

From carcass to cave: Large mammal exploitation during the Aurignacian at Vogelherd, Germany

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Abstract

Recent results from the zooarchaeological analysis of faunal remains from Vogelherd Cave, southwestern Germany, provide new insight into the subsistence behavior of early modern human groups during the Aurignacian. The results presented here represent the first comprehensive study of the archaeofauna from this site. Several episodes of occupation are inferred at this site, taking place primarily between 31 and 32 ka. Although a wide spectrum of Pleistocene mammals is represented in the Aurignacian at Vogelherd, reindeer (*Rangifer tarandus*) and horse (*Equus ferus*) were the primary prey taxa, and they are the most appropriate data sets with which to understand human subsistence on an intrasite level. Hunting of both taxa took place during the late summer and fall, coinciding with reindeer migrations and local abundance of horses. Complete or nearly complete prey carcasses were then transported from the kill locations to the cave for processing. This study shows that Vogelherd was a preferred locale of Aurignacian groups for a broad range of activities, including the time- and labor-intensive exploitation of ungulate prey for meat, marrow, and fat resources, as well as the production and maintenance of artifacts such as figurative artwork, personal ornaments, bone and ivory armatures, and lithic tools. With its rich faunal and artifact assemblages, the Aurignacian deposit at Vogelherd provides a wealth of information on this critical period of the early Upper Paleolithic, when cultural innovations were flourishing.

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Introduction

The Aurignacian is marked by a variety of cultural innovations in prehistoric Europe, including the systematic production of tools and other artifact types on organic materials such as bone, antler, and ivory; personal body adornment; and artistic expressions in the form of mobiliary and parietal artwork. Although the question of which hominin species (or subspecies) was responsible for the Aurignacian has been an ongoing theme in paleoanthropology (e.g., Gambier, 1989; D'Errico et al., 1998; Churchill and Smith, 2000; Stringer,

2002; Mellars, 2004), it is now clear that anatomically modern humans were, in fact, accountable. This evidence stems from directly dated human fossils associated with Aurignacian artifacts from the site of Mladeč, Czech Republic, dating to 31 ka (Wild et al., 2005). In addition, modern human remains are clearly associated with Aurignacian artifacts at Brassempouy, France (Henry-Gambier et al., 2004; Bailey and Hublin, 2005), dating to between 30 and 34 ka. In light of the suite of cultural innovations underway during this time, information on the subsistence behaviors of Aurignacian groups is clearly of interest.

Recent results from a zooarchaeological analysis of faunal remains from the Aurignacian deposit at Vogelherd Cave, Germany, provide new insights into early modern human subsistence. These results add to the rich database of contemporaneous archaeofaunas from cave and rockshelter localities in

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Europe dating to between 29 and 36 ka (e.g., Bouchud, 1975; Boyle, 1990; Cassoli and Tagliacozzo, 1994; Grayson and Delpech, 1998, 2002, 2003; Pike-Tay et al., 1999; Delpech et al., 2000; David and Poulain, 2002; Letourneux, 2003; Morin, 2004; Münzel and Conard, 2004).

Considering that exceptional examples of early figurative artwork, in the form of animal figurines carved in ivory, were recovered from Aurignacian contexts at Vogelherd, it is not surprising that the rich organic and stone artifact assemblages have been the subject of numerous analyses over the past decades. However, an in-depth consideration of the faunal remains has not previously been available. The archaeofauna is notable in that it is thus far the largest assemblage dating to the Aurignacian from this region of southwestern Germany. While the Middle Paleolithic and Magdalenian horizons from Vogelherd provide limited information on the site's past, the more sizeable Aurignacian deposits offer the primary source of information for the interpretation of subsistence strategies and site function at the locality.

The substantial reindeer and horse assemblages recovered from Vogelherd represent the most appropriate data sets with which to evaluate Aurignacian subsistence on an intrasite level. As presented below, the reindeer and horse data reflect a remarkable level of behavioral stability by Aurignacian groups in their use of the Vogelherd Cave (i.e., as a locus of secondary processing and consumption of reindeer and horse remains over a period of several occupation episodes), despite the potential “blending effects” of multiple occupational events (e.g., Lyman, 2003). These results, in turn, are employed in the development of insights into Aurignacian subsistence on a broader, regional scale.

Geographic setting

The cave of Vogelherd lies 18 m above the floor of the Lone Valley, one of many deeply incised valleys in the largest closed karst system in Germany known as the Swabian Jura (Abel et al., 2002). Located approximately 5–10 km north of the Danube River, the Lone Valley contains at least nine limestone caves, seven of which contained Paleolithic deposits (Hahn et al., 1985). From the upper (west) valley and running east, those sites include Haldenstein, the Bockstein complex (Bocksteinhöhle, Bocksteintörle, Bocksteinschmiede), Hohlenstein-Bärenhöhle, Hohlenstein-Stadel, and Vogelherd (Fig. 1).

A rich archaeological record from these sites, reflecting millennia of prehistoric occupations, speaks to the area's favorable character (Gamble, 1979). Two distinct ecosystems flank the Lone Valley: (1) the drier plateau to the north, probably a steppic landscape during much of the valley's hominin occupation, and (2) the expansive flatlands with marshes to the south stretching to the Danube. Herds of grazing animals would have moved seasonally in and out of these ranges, using the natural routes dissecting the Lone Valley. In addition to game, sources of lithic raw material were locally abundant (Hahn, 1987; Burkert and Floss, 2005).

Unique among this suite of caves, Vogelherd's topographic location offers several benefits. A panoramic view of the surrounding landscape would have been advantageous to prehistoric groups for monitoring the movements of game, predators, and other people. Two of three cave entrances provided southern exposure, and their terraces provided ample ground for activities. The interior of the cave consists of passages between 15 and 25 m long, 2 and 7 m wide, and 2 and 3 m high; such confined spaces would have been quicker to heat with fire (e.g., Opperman, 1996). These characteristics undoubtedly influenced the repeated occupation of this cave by human groups throughout the Middle and Upper Paleolithic, and were particularly suited to the range of activities taking place here during the Aurignacian. Although excavation methods in the 1930s were not comparable to those of today in regard to revealing spatial organization of a site, several important attributes of the Aurignacian record at Vogelherd inform us about the use of this space. Most significantly, cultural material was distributed throughout the entire extent of the cave and outside the entrances. The excavator documented six hearth features, four of which were located directly in the cave entrances or just in front of them. Significant portions of the faunal assemblage were recovered from terrace areas just outside the cave openings, and a large pile of mammoth bones and tusks was situated across the southwest entrance. In regard to the fauna, information on the spatial context of specific animal taxa or skeletal parts was not documented during excavation.

Background to the site of Vogelherd

Gustav Riek of the Eberhard-Karls-Universität Tübingen excavated Vogelherd over the course of ten weeks in 1931. In the course of this single season, Riek and his team collected a vast amount of archaeological material, much of which was studied and published in a series of articles (e.g., Riek, 1932, 1954, 1960) and a comprehensive monograph (Riek, 1934). The cave was fully excavated, leaving no cultural deposits for future research.

Over the last decades, numerous scholars have focused on various aspects of the archaeological finds from Vogelherd in greater detail (e.g., the lithic inventories: Müller-Beck, 1957; Hahn, 1977; organic artifact assemblages: Albrecht et al., 1972; Hahn, 1972, 1977, 1986; Müller-Beck and Albrecht, 1987). The paleontologist Ulrich Lehmann (1954) examined a portion of the fauna, focusing on taxonomic identification and the paleoecological implications. Relating to its extensive artifact assemblages, Vogelherd has played a significant role in our understanding of the human settlement of southwestern Germany and the cultural innovations of the early Upper Paleolithic. Since the recent evaluation of the fauna was done in the context of these rich artifact assemblages, it is useful to briefly summarize them.

Human fossil remains

Seven human skeletal remains representing at least two individuals were recovered from the base of the Aurignacian

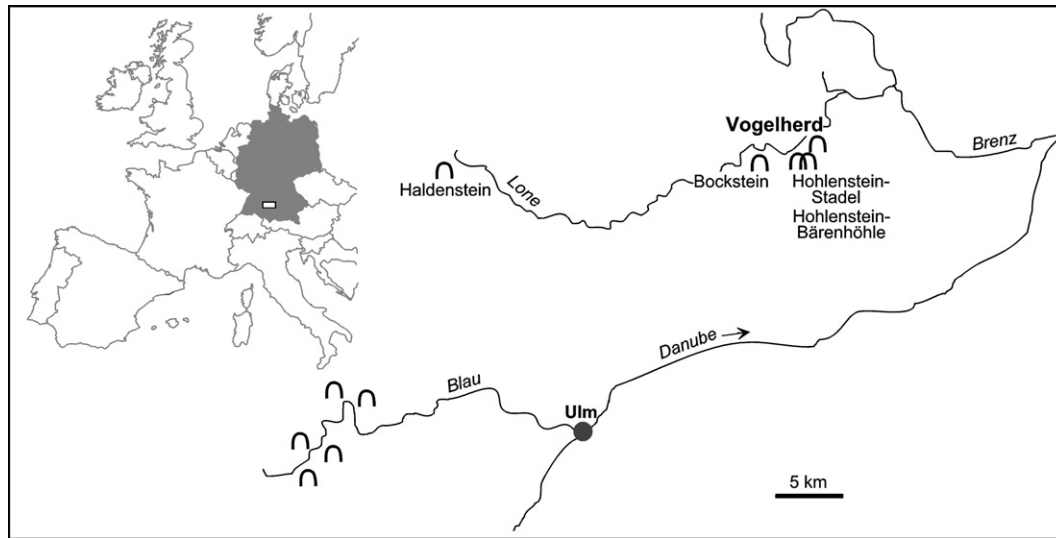


Fig. 1. Map showing the location of Vogelherd and other Paleolithic cave localities in the Lone Valley of the Swabian Jura, southwestern Germany. Additional Paleolithic caves (marked with cave symbol) in the Ach Valley to the southwest include Brillenhöhle, Geissenklösterle, Grosse Grotte, Hohle Fels, and Sirgenstein.

deposit at Vogelherd. Based on numerous radiocarbon dates from the two Aurignacian strata, the age of the human remains was inferred to be between 30 and 33 ka, and thus they represented some of the earliest anatomically modern humans in Europe. However, they can no longer be considered as such in light of a recent campaign to directly date the Vogelherd human fossils, which has yielded ages around 5 ka (Conard et al., 2004). Despite these recent dates from Vogelherd, as well as from other fossils in Germany previously attributed to the Aurignacian (Terberger and Street, 2003; Street et al., 2006), the association of modern humans with Aurignacian artifact assemblages is confirmed by the sites of Mladeč, Czech Republic (Wild et al., 2005), and Brassempouy, France (Henry-Gambier et al., 2004; Bailey and Hublin, 2005). Directly dated modern human remains from two caves in Romania (Trinkaus et al., 2004; Soficaru et al., 2006) and several other sites in Europe (Higham et al., 2006: Table 2) also fall into the Aurignacian timeframe, although secure associations with diagnostic artifacts are currently lacking.

Lithic artifacts

The Aurignacian lithic inventory numbers just under 6000 pieces. Local Jurassic chert is the dominant raw material (Riek, 1934); other raw materials acquired from sources located between 5 and 120 km from the site are present but less common (Burkert and Floss, 2005). Sources of tool-stone utilized by Aurignacian people from Vogelherd and other Swabian Jura caves generally follow the Danube River in an east–west trajectory (Hahn, 1987).

