

Stone Age hut in Israel yields world's oldest evidence of bedding

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Edited by Kent V. Flannery, University of Michigan, Ann Arbor, MI, and approved March 3, 2004 (received for review January 5, 2004)

The earliest archaeological remains of dwelling huts built by *Homo sapiens* were found in various European Upper Paleolithic open-air camps. Although floors of huts were found in a small number of cases, modern organization of the home space that includes defined resting areas and bedding remains was not discovered. We report here the earliest *in situ* bedding exposed on a brush hut floor. It has recently been found at the previously submerged, excellently preserved 23,000-year-old fisher–hunter–gatherers' camp of Ohalo II, situated in Israel on the shore of the Sea of Galilee. The grass bedding consists of bunches of partially charred *Puccinellia confer convoluta* stems and leaves, covered by a thin compact layer of clay. It is arranged in a repeated pattern, on the floor, around a central hearth. This study describes the bedding in its original context on a well preserved intentionally constructed floor. It also reconstructs on the basis of direct evidence (combined with ethnographic analogies) the Upper Paleolithic hut as a house with three major components: a hearth, specific working locales, and a comfortable sleeping area near the walls.

The houses of many contemporary hunter–gatherers have a hearth, as well as a clean and debris-free resting and sleeping area, covered for comfort by grasses, mats, carpets, etc. Within the house or immediately annexed to it, as part of the living area, are various task areas devoted to specific activities, especially those related to the preparation, consumption, or storage of food and those concerned with activities such as tool production or use (1, 2). This kind of divided living space represents a use of space that reflects attention to safety and health, as well as comfort, and may be what we think of as sophisticated living space standards similar to our own in certain respects but rarely visible in the prehistoric archaeological record.

Several components of human domestic behavior are well documented even in Middle Paleolithic cave sites (*ca.* 150,000–45,000 years ago), where simple hearths are preserved. Around the hearths, food remains such as bones and very rarely even seeds and fruits, as well as flint tools and their production waste, are sometimes concentrated in nonrandom patterns, reflecting activities carried out near the fire (3–5). However, the locations of areas devoted to resting and sleeping are not known, because bedding was not preserved. If there had been any floor coverings or bedding, they would have been made of perishables, and these substances do not readily lend themselves to preservation. Thus, a major component of the house, the sleeping/resting area, has never been clearly identified in a Middle Paleolithic site.

This paper presents the earliest archeological indication of a home space that includes bedding remains. Interestingly, it does not come from a cave site but rather from an open-air camp, Ohalo II (23,000-year-old site, Sea of Galilee, Israel). The *in situ* bedding remains were exposed on a brush hut floor, around a hearth, and with other facilities and residues. We begin by briefly addressing the issue of perishable materials in Paleolithic sites; we then present the Ohalo II Paleolithic camp and focus on the bedding and variety of finds from the brush hut intentionally constructed floors. Finally, a short comparison to European contemporaneous dwellings, Neolithic structures, and ethno-

graphic examples shows that the Ohalo II remains provide the earliest Paleolithic case of a brush hut with evidence of domestic behavior including a central hearth and defined locations for eating, working, and sleeping.

Paleolithic Perishables

The Ohalo II perishables are unique and are a major focus of this paper, given the large quantity and wide variety of relevant materials that were preserved in their original context. However, the use of plant materials by humans during the Upper Paleolithic was undoubtedly common and had begun long before. Thus, wood was preserved in rare cases as early as the Lower Paleolithic period, as evidenced by various wooden objects that include polished items from Geshur Benot Ya'aqov, a 780,000-year-old site in the Jordan Valley (6, 7), and the long carefully sharpened wooden spears from Shoningen, a 400,000-year-old site in Germany (8). It is probable that during these early times, most manufactured wooden items were used for hunting, digging up roots, and other practical purposes (9). Evidence of earlier woodworking and possibly even the preparation of wooden implements by bifacial stone tools was recently provided with the presentation of 1.7- to 1.5-million-year-old artifacts from Peninj, Tanzania (10). Even in much later Upper Paleolithic sites, well preserved wooden objects are still extremely rare, although several have been found at Ohalo II.

Soft plant fibers associated with human use have a lower survival and preservation rate and an even lower chance than wood of surviving the vagaries of time. Indeed, direct indications for the use of fibers begin to appear in the archaeological record, in extremely small numbers and usually in a very fragmentary state, only at \approx 26,000 years B.P. in Moravia (11). Inferences to clothing made of perishables that could have included plant fibers followed the study of European Upper Paleolithic female figurines, some of which appear to be clothed (12). Other remains have also been found, such as the charred fragments of a thick rope from Lascaux Cave, dated to *ca.* 17,000 B.P. (13). Larger quantities and a wider variety of remains of basketry, netting, and textiles are more commonly encountered only much later, in the early Holocene, as documented for sites in the Mediterranean Levant (14, 15) and in South and North America (16, 17).

