI for micromammals merits further discussion as certain taxa are much more identifiable than others. Only cranial elements, mandibles, and teeth (primarily molars) were used to make genus- or species-level identifications on the rodent and insectivore remains, as these are the most widely accepted and reliable elements to make such identifications (Niethammer and Krapp 1978, 1982, 1990; Hillson 2005). This level of identification is necessary for environmental reconstruction (Niethammer and Krapp 1978, 1982, 1990).

Different taxonomic groups of micromammals are identifiable based on different teeth, and whether a species or genus is identifiable based on the mandible or cranial elements varies by taxon. For example, most members of the subfamily Arvicolinae (lemmings and voles) can be identified to the species-level based on the lower first molar (Niethammer and Krapp 1982), except in the case of the water voles (genus *Arvicola*), collared lemmings (*Dicrostonyx*), and brown and true lemmings (genus *Lemmus*), all of which can be identified using any molar (Agadjanian and von Koenigswald 1977; Reichstein 1982a, b, c; Tast 1982). Other species, such as the insectivores, are identifiable to at least the genus-level based on features of their mandible and several teeth (Repenning 1967; Niethammer and Krapp 1990). Due to these discrepancies in identifiability between elements for each taxon, NISP values can greatly overestimate certain taxa. For this reason, we did not use tooth fragments that could not be identified to a specific tooth to calculate MNIs for the micromammal assemblage and we consider NISP and MNI together.

Results

We analyzed a total of 1457 specimens for this study: 1081 rodents and insectivores, 303 macromammals, and 73 birds. Like most sites in the Ach and Lone valleys, the Magdalenian macrovertebrate assemblage at Langmahdhalde is relatively small compared to pre-LGM Upper Paleolithic faunal assemblages in the region. Table 1 summarizes the macromammal remains. Hare, reindeer, and horse dominate the assemblage; these taxa are typical of Magdalenian faunal assemblages. The large sample of medium mammals is primarily driven by the relatively large number of unidentifiable long bone shaft fragments in the assemblage (n=76).

Taxon	GH 4&5 / AH IV&V		Cutmarks	Spiral Fractures	Carnivore Damage
	NISP	%NISP			
Mammoth (<i>Mammuthus primigenius</i>)	1	1.3			
Wild Horse (<i>Equus ferus</i>)	15	19.2	5	3	1
Red deer (<i>Cervus elaphus</i>)	9	11.5			
Reindeer (<i>Rangifer tarandus</i>)	19	24.4	1	3	
Roe deer (<i>Capreolus capreolus</i>)	2	2.6			
<i>Bos</i> or <i>Bison</i> sp.	1	1.3			
Ibex (<i>Capra ibex</i>)	1	1.3			
Hare (<i>Lepus</i> sp.)	23	29.5		1	1
Cave lion (<i>Pantera spelaea</i>)	1	1.3			
Fox (<i>Vulpes</i> sp.)	4	5.1	1		
Arctic fox (<i>Vulpes lagopus</i>)	1	1.3			
Weasels/ferrets/etc. (<i>Mustela</i> sp.)	1	1.3			
Total	78	100%			
Small carnivore	3		1		
Large cervid	5				
Cervidae	2				
Medium ungulate	5		1	1	
Large ungulate	12		5	3	1
Medium/large ungulate	3		1		
Ungulate	2				
Small mammal	34				
Medium mammal	108		9	5	1
Large mammal	4			1	
Medium/small mammal	20		1	3	
Medium/large mammal	16		1	3	
Mammal	9				
Small mammal or bird	2				
Total	225		26	23	4

Table 1: Macromammal summary table showing NISP and %NISP of each taxon in GH4/AHIV and GH5/AHV. %NISP was not calculated for those specimens that could only be identified to size class. The number of specimens that have cutmarks, spiral fractures, or carnivore alterations are also noted for each taxon/group.

