Reports

19,000-Year-Old Twisted Fibers from Ohalo II[1]

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The preservation of plant tissues in Palaeolithic sites is very rare. When one is fortunate enough to find such remains, they tend to be in hearths as small charred fragments of combustible material embedded in powdery ash. It is extremely rare to find direct evidence in Palaeolithic contexts for the vegetal components of human diets, carbonized seeds or fruits. It is even more unusual to find utensils made of plant material, and the worked wood from the Lower Palaeolithic site of Gesher Benot Ya'akov (Israel) is really one of a kind (Belitsky, Goren-Inbar, and Werker 1991). Tools and artefacts made of plant material from Palaeolithic sites are found almost exclusively in waterlogged sediments (see examples in Coles 1992). The aim of this paper is to describe three fragments of twisted fibers interpreted as cord remains found in such sediments at Ohalo II (19,300 B.P.).

Ohalo II was exposed in 1989 following a dramatic drop in the water level of the Sea of Galilee (fig. 1). During the last century, and probably for millennia before, the site was covered with sands 2–4 m underwater. Excavated between 1989 and 1991, it is now once again submerged (Nadel 1990, 1991, 1993).

The site seemed to cover an area of about 1,500 m^2. The central part was thoroughly studied, and 325 m^2 were completely exposed (fig. 2). The largest feature was a kidney-shaped structure 4.5 m wide (locus 1). The remains of its walls were still visible: stems, straw, and charcoal fragments created a clear dark line around a floor (fig. 3). Three successive floors of this hut, all with intact remains such as flint tools and food waste (Nadel n.d.*a*), were located. A similar but somewhat smaller structure (locus 2), also kidney-shaped, and a third structure (locus 3), this one pear-shaped, were also uncovered. The structures were surrounded by a series of hearths (loci 6, 7, 9, 11), each one distinct in color of ash and type of cultural debris. An area interpreted as a waste dump was identified along the eastern edge of the camp (locus 10). The only stone installation was a small round arrangement of one layer of unworked stones (locus 4). One grave was found, to the west of these loci (locus 5). The skeleton of a male was unearthed from a shallow pit. He was buried on his back, hands folded on the chest and knees folded backward. An incised worked bone tool had been placed beneath his head (Nadel and Hershkovitz 1991, Nadel n.d.*b*). According to pathological studies the 35-year-old man was disabled (Hershkovitz et al. 1993).

The structures and hearths contained a wealth of finds. Using wet-sieving methods (1.2-mm mesh during the third season), flotation of large quantities of charcoal (dozens of liters of clean material), and recovery of unsieved sediment samples, we managed to include extremely small finds in the material studied. Common finds included flint tools (mostly microliths) and waste, thousands of animal bones, of which fish bones were the most common, dozens of worked bone tools (Rabinovitch and Nadel n.d.), and ca. 130 *Dentalium* beads.

The site is unique for its excellent preservation of botanical remains. Thousands of carbonized seeds and fruits of more than 30 species, including hundreds of grains of wild barley and wild wheat, have been identified so far (Kislev, Nadel, and Carmi 1992). The charcoal remains include, in addition, large fragments of acorns, broken stems, and many pieces of burnt wood, some over 5 cm long. The presence of large quantities of charcoal enabled us to send 26 samples to three laboratories. The resulting dates are concentrated between ca. 18,000 and 21,000 B.P. and average 19,300 B.P. In addition, no remains of any other prehistoric culture were found at the site. Thus it could confidently be stated that this is a unicultural site belonging to the end of the local Upper Palaeolithic or the early Epipalaeolithic.

Three fragments of charred twisted fibers ca. 2–3 mm long were found during the sorting of the charcoal material. They originate from square F82a (height 212.10–212.15). This level is the second of three successive floors in locus 1. The three floors were found *in situ*, with a wealth of remains on them including a stone anvil and articulated animal bones (Nadel n.d.*a*). The

1. 0011-3204/94/3503-0005$1.00. We thank Ofer Bar-Yosef, Anna Belfer-Cohen, Israel Hershkovitz, David Gordon, and Irit Zohar for their help during various stages of the project. The Ohalo II project was supported by grants from the Irene-Levi Sala CARE Archaeological Foundation, the Jerusalem Center for Anthropological Studies, and the L. S. B. Leakey Foundation. Fieldwork was carried out on behalf of the Stekelis Museum of Prehistory in Haifa and the Israel Antiquities Authority (1989, L. 1634; 1990, L. 1724; 1991, L. 93/91).

