ANTHROPOLOGIE • XXXVI/1 – 2 • pp. 43 – 68 • 1998

OLGA SOFFER, JAMES M. ADOVASIO, DAVID C. HYLAND, BOHUSLAV KLÍMA, JIŘÍ SVOBODA

PERISHABLE TECHNOLOGIES AND THE GENESIS OF THE EASTERN GRAVETTIAN

ABSTRACT: Past research on Paleolithic technologies has focused on the manufacturing and use of stone and, to a lesser extent, bone, antler, and ivory artifacts and the implications of these inventories for hunting strategies, subsistence practices, and settlement systems. Coeval technologies in less-durable media, sporadically reported from Paleolithic sites, have received much less attention and their implications for past lifeways have been left unexplored. This paper reports on numerous fiber, cordage, and textile impressions on fired clay fragments recovered from the Gravettian site of Pavlov I in the Czech Republic. This, together with coeval data from the nearby sites of Dolní Věstonice I and II, attests to the use of plant-derived fiber for the production of a broad range of perishable implements including cordage, possibly netting, and non-heddle-loom-woven twining some 15,000 years before such items are documented in the European Mesolithic or Neolithic.

The extensive use of this perishable technology carries a number of important implications and ramifications concerning past human lifeways for this portion of Europe. Specifically, as suggested by ethnographic data indicating that the fibers most likely employed in perishable production were harvested and processed in the fall, the existence of this industry suggests the Moravian sites were also occupied during that season. Moreover, since ethnographic data also indicate that the procurement, processing, and use of plant fibers is strongly associated with females, we argue that women were present and processing these items in Upper Paleolithic Moravian sites, thus supporting their identification as base camps.

The existence of a fiber-based weaving technology at these sites, in what has heretofore been considered a big game hunting cultural milieu, indicates that our basic reconstructions and characterizations of this lifeway are in error. Instead of being dependent on hide and animal products processed largely as a consequence of stone and bone industries, at least some Upper Paleolithic groups led a far different life style in which fiber-based technologies played a major role, not only in storage and transportation needs, but also in basic food procurement. The group(s) who produced the Pavlov textiles also produced cordage and cordage byproducts like hunting nets and snares. This way of hunting is far different from directly confronting an animal with stone-tipped spears; first, it is communal, and second, it is far less stressful and dangerous. Both of these distinctions carry implications about selection pressures for morphology as well as for social organization.

Our findings suggest that the Gravettian adaptations – elaboration of processing rather than kill weaponry, large seasonal aggregations, and harvesting of numerous fur bearers – taken together, point to the central role played by hunting utilizing perishable technologies. Thus, we suggest that the genesis of Gravettian material culture inventories may not lie in the influx of new populations but in a change in hunting technology and the concomitant change in the organization of the hunt.

KEY WORDS: Gravettian – Pavlovian – Perishable technologies – Mass harvesting – Female labour

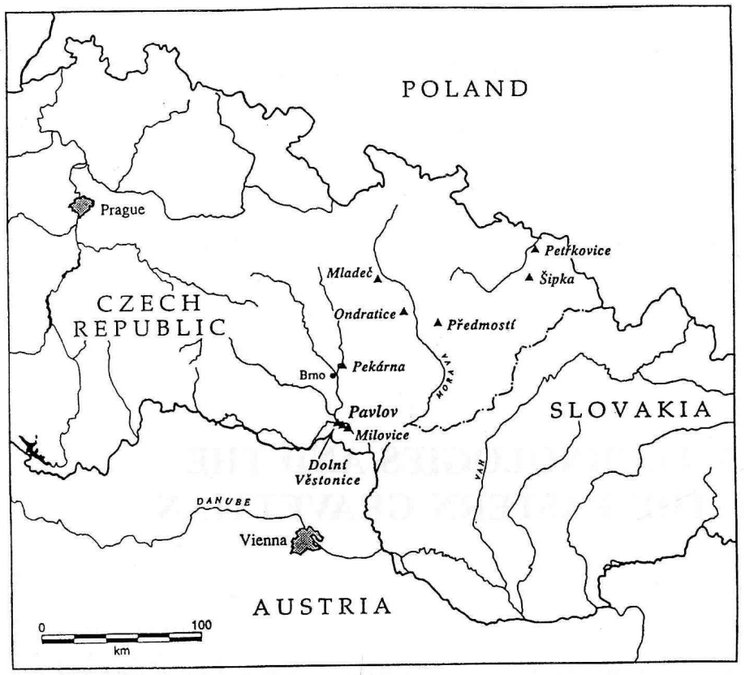


FIGURE 1. Map of the Czech Republic and adjacent countries showing the location of the sites discussed in the text.

INTRODUCTION

The Upper Paleolithic sites of Předmostí, Dolní Věstonice I and II, and Pavlov I and II, Moravia, Czech Republic, are all ascribable to the Pavlov culture, a local variant of the Eastern Gravettian technocomplex (*Figure 1*). These sites are well known for producing the earliest evidence of a number of technological innovations including ground stone technology (in the form of pendants and enigmatic large rings) and ceramic technology (in the form of animal and female figurines) in both Europe and the world at large (Svoboda *et al.* 1996, Vandiver *et al.* 1990). Recent research suggests that these sites and the culture they represent produced yet another innovation, the use of plant fibers in the manufacture of textiles, basketry, cordage, and perhaps netting. The evidence of this innovation is in the form of negative impressions of fiber-based constructions on small fragments of fired and unfired, or very low-fired, clay, the largest of which (No.12–1957) weighs a scant 9 g and measures only 34.9 × 22.1 mm and is but 13.6 mm thick.

PERISHABLE TECHNOLOGY

The impressions from Pavlov I and Dolní Věstonice II indirectly represent two distinctly different sets of structures: basketry and/or textiles on one hand and cordage and cordage byproducts on the other. Technically, basketry is usually treated as a subclass of textiles, defined as a larger all-encompassing class of woven materials. However, in terms of process and product both textiles and basketry can be regarded as belonging to or representing two distinct, albeit closely interrelated, industries and thus these two categories can be defined at an equivalent classificatory level. Specifically, basketry consists of those items, including containers, bags, and matting, which, as recognized by many researchers (e.g. Balfét 1952, Drooker 1992, Mason 1904), are usually not fully pliable and, as Driver (1961: 159) points out, are manually woven without the support of any frame or loom. Textiles represent generally infinitely flexible materials, such as cloth and fabric, produced with the aid of a frame or loom. The difference between basketry and textiles then is customarily determined by the degree of flexibility of the specimen, the form of the item, and whether the item was made with some variety of hanging or horizontal frame. Since these three features – and thus the distinction between basketry and textiles – can usually only be determined by examination of actual specimens and generally are not well represented, if at all, by impressions of fragmentary specimens, no final determination as to whether the Gravettian impressions represent flexible loom-woven materials or inflexible non-loom-woven constructions can be definitively made. Regardless of whether a supportive frame was used, however, the manufacturing process can often be distinguished from impressions. Of the three major and generally mutually exclusive manufacturing processes (i.e. twining, coiling, and plaiting [Adovasio 1970, 1977]) one technique, twining, is represented in the Gravettian collection.

FIGURE 2. Plan view map of the excavations at the site of Pavlov I.

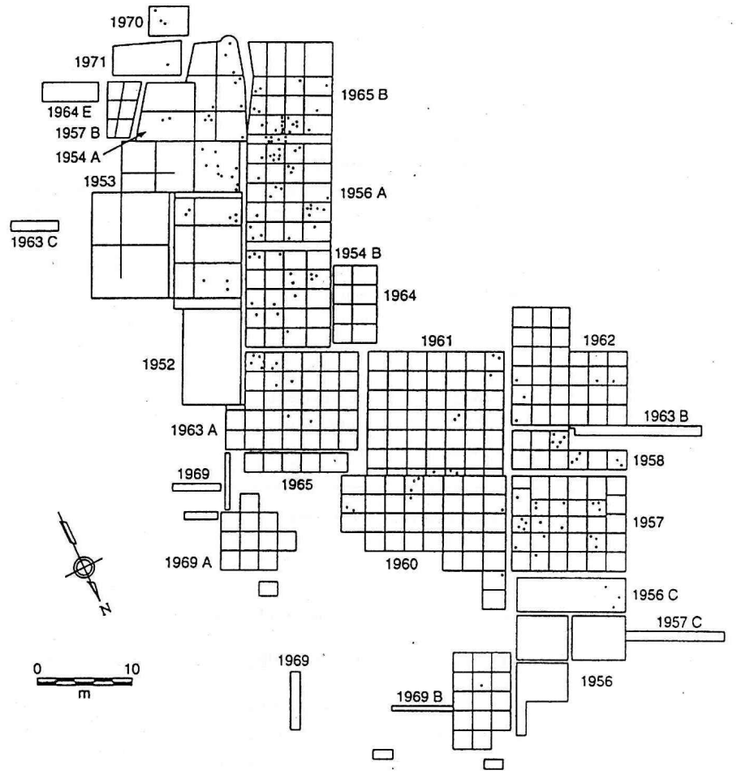


TABLE 1. Radiocarbon dates (on wood charcoal) from Pavlov I, Czech Republic.