The lithic assemblage contains a substantial scraper component, including nosed and carinated pieces. Burins and blades or flakes with retouch on their ends and/or edges are also abundant. Two notable factors characterize this inventory: (1) an abundance of heavily used and reworked pieces and

(2) a surplus of unused lithic material in the form of flakes and blades.

Some of the unused lithics were recovered in probable caches, described by Riek (1934) as isolated concentrations of ~300 flakes or dozens of blades. Similar clusters of scrapers and cores were also noted. Lithic caches may have served a variety of purposes to prehistoric groups (Frison and Bradley, 1999), but in light of the high proportion of unused flakes and blades in the Vogelherd concentrations, it seems probable that the ones described here were left as surplus for future tool production or to be used in their unmodified state (Gamble, 1986). Lithic caches have been documented at a number of North American prehistoric sites (e.g., Frison and Bradley, 1999) but less frequently in Eurasian Paleolithic localities (e.g., Derevianko, 1998). Therefore, the potential presence of lithic caching behavior at Vogelherd is of special interest.

Organic artifacts

The Aurignacian deposit yielded a rich and diverse assemblage of organic artifacts, including some of the earliest examples of figurative art in Europe. These consist of ten ivory figurines depicting Pleistocene mammals, including mammoth, horse, bison, and lion. Considering the faunal remains at the site, all of these species were members of the local resident fauna. Hahn (1993) believed that at least three of the ivory figurines were actually pendants, based on remaining traces of perforations. Additional examples of personal body adornment came in the form of incised pendants made from the incisors of red deer and brown bear (one each), an artifact type common in Aurignacian and later Upper Paleolithic periods both locally (e.g., Conard and Floss, 2001) and in other parts of Europe (e.g., White, 2001; Vanhaeren and d'Errico, 2006).

Bone, antler, and ivory artifacts are also numerous. Split-based points, diagnostic of the early Aurignacian (Peyrony,

1933), are present, as are a variety of shaped pieces showing use-wear. Soffer (2004) suggested that some beveled and pointed bone specimens from the Vogelherd Aurignacian show use-wear, perhaps associated with textile production. Bone retouchers are plentiful, indicating the frequent use of this expedient form of tool fashioned primarily from fragments of the long bone shafts of large ungulates and thought to have been used in brief episodes of stone-tool resharpening (Chase, 1990).

The repertoire of ivory artifacts ranges from the highly crafted animal figurines to unfinished items. For example, more than two dozen ivory rods—pencil-thin and sometimes split lengthwise—might have been intended for bead production, as has been inferred for identical pieces at several French and Belgian Paleolithic sites (e.g., White, 1989; Otte, 1997). The ivory rods from Vogelherd were found in a bundle (Riek, 1934), and like some of the lithic inventory, are thought to represent a cache of material intended for future use. These artifacts suggest that ivory-working took place here during the Aurignacian (Hahn, 1993), not surprising in light of the wealth of tusk portions, ivory chunks, and other raw ivory material recovered in the deposit (Niven, 2001).

Chronostratigraphy and climate

Riek (1934) defined nine cultural horizons, to which he assigned Roman numerals. Although some adjustments have been made to Riek's original names for the cultural horizons, which he based on stone-tool typology, the Roman-numeral designations are retained today and are as follows: I = Neolithic; II and III = Magdalenian; IV and V = Aurignacian; VI–IX = Middle Paleolithic (Conard et al., 2003). The Aurignacian horizons yielded the majority of cultural material, making up more than 90% of finds overall.

In order to adequately analyze the fauna from Vogelherd, the two archaeological horizons (AH) attributed to the Aurignacian—IV and V—were combined into one unit. This pooling was done because one-third of the Aurignacian faunal specimens were labeled as coming from *either* AH IV or AH V, and excluding this group of finds from the analysis would have entailed a substantial loss of information. Moreover, bone specimens from both strata exhibiting ancient fracture surfaces, as opposed to ones created during excavation or curation, were in numerous cases refitted with their counterparts. It is likely that the Vogelherd Aurignacian represents a palimpsest of several episodes of human occupation.

The Aurignacian deposit has been extensively dated by radiocarbon, and comprehensive lists have been published (Conard and Bolus, 2003; Conard et al., 2003). A few dates fall outside the Aurignacian, perhaps indicating sporadic Gravettian occupations that are not detectable in the archaeological material (Conard et al., 2003), but a statistically identical set of dates from the two strata IV and V indicate that the majority of Aurignacian occupations took place at Vogelherd between 31 and 32 ka (weighted mean of 11 uncalibrated dates: $31,622 \pm 192$ ka BP; see Table 2.3 in Niven, 2006).

Generally, this phase of oxygen isotope stage (OIS) 3 was marked by fluctuations in climate that were probably quite brief (~1000 years) (Van Andel, 2003) and increasingly colder towards ~30 ka. Unfortunately, this period has very few pollen diagrams because periglacial environments lack vegetation (Huntley and Allen, 2003; Müller et al., 2003), yet the data on hand (e.g., Frenzel, 1983) generally support a scenario in which colder intervals saw temperate grassland/steppe conditions with ample forage for the large grazing herbivores (Guthrie and van Kolfschoten, 2000) and some expanse of coniferous trees during milder phases (Van Andel and Tzedakis, 1996). Cold-climate animal taxa dominate the fauna spectrum in the Vogelherd Aurignacian, with species typical of more temperate and wooded environments represented in much smaller numbers.

The Vogelherd Aurignacian faunal assemblage

All faunal specimens >1 cm in length recovered from the Vogelherd Aurignacian were analyzed for this study, numbering 13,282 in total: 7055 identified to taxon and 6227 specimens identifiable to family or body size (after Brain, 1981; Bunn et al., 1988) (Table 1).

Sixteen mammalian and seven avian taxa are represented. Although mammoth, reindeer, and horse are nearly equal in terms of MNI, the latter two taxa represent the primary subsistence prey acquired by humans in the Aurignacian at Vogelherd. The use of mammoths as a source of food is not ruled out, though the data better support a scenario in which the majority of skeletal remains—in many cases, complete or nearly complete elements and tusks—were collected from natural death sites and used for a variety of nonfood subsistence needs such as fuel, building materials (e.g., barricading cave openings against wind, predators) and artifact production (Niven 2001, 2006). In fact, the sheer size of this mammoth assemblage distinguishes Vogelherd as one of the largest from the Aurignacian, as well as a key mammoth locality in central Europe.

The role of woolly rhinoceros in human subsistence is ambiguous, because clear evidence for anthropogenic involvement with the small number of remains is lacking. It is possible that this megaherbivore served nonfood subsistence needs similar to what has been proposed for the mammoths.

Represented by small numbers, the other ungulate prey taxa—large bovid, red deer, wild boar, and chamois—appear to have played a secondary role in human subsistence. Remains of all of these taxa exhibit evidence of butchery by people, largely in the form of cut marks, hammerstone impacts, and patterned, systematic spiral breakage of long bones resulting from marrow exploitation. These primarily temperate ungulate taxa might have been the prey of human groups during the interstadial or milder phases of a cold stage.

Hares and birds are not well represented; whether this is due to taphonomic or cultural factors is not clear. Anthropogenic modifications are exhibited on a number of these remains but are associated with artifact production and not exploitation of nutritional resources. However, the presence

Table 1
Summary of faunal remains from the Aurignacian at Vogelherd, expressed as NISP (number of identified specimens) and MNI (minimum number of individuals)

Taxon	NISP	MNI
Identified to taxon		
<i>Canis lupus</i> (wolf)	38	7
<i>Crocuta spelaea</i> (cave hyena)	17	2
<i>Vulpes/Alopex</i> (fox)	20	7
<i>Ursus spelaeus</i> (cave bear)	120	8
<i>Ursus arctos</i> (brown bear)	2	1
<i>Panthera leo spelaea</i> (cave lion)	4	2
<i>Felis silvestris</i> (wild cat)	3	2
<i>Gulo gulo</i> (wolverine)	1	1
<i>Coelodonta antiquitatis</i> (woolly rhino)	124	12
<i>Mammuthus primigenius</i> (mammoth)	3540	28
<i>Equus ferus</i> (horse)	1423	27
<i>Cervus elaphus</i> (red deer)	19	3
<i>Rangifer tarandus</i> (reindeer)	1633	28
<i>Bos/Bison</i> (aurochs/bison)	61	6
<i>Sus scrofa</i> (boar)	8	1
<i>Rupicapra rupicapra</i> (chamois)	2	1
<i>Lepus</i> sp. (hare)	27	3
Birds (various taxa)	13	8
Total	7055	147
Identified to size		
Large artiodactyl (horse or bovid)	424	—
Small artiodactyl (reindeer or roe deer)	1086	—
Indeterminate carnivore	33	—
Body size 5 (mammoth–rhino-sized)	1660	—
Body size 4 (horse–bear-sized)	2060	—
Body size 3 (reindeer–roe-deer-sized)	142	—
Body size 2 (fox–hare-sized)	26	—
Indeterminate	796	—
Total	6227	—
Comprehensive total	13282	147

of bird species (such as goose, ptarmigan, black grouse, and capercaillie) may suggest their occasional exploitation by people for food. Although birds appear to have played little role in Aurignacian subsistence at Vogelherd, the site of Fumane Cave, Italy, is a rare example in which they did, as evidenced by numerous human-modified avian remains from Aurignacian context (Cassoli and Tagliacozzo, 1994; Broglio, 2001).

Small and large carnivores are represented. The small taxa, such as fox and wild cat, appear to have been primarily background fauna, with the exception of at least one fox that was utilized by people. Cave bear is present but in much smaller numbers compared to neighboring cave sites during the Aurignacian (e.g., Hohlenstein-Stadel, where this taxon makes up 78% of the assemblage; Gamble, 1979). Hyena is infrequent but wolf is well represented, and the role of both taxa in the accumulation and/or destruction of bone is an important issue. Although age estimates based on teeth do not suggest denning of these carnivores in Vogelherd, it is possible that the fragile and small teeth of juveniles are lacking in this assemblage due to excavation practices or diagenesis. Therefore, evaluating whether hyena and wolf were bone collectors or simply

scavenged bone refuse left by former human occupants of the cave is better accomplished through the analysis of frequencies of carnivore tooth marks and anthropogenic hammerstone impacts (e.g., Blumenschine, 1988; Blumenschine and Marean, 1993; Capaldo, 1998; Marean et al., 2000). This is discussed in more detail below.

Analytical methods

Documentation of each faunal specimen employed the tripartite “element, portion, segment” coding format established by Gifford and Crader (1977). This system is beneficial in that each tier records information at an increasingly detailed level. Many of the “segment” codes incorporate skeletal element landmarks (Bunn and Kroll 1986; Todd and Rapson 1988; Morlan 1994), features that are unique to specific elements, such as the deltoid tuberosity (humerus) or the greater trochanter (horse femur). This method is invaluable for fragmentary assemblages in facilitating identification of difficult fragments of long bone shafts and thus increasing the overall assemblage counts. Systematic refitting of bone fragments was conducted over a period of several months for each taxon, though these efforts did not yield a significant increase in identifications.