In general, there is significant damage from root etching and chemical weathering on most macromammal remains from the Magdalenian horizons. Most specimens also show pitting and fine cracks, and some peeling is also present. In some cases this weathering has impeded identifiability. Despite the degree of weathering, there are still some fairly complete bones. For example, a nearly complete horse pelvis was found in the top portion of GH4/AHIV, just above the combustion features (Fig. 5). It has a large anthropogenic hack mark on the right pubis. Four antler fragments were also recovered from the site, three of which have been identified to reindeer. One of these specimens measures over 35 cm in length (Fig. 6).

Table 2 summarizes the bird remains. Ptarmigen dominates the assemblage. Approximately half of the bird remains were only identifiable to size class; of these, the majority are medium-sized birds.

Taxon	GH 4&5 / AH IV&V	
	NISP	%NISP
Grouse/pheasant/partridge (Phasianidae) ^M	1	2.6
Ptarmigan (<i>Lagopus</i> sp.) ^M	17	48.6
Hazel grouse (<i>Tetrastes bonasia</i>) ^M	2	5.7
Black grouse (<i>Tetrao tetrix</i>) ^M	1	2.6
Doves and pigeons (Columbidae) ^M	1	2.6
Grey geese (<i>Anser</i> sp.) ^M	1 ^W	2.6
Dabbling ducks (<i>Anas</i> sp.) ^M	1	2.6
Common teal (<i>Anas crecca</i>) ^M	2	5.7
Shore birds (Charadriiformes) ^M	3	8.6
Eurasian golden plover (<i>Pluvialis apricaria</i>) ^M	1	2.6
Grebes (Podicipedidae) ^M	1 ^{SP}	2.6
White stork (<i>Ciconia ciconia</i>) ^L	1	2.6
Perching/song birds (Passeriformes) ^S	3 ^{SP}	8.6
Total	35	100%
Small birds (Passeriformes/Piciformes/etc.)	6	
Medium birds (Galliformes /Columbiformes/Anseriformes/etc.)	29 ^{CM,SP,CA}	
Large birds (raptors/owls/ vultures/geese/swans/etc.)	4 ^{CA}	
Total Size Class NISP	39	

Table 2: Bird summary table showing NISP and %NISP of each taxon in GH4/AHIV and GH5/AHV. %NISP was not calculated for those specimens that could only be identified to size class. S = small bird; M = medium bird; L = large bird; SP = one specimen has a spiral fracture; CM = one specimen has cutmarks; CA = one specimen has carnivore modifications; W = worked bone.

We present a summary of the results of the micromammal analysis in Table 3, which shows the NISP and MNI for each taxonomic group by geological and archaeological horizon. There is a clear taxonomic trend in the data that separates the Holocene horizons (GH2/AHII and GH2a/AHIIa) from the Pleistocene horizons (GH3/AHIII and GH4/AHIV). The common and/or field vole (*Microtus arvalis/agrestis*) and red-backed voles (genus *Myodes*, represented by *Myodes glareolus* during the Holocene in Germany; Hutterer et al. 2016) dominate the Holocene assemblage. The common and/or field vole, narrow-headed vole (*M. gregalis*), and collared lemmings (genus *Dicrostonyx*) are the most common taxa in the Pleistocene assemblage. Common and field voles are regularly represented in German microvertebrate assemblages and their dominance is expected from the Late Pleistocene through the Holocene in this region (Kurtén 1968, 217; Storch 1973, 1987; von Koenigswald 1985; Ziegler 1995; Kowalski 2001, 243-247).



Fig. 5: Langmahdhalde. Horse pelvis in situ in the Magdalenian horizon GH4/AHIV. The arrow points north and the scale is 25 cm long. Photo: A. Janas.



Fig. 6: Langmahdhalde. Reindeer antler in situ in the Magdalenian deposits. Photo: A. Janas.

It is important to note that the apparent dominance of collared lemming specimens in GH4/AHIV, as reflected in the NISP, is likely a result of the high identifiability of this taxon, not of actual abundance. As stated above, unlike the genus *Microtus*, collared lemmings can be identified using every molar. This is clear when the NISP and MNI values are compared; common and/or field voles (both genus *Microtus*) has the largest MNI value for this horizon, followed by collared lemmings and narrow-headed voles.