Lab Number	Year Excavated, Site Provenience	Radiocarbon Date
GrA-192	1953 excavation, area b	25,530 ± 110 BP
GrN-19539	1953 excavation, area b	26,650 ± 230 BP
GrN-1272	1956 excavation, area b	26,620 ± 230 BP
GrN-1325	1956 excavation, area b	25,020 ± 150 BP
GrN-4812	1956 excavation, area b	26,730 ± 250 BP
GrN-20391	1957 excavation, area a	26,170 ± 450 BP

Source: Svoboda *et al.* (1996: Table 6.2.).

Impressions of cordage are also present at both Pavlov I and Dolní Věstonice II. Cordage is a perishable structure consisting of one set of elongate fibrous elements twisted or spun together to form a uniform, cylindrical, and generally flexible strand of potentially unlimited length (cf. Emery 1966: 8–14, Scholtz 1975: 9, Wendrich 1991: 3). The range or set of structures produced by twisting and/or spinning lengths of fibrous material includes and subsumes items denoted in English usage by the following set of terms: thread, yarn, ply, cord, string, cable, and rope.

In addition to the indirect evidence of unmodified cordage, close scrutiny of the Pavlov I impressed clay assemblage has revealed several impressions of knotted cordage. Depending on its precise configuration (i.e. mesh diameter, knot type, method of construction), knotted cordage often represents fragments of netting, either derived from various kinds of capture nets or from more complex netting forms, such as string bags and sundry types of restraining devices. Following Emery (1966: 30), netting is defined as a cordage byproduct "built up by the repeated interworking of a single continuous element with itself." The usual method employed for the production of

TABLE 2. Gröningen radiocarbon dates from Dolní Věstonice II, Czech Republic.

Lab Number	Site Provenience	Radiocarbon Date
GrN-2092	brickyard	28,300 ± 300 BP
GrN-2598	brickyard	29,000 ± 200 BP
GrN-13962	units A-C	27,660 ± 80 BP
GrN-14831	triple burial	26,640 ± 110 BP
GrN-15276	burial DV XVI	25,570 ± 280 BP
GrN-15277	unit 1	25,740 ± 210 BP
GrN-15279	unit 2	26,920 ± 250 BP
GrN-15278	unit 3	27,070 ± 300 BP
GrN-21122	unit 4	26,970 ± 200 BP
GrN-15324	southern hearth	27,070 ± 170 BP
GrN-15325	eastern hearth	26,970 ± 160 BP
GrN-15327	western hearth	27,080 ± 170 BP
GrN-21123	unit LP/1–4	26,390 ± 190 bP
GrN-14830	mammoth deposit	26,100 ± 200 BP

Source: Svoboda *et al.* (1996: Table 6.2).

TABLE 3. Quantity and frequency of twining types at Pavlov I, Czech Republic.

Type	Structural Characteristics	Quantity	Percent
I.	Open Simple Twining Z Twist Weft	2	6.9
II.	Close Simple Twining S Twist Weft	2	6.9
III.	Open Simple Twining S Twist Weft	3	10.3
IV.	Close Diagonal Twining Z Twist Weft	1	3.4
V.	Open Diagonal Twining Z Twist Weft	4	13.8
VI.	Close Diagonal Twining S Twist Weft	2	6.9
VII.	Open Diagonal Twining S Twist Weft	3	10.3
VIII.	Close Simple Twining (unknown weft twist)	2	6.9
IX.	Open Twining Z Twist Weft (unknown warp engagement)	2	6.9
X.	Simple Twining S Twist Weft (unknown weft spacing)	1	3.4
XI.	Twining (unknown weft spacing, warp engagement, weft twist)	7	24.1
	Total	**29**	**100.0**

aboriginal or prehistoric nets is a variant of looping called knotted looping. Knotted looping, in turn, is defined as a single-element looped structure in which the loops are secured by knots (Emery 1966: 34). Netting produced by this technique exhibits a mesh of varying size depending on intended use and is called knotted netting. While several varieties of knotted netting exist (Emery 1966), only one type of knotted netting is thus far inferred for the Gravettian collection from Pavlov I.

THE IMPRESSIONS

The data base

The data base for this study consists of a set of 90 negatively impressed, small, fired and unfired clay fragments. Eighty-nine of these specimens derive from the multi-year excavations at Pavlov I (Klíma 1955, Svoboda 1994, Svoboda *et al.* 1996) while the remaining example originates from Dolní Věstonice II excavated by Klíma

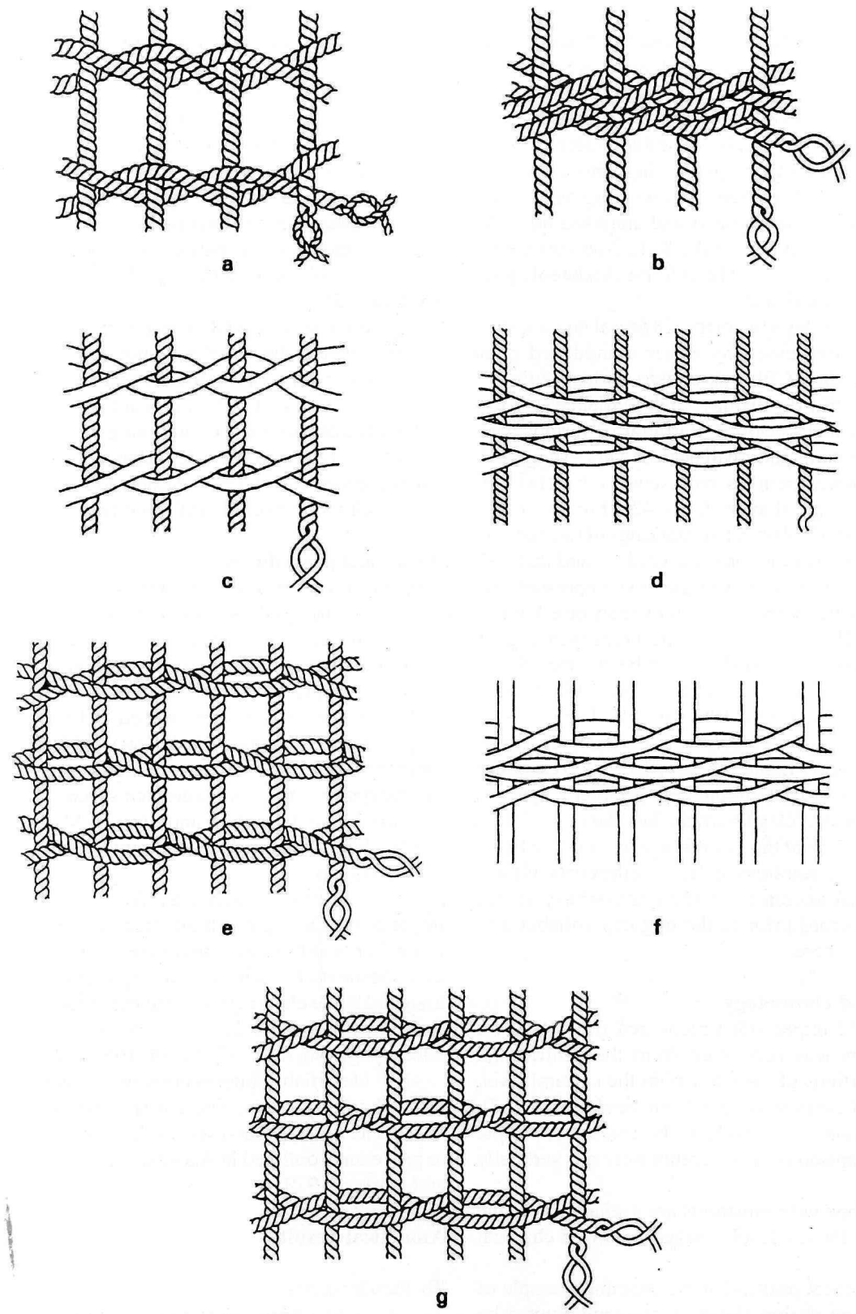


FIGURE 3. Schematic diagrams of twining types represented by the textile impressions at Pavlov I. a – Type I; b – Type II; c – Type III; d – Type IV; e – Type V; f – Type VI; g – Type VII.

(1995) and Svoboda (1991) between 1985 and 1987. This set of specimens, selected by O. Soffer, P. Vandiver, and J. M. Adovasio following preliminary scrutiny of the collections curated at the Dolní Věstonice branch of the Institute of Archaeology Brno, Czech Academy of Sciences, does not encompass the entire fired and unfired clay assemblage recovered from these sites but rather represents that group of specimens initially determined to have a high probability of presenting impressions of textiles, basketry, and cordage. This working assemblage was then thoroughly scrutinized and analysed by J. M. Adovasio and D. C. Hyland at the R. L. Andrews Center for Perishables Analysis, Mercyhurst Archaeological Institute, Erie, Pennsylvania.