Quantification of the Vogelherd faunal remains involved four analytical units. The primary quantification unit—NISP (number of identified specimens)—refers to the number of specimens identified to taxon and includes those identified to genus, family, and order (Lyman, 1994). As a derived quantification unit, MNE (minimum number of elements) considers all complete or fragmentary specimens observed for that element by taxon (following Binford, 1984). Two possible methods of counting MNE are available: (1) by element portion or landmark, and (2) comprehensively. The first method does not take into account side, sex, or age, while the second method does. Totals in Tables 2 and 3 are expressed as comprehensive MNEs, which better approximate the number of skeletal elements that represent each taxon. The MNI refers to the minimum number of individual animals represented by each skeletal element for every taxon in an assemblage; MNI values in this study consider age, sex, and size (using osteometrics when necessary; e.g., Todd, 1987), sometimes referred to as maximum distinction MNI. The minimum number of animal units (MAU) facilitates comparison of frequencies of each skeletal element by taxon to a standard—the complete animal skeleton (Binford, 1984)—with the goal of showing patterns in the decision-making of prehistoric people in terms of transport and processing of prey. By standardizing MAU values (%MAU), the observed bone frequencies versus the expected ones for each taxon are then evident.

Assemblage formation and preservation

In order to summarize and interpret the data on Paleolithic subsistence from Vogelherd, it is essential to first investigate the degree to which patterning among the archaeological materials is the result of human behavior, animal actions, natural processes, excavation bias, or other factors. Although cave

Table 2
Skeletal element representation of reindeer, expressed as NISP, comprehensive MNE, MAU, and %MAU

Skeletal element	NISP	Left	Right	NS	MNE	MAU	%MAU
Cranium							
Bone	10	2	2	0	2	2.0	7.3
Teeth	7	2	4	1	—	—	—
Total	17	2	2	0	2	2.0	7.3
Mandible							
Bone	22	3	4	0	7	3.5	12.7
Teeth	19	8	7	4	—	—	—
Total	41	3	4	0	7	3.5	12.7
Antler	215	—	—	—	—	—	—
Cervical 3–7	2	—	—	1	1	1.4	5.1
Thoracic 1–13	5	—	—	2	2	1.5	5.5
Lumbar 1–6	3	—	—	3	3	0.5	1.8
Rib	50	19	21	—	40	1.5	5.5
Sternal element	3	—	—	3	3	—	—
Innominate	22	4	2	0	6	3.0	10.9
Scapula	18	3	3	0	6	3.0	10.9
Humerus	98	13	9	1	23	11.5	41.8
Radius	128	7	11	0	18	9.0	32.7
Ulna	33	8	13	0	21	10.5	38.2
Cuneiform	1	1	—	0	1	0.5	1.8
Scaphoid	1	1	—	0	1	0.5	1.8
Unciform	2	—	2	0	2	1.0	3.6
Magnum	1	—	1	0	1	0.5	1.8
Metacarpal	100	9	8	0	17	8.5	30.9
Femur	115	8	7	0	15	7.5	27.3
Patella	4	4	—	0	4	2.0	7.3
Tibia	287	28	27	0	55	27.5	100.0
Astragalus	26	10	16	0	26	13.0	47.3
Calcaneus	23	10	11	0	21	10.5	38.2
Navicular	17	9	8	0	17	8.5	30.9
Cuneiform pes	1	1	0	0	1	0.5	1.8
Metatarsal	284	15	20	0	35	17.5	63.6
Phalanx I	47	—	—	44	44	5.5	20.0
Phalanx II	25	—	—	25	25	3.1	10.9
Phalanx III	14	—	—	—	14	1.8	6.5
Dew claw	4	—	—	4	4	0.5	1.8
Metapodial fragment	33	—	—	—	—	—	—
Long bone fragment	11	—	—	—	—	—	—
Cancellous fragment	2	—	—	—	—	—	—
Total	1633				415		

NS refers to not-sided, as opposed to number.

deposits and archaeological records such as this one present complex formational and interpretive challenges, the task of archaeology is to maximize their interpretive potential. This study addresses characteristics of the faunal assemblage in order to evaluate the various taphonomic and anthropogenic agents and processes that influenced its preservation and current structure.

Collection bias

Having been recovered in excavations more than 70 years ago, the assemblages from Vogelherd offer advantages and disadvantages. The most significant advantage is that a complete set of finds can be evaluated from this site, because all cultural deposits were removed in excavation. A disadvantage

Table 3
Skeletal element representation of horse, expressed as NISP, comprehensive MNE, MAU, and %MAU

Skeletal element	NISP	Left	Right	NS	MNE	MAU	%MAU
Cranium							
Bone	6	1	0	0	1	1.0	3.8
Teeth	178	22	14	0	—	—	—
Total	184	22	14	0	22	22.0	84.6
Mandible							
Bone	51	1	2	0	3	3.0	11.5
Teeth	149	17	14	—	—	—	—
Total	200	17	14	—	26	26.0	100.0
Incisor	80	—	—	—	—	—	—
Indeterminate tooth fragment	271	—	—	—	—	—	—
Atlas	1	—	—	1	1	1.0	3.8
Cervical 3–7	6	—	—	6	6	1.5	5.8
Thoracic 1–18	1	—	—	1	1	0.5	1.9
Lumbar 1–6	2	—	—	2	2	3.3	12.7
Rib	137	8	6	0	14	3.8	14.6
Innominate	17	2	2	0	4	4.0	15.4
Sacrum	1	—	—	1	1	0.5	1.9
Scapula	12	2	2	0	4	2.0	7.7
Humerus	75	7	9	0	16	8.0	30.8
Radius-ulna	61	2	10	0	12	6.0	23.1
Lunate	1	1	0	0	1	0.5	1.9
Trapezoid	3	0	3	0	3	1.5	5.8
Capitate	4	1	3	0	4	2.0	7.7
Metacarpal II	4	2	1	0	3	1.5	5.8
Metacarpal III	15	4	3	0	7	3.5	13.5
Metacarpal IV	3	1	1	0	2	1.0	3.8
Femur	66	5	6	1	12	6.0	23.1
Patella	3	1	2	0	3	1.5	5.8
Tibia	110	14	9	0	23	11.5	44.2
Fibula	1	0	0	1	1	0.5	1.9
Astragalus	3	1	2	0	3	1.5	5.8
Calcaneus	2	0	2	0	2	1.0	3.8
Navicular	4	1	3	0	4	2.0	7.7
Intermediate cuneiform	1	0	1	0	1	0.5	1.9
Metatarsal II	2	0	2	0	2	1.0	3.8
Metatarsal III	17	6	3	0	9	4.5	17.3
Metatarsal IV	6	2	2	0	4	2.0	7.7
Phalanx I	10	—	—	10	10	2.5	9.5
Phalanx II	8	—	—	8	8	2.0	7.7
Phalanx III	4	—	—	4	4	1.0	3.8
Sesamoid	8	—	—	4	4	3.3	12.7
Metapodial fragment	38	—	—	—	—	—	—
Long bone fragment	59	—	—	—	—	—	—
Vertebral fragment	1	—	—	—	—	—	—
Total	1423				221		

NS refers to not-sided, as opposed to number.

of this site is that screening of sediments was not conducted and small remains were therefore not systematically recovered. Based on the faunal remains reported here, it is estimated that Riek discarded many undiagnostic bone fragments <3 cm in maximum length. Above that size cutoff, it appears that Riek and his team collected everything, including fragments of long bone shafts; in other words, selective collecting of diagnostic articular ends and teeth did not occur. In fact, fragments of long bone shafts—exhibiting ancient breaks, not modern curatorial ones—make up a significant portion of the Vogelherd faunal assemblage overall.

In order to measure the degree of excavation bias (i.e., completeness) of the Vogelherd Aurignacian sample (following Marean et al., 2004), frequencies of long bone elements were quantified by circumference types. Following the procedure of Bunn (1983: Fig. 4), these three types are: complete circumference (Type 3), greater than half the circumference (Type 2), and less than half the circumference (Type 1). With the exception of the megaherbivores, frequencies of long bone elements for all ungulate taxa from the Vogelherd Aurignacian are compared in Fig. 2 to both fully and partially collected faunal assemblages discussed by Marean et al. (2004). The most fragmented specimens (Type 1) make up 90% of finds in the Vogelherd assemblage, slightly less than the complete (i.e., screened) assemblage of Die Kelders 1. Another test of assemblage completeness is illustrated in Fig. 3, showing MNE values of all reindeer and horse long bones by portion. From this graph, it is clear that diagnostic articular ends of long bones were not preferentially collected, and that the Vogelherd Aurignacian overall was not significantly biased by collection practices. It goes without question that analysts should clearly document an assemblage's completeness for others to evaluate (Marean et al., 2004), although the Vogelherd example serves as a useful reminder that old collections still hold analytical value.

Considering that Riek documented several hearth features across the cave floor and that he mentions burnt bone having

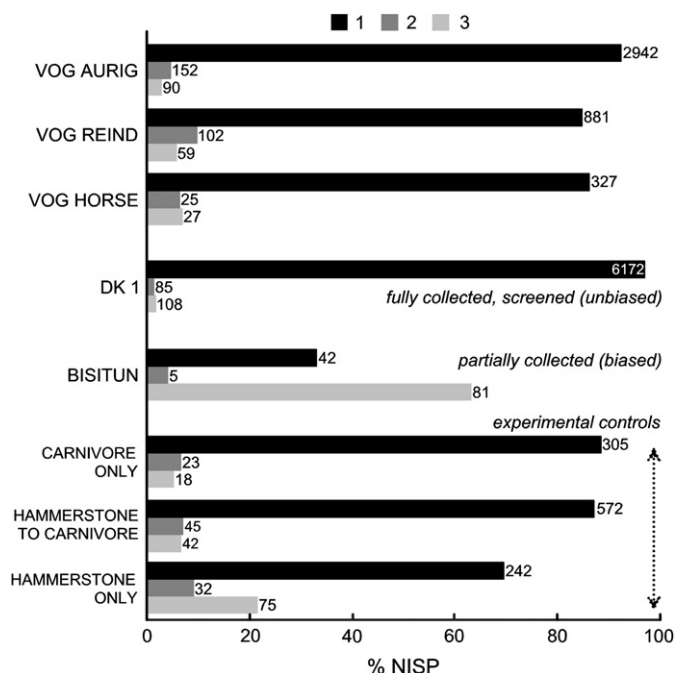


Fig. 2. Frequencies (%NISP) of circumference types for long bones from the Vogelherd Aurignacian (top three: comprehensive; reindeer only; horse only) compared to faunal assemblages completely collected, screened, and unbiased by excavation techniques (Die Kelders 1, South Africa); biased by excavation techniques (Bisitun, Iran); and experimental control samples. Data for Die Kelders 1, Bisitun, and experimental samples are from Marean et al. (2004: Fig. 6). Circumference types after Bunn (1983) are: (1) less than half the circumference; (2) greater than half the circumference; (3) complete circumference. Number (*n*) of bones is shown at the end of each bar.

been present in the Aurignacian levels, the presence of burnt bone in the faunal assemblage would be expected. However, with the exception of a few dozen examples of mammoth- or rhinoceros-sized bone fragments, burnt specimens are distinctly lacking and it is presumed that most were highly fragmented and therefore too small for Riek to collect.