Evidence of human activity on the faunal remains

It seems clear that humans deposited at least a significant proportion of the macrofaunal assemblage at Langmahdhalde. Table 1 indicates the number of specimens for each taxon or group that have evidence of cutmarks, spiral fractures, or carnivore modification. Several macromammal remains have evidence of human modification in the form of cutmarks, particularly horse, large ungulates, and medium mammals. There is one cutmark on a fox mandible that is likely the result of skinning (Binford 1981, 47). Further, several of the macromammal specimens also have spiral fractures, indicating that these elements were broken while still fresh. Although several processes can create spiral fractures (Shipman et al. 1981), humans often break bones for access to marrow and grease while they are fresh and this may be the cause of these breaks here. As of yet, we have observed no human modifications on the antler remains at Langmahdhalde. Carnivore modifications are rare in the macromammal assemblage (Table 1).

Taxon	GH2 / AHII		GH2a / AHIIa		GH3 / AHIII		GH4 / AHIV	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Common mole (<i>Talpa europaea</i>)	1	1	0	0	0	0	0	0
Shrews (Soricidae)	1	1	0	0	0	0	0	0
Long-tailed shrews/old world water shrews (<i>Sorex/Neomys</i>)	10	3	0	0	0	0	0	0
Eurasian water shrew (<i>Neomys fodiens</i>)	0	0	0	0	0	0	3	1
Long-tailed shrews (<i>Sorex</i> sp.)	5	1	0	0	0	0	3	1
Dormice and hazel mice (Gliridae)	1	1	0	0	0	0	0	0
Dormouse (<i>Glis glis</i>)	6	1	0	0	0	0	0	0
Yellow-necked/wood mouse (<i>Apodemus flavicollis/sylvaticus</i>)	15	2	1	1	0	0	1	1
Common/field vole (<i>Microtus arvalis/agrestis</i>)	17	10	2	2	2	1	188	91
<i>Microtus arvalis/agrestis</i> OR <i>gregalis</i>	0	0	0	0	0	0	2	1
Narrow-headed vole (<i>Microtus gregalis</i>)	0	0	0	0	0	0	100	50
Tundra vole (<i>Microtus oeconomus</i>)	0	0	0	0	1	1	4	2
Eurasian snow vole (<i>Chionomys nivalis</i>)	6	2	0	0	0	0	7	3
Collared lemming (<i>Dicrostonyx</i> sp.)	0	0	0	0	4	1	358	52
Red-backed voles (<i>Myodes</i> sp.)	78	11	4	1	1	1	1	1
Water voles (<i>Arvicola</i> sp.)	5	3	0	0	0	0	1	1
Pine voles (<i>Pitymys</i> sp.)	3	2	0	0	0	0	0	0
TOTAL	148	38	7	4	8	4	668	204

Table 3: Micromammal summary table showing NISP and MNI of each taxon by geological and archaeological horizon.

The base of the large antler specimen is preserved and demonstrates that the antler was collected after it was shed, indicating that this specimen was likely not deposited as a result of hunting. Similarly, the presence of a piece of mammoth ivory at the rock shelter does not necessarily imply that humans were hunting mammoth or that mammoth were present in the Lone Valley while humans used this rock shelter, as ivory is easily collected.

Like micromammals, small birds, such as those species belonging to the order Passeriformes, are very rarely hunted or collected by humans and are thus likely the remains of mammalian carnivore or predatory bird activity at the site. Of the larger species of bird, several are common in Magdalenian assemblages and have been documented as human food sources, the most prominent of which are those species belonging to the family Phasianidae (e.g., the genus *Lagopus*). For example, we mentioned above that Ptarmigans (*Lagopus* sp.) are common in the Magdalenian horizons of Brillenhöhle (Boessneck and von den Driesch 1973, tables 1 and 2) and Petersfels (Peters 1930; Albrecht 1979; Albrecht and Hahn 1991). There is one cut bird specimen in our sample. Unfortunately, we could not identify it above size class. It is a medium-sized bird sternum fragment with four cutmarks running diagonally across the bone that are approximately 3 mm in length. The assemblage also includes the distal humerus of a goose (*Anser* sp.) that is likely a needle blank (Conard et al. in prep). It is therefore likely that the Magdalenian bird assemblage at Langmahdhalde is the result of both human and non-human predator activity. This is also supported by the fact that two bird specimens (one large and one medium bird) show evidence of carnivore modifications.