Of this set of 90 clay specimens, 28 reveal no indication of having been impressed by either unmodified plant materials or modified fibrous constructions while the remainder (n = 62) do display such evidence. Of this number, 19 specimens bear the markings of various plant parts – primarily stems and small peeled twigs – suggesting that these examples perhaps represent daub, while the balance of the sample (Pavlov I, n = 42; Dolní Věstonice II, n = 1) manifests the distinctive markings of twisted and/or woven fibrous constructions (i.e. cordage and textiles). Furthermore, in some cases, a single fiber-impressed clay specimen bears the imprint of more than one kind of construction. The set of 43 items (representing 49 impressions) described and discussed below specifically includes clay artifacts recovered from the 1954 (n = 4), 1956 (n = 2), 1957 (n = 8), 1960 (n = 4), 1961 (n = 3), 1962 (n = 13), 1963 (n = 3), 1964 (n = 1), and 1965 (n = 4) excavations at Pavlov I, and the 1987 (n = 1) excavations at Dolní Věstonice II. These impressed specimens represent only 0.5 % of the total clay fragment inventory (n = 7,978) at Pavlov I and 0.2 % of the assemblage (n = 407) at Dolní Vestonice II. These quantities underscore the rarity of these impressions and account for their invisibilty in the archaeological record prior to the ongoing collaborative research reported here.

Provenience and chronology

The subset of 42 impressions recovered from Pavlov I discussed below was recovered from the central and southeastern portions of the site within the cultural level, which in some cases was *ca* 60 cm thick (*Figure 2*). Unfortunately, though this level clearly represents multiple occupation/use episodes, these events were not vertically segregated.

Six radiocarbon determinations are available from the cultural zone at Pavlov I, all assayed on wood charcoal (*Table 1*).

While the vertical position of the examined sample of fiber impressions within the cultural zone cannot be specified and dates were not obtained for materials from the 1954, 1960, 1961, 1962, 1963, 1964, and 1965 excavations at Pavlov I, the samples appear to be confidently ascribable (i.e. they do not derive from disturbed or intrusive contexts) to the time range bracketed by the upper limit of the oldest and the lower limit of the youngest of the available dates, *ca* 26,980–24,870 BP.

The cordage-impressed specimen from Dolní Věstonice II was recovered during discontinuous salvage excavations conducted at this locality between 1985 and 1987 (Klíma 1995, Svoboda 1991). This work revealed the remains of a number of settlement units consisting of shallow hearths ringed by small pits, probable remnants of lightly-constructed surface dwellings, and the famed triple and single burials. These remains indicate, as is the case at Pavlov I, multiple occupational episodes on the slopes of the Pavlov Hills during the time between 29,200–25,290 BP (*Table 2*).

It should be stressed that despite the absence of precise vertical control, the samples do not derive from disturbed or intrusive contexts as there are no underlying or overlying culture-bearing strata of significantly older (e.g. Middle Paleolithic or Aurignacian) or younger (e.g. Mesolithic or Neolithic) ages at these sites. Hence, these impressions cannot be viewed as later (or earlier) additions to the Pavlov I and Dolní Věstonice II artifactual inventories.

Analytical procedures

The analytical procedures applied to the Gravettian impressions follow those specified in Chapman & Adovasio (1977) for negative impressions recovered from open archaeological loci. Positive impressions were prepared according to protocols specified by Drooker (1992: 251–254). Positive casts were examined and photographed by employing a research-grade Leica-Wild M10 1:10 zoom stereomicroscope with an apochromatically corrected optical system, and all measurements were taken with both a Helios dial sliding caliper and a Fowler MaxCal electronic digital sliding caliper. Measurements are presented in the metric system.

In most cases, each clay fragment presents one impression of a single technological type, but on occasion, more than one type was discovered to be impressed on a clay specimen. In such cases, a single specimen number is assigned to the clay fragment and the separate impressions associated with it are designated by sequential lower case letters (e.g., No.7a–1957, No.7b–1957, etc.).

The identifiable impressions were assigned to seven textile/basketry types, five cordage types, one possible knotted netting type, and six residual categories according to procedures outlined in Adovasio (1977), Emery (1966), and Hurley (1979).

Analytical results

Textiles/Basketry

Twenty-nine impressions representing seven specific structural types and four residual categories of textiles or basketry were identified in the Gravettian impression sample (*Table 3, Figure 3*). These specimens are briefly described and discussed below by sequential type number.

FIGURE 4. Positive cast of Type II: Close simple twining, S–twisted weft (No.51–1963). (Photo D. C. Hyland, J. M. Adovasio).

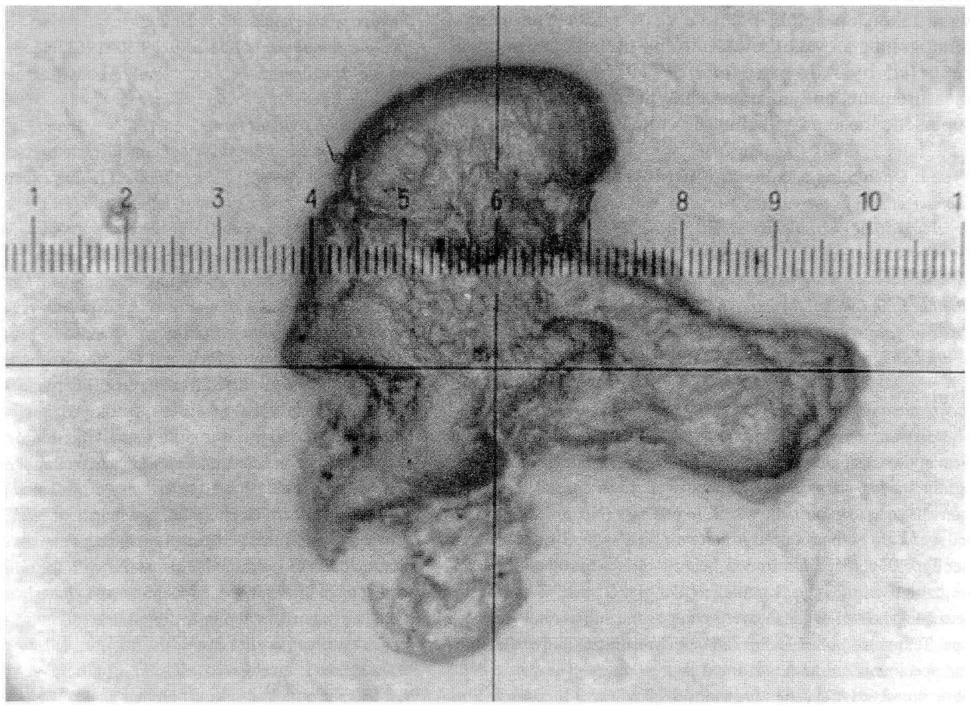
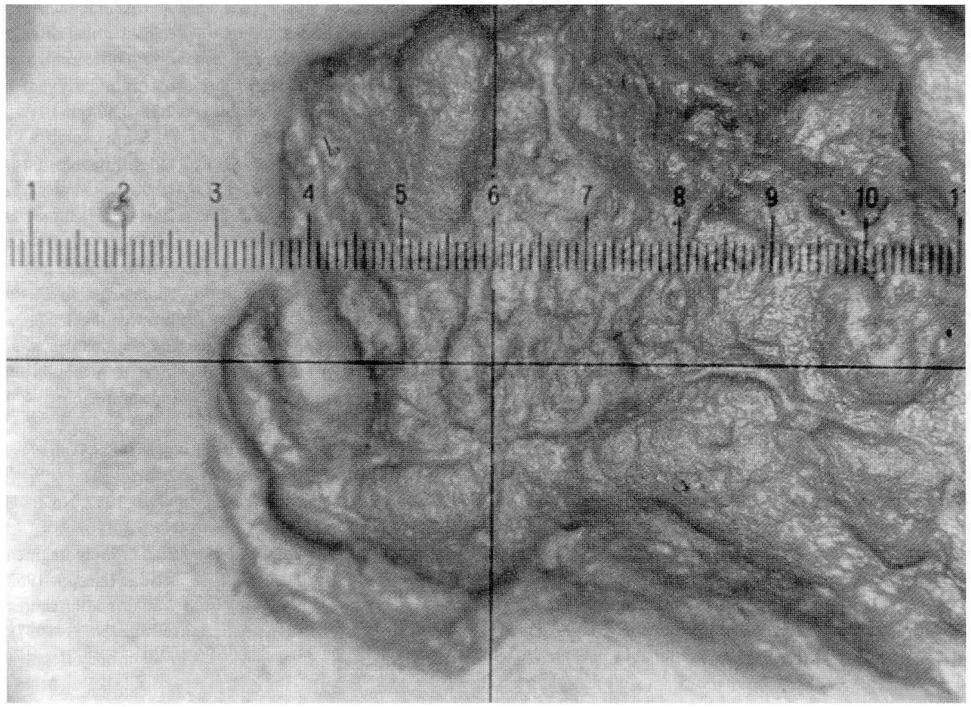


FIGURE 5. Positive cast of Type III: Open simple twining, S–twisted weft (No.68–1962). (Photo D. C. Hyland, J. M. Adovasio).



It should be noted that the measurements provided here were taken on actual positive casts rather than scaled photographs as was the case in the preliminary analysis reported by Adovasio *et al.* (1996). The present measurements and all other analytical details, therefore, supersede those provided in the earlier publication.