The Ohalo II Site

The Ohalo II site is located on the southwestern shore of the Sea of Galilee, Israel, at 212–213 m below mean sea level (Fig. 1). It was submerged during most of its history and even most of the 20th century. Since 1989, during 7 unsuccessful years of severe drought and heavy pumping from the lake, the water level dropped far enough to expose the site and permit excavation.

This paper was submitted directly (Track II) to the PNAS office.

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four seasons and thus suggest that the camp was occupied year-round.

The best-preserved bedding in the site was found on the bottom floor of hut 1. However, in the same hut, a distinct microscopic layer of horizontal grass fragments was also found on the second floor (Fig. 7, which is published as supporting information on the PNAS web site). Furthermore, the floor in each of two other huts (huts 3 and 12; see Fig. 1) exhibited a continuous millimeter-thick black layer at the bottom. In both of these huts, the layer was situated above the bedrock clay, under the typical debris of everyday activities and always within the boundary of the hut. Also in both, it was preserved near the walls and not in the center. Thus, the inhabitants appear to have covered the floor with plant material in at least three huts. In hut 1, the bottom bedding was well preserved, whereas the grass cover on a later floor in the same hut was visible only in microscopic thin sections. In all three huts, the grass layers were preserved *in situ* but only as a compact black layer (except for the bottom floor of hut 1), with no identifiable details regarding the species or arrangement of the grasses. It is possible that in these cases, the grass layer was not protected in the same manner as the bedding from the bottom floor of hut 1, and therefore preservation is not as good.

Bedding and Perishables

To create their bedding, the Ohalo II people chose a grass species characterized by dense bunches of soft delicate stems, which was growing in nearby saline soil. At the same time in Upper Paleolithic European sites, plant fibers were being used for manufacturing various products, as evidenced by the small clay fragments with impressions of cordage, textile, and basketry found at Moravian sites (11) and the female figurines wearing clothing and headgear found at other European sites (12). The suggestion that some of the clay fragments with fiber impressions could represent “floor coverings or sitting/sleeping platform coverings” (37) is possible, although it is based on very small fragments, none of which were found *in situ* as part of a floor.

At Ohalo II, several cord fragments were discovered on the second floor of hut 1 (18). These attest to the presence of local fiber technology, possibly representing rope use, basketry, and netting. Tens of double-notched pebbles and the plethora of fish remains probably indicate the presence of fishing technology that included simple fishing nets composed of plant fibers and stone weights (38). However, although the preservation of delicate plant tissues is excellent at the site, no remains of woven mats were identified. It is therefore possible that the Ohalo II grass floor coverings represent the first stage of bedding, whereas fully woven mats evolved only millennia later.

Upper Paleolithic Dwellings

The Upper Paleolithic material remains demonstrate what could be termed a “revolution” in many aspects of technology, economy, social organization, and spiritual life (39). Within this sphere of innovations, the archaeological evidence includes open-air camps with dwelling remains. In the better-preserved sites, several dwellings are found together, similar to each other in dimensions and shape. The structures are commonly round or oval, built of local materials such as stones (for wall foundations), large bones, or wood and thatch. Hides were probably used as well, although no remains have been preserved.

In Eastern Europe, especially in the Russian Plain, round dwellings constructed of heavy mammoth bones were common in many sites (40). These had an inner diameter of 2–5 m, with storage pits placed outside. The Ohalo II huts are similar in size and shape to many of these northern huts. Small shallow hearths were found outside and even inside some of the European dwellings. Food preparation and flint knapping took place inside, too, at least in some cases. In a minority of sites,

excavations exposed very large shallow pits with an inner line of small hearths, and an area exceeding 100 m² (41). If these were indeed dwellings, they were probably occupied by much larger-sized groups than that of a nuclear family.

In Western Europe (France, for example), paved and stone-lined rectangular or subrectangular areas were interpreted as floors or hut foundations (42). The floor areas were usually 6–15 m². Of particular interest is the site of Pincevent, where the location and size of small round dwellings were reconstructed according to the distribution patterns of flints and bones and not by the remains of defined walls or floors (43). In sum, dwellings with an indoor or annexed hearth, and sometimes with identifiable indoor working areas, have been preserved in several European sites. However, a dwelling with all three components, a hearth, a defined working area, and a preserved sleeping area with bedding, was found only at Ohalo II.