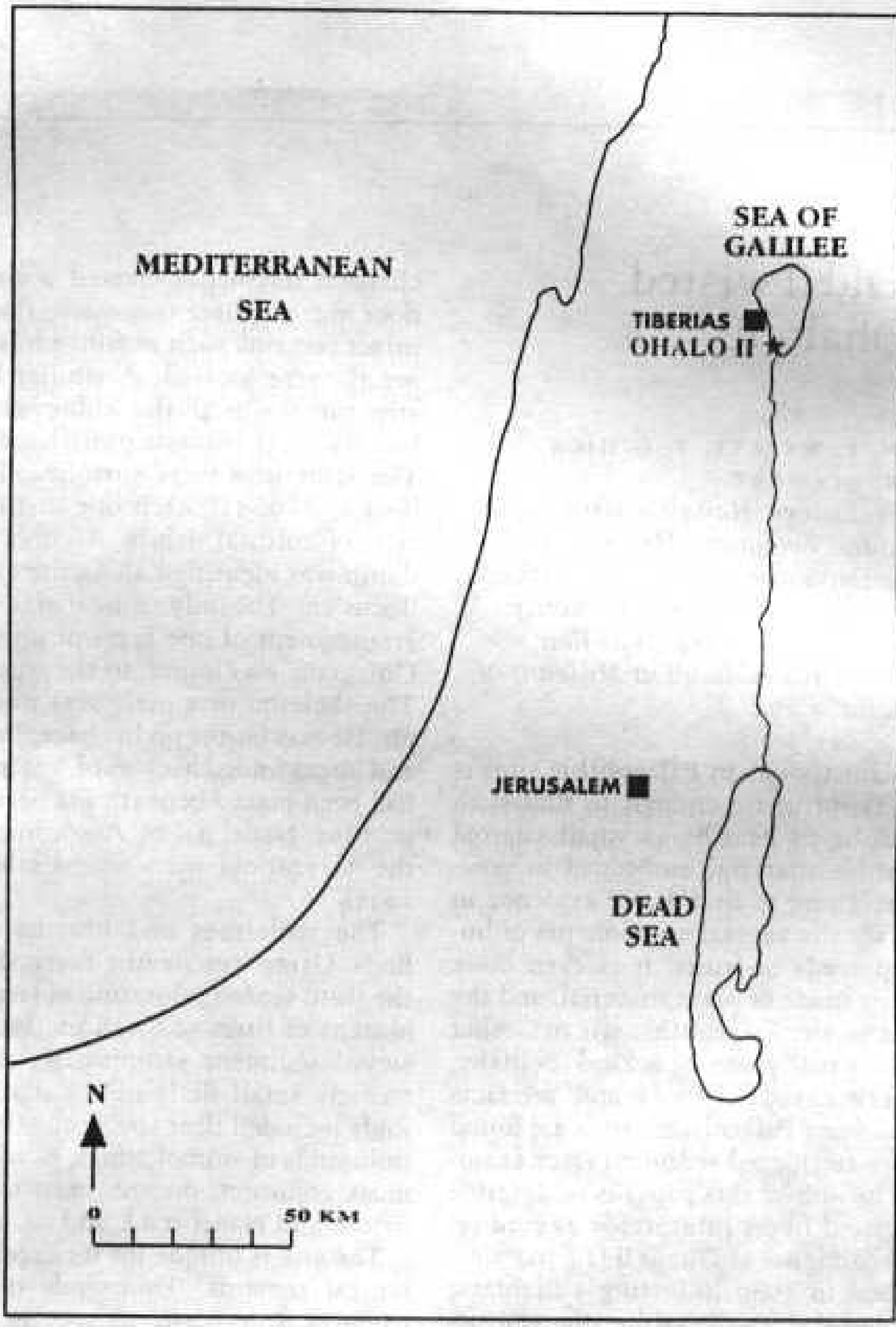

FIG. 1. *Location of Ohalo II.*

hut itself was burnt to the ground in antiquity, and large quantities of charcoal fragments were visible on the floor. These include the remains of the walls (pieces of burnt wood, some of them 3–5 cm long, stems, and fine straw) as well as the burnt contents of the hut, such as tools and food.