Type I: Open Simple Twining, Z Twist Weft

Number of specimens:	2
Specimen numbers:	No. 5–1957, No. 58–1962
Types of specimens:	Wall or body fragment without selvage (n=2)
Number of individual forms:	2 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These specimens represent examples of plain or simple twined weaving over single warps. Specifically, the specimen consists of tightly spaced warps and Z-twisted weft rows spaced at regular intervals so as to expose the warps. In one case (No. 5–1957), warps and wefts are both produced from two-ply, Z spun, S twist cordage (see Type III cordage description, below) while in the other the warps are composed of Type II cordage (two-ply, S spun, Z twist [see description below]) while the wefts comprise an indiscernible cordage type. Texture of both specimens is either semi-flexible or flexible. The specimens are unmended and lack selvages. The sections of fabric preserved in these impressions display heavy pre-impression use-wear. Method of insertion of new warp and weft elements is unknown. In both cases, the specimens may derive from either portions of woven bags or mats or from lengths of fabric of an indeterminable shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.95–0.95 mm
Warp Diameter, Mean	0.95 mm
Weft Diameter, Range	0.60–0.62 mm
Weft Diameter, Mean	0.61 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	6.0
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	Indeterminable
Weft Gap, Range	1.39–1.75 mm
Weft Gap, Mean	1.60 mm
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type II: Close Simple Twining, S Twist Weft *(Figure 4)*

Number of specimens:	2
Specimen numbers:	No. 50–1963, No. 51–1963
Types of specimens:	Wall or body fragment without selvage (n=2)
Number of individual forms:	2 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These two specimens, like other simple twined forms, represents an example of plain twined weaving over single warps. Specifically, the specimen consists of tightly spaced warps and S-twisted weft rows. Warps are produced from single- or multiple-ply S spun cordage (Type VII [see below]). Likewise, the weft element of one specimen (No. 50–1963) is produced from Type VII cordage while the wefts of the other consist of fibers whose direction of twist is indeterminable. Texture is either semi-flexible or flexible. The specimens are unmended, undecorated, and lack splices and selvages. They are moderately frayed to badly worn. Method of insertion of new warp and weft elements is unknown. In both cases, the specimens may derive from either portions of woven bags or mats or from lengths of fabric of an indeterminable shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.25–0.36 mm
Warp Diameter, Mean	0.31 mm
Weft Diameter, Range	0.35–0.40 mm
Weft Diameter, Mean	0.38 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	12.0
Wefts per cm, Range	12.0–16.0
Wefts per cm, Mean	14.0
Weft Gap, Range	Not applicable
Weft Gap, Mean	Not applicable
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type III: Open Simple Twining, S Twist Weft *(Figure 5)*

Number of specimens:	3
Specimen numbers:	No. 3–1957, No. 68–1962, No. 79–1962
Types of specimens:	Wall or body fragment without selvage (No. 79–1962) Wall or body fragment with (?) selvage (No. 3–1957) Wall or body fragment with end and side selvage (No. 68–1962)

Number of individual forms:	3 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These items represent some of the more unique and complex forms identified in the Gravettian assemblage. The specimens, like those described above (i.e. Types I and II), represent examples of plain twined weaving over single warps. Specifically, each of these items consists of tightly spaced warps and S-twisted weft rows spaced at regular intervals which leave the warps exposed. In one case (No. 3–1957), warps consist of a fibrous bunch to which has been imparted little to no twist, and wefts are produced from single-ply, S spun cordage. The other two specimens have warps of either single- or multiple-ply Z twist cordage (Type VI) and wefts of indeterminable twist.
Owing to the unique qualities expressed by two of these specimens (No. 3–1957, No. 68–1962), each deserves separate commentary.
Specimen No. 3–1957 is a uniquely impressed article bearing an imprint of twined fabric on both sides and one edge of the clay fragment. The impressions on both sides of the specimen represent the same structural basketry/textile type (i.e. Type III) but appear to be parts of different constructions. If the obverse and reverse impressions represent two separate sections of fabric, they may have been spliced or sewn together with a running stitch, the imprint of which is borne on the edge of the impressed clay specimen. Six circuits of a right to left running stitch are visible on one edge of the specimen and may represent a composite selvage employed to join the two putatively separate fabric sections.
Specimen No. 68–1962 is the only specimen from this assemblage which exhibits both side and end selvages. The specimen apparently represents a corner of a fabric of unknown configuration. Specifically, three warps and two wefts are in evidence. The warps form an end selvage in which they are folded into the adjacent weft row at a 180° angle while the wefts form a continuous side selvage. The stubs of the warps are not visible.
Texture of all specimens is either semi-flexible or flexible and none of them exhibit mends or are decorated. The amount of wear from utilization is indeterminable on one specimen (No. 3–1957) while the others demonstrate heavy use-wear. Method of insertion of new warp and weft elements is unknown. The specimens may derive from either portions of woven bags or mats or from lengths of fabric of an indeterminable shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.39–1.36 mm
Warp Diameter, Mean	0.62 mm
Weft Diameter, Range	0.40–1.09 mm
Weft Diameter, Mean	0.75 mm
Warps per cm, Range	4.0–28.0
Warps per cm, Mean	14.6
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	6.0 (No. 3–1957)
Weft Gap, Range	0.81–1.41 mm
Weft Gap, Mean	1.12 mm
Angle of Twist (Warps)	40.0° (No. 79–1962)
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type IV: Close Diagonal Twining, Z Twist Weft

Number of specimens:	1
Specimen numbers:	No. 10a–1957
Types of specimens:	Wall or body fragment without selvage
Number of individual forms:	1
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
This specimen represents an example of diagonal (twill) twined weaving over paired warps. Specifically, the specimen consists of tightly spaced warps and Z-twisted weft rows. Warps are produced from single-ply S spun cordage while the weft element is produced of fibers whose direction of twist is indeterminable. Texture is either semi-flexible or flexible. Of those twining impressions examined to date, however, this specimen exhibits the coarsest weave. The specimen is unmended, undecorated, and lacks selvage. The amount of wear evinced by the specimen could not be determined. Method of insertion of new warp and weft elements is unknown. The specimen may derive from a woven bag or mat or from a length of fabric of unknown shape. As with the other examples of twining from Pavlov I, this specimen may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element.	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.50–0.50 mm
Warp Diameter, Mean	0.50 mm
Weft Diameter, Range	1.28–1.31 mm
Weft Diameter, Mean	1.29 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	8.0
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	8.0
Weft Gap, Range	Not applicable
Weft Gap, Mean	Not applicable
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type V: Open Diagonal Twining, Z Twist Weft *(Figure 6)*

Number of specimens:	4
Specimen numbers:	No. 2–1954, No. 7b–1957, No. 10b–1957, No. 11–1957
Types of specimens:	Wall or body fragment without selvage (No. 7b–1957, No. 11–1957)
	Wall or body fragment with side selvage (No. 2–1954)
	Center fragment without selvage (No. 10b–1957)
Number of individual forms:	4 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These specimens represent examples of diagonal (twill) twined weaving over paired warps. Specifically, each specimen consists of tightly spaced warps and Z-twisted weft rows spaced at regular intervals so as to expose the warps. Warps are produced in two cases (No. 7b–1957, No. 10b–1957) from single-ply S spun cordage while the others have warps made of either single-ply Z spun or two-ply, S spun, Z twist cordage (Type VI [see below]). In one case (No. 10b–1957), the weft element is produced of fibers whose direction of twist is indeterminable while the other three specimens have wefts made of either single-ply Z spun or two-ply, S spun, Z twist cordage (Type VI). Texture is either semi-flexible or flexible. The specimens are unmended and undecorated.
One specimen (No. 2–1954) displays evidence of a side selvage of the continuous wrapped variety. Another specimen (No. 10b–1957) displays a center whose exact configuration is indeterminable. The sections of fabric preserved in these impressions all display heavy wear from utilization. Method of insertion of new warp and weft elements is unknown. The specimens may derive from woven bags or mats or from lengths of fabric of unknown shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.40–0.68 mm
Warp Diameter, Mean	0.49 mm
Weft Diameter, Range	0.74–0.81 mm
Weft Diameter, Mean	0.65 mm
Warps per cm, Range	8.0–12.0
Warps per cm, Mean	9.33
Wefts per cm, Range	4.0–8.0 (No. 2–1954, 7b–1957)
Wefts per cm, Mean	6.0 (No. 2–1954, 7b–1957)
Weft Gap, Range	1.44–2.36 mm (No. 2–1954, No. 7b–1957, No. 11–1957)
Weft Gap, Mean	1.77 mm (No. 2–1954, No. 7b–1957, No. 11–1957)
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type VI: Close Diagonal Twining, S Twist Weft

Number of specimens:	2
Specimen numbers:	No. 6–1957, No. 26–1956
Types of specimens:	Wall or body fragment without selvage (n=2)
Number of individual forms:	2 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These specimens represent examples of diagonal (twill) twined weaving over paired warps. Specifically, they each consist of tightly spaced warps and S-twisted weft rows. In one case (No. 6–1957), warps and wefts are produced from a fibrous bunch to which has been imparted little to no discernible twist. The other specimen has wefts made of Type VII cordage (see below) with warps that are obscured and thus of indeterminable configuration. Texture is either semi-flexible or flexible. The specimens are unmended, undecorated, and lack selvage. One specimen (No. 6–1957) bears a moderate amount of wear from utilization. Method of insertion of new warp and weft elements is unknown. The specimens may derive from woven bags or mats or from lengths of fabric of unknown shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.76–0.85 mm
Warp Diameter, Mean	0.80 mm
Weft Diameter, Range	0.42–0.46 mm
Weft Diameter, Mean	0.45 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	12.0 (No. 6–1957)
Wefts per cm, Range	8.0–12.0
Wefts per cm, Mean	10.0
Weft Gap, Range	Not applicable
Weft Gap, Mean	Not applicable
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

FIGURE 6. Positive cast of Type V: Open diagonal twining, Z-twisted weft (No.11–1957). (Photo D. C. Hyland, J. M. Adovasio).