Carnivores

The role of carnivores in the accumulation and/or the destruction of bone from Vogelherd is important to address, because a variety of predators competed with prehistoric people for this cave. Of concern in this case are cave and brown bear, lion, hyena, and wolf. The latter three taxa are known to transport their prey to protected locations such as caves, as well as scavenge bone refuse left behind by people or other predators. Although represented by just one individual, the carnivorous brown bear is a potential transporter and gnawer of bone remains in a cave setting (Haynes, 1980). However, the more numerous cave bear (MNI = 8) very likely had little or no role in the accumulation and scavenging of bone, considering that its diet was purely vegetarian (Bocherens et al., 1994). This leaves wolf and hyena as the most likely candidates for accumulating bone and scavenging bone refuse left behind from human occupations in this assemblage. These taxa are represented by an MNI of seven and two, respectively.

A variety of criteria can be used in evaluating the role of carnivores in an assemblage, with the application of multiple criteria being most productive. In addition to the revised list of criteria that Pickering (2002) recommended for zooarchaeologists are several contributions from recent studies involving Pleistocene carnivores from Europe (e.g., Brugal et al., 1997; Bartram and Villa, 1998; Fosse, 1999), which proved valuable in assessing Vogelherd.

The four large carnivores represent just below 13% of the total MNI in the Vogelherd Aurignacian assemblage, falling below the 20% minimum proportion required to designate the assemblage exclusively carnivore (Cruz-Urbe, 1991). If the Vogelherd Aurignacian was a true hyena accumulation, it would contain >50% carnivores, similar to what we see in Pleistocene Europe (Brugal et al., 1997).

Age data from lion, wolf, and hyena in Vogelherd indicate that all individuals were adults, although the paucity of juveniles might be a factor of preservation and collection bias. If these carnivores denned in the cave, we would expect an equal representation of juvenile and adult animals. However, evidence for denning is also absent in the type of bone remains and gnawing damage (i.e., we do not see examples of long bone shaft cylinders with the cancellous bone scooped out and ragged break edges; Zapfe, 1939; Sutcliffe, 1970). For contrast, it is useful to note that this type of damage characterizes the largest of the Middle Paleolithic horizons at Vogelherd (AH VII), in which 79% of the fauna exhibits gnawing by hyena and wolf. This deposit is thought to represent a mixed carnivore/hominin accumulation but with a much higher contribution from the carnivores (Niven, 2006). Although denning of wolves and hyena cannot be ruled out for the Aurignacian

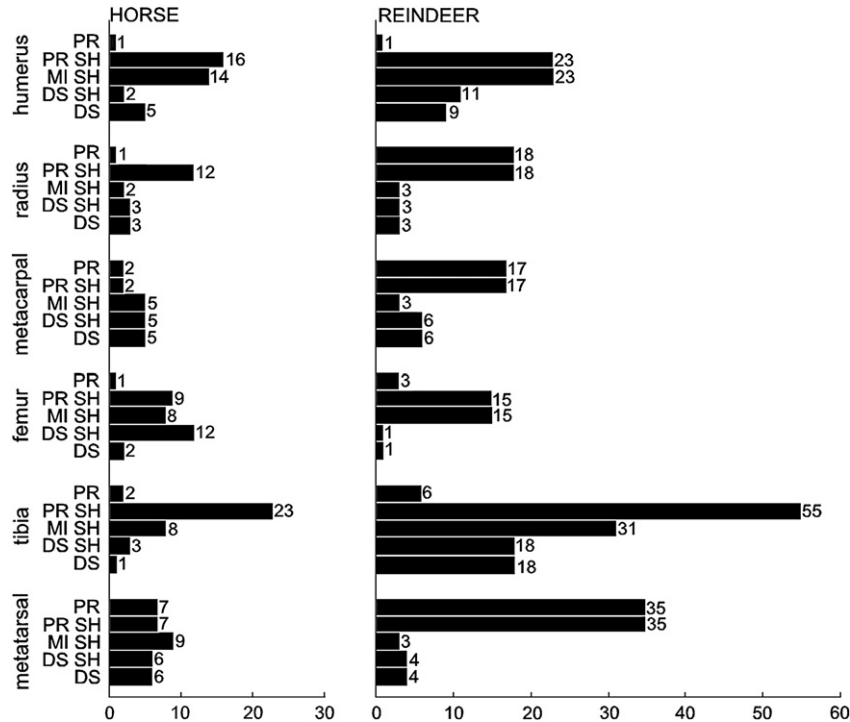


Fig. 3. Estimates of minimum number of elements (MNE) for horse and reindeer appendicular bones from the Vogelherd Aurignacian. Presentation of the data by bone portion (PR: proximal; PR SH: proximal shaft; MI SH: midshaft; DS SH: distal shaft; DS: distal) illustrates differential survival of the various bone portions, following Marean et al. (2004: Fig. 8).

deposit, it is presumed that these predators were instead occasional visitors to the cave following human occupations.

Evaluating mortality profiles of prey can provide insight on the predator(s) involved in bone accumulations, though it is rarely a straightforward process due to such factors as preservation bias between differently sized animals (Pickering, 2002). However, it has been clearly established that nonhuman predators generally prey on the vulnerable age classes—the youngest and oldest individuals—while hominins generally hunt prime adults (Stiner, 1990, 1991; Steele, 2003). In fossil faunas in particular, the proportions of juveniles goes up according to the body weight of the prey taxon (Palmqvist et al., 1996).

For the Vogelherd Aurignacian fauna, age information could be obtained from the reindeer, horse, woolly rhinoceros, and mammoth assemblages. Prime adults form the largest proportion of reindeer and horse, which represent the primary prey of human groups, though juvenile and senile individuals are also present in smaller numbers. In contrast, the youngest and oldest age classes predominate among woolly rhinoceros and mammoth. It has been argued (Niven, 2001, 2006) that mammoth were probably not hunted by Aurignacian people at Vogelherd, but instead their remains were collected from natural deaths and in the case of the numerous infant individuals, brought to the cave by carnivores. Support for the infant mammoths as carnivore prey is found in tooth marks on many specimens; the same evidence is abundant on the infant rhinoceros remains. Late Pleistocene hyenas were capable of hunting young mammoths of up to 700 kg in size (Lister, 2001); these animals, as well as rhinoceros infants, would

have been well in the range of hunting capability of wolf and lion, if we consider the predatory behaviors of their extant counterparts (Mech, 1970; Owen-Smith, 1988). In summary, the mortality data from the four species in the Vogelherd Aurignacian conform in part to the established patterns of predatory behavior in nonhuman and human hunters, and the additional data sets for bone modifications on the megaherbivores strengthen the argument that the infant individuals of both taxa were introduced to the cave by carnivore predators.

Skeletal element abundances of prey species are potentially informative about the role of carnivores versus humans in faunal assemblages; however, because both classes of predator select meat and fat resources, these data sets are tricky to interpret. In a carnivore accumulation, long bones are generally frequent, particularly among the largest ungulates, such as bovids and equids (Palmqvist et al., 1996; Fosse, 1999). Skulls are generally more numerous in Pleistocene hyena dens but more comparable to the rest of the skeleton in mixed faunas (Fosse, 1999: Fig. 3). The fragile axial skeleton is consistently underrepresented when carnivores are involved. Because patterns of skeletal element frequencies are not strictly characteristic to one or the other predator, additional criteria are necessary for interpreting assemblages. For example, humans and nonhuman predators might select the same skeletal parts to consume, but the ways in which they utilize these elements differ and have unique signatures.

The best method for discerning the impact of carnivores is through the systematic analysis of tooth marks, cut marks, and hammerstone percussion marks (Blumenschine and Marean, 1993; Blumenschine et al., 1996; Capaldo, 1998; Marean

et al., 2000). In the Vogelherd study, evaluation of bone surfaces was done under a powerful light source with a 15× hand lens. Because of the large size of the assemblage, microscopic examination of every bone was not possible. However, in cases where possible anthropogenic or carnivore modifications were detected with the hand lens, specimens were subjected to more thorough evaluation with the aid of a 10–40× microscope. Each type of modification was scored only when it was unambiguous; low-confidence examples are not included in the final counts.

In the Aurignacian faunal assemblage overall, just 4% of the specimens exhibit carnivore tooth marks. In regard to the main subsistence taxa (reindeer and horse), the tooth-marked numbers are 2.4% and 9.8%, respectively. These frequencies are significantly lower than those found in bone assemblages attributed solely to carnivores, which range from 57% to 83% on various portions of the long bones (Marean et al., 2000: Table 3). Both experimental and fossil faunas modified by humans and subsequently by carnivore scavengers exhibit tooth mark frequencies between 7% and 19% (Marean et al., 2000: Table 3). Only one horse specimen shows both a cut and tooth mark.

The distinction in tooth mark frequency on the Vogelherd reindeer and horse likely relates to the varying amounts of within-bone nutrients available in the long bones of these taxa, particularly the midshaft portions, which make up much of the assemblage. Even in a fractured state as the result of human breakage for marrow extraction, equid long bone shafts or fragments thereof contain more trabecular bone that would appeal to carnivores seeking within-bone nutrients. In contrast, reindeer shaft fragments would hold no nutritional value following human utilization.

Articular ends of long bones are relatively infrequent among the Vogelherd reindeer and horse remains, raising the question of whether this might be the result of carnivore consumption of these nutritionally rich bone portions. The low frequencies of tooth marks on portions of long bone shafts and the complete lack of long bone shaft cylinders—characteristic bone remains in carnivore dens (Sutcliffe, 1970)—suggest that carnivores were not the primary destructive force behind the low number of articular ends in Vogelherd.

Density-mediated destruction

One important step in the evaluation of skeletal element representation involves assessing the influence of bone density on survivorship in the fossil record (Brain, 1969; Lyman 1984; Lam et al., 1998). This can be accomplished by plotting computed tomography (CT) density values of bones from the taxon in question, found in Lam et al. (1999), against the relative element abundance (excluding neurocranium, carpals, small tarsals) in the archaeofauna. For Vogelherd, this process began by grouping skeletal parts into low survival and high survival sets (Marean and Cleghorn, 2003; Cleghorn and Marean, 2004). Low survival elements include ribs, vertebrae, pelvis, tarsals, carpals, and phalanges of small ungulates (i.e., Size 1–2), and their abundance in an assemblage should reflect the degree of bone destruction by means of carnivores and density-mediated

attrition. High survival elements include the long bones, mandible, and cranium. Identifiable bone portions of comparably high density are more valuable for discerning accurate skeletal element representation from an assemblage and, in turn, interpreting human economic decisions (Marean and Cleghorn, 2003: 34). As argued by Cleghorn and Marean (2004: 57), body size and taxonomy influence the composition of the high and low survival sets, and accordingly, some adjustments were made for the Vogelherd assemblage. For both taxa, the articular end of the scapula was included in the high survival set, since it remains identifiable even when fragmented. For horse, the first phalanx was also placed in the high survival set. Considering that the values of bone mineral density (BMD) for both elements equal those of the densest portions of long bone shafts, their inclusion as high survival elements is justified. Lastly, the radius and ulna were considered a single fused element as opposed to counting these long bones separately. Not only are these elements indeed fused in reindeer and horse, but fragmentary ulnar shaft fragments are difficult to quantify with confidence and their BMD value is well below those in the set of high survival elements.