One of the charred fiber fragments was examined with a Jeol M35 scanning electron miscroscope after having been sputtered with a thin layer of gold. Following Fahn (1990:4), we use the term "fibers" in its broad commercial rather than its strict botanical sense, that is, to include whole or longitudinally divided stems and other plant parts down to single vascular bundles with their surrounding sheaths of fiber cells. The fibers lie on a slant like the center part of the letter Z (figs. 4, 5), the angle of the twist varying from ca. 20 to 80°. Such irregularity in a single-strand cord would make it not very strong, but it could be that the three specimens are fragmentary not only lengthwise but also in their thickness. Most cords are either doubled back on themselves or else plied from two or more twisted strands, the twisting and doubling making them both strong and flexible (fig. 6).

Identification of the material was difficult because of the fragments' small size and state of preservation. We were able to determine only that it includes scattered vascular bundles (fig. 7) and is therefore probably derived from the stem or leaf of a monocotyledonous plant. In order to interpret this result correctly we looked for plants with twisted tissues in Israel, the reasoning being

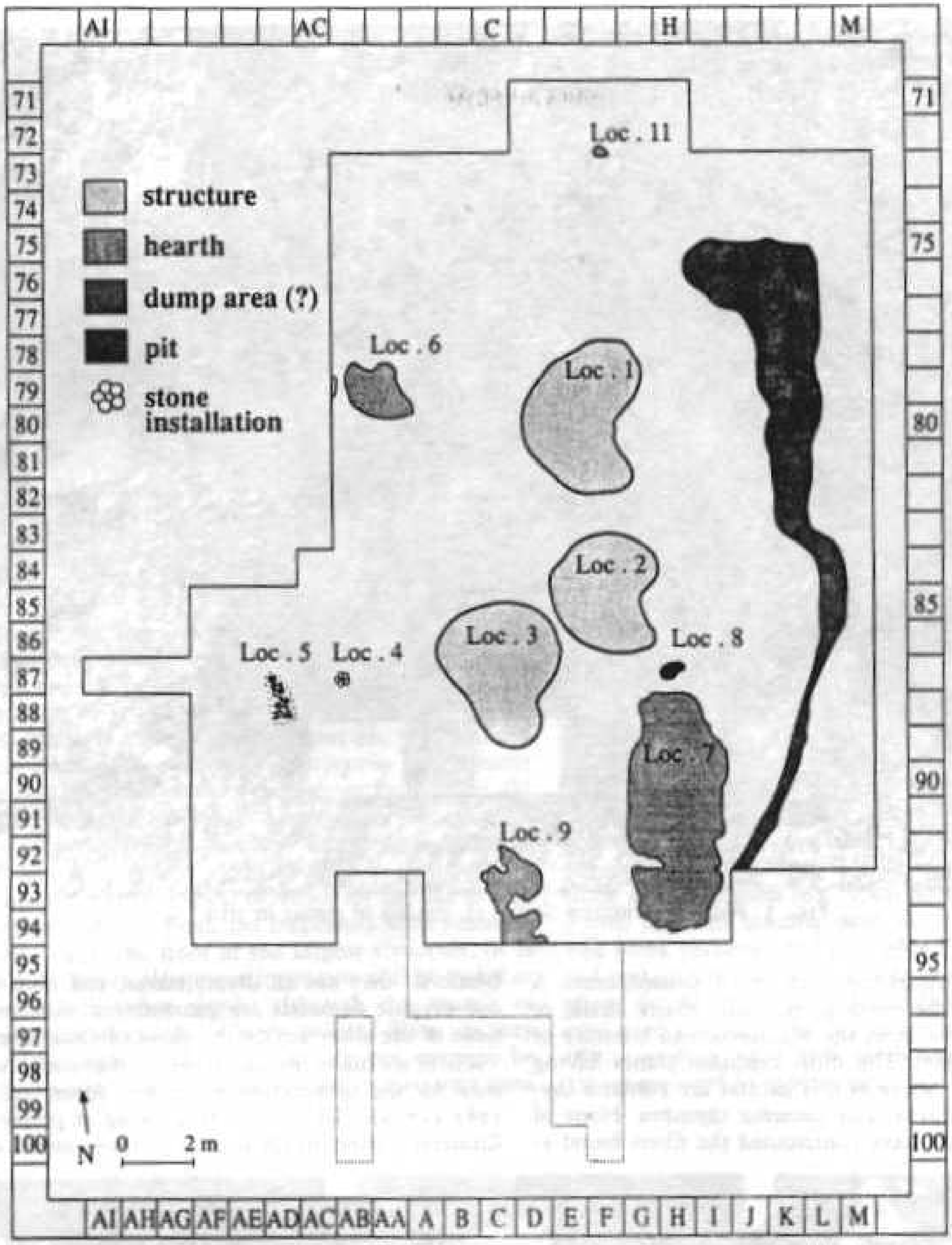

FIG. 2. *Plan of main area of excavation at Ohalo II.* 1, 2, 3, *structures;* 4, *stone installation;* 5, *grave;* 6, 7, 9, 11, *hearths;* 8, *pit;* 10, *trash dump.*

...at if the Ohalo II twisted plant parts are not the result ... natural growth, they are most probably the remains ... a manmade cord. From unpublished information gath... ed in Israel and Sinai (A. Danin) it seems that naturally ...wisted stems and roots are found in harsh habitats and ...ry rarely in monocotyledons. Twisted stems and roots ...uch thicker than those described here are found in ...sert semishrubs of the Chenopodiaceae such as *Salsola tetrandra* and *S. cyclophylla.* Plants of sandy habitats, mainly in desert areas, also have twisted stems and roots. Among these are *Convolvulus lanatus* (Danin 1983: fig. 34) and *Artemisia monosperma.* All these plants occur in areas with less than 100 mm mean annual rainfall. Another habitat supporting plants with twisted stems or roots is the spray zone of the Mediterranean coast. The most common plants here are the semi-

FIG. 6. *Twisting and doubling of plant fibers to make a strong, flexible cord (reprinted from Danin 1983 by permission of the publisher).*