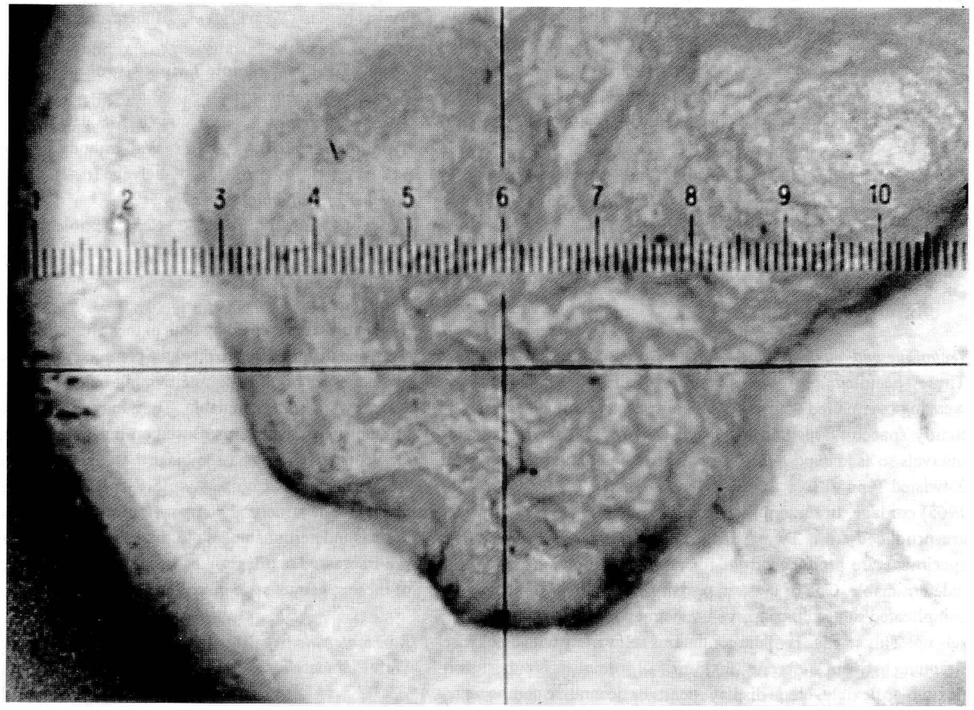
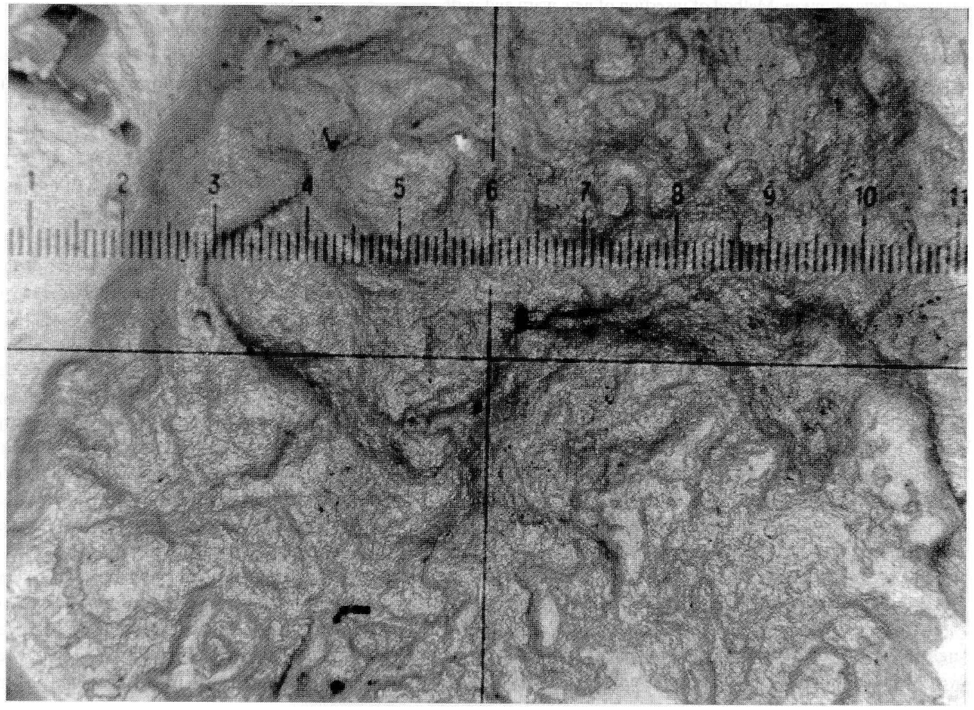


FIGURE 7. Positive cast of Type VII: Open diagonal twining, S-twisted weft (No.30a–1965). (Photo D. C. Hyland, J. M. Adovasio).



Type VII: Open Diagonal Twining, S Twist Weft *(Figure 7)*

Number of specimens:	3
Specimen numbers:	No. 29–1965, No. 30a–1965, No. 42–1960
Types of specimens:	Wall or body fragment without selvage (No. 30a–1965, No. 42–1960)
	Wall or body fragment with side selvage (No. 29–1965)
Number of individual forms:	3 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These specimens represent examples of diagonal (twill) twined weaving over paired warps. Specifically, each specimen consists of tightly spaced warps and S-twisted weft rows spaced at regular intervals so as to expose the warps. Warps are produced either from Z-twisted Type VI (No. 30a–1965) or S-twisted Type VII (No. 29–1965) cordage. In the only identifiable case (No. 29–1965), wefts are produced from Type VII cordage. The wefts of the other specimens are produced from fibers whose direction of twist is indeterminable. One of these impressions (No. 29–1965) is a quite complicated and well-preserved specimen which exhibits a side selvage. This selvage is of the continuous self variety with clockwise wrapping between weft rows. Texture of all specimens is either semi-flexible or flexible. None display mends or decorative components. One specimen (No. 29–1965) exhibits a moderate amount of fraying from use-wear while the other impressions appear to be in a state of advanced disintegration. Method of insertion of new warp and weft elements is unknown. The specimens may derive from woven bags or mats or from lengths of fabric of unknown shape. As with the other examples of twining from Pavlov I, these specimens may have been produced on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.35–0.50 mm
Warp Diameter, Mean	0.44 mm
Weft Diameter, Range	0.69–0.75 mm
Weft Diameter, Mean	0.72 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	8.0 (No. 29–1965, No. 30–1965)
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	8.0 (No. 30–1965)
Weft Gap, Range	0.50–1.00 mm (No. 29–1965, No. 30–1965)
Weft Gap, Mean	0.75 mm (No. 29–1965, No. 30–1965)
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type VIII: Close Simple Twining, (unknown weft twist)

Number of specimens:	2
Specimen numbers:	No. 54b–1962, No. 60–1962
Types of specimens:	Wall or body fragment without selvage (n=2)
Number of individual forms:	2 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
The textiles represented by both of these impressions are sufficiently worn and disintegrated to preclude complete structural analysis. Both are examples of close simple twining but the twist direction of the weft rows is indeterminable. They may either be S- or Z-twisted around successive warps. Based on the composition of the diverse Gravettian twining subassemblage these specimens most likely derive from examples of close simple S-twisted twining (Type II [see above]). The structural composition of the separate warp and weft units is indeterminable due to the heavily disintegrated state of the pre-impressed textiles. Likewise, no other details or measurements of these specimens are discernible.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements: No measurements taken.

Type IX: Open Twining (unknown warp engagement), Z Twist Weft

Number of specimens:	2
Specimen numbers:	No. 1–1954, No. 8–1954
Types of specimens:	Body or wall fragment without selvage (n=2)
Number of individual forms:	2 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
These specimens represent twined weaving over single or possibly paired warps. The specimens represent plain twining if the warps are single and diagonal (twill) twining if the warps are paired. Specifically, the specimens consist of tightly spaced warps and Z-twisted weft rows spaced at regular intervals leaving the warps exposed. Warps of both specimens and one set of weft elements (No. 1–1954) are produced from two-ply, Z spun, S twist cordage (see Type II cordage, below). The wefts of the other specimen are produced from a fibrous bunch to which has been imparted little to no discernible twist. Texture is either semi-flexible or flexible. The specimens are unmended and lack selvage. The section of fabric preserved in one impression (No. 8–1954) displays heavy use-wear. The other specimen appears to exhibit a limited amount of wear

from utilization, although the degree is unquantifiable. Method of insertion of new warp and weft elements is unknown. These specimens may be either portions of woven bags or mats or lengths of fabric of unknown shape. Though it is possible to manually produce lengths of fully flexible fabric with a gauge as fine as that evinced by this specimen, production would be far simpler on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	0.35–0.74 mm
Warp Diameter, Mean	0.56 mm
Weft Diameter, Range	0.66–0.80 mm
Weft Diameter, Mean	0.73 mm
Warps per cm, Range	Indeterminable
Warps per cm, Mean	10 (No. 1–1954)
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	6 (No. 1–1954)
Weft Gap, Range	1.17–1.35 mm (No. 1–1954)
Weft Gap, Mean	1.27 mm (No. 1–1954)
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type X: Simple Twining (unknown weft spacing), S Twist Weft