A comprehensive summary of the highest landmark %MAU values by bone portion from Vogelherd and the BMD values of their equivalent CT scan site is presented in Table 4. For evaluation, skeletal elements were sorted into high and low survival sets, and the highest %MAU value for each skeletal element was logged; among all the long bones, the midshaft portions consistently had the highest %MAUs. BMD values by scan site were also logged and each set of skeletal elements was subjected to regression analysis by taxon (Fig. 4).

For reindeer (Fig. 4a,b), the correlation between bone density and preservation is relatively high but nonsignificant for the high ($r = 0.60$, $p = 0.09$) and low ($r = 0.64$, $p = 0.09$) survival sets. A lower but still nonsignificant correlation is seen among the horse remains (Fig. 4c,d) among the high ($r = 0.23$, $p = 0.56$) and low ($r = 0.48$, $p = 0.19$) survival elements. Considering the reindeer results, it appears that density-mediated attrition played some role in assemblage formation, though neither of the relationships is significant. In regard to the horse, results indicate that density-mediated attrition played a much smaller role in shaping the assemblage. Overall, the fragile axial skeleton and less dense articular end portions of some long bones are indeed poorly represented in comparison to the denser midshaft portion (Table 4) among both taxa, which is likely due in part to their low density. However, this evaluation shows that bone density alone is not significantly correlated with preservation of skeletal elements and therefore not a key factor in the overall skeletal element abundances of reindeer and horse at Vogelherd. These issues are discussed more below.

Fragmentation and preservation

The Aurignacian fauna is extensively fragmented. The majority of breakage is ancient and was produced by human, animal, and natural agents. Excluding teeth, complete elements of reindeer and horse are rare, with the exception of joint

Table 4

Values of bone mineral density (BMD)* and standardized minimum animal units (%MAU) for most reindeer and horse skeletal elements from the Vogelherd Aurignacian

Element	Reindeer			Horse		
	Scan	BMD	%MAU	Scan	BMD	%MAU
Mandible (MR)						
Cranial (CR)	DN3	1.07	20.0	DN3	0.98	8.7
Caudal (CD)	DN5	1.05	12.7	DN5	0.96	13.0
Cervical (CE)	CE1	0.45	5.1	CE1	0.50	16.2
Thoracic (TH)	TH2	0.53	5.5	TH2	0.49	1.9
Lumbar (LM)	LU3	0.51	1.8	LU1	0.48	12.7
Rib (PR) (RB)	RI3	0.96	5.5	RI2	0.39	14.6
Innominate (IM)						
Acetabulum (AC)	AC1	0.64	9.1	AC1	0.65	7.8
Ilium (IL)	IL2	1.02	10.9	IL2	0.94	3.8
Ischium (IS)	IS1	0.94	1.8	IS1	0.98	3.8
Scapula (SC)						
Blade (BL)	SP4	1.01	10.9	SP2	1.01	1.9
Distal (DS)	SP1	1.01	10.9	SP1	1.03	7.8
Humerus (HM)						
Proximal (PR)	HU2	0.44	3.6	HU2	0.33	3.8
Shaft (SH)	HU3	1.12	43.6	HU3	1.10	30.8
Distal (DS)	HU4	1.08	16.4	HU4	1.05	0.0
Radius (RD)						
Proximal (PR)	RA1	0.53	32.7	RA2	1.04	5.8
Shaft (SH)	RA3	1.09	32.7	RA3	1.08	23.1
Distal (DS)	RA5	0.49	5.5	RA4	0.94	13.5
Ulna (UL)						
Proximal (PR)	UL1	0.49	20.0	UL1	0.43	1.9
Shaft (SH)	UL2	0.84	18.2	UL2	0.70	1.9
Metacarpal (MC)						
Proximal (PR)	MC1	0.92	30.9	MC2	1.03	7.8
Shaft (SH)	MC3	1.10	34.5	MC3	1.10	15.4
Distal (DS)	MC6	0.68	9.1	MC6	0.60	11.5
Femur (FM)						
Proximal (PR)	FE2	0.52	5.5	FE1	0.35	5.8
Shaft (SH)	FE4	1.15	45.5	FE4	1.09	23.1
Distal (DS)	FE6	0.32	1.8	FE5	0.51	5.8
Tibia (TA)						
Proximal (PR)	TI2	1.01	12.7	TI2	0.77	7.8
Shaft (SH)	TI3	1.13	100.0	TI3	1.07	44.2
Distal (DS)	TI5	0.73	29.1	TI4	1.05	5.8
Metatarsal (MT)						
Proximal (PR)	MR1	0.90	63.6	MR2	1.07	15.4
Shaft (SH)	MR2	1.10	60.0	MR3	1.10	15.4
Distal (DS)	MR6	0.59	14.5	MR6	0.60	0.0
Astragalus (AS)	AS2	0.70	47.3	AS1	0.67	5.8
Calcaneus (CL)						
Proximal (PR)	CA1	0.52	41.8	CA1	0.45	1.9
Shaft (SH)	CA2	0.94	36.4	CA2	0.69	3.8

* BMD data and scan-site definitions are from Lam, et al. (1999: Table 1). Highest density values are shown.

and foot bones. Among these two taxa, green breakage is the predominant fragmentation type: 60% for reindeer, 45% for horse. Based on the presence of hammerstone impacts, much of the fresh spiral breakage was generated during marrow extraction by people; however, bone-chewing carnivores can also produce such breakage (Haynes, 1983; Arribas and Palmqvist,

1998) and are likely responsible for a portion of what we see here. Dry breakage—ancient fragmentation after the bone lost its organic content—affects the reindeer (11%) and horse (24%) significantly as well, followed by smaller amounts of indeterminate breakage types.

Bone surface preservation ranges from excellent to fair [Behrensmeyer's (1978) weathering Stages 1–3] on all taxa, except the mammoth and woolly rhinoceros, which were consistently more heavily weathered. Documentation of modifications such as cut marks, impact fractures, and carnivore gnawing was generally facilitated by fair preservation, though the degree of dry fragmentation, coupled with bone surface weathering, reduced the overall frequencies of bone surface modifications.

Reindeer and horse as prey

Reindeer and horse were the primary ungulate prey taxa acquired by humans in the Vogelherd Aurignacian. Utilization of these two taxa is shown in extensive butchery evidence in the form of stone-tool cut marks, hammerstone percussion damage, chop marks, and fresh breakage of long bones, presumably to obtain marrow. Although skeletal element abundances appear to have been partly altered by preservational factors, these data provide significant insight on differential exploitation of reindeer and horse. Season-of-death information, mortality profiles, and herd demography each contribute to an understanding of the human hunting strategies unique to each taxon. In addition, a variety of research on modern reindeer/caribou (Burch, 1972; Miller, 1974; Spiess, 1979) and equid behavior (Berger, 1983, 1986; MacFadden, 1992; Bahloul et al., 2001) is summarized here, in order to more fully reconstruct the ecology of their Pleistocene counterparts.

Like many cold-climate mammals, reindeer have seasonally restricted mating and birthing seasons; mating occurs in autumn and birth in late May to early June (Spiess, 1979). Social groupings of reindeer contain seasonally fluctuating numbers of males, females, subadults, and juveniles (Miller, 1974), and they migrate in autumn and spring, a behavior inferred to apply to Pleistocene *Rangifer*. Although herds probably did not follow exactly the same migration routes year after year (Burch, 1972), modern reindeer tend to follow consistent patterns in terms of topography. As such, the location of reindeer would have been somewhat predictable during migrations. This variable is especially relevant in understanding the hunting strategies of prehistoric peoples, because trails left on the landscape by migrating animals may have been numerous and diverse; hunters with knowledge of reindeer behavior would have been able to assess the possible routes and plan ambushes accordingly (Enloe and David, 1997).

Based on modern equid behavior, it is presumed that the mating and birthing events of Pleistocene horses were similarly seasonally restricted. Following a 12-month gestation, mares typically give birth between April and June (MacFadden, 1992). Family and bachelor groups make up the two distinct social combinations noted in extant wild horse populations (Berger, 1986; Bahloul et al., 2001); these groups are maintained year-round (Berger, 1983). Family groups, consisting

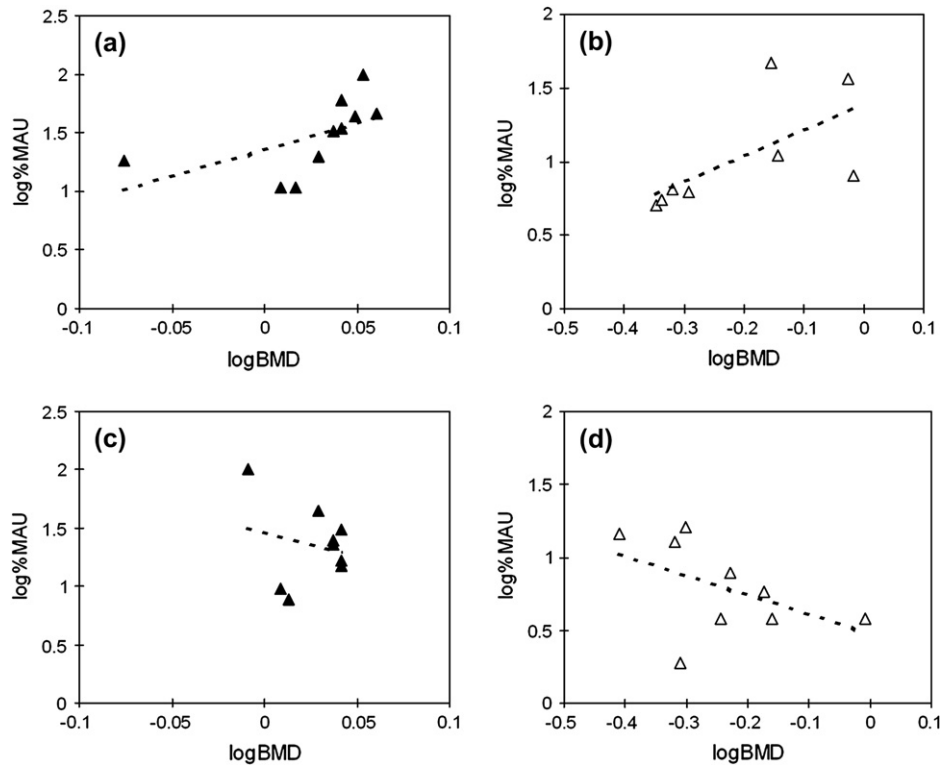


Fig. 4. Logged values of bone mineral density (BMD) and %MAU for reindeer (a,b) and horse (c,d) skeletal parts, excluding cranium, carpals, and smaller tarsals, and grouped by high survival (filled triangles) and low survival (open triangles) sets (after Mearns and Cleghorn, 2003). BMD values, produced through computed tomography (CT), are from Lam et al. (1999: Table 1). Plotted values are the highest %MAU for each element from Vogelherd and their equivalent scan site.

of several mares, their young, and one dominant male, inhabit restricted home ranges near reliable sources of water and food, migrating outside their territory only rarely (Berger, 1986). When male offspring in the family group reach the age of 2–4 years, they are forced out of the group by the dominant male, subsequently forming bachelor herds. As with other large migratory animals, horses leave trails that are visible to predators. Since family groups of horses were somewhat predictable in their movements and location, prehistoric hunters might have targeted them more often than the more aggressive bachelor herds (Levine, 1983; West, 1996).