II could have come from three species of *Typha*, three species of *Juncus*, five species of *Cyperus*, three species of *Scirpus*, *Sparganium erectum*, and *Phoenix dactylifera*.

Although the three twisted-fiber fragments are very small and unidentifiable on the genus level and do not permit a reconstruction of a complete cord/rope or any object made of it (e.g., a net or bag), we believe they are important. Naturally twisted plant fibers of the kind found at Ohalo II are not known to occur in the Kinneret region, and the species that grew there in the past did not have such naturally twisted tissues. (The range of species 19,000 years ago was very similar to the current one [Kislev, Nadel, and Carmi 1992].) In addition, we have indirect archaeological evidence for the use of bags and nets at the site. First, the fragments were found in one place only, the floor of the largest structure. (It is possible, however, that more fragments will be found in the future.) In other words, although the sample of charred material studied is large, twisted fibers are very rare. Accordingly, these fragments do not seem to be part of the common repertoire of plant materials used at the site. Furthermore, on the same floor we identified four piles of fish bones (fig. 8). It should be stressed that the fish piles include all skeletal elements, though here only the vertebrae are presented. A preliminary study of a sample of 55 bones from one pile (square F79d [2.07–2.12]) has been conducted. Most bones belong to the Cyprinidae, and one is identified as *Barbus*. When the distribution pattern of fish vertebrae is plotted on a 0.5 × 0.5-m grid, these piles are clearly distinct: there are more than 1,000 vertebrae in a pile while on the rest of the floor the concentration is only several tens per unit (Nadel n.d.*a*). As the piles of bones are not associated with pits and it seems unlikely that the bones were just piled on the floor, it is reasonable to assume that the fish were kept together, either tied with a cord or placed (dried, smoked, or unprocessed) in a fiber container of some kind. The vertebrae in these piles have diameters of ca. 1–3 mm, indicating the presence of small fish only. If they were in fiber "bags," these would have had to be fine-meshed. Our second line of reasoning is also associated with fish. The many thousands of bones include bones of hundreds of very small fish (many of the complete specimens no longer than ca. 10–20 cm). These, it would seem, would not have been caught one by one with harpoons or similar fishing tools; rather, the use of fine nets or some kind of fiber trap seems plausible.