Paleoenvironment

We identified seven different habitat preferences in the microvertebrate assemblage: rocky, open, woodland, humid/wet, dry, steppe, and tundra. The MNI values of each taxon were combined based on their habitat preferences and these values are presented in Fig. 7 as relative proportions for both the Holocene and Pleistocene horizons. The Eurasian snow vole (*Chionomys nivalis*) prefers rocky habitats (Amori 1999). Although this genus is not currently present in the Swabian Jura, the presence of rocky-adapted species in this region during the Holocene is not surprising considering the Swabian Jura is a karstic system. Pine voles (genus *Pitymys*; Kurtén 1968, 219) and narrow-headed voles (*Microtus gregalis*; Kurtén 1968, 219-220; Batsaikhan et al. 2016) prefer open habitats. Red-backed voles (genus *Myodes*; van Kolfschoten 1985; Hutterer et al. 2016) and dormice (*Glis glis*; Amori et al. 2016a) prefer woodland environments. In the category “humid/wet” we have included tundra voles (*Microtus oeconomus*; von Koenigswald 1985; Linzey et al. 2016) and pine voles (genus *Pitymys*; Kurtén 1968, 219), which prefer humid or moist conditions, as well as the water voles (genus *Arvicola*), who are tied to water sources. Species that are tied to water are expected in this assemblage as the site is less than 100 m from the Lone River. Red-backed voles, Eurasian snow voles, narrow-headed voles, and collared lemmings (genus *Dicrostonyx*; von Koenigswald 1985; Kurtén 1968, 219-220; Tsytsulina et al. 2016) prefer dry environments. Narrow-headed voles (Batsaikhan et al. 2016) prefer steppe and tundra environments and collared lemmings prefer tundra environments (Kurtén 1968, 219-220; Tsytsulina et al. 2016).

We did not use yellow-necked mice, wood mice, shrews, or common moles (*Apodemus sylvaticus*, *A. flavicollis*, genus *Sorex*, and *Talpa europaea*) for environmental reconstructions in this study. Yellow-necked and wood mice are only distinguishable based on measurements taken on molars (Niethammer 1978). This work is in progress and our future reconstructions will incorporate the specific habitat requirements of yellow-necked mice (Amori et al. 2016b). Similarly, species-specific identifications on shrews are underway and will be included in future work. The common mole does not have specific habitat