With a NISP of 1633 (Table 2), a total of 28 reindeer individuals are represented (based on tibiae midshaft portions) in the Vogelherd Aurignacian fauna. A total of 1423 horse specimens (Table 3) represent at least 27 individuals (26 individuals based on mandibular teeth, one individual from a single fetal femur); these numbers are revised from a preliminary study of the horse remains (Niven, 2003). Teeth of reindeer are scarce (NISP = 30) and the assemblage is made up almost entirely of postcranial bones. In contrast, teeth are nearly equal in number to bones (NISP 745:678) among the horse specimens.

Mortality profiles, season of death, and herd demography

For reindeer, an isolated dp4 along with a partial mandibular tooth row containing dp₂–dp₄, indicate an age at death

between 3–6 months, or late summer through fall. Two additional mandibular third molars suggest death between 17–22 months (late fall to spring), although these estimates remain tentative due to variation in M3 eruption. Based on the reindeer dentition overall, all age groups are represented (expressed as %MNE; Fig. 5a). In terms of MNI, there are two calves, one young adult (2–4 years), five prime adults (5–10 years) and one old adult (>9 years). Osteometric data from proximal radii point to nearly equal numbers of males and females being present. The combination of mortality and herd demography data suggest that the hunting event(s) took place during the fall—and perhaps spring—reindeer migration.

The narrowest age and season-at-death assessment for horse comes from a complete femur of a fetus. Based on the absolute length of domestic horse fetal long bones presented in Habermehl (1975), the Vogelherd femur (measuring 66 mm), is approximately 25 weeks into term. If we assume a birthing date between April and June (MacFadden, 1992), then the death occurred sometime between September and October. A mandibular dp4 from an animal that perished between 2 and 6 months of age also indicates summer–fall mortality.

The majority of horse teeth provide less precise season-at-death estimates, but detailed age information (Fig. 5b): a total of 128 teeth, isolated or in partial tooth rows, represent seven juvenile, twelve prime adult, and seven old adult individuals (MNI). The conspicuous drop in 5–8-year-old individuals is not attributed to preservation because the teeth are fully

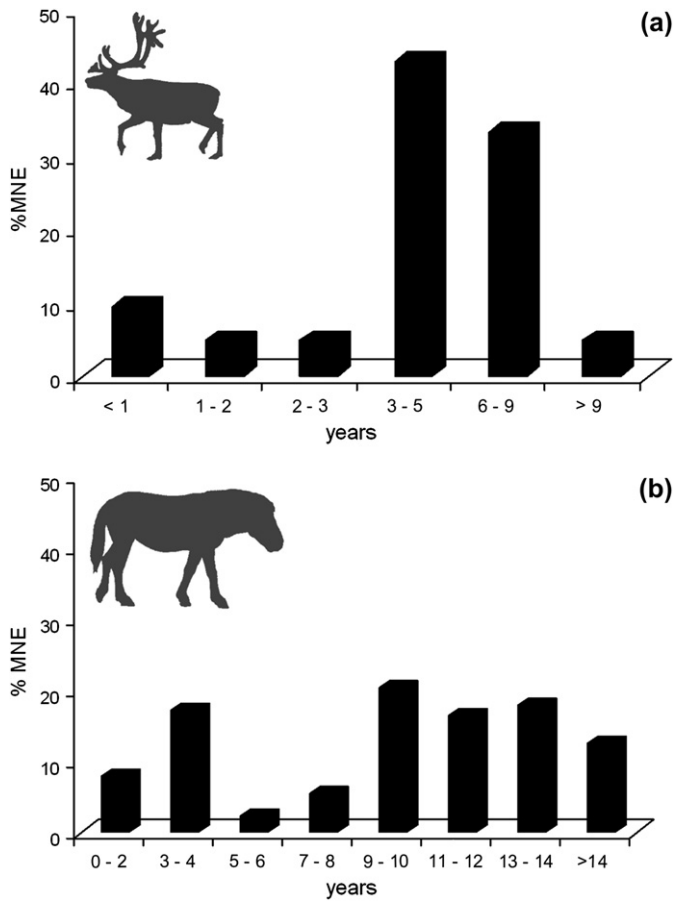


Fig. 5. Mortality profiles of reindeer (a) and horse (b). Reindeer MNE data by age: <1 year (2); 1–2 years (1); 2–3 years (1); 3–5 years (9); 6–9 years (7); >9 years (1). Horse MNE data by age: 0–2 years (10); 3–4 years (22); 5–6 years (3); 7–8 years (7); 9–10 years (26); 11–12 years (21); 13–14 years (23); > 14 years (16).

mineralized by this age (Levine, 1983). Instead, the underrepresentation of these age classes likely relates to the loss of young male horses forming their own bachelor herds. The lack of adolescents correlates nicely with Levine’s (1983) family-group model of mortality, in which horses 3–6 years of age are disproportionately low. Additional support for the absence of young males is a lack of canine teeth in the Vogelherd assemblage; female and male equids may have canines, but the frequency in females is much lower (Turner, 2002). Because preservation and collection factors are unlikely to be behind the lack of this tooth in the assemblage, their absence is an indication of a predominantly female herd structure.

Carcass utilization: skeletal element abundances

Relative skeletal element abundances for reindeer and horse are illustrated as %MAU in Fig. 6. As mentioned above, appendicular elements are clearly more abundant than axial elements for both taxa. While relative abundances of forelimb and upper hindlimb elements are somewhat comparable between reindeer and horse, lower hindlimb elements are considerably more frequent for reindeer. These variable patterns in

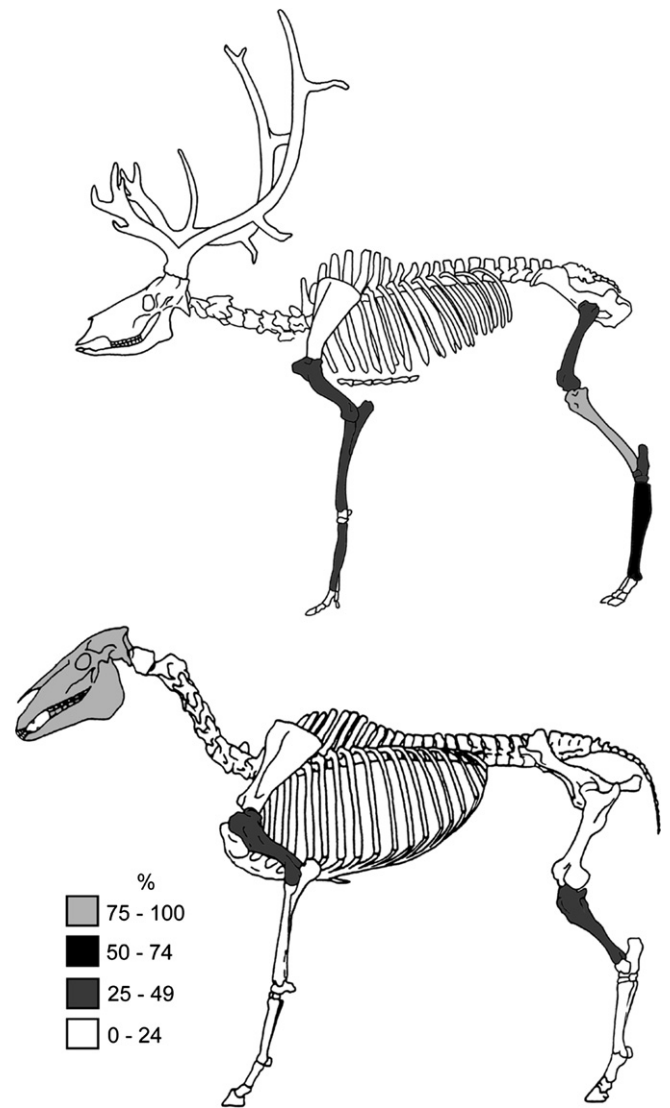


Fig. 6. Standardized values of minimum animal units (%MAU) for reindeer and horse. Reindeer antler excluded.

skeletal part representation could be explained by density-mediated attrition or human behavior.

The bone frequency data show that the densest portions of some elements are not always or consistently the best-represented. For example, in reindeer, the upper shaft portions of both the femur and tibia are among the densest long bone portions in the skeleton. If density-mediated destruction were the only variable determining element frequencies in this assemblage, we might expect femoral and tibial shafts to be more or less equally represented. But in fact, tibiae are nearly four times as numerous as femora in the reindeer assemblage. As discussed above, this disparity might be explained by variability in bone density’s influence on survivorship in the fossil record (e.g., Lam and Pearson, 2004; Stiner, 2004), though it could also be a factor of selective transport. Ethnoarchaeological studies (Monahan, 1998) have shown that despite its high nutritional value, the femur was more often discarded (along with ribs) than other skeletal parts, simply because the meat

could be removed quickly and easily from this bulky element on-site.

The most glaring difference in element frequencies involves the complete skull: based on numbers of teeth, both the crania and mandibles are well represented for horse, but underrepresented for reindeer. Taphonomic factors and human behavior could be behind this pattern. Although fully formed teeth are among the densest elements in the animal skeleton, the smaller size of reindeer molars in comparison to those of horse may be more of a factor in their lower survivorship than robusticity of teeth in general.

If teeth are truly representative of the number of skulls brought back to Vogelherd, then it might reflect selective transport by people, perhaps influenced by the location of hunts. A scenario in which the reindeer were hunted and butchered a great distance from the cave would conceivably mean skulls were discarded on-site, considering that little to no tissue remains on small ungulate crania following skinning and tongue removal (Lupo, 1998). In contrast, horses may have been procured nearby and were transported in full to the cave for butchering. Due to their high nutritional value, equid skulls would have been worthy of transport despite their bulk. Based on results from African ungulate butchery experiments (Lupo, 1998), zebra crania are valued by modern hunter-gatherers for several reasons: (1) they are easy to break open for obtaining tissues (also see O'Connell et al., 1988); (2) large amounts of tissue still remain after initial processing and removal of external flesh and tongue, especially in the large nasal cavity; and (3) the equid skull is less susceptible to fat depletion in comparison to other body parts (Stiner, 1994; Lupo, 1998). Lastly, modern ethnographic data collected in central Asia by Levine (1998) contribute additional support to the economic utility of equid heads: the content of important fatty acids in the milk and meat of horses is much higher than in other ungulates.

Another issue worth mentioning in regard to the frequency of reindeer and horse skulls is the overall paucity of cranial bone from both taxa. Mandible fragments are present but bony parts of the skull are rare, including the extremely robust petrous portion. Overall density of reindeer skulls is presumably lower than those of equids, although there are currently no data to support this notion. In the case of Vogelherd, the skulls of both prey taxa may have been processed extensively for their nutritional yields, resulting in small fragments that either did not survive in the fossil record or were not collected during excavation. An argument for utilization of the skulls for their nutritional resources is consistent with the rest of the reindeer and horse assemblages, indicating extensive processing for meat and fat.