In the Mediterranean Levant, dwelling remains that are contemporaneous with or even thousands of years later than the Ohalo II finds are very rare and ambiguous in nature, because no full contours of walls or floors are clearly preserved. Indeed, the earliest stone foundations of walls appear in several Natufian open-air camps and cave sites (44, 45). The remains of Natufian structures are typically oval or circular and contain debris of domestic activities; built indoor hearths have also been found in many cases. Although tens of Natufian structures have been excavated, no grass floor coverings or mats have been found.

Discussion

Evidence of floor covering in the house is extremely scarce in sites of the Upper Paleolithic period. In the Mediterranean Levant, the remains of matting, weaving, and textile production have been discovered at several Neolithic sites, with the earliest specimens dating almost 10,000 years later than the remains at Ohalo II. For example, impressions of large round mats were preserved on floors and courtyards in Pre-Pottery Neolithic Jericho (14), where the long stems and wide leaves of reeds were commonly used. The fabrics, baskets, and mats from the somewhat later Nahal Hemar desert cave (*ca.* 9,000 years B.P.) constitute by far the largest, best-preserved, and most varied assemblage of any Levantine Neolithic site (15).

In the Americas, the oldest remains of fiber-based technology include cordage, basketry, textile, and netting; they are found across the continents, from Monte Verde in Chile (dated to the 11–10th millennia B.C., ref. 16) to many sites in North America. The oldest remains of mats from North America were recently reported from Nevada, dated to 10,500 calendar years B.P. (17).

The practice of covering floors with mats, rugs, and carpets has parallels in many recent and contemporary hunter-gatherer and non-Western societies throughout the world. Also common is the choice of fresh local grasses, whose proximity demands a minimum of effort, for producing floor coverings and bedding that provide comfort and insulation from harsh temperatures, as well as a pleasant fragrance (46, 47). In fact, grass floor coverings even appear in cases where mats, carpets, or blankets are used (48). The 19th and 20th centuries still witnessed the practice of placing a simple bedding material, such as a grass floor covering, all along the walls of a room (48–50) and arranging bunches of stems with leaves in straight parallel sets (51).

The discovery at Ohalo II of a complex bedding, composed of thick grass bunches arranged in a tile-like manner and attached to each other by a compact layer of clay substance, is the earliest *in situ* example of the common modern practice of making the sleeping area comfortable. This was achieved by creating a soft layer on the floor, but only near the walls and not in the center. The Ohalo II remains reveal new aspects of life during the Upper Paleolithic period, indicating that technologies and routine activities did not focus exclusively on activities directly related to survival. The new finds are not surprising, because several

aspects of the Ohalo II camp are similar to those recorded in ethnography (1, 2). They do confirm that by that time, comfort in the home was also an important consideration, as it is for us today. People invested in their sleeping area by bringing bundles of one chosen grass species and constructing sophisticated bedding with the use of an adhesive substance. Other parts of the covered floor were used for tool preparation and food processing around the hearth, near the hut entrance, or next to a large flat stone. This conception and organization of the domestic space are similar to the modern home.

No grass bedding remains were found in contemporaneous European sites, probably due to poor preservation conditions, lack of suitable species, or a preference for skins and furs in the colder zones. True woven mats, which can be viewed as a further development of the first bedding reported here, are not found before the Middle Eastern Neolithic period. The mats were made in a tight warp and woof pattern and were much stronger than the Ohalo II grass bedding. The Neolithic mats were

portable, thus facilitating transportation from the place of manufacture to the house and increasing cleanliness by allowing the dirt to be shaken off outside. The Ohalo II bedding and associated finds, preserved *in situ* on the same floor, add to our understanding of the organization of the indoor house space and the origin of a variety of modern domestic behaviors.

We thank Ofer Bar-Yosef, Anna Belfer-Cohen, and Paul Goldberg for improving an early version of the manuscript, and Yossi Zaidner for contribution during field and laboratory work. The drawings in Figs. 1 and 2 were made by Sapir Ad (Zinman Institute of Archaeology) and Bella Burdman (Zinman Institute of Archaeology), and Fig. 4 represents a photograph by Yaaqov Langzam (Bar Ilan University). E.W. is the MacCurdy Postdoctoral Fellow of the Department of Anthropology, Harvard University. The Ohalo II project was generously supported by the Irene Levi Sala Care Archaeological Foundation, the Israel Academy of Science (Grant 831/0), the Jerusalem Center for Anthropological Studies, the L. S. B. Leakey Foundation, the M. Stekelis Museum of Prehistory in Haifa, the MAFCFA Foundation, the National Geographic Society, and the Israel Antiquities Authority.

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