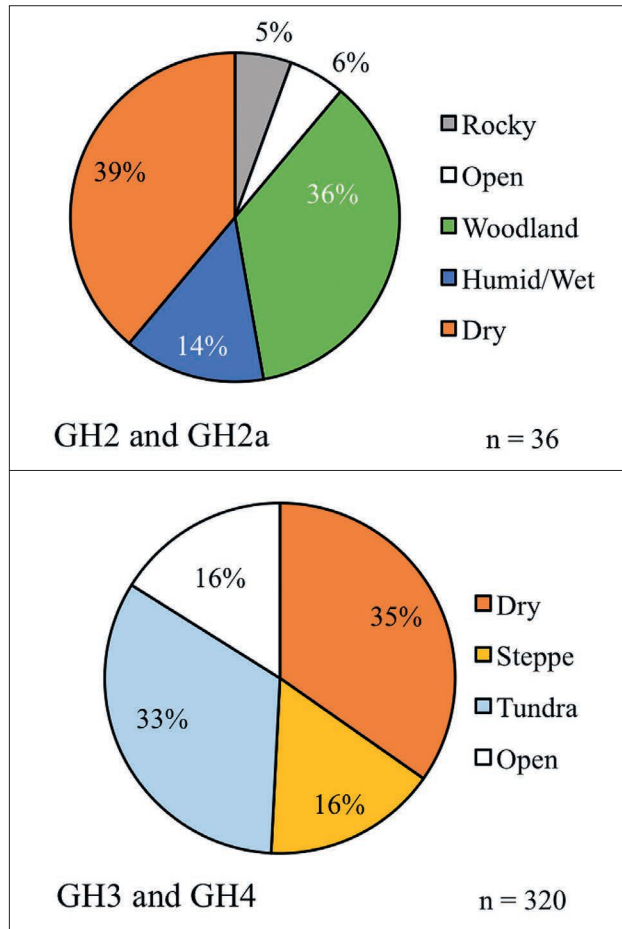


Fig. 7: Langmahdhalde. Habitat preferences for the microvertebrate specimens of GH2 and GH2a (top) and GH3 and GH4 (bottom). Percentages are based on MNI counts presented in Table 1. Percentages that are 1% or less are not shown. Full color version available online: mgfuopenaccess.org.

preferences and is present in most environments that have soils deep enough for tunneling (Mitchell-Jones et al. 1999). Common and field voles are also not included in our environmental reconstructions as they do not share specific habitat preferences and are indistinguishable in fossil contexts (Niethammer and Krapp 1982; Mitchell-Jones et al. 1999).

Fig. 7 depicts differences in Pleistocene and Holocene environments, as reconstructed from the Langmahdhalde micromammal assemblage. Extensive past research has demonstrated that the Holocene of Central Europe was more temperate and wooded whereas the Pleistocene was more open, had steppe/tundra conditions, and colder temperatures (see von Koenigswald 2003 and Otte 2009 for summaries; see Krönneck 2008 and 2012, Riehl et al. 2014, and Miller 2015 for local conditions). The Holocene assemblages at Langmahdhalde reflect micromammals with a preference for dry and woodland environments.

The Pleistocene assemblages demonstrate species with a preference for open, dry, steppe, and tundra environments, conforming to our current understanding of environments during the post-LGM Pleistocene. Interestingly, ptarmigan are also common in GH4 and this taxon prefers cold and open tundra habitats (Peterson et al. 2002). Further work with these assemblages will target understanding the specifics of climate fluctuations during these periods.

Discussion and Conclusions

In this paper, we have summarized the Magdalenian archaeofaunal assemblage from the newly excavated rock shelter, Langmahdhalde. This analysis has demonstrated that both the macro- and microvertebrate assemblages at the site have the potential to address current questions in Magdalenian research. Based on the archaeological context of the site and the taphonomy of the remains, we argue that a significant portion of the macrofaunal assemblage was deposited as a result of human activity. Additionally, the direct association of the anthropogenic remains (lithics, combustion features, and macrovertebrate remains) with an extensive microvertebrate assemblage makes this site even more compelling. Although the implications of the micromammal results presented here are very broad in scale, our ongoing work with this assemblage will focus on applying new methods of analysis, such as the Mutual Ecogeographic Range method (Agusti et al. 2009; Blain et al. 2009; Lyman 2016; Rey-Rodríguez et al. 2016) or bioclimatic analysis (Hernández Fernández 2001), that will allow us to make local- and regional-scale environmental and climatic reconstructions. These will compliment data from macrovertebrate assemblages from the Swabian Jura (Langmahdhalde included) and be applied to questions of Magdalenian socio-economic and settlement dynamics.

Taphonomic and geological studies of Langmahdhalde will also contribute to this question. The three combustion features in the Magdalenian horizons, as well as the density of lithic artifacts in association with them, suggests that this site was used intensely by Magdalenian humans, even if for a short period of time. The preservation of the faunal remains and overall taphonomy of the site indicate that this Magdalenian horizon was likely exposed for a period of time before deposition occurred. We are working on the dynamics of this depositional history and rates of sedimentation at the site, as these could have implications for human use of the site and likely explain why the macrovertebrate assemblage is small. Both emphasize the need for continued excavation and study of the site. Specifically, geoarchaeological studies and continued, detailed taphonomic analyses of the assemblage are necessary to fully evaluate these interpretations.

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