Food utility indices are a valuable tool for exploring relative skeletal element abundance values and their relationship to the economic decision-making behavior of prehistoric peoples (Binford, 1978). These indices measure average food values of meat, marrow, and the overall economic utility of skeletal elements for a given prey taxon (e.g., Binford, 1978; Metcalfe and Jones, 1988; Emerson, 1990; Blumenschine and Madrigal, 1993; Brink, 1997; Outram and Rowley-Conwy,

1998). Application of these indices is usually intended to distinguish between axial- and appendicular-dominated assemblages, but in cases where the low survival elements of the axial skeleton did not survive postdepositional processes, such distinctions cannot be made (Marean and Cleghorn, 2003).

Skeletal elements of reindeer with the best potential for investigating human economic decisions at Vogelherd include the robust appendicular elements, especially those of the lower hindlimb. Therefore, the missing portions of the axial skeleton have been excluded, because it is impossible to know how many of these low survival reindeer elements were once present. In Fig. 7a, reindeer long bone %MAU values are plotted against the standardized food utility index (S)FUI (Metcalfe and Jones, 1988). The preserved appendicular portions show little to no correlation with overall food utility ($r = 0.37$, $p = 0.33$). However, plotting %MAUs against the marrow index (Binford, 1978) shows a stronger but nonsignificant correlation ($r = 0.73$, $p = 0.10$) (Fig. 7b). The abundance of tibiae and metatarsals correlates strongly with the high marrow yields of these elements and emphasizes the importance of this fat-rich food source in human subsistence at Vogelherd, although their numbers are partly due to the robustness of both elements.

Evaluating relative skeletal element abundance in terms of food utility indices for the horse assemblage is less informative. A low but nonsignificant correlation ($r = 0.23$, $p = 0.46$) is visible in the plot of %MAU versus (S)FUI (Outram and Rowley-Conwy, 1998), again excluding the axial skeleton (Fig. 7c). With the possible exception of the tibia, plotting horse %MAUs against the marrow index (Fig. 7d) also shows a low and nonsignificant correlation ($r = 0.42$, $p = 0.40$) and is minimally helpful in explaining relative skeletal element abundances in economic terms.

In summary, the data on skeletal element frequency provide some hints at human subsistence behavior, despite the influences of preservation. Additional insight into the exploitation of reindeer and horse products can be found in the modification of these animals' remains.

Carcass utilization: bone modifications

Butchery processes and overall utilization of reindeer and horse carcasses are evaluated in terms of their associated bone modifications: cut marks, hammerstone percussion damage, and breakage. No traces of burning were detected on either the reindeer or horse remains.

Overall, 20.3% of reindeer and 8.2% of horse bones bear cut marks (Table 5). Binford's (1981) work provides a useful framework for evaluating cut mark evidence on the Vogelherd reindeer and horse assemblages. Following his system, cut marks on and around articular ends are inferred to be characteristic of disarticulation, while cut marks on upper long bone shafts indicate meat removal. Both of these sets of cut marks are evident on the Vogelherd material, though disarticulation cut marks are less frequently documented due to the weaker representation of articular ends overall. In other words, it is

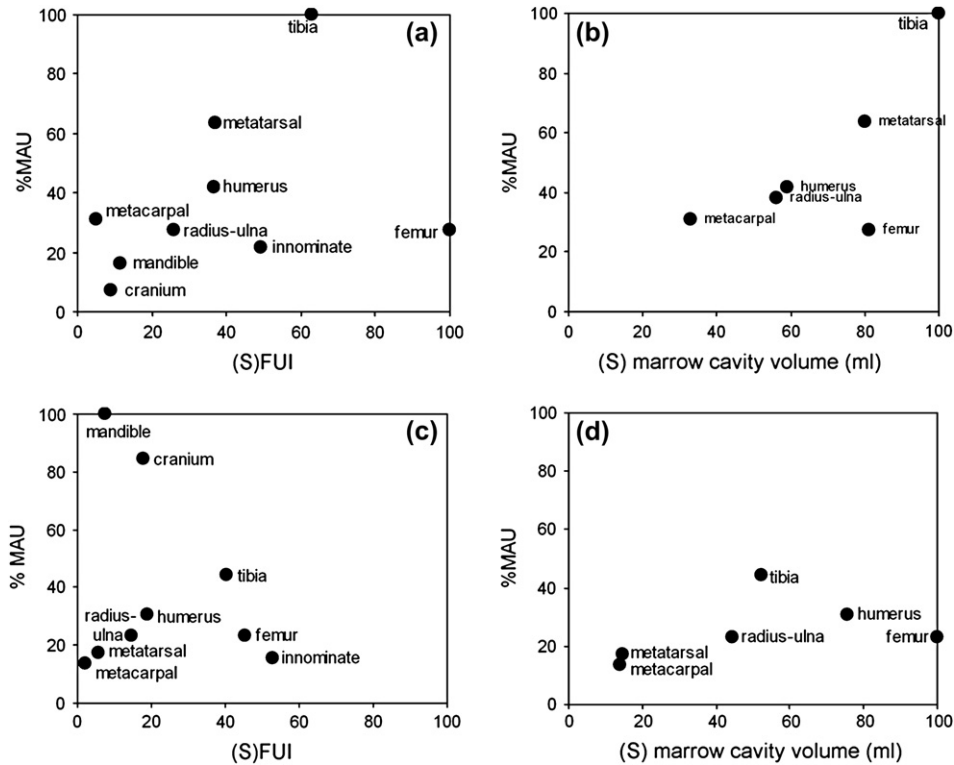


Fig. 7. Standardized values of minimum animal units (%MAU) for reindeer plotted against (a) the standardized food utility index [(S)FUI] and (b) the marrow index [(S) marrow cavity volume (ml)]; reference data are from Metcalfe and Jones (1988: Table 3) and Binford (1978: Table 1.7). %MAU values for horse plotted against (c) the (S)FUI and (d) the marrow index; reference data are from Outram and Rowley-Conwy (1998: Tables 4, 6).

not possible to know the true extent of cut marks on epiphyseal portions because many of those portions did not survive in the fossil record. Because lower appendicular elements (radii, tibiae, metapodials) carry little if any meat, cut marks on these bones are said to be associated with removal of the periosteum, tendons, and perhaps bits of flesh in preparation for marrow cracking.

Hammerstone impact scars are present on 6.0% of reindeer and 7.7% of horse bones (Table 5). Reindeer long bones contain substantial marrow cavities that can be broken open by means of percussion—stone upon bone or vice versa. Applying a strategy in which one or two strikes are focused on the area of shaft just below or above the articular ends in order to expose the marrow cavity should result in an assemblage characterized by numerous shaft fragments and articular ends possessing minimal shaft (Binford 1981). This is generally the pattern observed in the Vogelherd reindeer assemblage, with the former being most abundant (Niven, 2006: Figures 5.17–5.18).

Although the long bones of horse contain marrow, amounts are much less than in reindeer, especially considering the taxonomic differences in size of comparable elements (Outram and Rowley-Conwy, 1998: Fig. 6). Much higher proportions of trabecular bone in equids reduce the marrow cavity to small pockets (Outram and Rowley-Conwy, 1998: Fig. 7). Fracturing horse bones to access the marrow cavity is inferred to follow the same procedure as described for reindeer, although a great deal more force is required to break the thicker cortical bone

of horse. The general pattern of marrow processing on the Vogelherd horse material involves impacts on the shaft near articular ends (Niven, 2006: Figures 5.19–5.21).

Many appendicular elements show evidence of systematic breakage consistent with marrow processing (e.g., reindeer metatarsals broken to expose the entire length of the marrow cavity). Unfused, fusing, and completely fused long bones of reindeer and horse were similarly exploited for marrow. This, in addition to the fact that no reindeer long bone was left unprocessed for its within-bone nutrients, indicates that Aurignacian groups practiced no selective processing of this taxon based on age and sex of the animals (e.g., Gaudzinski and Roebroeks, 2000). In light of the preponderance of marrow-rich limb elements in this assemblage overall, these data support the inference that efficient and extensive marrow processing was a key aspect of reindeer and horse exploitation throughout the Aurignacian at Vogelherd.

Despite the ample evidence for marrow processing of reindeer and horse elements, the overall frequencies of hammerstone percussion scars are low in comparison to experimental and archaeological assemblages (Marean et al., 2000). In actualistic studies where humans were the sole modifier, percussion frequencies on long bones were the sole modifier, percussion frequencies of 20–36% were evident on long bone assemblages with contributions from carnivores and humans (Marean et al., 2000: Table 3). For comparison, a variety of archaeological assemblages with medium and large ungulate remains have long bone percussion frequencies between 13–35%

Table 5
Summary of NISP, cut marks, and hammerstone impacts by element portion for reindeer and horse¹

Element	Reindeer					Horse				
	NISP	Cut	%	Impact	%	NISP	Cut	%	Impact	%
Cranium	10	1	10.0	0	0.0	6	0	0.0	0	0.0
Mandible	22	1	4.5	0	0.0	51	2	3.9	1	2.0
Cervical	2	0	0.0	0	0.0	7	0	0.0	0	0.0
Thoracic	5	0	0.0	0	0.0	1	0	0.0	0	0.0
Lumbar	3	0	0.0	0	0.0	2	0	0.0	0	0.0
Sacrum	0	0	0.0	0	0.0	1	0	0.0	0	0.0
Rib	50	1	2.0	0	0.0	137	11	8.0	0	0.0
Pelvis	22	1	4.5	0	0.0	17	3	17.6	0	0.0
Scapula	18	4	22.2	1	5.6	12	2	16.7	1	8.3
Humerus PR	3	0	0.0	0	0.0	2	0	0.0	0	0.0
Humerus SH	70	20	28.6	8	11.4	63	6	9.5	2	3.2
Humerus DS	25	4	16.0	1	4.0	9	0	0.0	0	0.0
Radius-ulna PR	22	6	27.3	2	9.1	1	0	0.0	0	0.0
Radius-ulna SH	97	51	52.6	17	17.5	55	4	7.3	10	18.2
Radius-ulna DS	9	0	0.0	1	11.1	5	0	0.0	0	0.0
Ulna PR	24	13	54.2	5	20.8	2	0	0.0	1	50.0
Ulna DS	9	8	88.9	0	0.0	0	0	0.0	0	0.0
Metacarpal PR	26	1	3.8	1	3.8	2	1	50.0	0	0.0
Metacarpal SH	65	14	21.5	5	7.7	7	0	0.0	3	4.3
Metacarpal DS	9	1	11.1	0	0.0	5	0	0.0	0	0.0
Metacarpal CO	0	—	—	—	—	1	—	—	—	—
Carpal	5	0	0.0	0	0.0	8	0	0.0	0	0.0
Femur PR	6	0	0.0	0	0.0	6	3	50.0	0	0.0
Femur SH	101	20	19.8	10	10.0	59	6	10.2	8	13.6
Femur DS	8	0	0.0	0	0.0	1	0	0.0	0	0.0
Patella	4	0	0.0	0	0.0	3	0	0.0	0	0.0
Tibia PR	9	1	11.1	0	0.0	2	1	50.0	1	50.0
Tibia SH	259	78	30.1	21	8.1	106	11	10.4	21	19.8
Tibia DS	19	1	5.3	1	5.3	2	1	50.0	1	50.0
Metatarsal PR	59	7	11.9	1	1.7	3	1	33.3	0	0.0
Metatarsal SH	217	41	18.9	8	3.7	8	0	0.0	1	12.5
Metatarsal DS	8	0	0.0	0	0.0	0	0	0.0	0	0.0
Metatarsal CO	0	—	—	—	—	6	—	—	—	—
Astragalus	26	5	19.2	0	0.0	3	0	0.0	0	0.0
Calcaneus	23	1	4.3	1	4.3	2	0	0.0	0	0.0
Tarsal	18	3	16.7	0	0.0	5	0	0.0	0	0.0
Metapodials	28	0	0.0	0	0.0	53	4	7.5	6	11.3
Phalanx I	47	0	0.0	1	2.1	10	1	10.0	1	10.0
Phalanx II	25	0	0.0	0	0.0	8	1	12.5	0	0.0
Phalanx III	14	0	0.0	0	0.0	4	1	25.0	0	0.0
Long bone fragment	11	0	0.0	0	0.0	61	2	3.3	0	0.0
Other ²	14	0	0.0	0	0.0	9	0	0.0	0	0.0
Total	1392	283	20.3	84	6.0	745	61	8.2	57	7.7

¹ Total NISP counts at the bottom of table for bone only—antler and teeth excluded. Codes following skeletal elements: PR (proximal); SH (shaft); DS (distal); CO (complete).