Number of specimens:	1
Specimen numbers:	No. 62–1962
Types of specimens:	Wall or body fragment without selvage
Number of individual forms:	1
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
This specimen represents an example of plain twined weaving over single warps. Specifically, this item consists of a single warp with one S-twisted weft crossing. Since only one weft row is represented in this impression, the amount or degree of spacing between successive weft rows is indeterminable. The configuration is open if the weft rows are spaced at regular intervals in a manner which leave the warps exposed; it is closed if the weft rows lie tightly packed against adjacent members effectively, if only partially, obscuring the underlying framework of warps. The warp of this specimen is produced from S spun, Z twist cordage (Type II) while the composition of the weft is indeterminable. Texture is either semi-flexible or flexible. There is no evidence of mends, decorative elements, or selvage. Method of insertion of new warp and weft elements is unknown. The specimen is badly fragmented, presumably due to heavy use-wear. Like others from this assemblage, the specimen may represent either a portion of a woven bag or mat or a length of fabric of unknown shape. Though it is possible to manually produce lengths of fully flexible fabric with a gauge as fine as that evinced by this specimen, production would be far simpler on a hanging or horizontal non-heddle frame.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	Indeterminable
Warp Diameter, Mean	0.35 mm
Weft Diameter, Range	Indeterminable
Weft Diameter, Mean	Indeterminable
Warps per cm, Range	Indeterminable
Warps per cm, Mean	Indeterminable
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	Indeterminable
Weft Gap, Range	Indeterminable
Weft Gap, Mean	Indeterminable
Angle of Twist (Warps)	40.0°–45.0°
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Type XI: Twining (unknown weft spacing, warp engagement, and weft twist)

Number of specimens:	7
Specimen numbers:	No. 15–1960, No. 32–1965, No. 33–1964, No. 44–1960, No.76–1962, No. 87–1962, No. 88–1962
Types of specimens:	Wall or body fragment without selvage (n=6)
	Wall or body fragment with end selvage (No. 15–1960)
Number of individual forms:	7 (?)
Types of forms:	Semi-flexible bag or mat, or fully flexible fabric, exact form unknown

Technique and comments:
All of these specimens represent fragments of twining clearly in varying states of severe disintegration. Specifically, they all but completely lack structural integrity. Distinctions between close versus open, simple versus diagonal, and S- versus Z-twisted wefts in all cases are ambiguous at best. Classification as twining is based on the observation of fragmentary lengths of cordage diagonally lying against and crossed over by similar cord segments in the manner of wefts crossing warps. Recordation of measurements and details of manufacture are preclusive in all but one instance. Specimen No. 15–1960 consists of a single warp with one discernible weft crossing. The warp consists of a segment of final S-twisted (Type VII [see below]) cordage which is bent 180° at one end and clipped short to form a folded end selvage. Details concerning the weft of this specimen are unavailable. Considering the diameter of the fragmentary cords comprising these twining specimens, texture is

either semi-flexible or flexible. Needless to say, there is no evidence of mends or decorative elements and the method of insertion of new warp and weft elements is unknown. Finally, like others from this assemblage, these specimens may represent either portions of woven bags or mats or lengths of fabric of unknown shape.

Raw material:

Weft Element:	Retted vegetal fiber, genus and species unknown
Warp Element:	Retted vegetal fiber, genus and species unknown

Measurements:

Warp Diameter, Range	Indeterminable
Warp Diameter, Mean	0.66 mm (No. 15–1960)
Weft Diameter, Range	Indeterminable
Weft Diameter, Mean	0.33 mm (No. 15–1960)
Warps per cm, Range	Indeterminable
Warps per cm, Mean	6.0 (No. 15–1960)
Wefts per cm, Range	Indeterminable
Wefts per cm, Mean	Indeterminable
Weft Gap, Range	Indeterminable
Weft Gap, Mean	Indeterminable
Angle of Twist (Warps)	Indeterminable
Twists per cm (Warps)	Indeterminable
Angle of Twist (Weft Plies)	Indeterminable
Twists per cm (Weft Plies)	Indeterminable

Cordage

In addition to the individual warp and weft units described above, twenty impressions of cordage, representing five structural types and two residual categories, have been identified to date in the Gravettian sample. These specimens are briefly described and discussed below by sequentially numbered type *(Table 4)*. Nineteen of these impressions are from Pavlov I while the remaining one is from Dolní Věstonice II. It should be noted that the measurements and data of the Dolní Věstonice II impression have been combined and reported with those of the same type from Pavlov I.

Single-Ply Cordage

One impression, from the 1957 excavations at Pavlov I, reveals the presence of a single-ply cord. Single-ply cordage consists of a single set of fibrous elements twisted together in one direction, either right (S twist) or left (Z twist). Typically, such examples often represent the ply components of unraveled pieces of multiple- or compound-ply specimens, or they may represent the constituents of a work in progress that was never completed. In other cases, they may have been intentionally produced and used as single-ply cords for expedient and non-taxing uses in situations where high strength and durability are not a requirement.

TABLE 4. Quantity and frequency of cordage types at Pavlov I and Dolní Věstonice II, Czech Republic.

Type	Structural Formula	Quantity	Percent
I.	Z	1	5.0
II.	Z S / S	2	10.0
III.	S Z / Z	4	20.0
IV.	S Z (S) / (S) / (S) / Z (S)	1	5.0
V.	# S (?) / (?) / (?) / S (?) / (?)	1	5.0
VI.	Z (?) / (?)	3	15.0
VII.	S (?) / (?)	8	40.0
Total		**20**	**100.0**

Note: The pound sign (#) is used to denote oblique interlacing or braiding.

Type I: Single, One-Ply, Z Spun

Number of specimens: 1
Specimen numbers: No. 7a–1957

Technique and comments:
Only one length of cordage is represented by this specimen. Specifically, this impression represents a specimen which consists of a single bunch of fibrous material given a Z twist. Based on two primary manufacturing attributes, angle of twist and number of twists per centimeter, the specimen is categorized as very hard spun. Very hard spun cordage often indicates a high level of manufacturing proficiency and product quality. Although no splices or decorative components are apparent in this specimen, it does display a rat-tail configuration. In other words, the diameter of the specimen gradually and regularly narrows and thins from one end to the other. The specimen does not exhibit extensive wear.

Raw material: Retted vegetal fiber, genus and species unknown

Measurements:

Length, Range	Not applicable
Length, Mean	9.65 mm
Cord Diameter, Range	0.26–0.66 mm
Cord Diameter, Mean	0.46 mm
Ply Diameter, Range	Not applicable
Ply Diameter, Mean	Not applicable
Angle of Twist, Range	40.0°–50.0°
Angle of Twist, Mean	Indeterminable
Twists per cm, Range	Indeterminable
Twists per cm, Mean	10

Multiple-Ply Cordage

Six impressions of multiple-ply cordage have been identified in the Pavlov I fired and unfired clay assemblage. Multiple-ply cordage consists of two or more twisted sets of elements (i.e. two or more single plies) secondarily twisted upon one another. Generally, the plies forming multiple-ply cordage, taken individually, are twisted or spun in the same direction. When these plies are then united to form a more substantial structure (i.e., multiple-ply cordage), they are combined by twisting together in the direction opposite that of their initial spin. The alternation of twist directions over successive stages of manufacture serves to interlock the plies together in a coherent composition.

It is interesting to note that in many of those cases where the structural identity of the warp and weft elements is discernible in the twined specimens enumerated and described above, these components are produced from Type III cordage.

Type II: Multiple, Two-Ply, S Spun, Z Twist

Number of specimens: 2
Specimen numbers: No. 64–1962, No. 72–1962
Technique and comments:
These specimens represent one of two basic forms of two-ply cordage. Specifically, they consist of two S spun fibrous bunches combined with a final Z twist. One specimen (No. 72–1962) is crepe-twisted. Crepe-twisting refers to cordage so tightly twisted together that it retwists upon itself when not under tension (Emery 1966: 12). In contrast to most of the Gravettian sample as well as the other member of this type, the remaining specimen (No. 64–1962) is loosely spun. Owing to the fineness of the specimens, they were probably manufactured of bast fibers processed via plant stem retting. The specimens exhibit no splices or decorative components and are not rat-tailed. The degree of wear is not discernible.