Remains of cordage from the Palaeolithic period are extremely scarce. Nevertheless, there are several indirect indications of the use of cordage in various ways during the Upper Palaeolithic, Epipalaeolithic, and Mesolithic. For example, it is assumed that many of the stone and bone tools (e.g., spearheads, arrowheads, harpoons) required binding onto shafts (Clark 1952:226). The bows perhaps used by Upper Palaeolithic hunters and certainly used by later ones required some sort of strong flexible material to propel the arrow. In addition, eyed needles (Clark and Piggott 1965:74, 99) and perforated ornaments made from teeth and shells (Vogt 1937: 37) are reported from sites in Europe. Upper Palaeolithic

FIG. 7. *Scanning electron micrographs presenting details of specimen 3. Cross sections of the specimen show two vascular strands (left, × 2,200; center, × 3,000) and a cluster of fiber cells (right, × 2,400).*

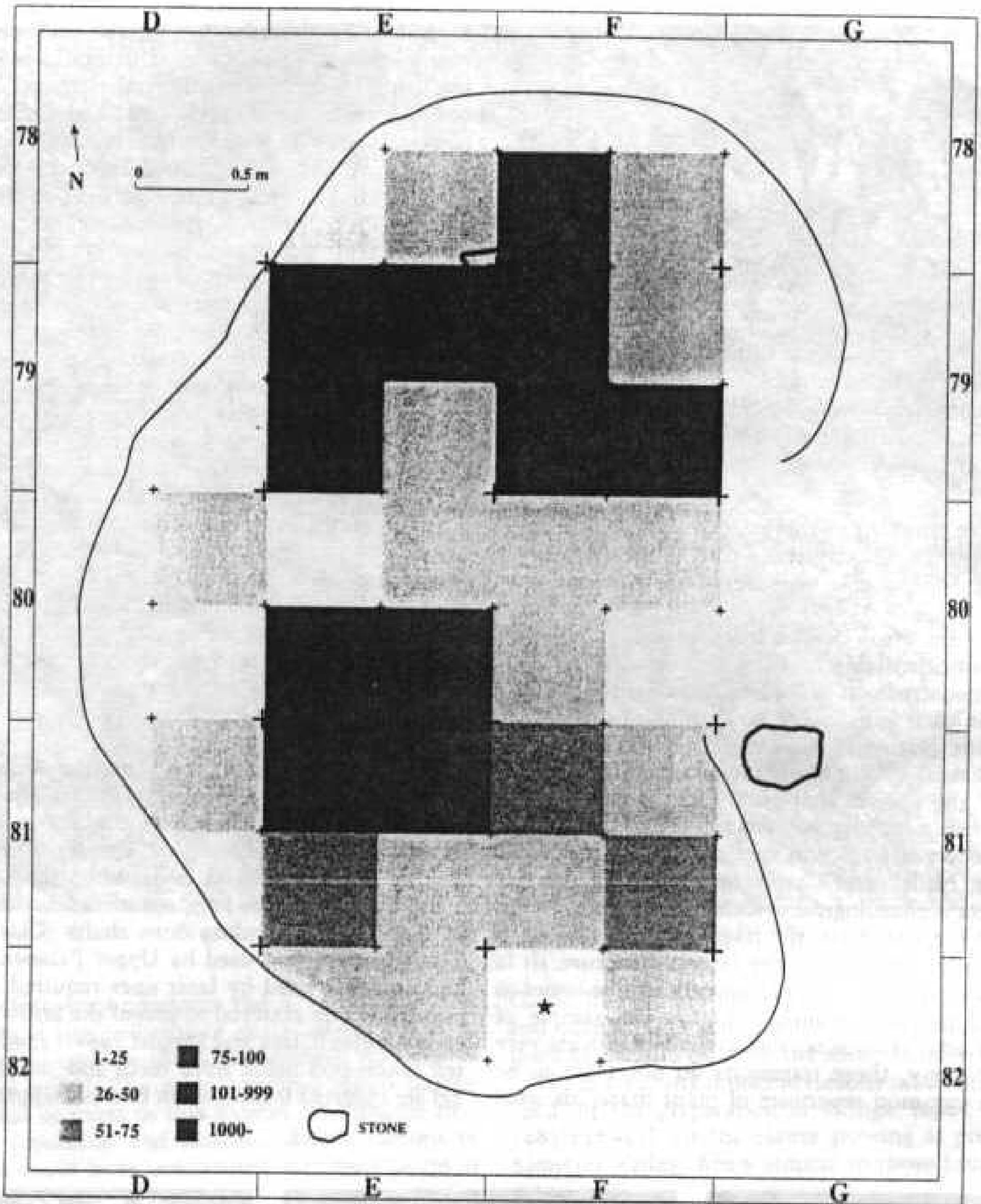

FIG 8. *Distribution of fish vertebrae on floor of locus 1.* Star, *where fragments of twisted fibers were found.*

layer D from Hayonim Cave contained perforated horse and deer teeth (Belfer-Cohen and Bar-Yosef 1981: fig. 6, *10, 11*). Small *Dentalium* beads are common in several Upper Palaeolithic sites (Bar-Yosef 1989; Nadel 1933: fig. 10). It seems reasonable to suggest that at least some of these perforated items were attached to strings of some kind. Perforated art objects are relatively common in Natufian sites (e.g., Belfer-Cohen 1991: figs. 2, 8). Weights for fishing nets have been reported from the Natufian site of Mallaha; these stone weights (ca. 5 cm long) have a wide notch on each side, probably for securing them to the net with a string (Perrot 1966: fig. 20, *1–4*). Thus, the accumulating data available so far do suggest the use of cordage in Upper Palaeolithic and succeeding cultures in the Levant and in Europe. However, we do not know what materials were used in making the cordage. They could have been made of animals' guts, tendons, sinew, etc., as well as from plant fibers.