² Other: dew claws, sesamoids, cancellous fragments; second or fourth metapodials of horse.

when carnivore influence is minimal to none [e.g., Les Pradelles, France, Layers 9–10 (Costamagno et al., 2005, 2006) and Salzgitter-Lebenstedt, Germany (Gaudzinski and Roebroeks 2000, 2003), both Middle Paleolithic reindeer-dominated faunas; Die Kelders I, South Africa (MSA, size 3–4 ungulates; Marean et al., 2000); and Clary Ranch, USA (late Paleoindian, bison; Hill, 2001)]. Faunas from complicated palimpsest deposits with some carnivore contribution, such as the Middle and Upper Paleolithic horizons at St. Césaire, France (Morin, 2004), and Mezmaiskaya Cave, Russia (Cleghorn, 2006), tend to have percussion mark frequencies <10%, values that are similar to that of Vogelherd.

Carnivore destruction of bone following human occupation of a site undoubtedly removed fragments with percussion marks or rendered them analytically undetectable. However, in assemblages such as Vogelherd and St. Césaire (all horizons), where carnivore tooth mark frequencies are also <10%, other factors must be involved in the low frequencies of hammerstone percussion marks. In the case of Vogelherd, bone surface weathering and the extent of ancient dry breakage certainly reduced the readability of bone surfaces for anthropogenic modifications. A more thorough evaluation of these issues, using a variety of ungulate faunas would be worthwhile in future studies.

Discussion

Significant patterns in subsistence behavior are recognizable in the Vogelherd Aurignacian fauna despite potential problems with the assemblage overall. These problems include: (1) collection bias during excavations that discarded many small, undiagnostic bone fragments smaller than 3 cm in length, including burnt specimens; (2) probable destruction of fragile bone portions by carnivores such as hyena and wolf; (3) differential preservation of dense bone in comparison to the more delicate spongy skeletal parts; and (4) fragmentation and bone surface preservation, which may have contributed to the low frequency of anthropogenic modifications on the reindeer and horse material. It is a challenge to obtain reliable information from old faunal assemblages such as this one, although the hindrances in the Vogelherd fauna were addressed through the application of a problem-oriented and attribute-based approach to the assemblage.

As discussed above, a variety of agents other than human behavior influenced the Vogelherd faunal assemblage that we have today. Despite these factors, it is nonetheless clear from the zooarchaeological study of the extant assemblage that a surprising level of consistency is reflected in the general treatment of carcasses displayed by the Aurignacian faunal remains, most especially among the primary prey taxa—reindeer and horse—exploited by human groups. Various lines of evidence indicate that Aurignacian groups procured these taxa regularly during late summer and fall; in the case of reindeer, timing of hunts correlates with their migration. In addition, people invested considerable time and labor to intensively exploit reindeer and horse for fat in addition to meat protein in a consistent fashion over many millennia at this site. Subsistence-related behaviors include: (1) thorough processing of selected carcass portions and (2) emphasizing the extraction of various macronutritional products beyond that predicted by standard energetic values, including lipids from animal fat.

Many of the animal-processing activities were likely conducted around hearths, although clear associations of bone with fire are scarce. Burnt bone was only minimally collected during excavation, although the documentation of multiple hearths by the excavator in 1931 suggests that these features did play an essential role in site use and subsistence activities.

The consistent patterning detected in faunal exploitation at Vogelherd is likely due in part to the seasonal nature of these occupations. Such resolution would not be expected in long-term, year-round occupations; instead, we would see coarse-grained resolution among the faunal remains or other archaeological material, and less redundancy in the way a certain activity, such as prey utilization, was conducted (Binford, 1980). This strongly seasonal signature in turn suggests that the timing of occupations at Vogelherd were based on the seasonal availability of prey.

Based on ethological information on reindeer and horse, it is reasonable to assume that these animals were locally abundant during certain seasons. Their movements would have covered areas between the steppe plateau to the north of the valley and the flatlands to the south, close to the Danube.

Based on reindeer migratory behavior, we might predict that their migrations followed ridgelines in the hills to the north of Vogelherd and along rivers. Family groups of horses, which are indicated in the Vogelherd assemblage, normally remain in small home ranges with limited movements between feeding areas and water sources. The vantage point from Vogelherd likely facilitated locating the seasonally predictable and aggregated reindeer and horse herds. Evidence for site occupation at other times of the year is lacking and, in fact, one deciduous tooth of a large bovid also indicates a late summer–fall season of death. Other factors presumably influenced the seasonally specific occupations of Vogelherd, though the faunal data show that local predictability of prey was a prominent one.

Additional support arguing for limited seasonal occupations during the Aurignacian involves the artifact data sets, though this assumes that the fauna and artifacts were spatially and temporally associated. In a palimpsest deposit such as this, such clear association cannot be proved. However, the nature of many of the artifact assemblages and their inferred relevance to hunting and processing of animal products suggest that a certain amount of spatial and temporal association between the fauna and artifacts is probable.

Finds likely relating to large mammal exploitation at Vogelherd include organic and lithic armatures and tool assemblages. Manufacture of bone, antler, and stone artefacts on-site is presumed, based on several factors. A number of bone and antler items exhibiting use-wear could conceivably represent unfinished projectile points, based on examples illustrated by Knecht (1993). Antler, the preferred raw material for making points (Knecht, 1997), was recovered in abundance in the Vogelherd Aurignacian. The lithic assemblage also reflects various stages of tool production, ranging from caches of cores to unused flakes. Taken together, these assemblages suggest “gearing up” activities (following Binford, 1979) involving the production of personal gear in anticipation of current and future needs. Based on the toolkits represented in the Aurignacian deposit, these needs included hunting (e.g., split-based bone and antler points), carcass butchery (e.g., blades, flakes, and scrapers), wood and bone working (e.g., notches, burins, drills, and flake tools), and probably hide working (e.g., scrapers).

In addition to the production of tools and hunting gear, maintenance of these items is also indicated. According to Albrecht et al. (1972), most of the organic weapons from the Vogelherd Aurignacian were damaged, suggesting to Gamble (1986: 284–285) that they were broken in use and later retooled here. Retooling would have involved replacing the broken hafted piece—the bone or antler point—with a usable one (Keeley, 1982). Since the manufacture of organic tools requires more time and effort than the manufacture of stone tools (Knecht, 1997), investment in maintaining the use-life and reliability of these items is expected in locations such as Vogelherd, where seasonally specific hunting activities took place (e.g., Pike-Tay, 1993; Pike-Tay and Knecht, 1993). Such personal gear is generally highly curated, because these items are used for specific functions and need to be in operational condition at all times (Binford, 1979). Gamble (1986)

also proposed a close functional relationship between gear maintenance and the origin of the tool stone involved, arguing that the majority of these tools should be made from local raw materials. This pattern is strongly expressed at Vogelherd, with high proportions of scrapers, burins, and flake tools made on local raw materials. Such evidence of on-site weaponry repair supports the inferred hunting-related behaviors conducted here.

Anticipated reuse of the cave is seen in several aspects of the artifact assemblages. The unworked ivory raw material and the bundle of unfinished ivory rods suggest caching of these items for future artifact manufacture. The presumed caches of unused flakes, scrapers, blades, and cores, as well as the supplies of mammoth bone for fuel and/or building, would have served as insurance gear, and they imply logistical planning for future visits. As argued above, these occupations were on a seasonal basis.

In addition to the factors involving seasonally abundant large game resources in the local area, the favorable placement of Vogelherd on the landscape undoubtedly played a large role in its repeated occupations. The shelter of caves in general was one of the primary factors behind their repeated use across Paleolithic Europe (e.g., Straus, 1990), though site-specific attributes such as a panoramic view from the cave itself and its visibility from afar, southern exposure, and proximity to water, game trails, and tool stone meant Vogelherd held an important place in the local settlement system. A correlation among factors such as site topography, season of occupation, and prey resources was discussed by White (1985) for Paleolithic sites in southwestern France, and a comparable situation is evinced at Vogelherd. In all likelihood, some or all of the Lone Valley caves were frequented by the same groups of people; radiocarbon dates from several of these caves suggest contemporaneity among them during the Aurignacian (Niven, 2006).

The Aurignacian in the Swabian Jura was marked by increasingly intensive human settlement, as seen in the extensive archaeological deposits in many sites. Growth in human presence appears to have prompted interaction and social networks along the Danube, and perhaps the development of such cultural innovations as symbolic artwork in the form of ivory figurines (Gamble, 1999; Conard and Bolus, 2003). In addition to the exceptional pieces recovered at Vogelherd, examples of figurative artwork dating to the Aurignacian have been found at Hohlenstein-Stadel and in the caves of Hohle Fels and Geissenklösterle in the nearby Ach Valley (Hahn, 1977, 1986; Conard, 2003).

One aspect of social interactions between local and regional Aurignacian groups may have involved seasonal aggregations at Vogelherd, based in part on the predictability of prey during certain times of the year. Such gatherings would have involved larger groups of people, with concomitant increases in food requirements. The intensive and patterned processing of prey carcasses for fat and meat protein, as inferred for the Vogelherd reindeer and horse assemblages, could relate to these dynamics.

Another probable sign of social interaction involves the presence of exotic raw materials in the Vogelherd lithic

assemblages, as well as those from the Aurignacian of neighboring Hohlenstein-Stadel and Bocksteintörl. Sourcing of these exotic materials (Hahn, 1987; Burkert and Floss, 2005) suggests that movements of people were oriented in an east–west trajectory, along the Danube and areas to the north into present-day Bavaria. Movements of Aurignacian groups might have, at times, been related to movements of game animals, for example the migratory reindeer. A relationship between the acquisition of nonlocal lithic raw materials, human mobility, and exploitation of migratory game was proposed by Blades (1999) as a significant feature of Aurignacian settlement dynamics in southwestern France, and the record from Vogelherd and its neighboring sites may reflect similar behaviors.

The diverse artifact assemblages from the Aurignacian at Vogelherd have long been appreciated by prehistorians for providing insight on the complex range of activities conducted by early modern humans at this site. New results from the zooarchaeological study of faunal remains from this cave allow us to see another dimension of site use and possibly the interplay between subsistence behavior, increasing human settlement of the area, and the increase of cultural innovations taking place during the Aurignacian.

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