Raw material: Retted vegetal fiber, genus and species unknown

Measurements:

Length, Range	1.72–3.57 mm
Length, Mean	2.64 mm
Cord Diameter, Range	0.25–0.50 mm
Cord Diameter, Mean	0.38 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	Indeterminable
Angle of Twist, Mean	20.0°
Twists per cm, Range	Indeterminable
Twists per cm, Mean	Indeterminable

Type III: Multiple, Two-Ply, Z Spun, S Twist *(Figure 8)*

Number of specimens: 4
Specimen numbers: No. 9–1957, No. 12a–1957, No. 38–1954, No. 80–1962

Technique and comments:
Each cordage specimen consists of two Z spun fibrous bunches combined with a final S twist. Several of these impressions are sufficiently unique as to warrant individual commentary. Impression No. 9–1957 represents a mass of parallel strings, all of which exhibit the same structural configuration. They do not appear to derive from a twined fabric but this possibility cannot be wholly discounted. Specimen No. 12a–1957, while not unique in its own right, does derive from an impressed clay fragment which also bears an impression of netting produced with cordage of the same final twist (see below). Probably the most unique Type III specimen is No. 38–1954. This impression is, more properly speaking, a cordage-based miscellaneous construction. It consists of three parallel lengths of Type III cordage arranged as pseudo-warps with a secondary crossing element secured to them apparently with successive overhand knots. The structural assignation of the crossing component is unknown. Lastly, specimen No. 80–1962 is rat-tailed; that is, the diameter of the specimen gradually and regularly narrows and thins to its end. No splices or decorative components are apparent in these specimens. The amount of wear evinced by the specimen No. 9–1957 is indeterminable while the others exhibit significant levels of wear and fraying.

Raw material: Retted vegetal fiber, genus and species unknown

Measurements:

Length, Range	Indeterminable
Length, Mean	2.78 mm
Cord Diameter, Range	0.40–0.60 mm
Cord Diameter, Mean	0.51 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	35.0°–45.0°
Angle of Twist, Mean	40.0°
Twists per cm, Range	16.0–28.0
Twists per cm, Mean	21.0

Compound-Ply Cordage

One impression of compound-ply cordage has been identified in the Pavlov I fired and unfired clay assemblage. Compound-ply cordage consists of a structure in which each of the twisted elements or "plies" is itself formed of

multiple-ply cordage. In other words, there are at least three, and possibly more, levels of construction. First, individual bunches are initially spun. Second, two or more spun bunches are combined by twisting. Third, these spun and twisted plies are once again combined, with another like unit, by twisting. As with multiple-ply cordage, the alternation of twist directions over successive stages of the laying-up process serves to interlock the entire arrangement of bunches, plies, and/or elements together in an integrated fashion.

Type IV: Compound, Two-Ply, Z Spun, S Twist
Number of specimens: 1
Specimen numbers: No. 22–1956

Technique and comments:
This specimen is one of the more interesting ones in the entire assemblage. It is a knotted construction manufactured of cordage more robust and heavier than that of most other specimens in the Gravettian collection, and is the only example of compound-ply cordage. This specimen consists of two plies, each of which is a length of Type II (multiple-ply, two-ply, S spun, Z twist) cordage (see above). These separate plies are then combined with a final S twist to create Type IV cordage. More specifically, at the first level of construction these specimens each consist of four bunches of bast fibers which were presumably given an initial S spin but whose direction of twist is indeterminable. Each of these strands is then paired with another and combined to its mate with a Z twist. In the last stage of laying up, the two Z plies are combined with an opposing and final S twist.
The specimen is constructed of two lengths of Type IV cordage tied to one another with what appears to be a weaver's knot or sheet bend or a closely related style of knot such as a fishnet knot (see Knotted Netting, below). The specimen is moderately frayed, is not spliced or rat-tailed, and does not display evidence of decoration.

Raw material: Retted vegetal fiber, genus and species unknown

Measurements:

Length, Range	Indeterminable
Length, Mean	Indeterminable
Cord Diameter, Range	0.78–1.15 mm
Cord Diameter, Mean	0.93 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	Indeterminable
Angle of Twist, Mean	35.0°
Twists per cm, Range	Indeterminable
Twists per cm, Mean	12.0

Braided Cordage
One impression of braided cordage has been identified in the Pavlov I fired and unfired clay assemblage. Braided cordage consists of a structure in which each component of a set of more than two twisted elements or "plies" is obliquely interlaced with the other members of the set (Emery 1966: 62). Each element may be composed of single-, multiple-, or compound-ply cordage. However, the final combination of these elements, whatever their configuration, is produced not by twisting but by obliquely interlacing, that is, by braiding. As with compound-ply cordage, there are several levels of construction. First, individual bunches are initially spun, and oftentimes, secondarily twisted with other similar members, as in the formation of twisted cordage. Last, these plies are combined, with at least two other like units, by braiding.

Type V: Braided, Three-Strand *(Figure 9)*
Number of specimens: 1
Specimen numbers: No. 14b–1960

Technique and comments:
This specimen is a three-strand braided cord produced by crossing each subsidiary component in a left-over-right fashion. Each of the strands or elements has been spun and exhibits a final S twist. The precise structural type of each strand, however, is indeterminable; that is, each represents a length of Type VII cordage (see below). The specimen exhibits no evidence of splicing, rat-tailing, or decoration. It is lightly frayed.

Raw material: Retted vegetal fiber, genus and species unknown

Measurements:

Length, Range	Not applicable
Length, Mean	12.46 mm
Cord Diameter, Range	Indeterminable
Cord Diameter, Mean	1.82 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	0.74 mm
Angle of Twist, Range	Indeterminable
Angle of Twist, Mean	Indeterminable
Twists per cm, Range	Indeterminable
Twists per cm, Mean	Indeterminable

Residual Cordage Categories
The two residual categories of cordage discussed below represent those impressions for which a definitive identification and assignation of structural type was not possible. Generally speaking, these impressions bore recognizable evidence of a length of cordage and its final twist but did not unequivocally reveal the presence (or absence) of constituent plies or their respective direction of twist. In other words, these specimens most likely represent either examples of single-ply cordage or multiple-ply cordage. Eleven such impressions have been identified in the Pavlov I and Dolní Věstonice II fired and unfired clay assemblage and are presented below by final twist direction.

Type VI: Z Twist
Number of specimens: 3
Specimen numbers: No. 21–1961, No. 31–1965, No. 48–1963

FIGURE 8. Positive cast of Type III: Multiple, two-ply, Z-spun, S-twisted cordage (No.12a–1957). (Photo D. C. Hyland, J. M. Adovasio).

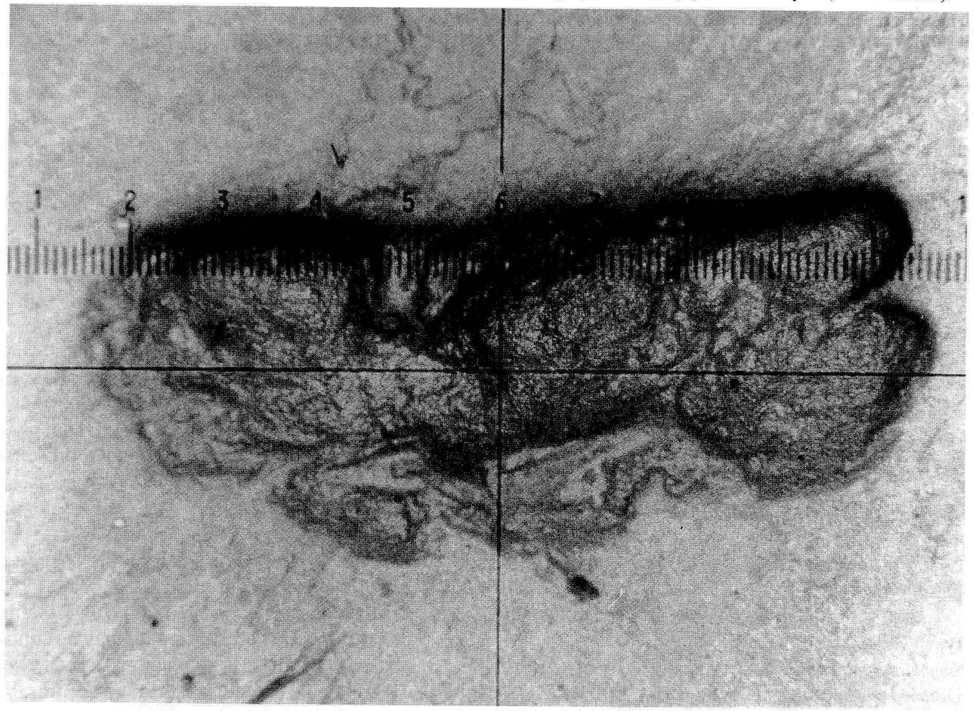
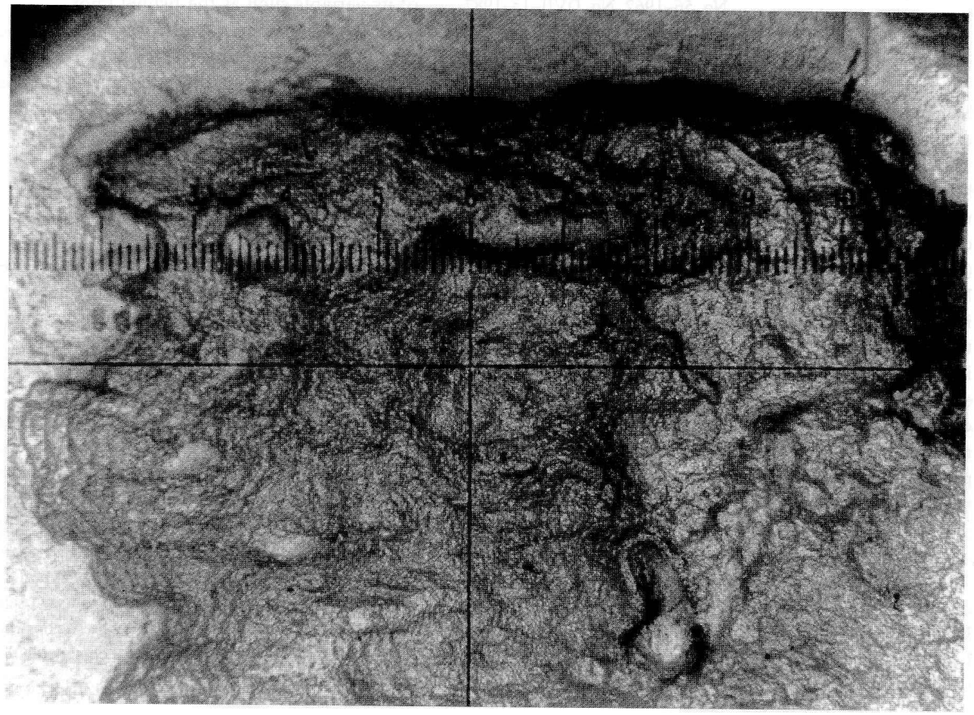


FIGURE 9. Positive cast of Type V: Three strand braided cordage (No.14b–1960). (Photo D. C. Hyland, J. M. Adovasio).