The earliest direct evidence for the use of plant fibers (probably bast) to make cordage comes from Lascaux Cave (France) ca. 17,000 B.P. Here five fragments of charred cords and their imprints on clay have been discovered (Leroi-Gourhan and Allain 1979, Leroi-Gourhan 1982). The reconstructed rope, 30 cm in length, is twisted and plied to a thickness of 7–8 mm (Glory 1959:137–46, figs. 1–6). It has been suggested that the rope was used to facilitate entrance to the cave. Plant material remains used for producing cordage, nets, bags, and the like become more common in the archaeological record only much later. A relative abundance of them is found in waterlogged sites in Europe and America as early as the 10th–8th millennia B.P. Some of the more outstanding examples come from Noyen in France, where fish traps and baskets were found in layers dated to 8,000 B.P. (Mordant and Mordant 1992:61 and figs. 7.11, 7.13), and Friesack 4 in Germany, where net fragments of various kinds are dated to 9,300 B.P., the oldest in Europe (Gramsch 1992:69 and figs. 8.7, 8.8).

By the Neolithic period, cordage basketry and nets are found in several dry sites in the Near East: Çatal Huyuk (Mellart 1967:116–18, 218–20, pls. 94, 95), Jarmo (Adovasio 1975–77), Jericho (Crowfoot 1982:548–50), Nahal Hemar Cave (Schick 1988), Netiv Hagdud (Schick 1988: 40), and Gilgal, as well as in numerous wet sites in Europe (e.g., Vogt 1947:1947–48; Bender 1986:204–5; Rimantiene 1992:367). These examples attest to the wide use and long tradition already established by the beginning of the Holocene.

We believe that the remains presented here are fragments of cordage probably used as bags or nets. If the piles of fish bones represent stored fish in bags, then they are the oldest evidence for above-ground storage (Soffer 1989), and the advent of storage, even on a small scale, is generally considered an important step in the development of complex economic systems (Testart 1982). It should be noted that fish were not an important component of Palaeolithic diets in the Levant, and in most cases their bones are rare or absent. The large quantities of the fish at Ohalo II are thus an exception to the general local trend. However, the absence of fishing tools from the Ohalo II stone and bone tool assemblages is noteworthy. The use of nets seems to be in accord with everything we know about the site so far.

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