Technique and comments:
These specimens represent lengths of spun cordage exhibiting a final Z twist direction. While their respective and specific structural types are equivocal, depending on the presence of plies and their corresponding twist directions, these specimens are in all likelihood members of either Type I or Type II cordage (see above). None of the specimens exhibits splices, decorative elements, or rat-tailing. One specimen (No. 31–1965) does display evidence of crepe-twisting. Patterns of wear are not discernible.

Raw material:	Retted vegetal fiber, genus and species unknown
Measurements:	
Length, Range	2.90–9.93 mm
Length, Mean	6.42 mm
Cord Diameter, Range	0.35–0.59 mm
Cord Diameter, Mean	0.51 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	25.0°–50.0°
Angle of Twist, Mean	41.6°
Twists per cm, Range	14.0–24.0
Twists per cm, Mean	19.0

Type VII: S Twist

Number of specimens:	8
Specimen numbers:	No. 12b–1957, No. 14a–1960, No. 17–1961, No. 19–1961, No. 30b–1965, No. 54a–1962, No. 56–1962, No. DVII–1a–1987

Technique and comments:
This majority category is a catchall grouping of S-twisted cordage. More specifically, these specimens represent lengths of spun cordage exhibiting a final S twist direction but whose constituent parts are of indeterminable form. While the specific details of manufacture, and hence structural type affiliation, are not discernible, these specimens most likely represent examples of Type III cordage or the complimentary form (i.e. opposing twist direction) of Type I cordage (see above). Three of these specimens (No. 12b–1957, No. 17–1961, No. 56–1962) are knotted, and the configuration of these knots indicates that they are most likely weaver's knots or sheet bends. All three of these knotted constructions display at least two similar knots indicative of netting manufacture (see Knotted Netting, below). One specimen (No. DVII–1a–1987) displays a rat-tail at one end of the cord. None of the specimens provide evidence of splicing or the incorporation of decorative components. Those with discernible wear patterns, particularly the putative netting specimens, show signs of moderate to heavy use.

Raw material:	Retted vegetal fiber, genus and species unknown
Measurements:	
Length, Range	2.00–7.85 mm
Length, Mean	4.22 mm
Cord Diameter, Range	0.31–0.96 mm
Cord Diameter, Mean	0.55 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	35.0°–50.0°
Angle of Twist, Mean	43.0°
Twists per cm, Range	10.0–20.0
Twists per cm, Mean	14.8

Knotted Netting (?)
Four impressions yielded evidence of at least one kind of knot which may have been used in the production of knotted netting. Knots or ties are generally used to create more complex constructions from cordage and are often effective as high-resolution indicators of the structure and function of perishable tools/implements. Weaver's knots and sheet bends (which are functionally and morphologically identical except for the method of tying), for instance, are widely used for the manufacture of knotted netting as they provide an effective and simple way for producing a net with a fixed and secure mesh diameter. Nets produced in this manner have been ethnographically and archaeologically documented as being used for the capture (i.e. hunting) of both small and big game animals (e.g. Frison *et al.* 1986, Andrews, Adovasio 1980). While the assignation of the Pavlov I knot impressions as evidence of netting and its attendant uses may be equivocal, there is no doubt that these impressions minimally reveal evidence of knotted cordage and constructions based on the manipulation of cordage. With near equal certainty these knot impressions are identified as weaver's knots or one of its variants such as the fishnet knot.

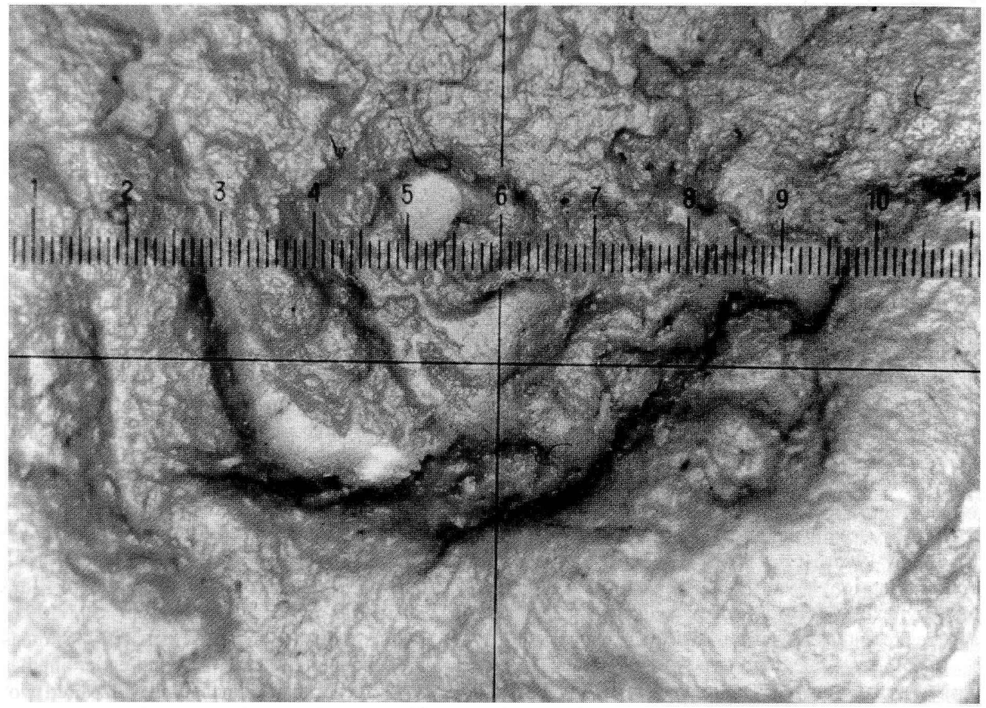
In terms of the analysis presented here, cordage and netting are cross-cutting categories. That is, cordage is used to produce nets and netting is comprised of cordage. Thus, the netting specimens are discussed and documented twice, both as cordage (see above) and as netting.

Type I: Weaver's Knotted Netting *(Figure 10)*

Number of specimens:	4
Specimen numbers:	No. 12b–1957, No. 17–1961, No. 22–1956, No. 56–1962,
Types of specimens:	Body Fragmenst (n = 4)
No. of nets represented:	Indeterminable
Types of nets represented:	Indeterminable

Technique and comments:
These specimens consist of imprints of knotted cordage. Specifically, seven knots are represented as evidenced by impressions of fibers, both twisted and untwisted, and by multiple crossed or interworked units of cordage representing the tie itself. The structural type of cordage involved in three of these constructions is Type VII, while the remaining specimen (No. 22–1956) is produced from a compound-ply variety with a final S twist (Type IV). The kind of knot, or specifically, bend (a tie used to join two separate cordage lengths to one another), represented by these constructions appears to be a weaver's knot or sheet bend or a closely related style of knot such as a fishnet knot.

FIGURE 10. Positive cast of a weaver's knot representative of Type I: Weaver's knotted netting (No.22–1956). (Photo D. C. Hyland, J. M. Adovasio).



All of the impressions produced from Type VII cordage evince two successive and similarly produced knots. The distance between successive knots is reported below and in conjunction with the geometric relationships between the knots of a standard specimen of knotted netting is used to determine mesh diameter. These results are reported below as extrapolated mesh diameter.
The specimens do not present evidence of splicing or decoration but do exhibit a fair amount of use-wear in the form of frayed ends. The fact that no substantial lengths of cordage extending to or from the knots are apparent also attests to a high degree of use-wear. If these specimens do derive from a net (or nets), its method of manufacture, whether via the tennis net method or the shuttle and mesh method (Andrews & Adovasio 1980: 309–310; Shaw 1972: 118–119), cannot be determined without evidence of larger netting segments.

Raw material:	Retted vegetal fiber, genus and species unknown
Measurements:	
Construction Length, Range	Indeterminable
Construction Length, Mean	Indeterminable
Knot-to-knot Distance, Range	0.5–5.36 mm
Knot-to-knot Distance, Mean	2.95 mm
Extrapolated Mesh Dia., Range	0.71–7.58 mm
Extrapolated Mesh Dia., Mean	4.17 mm
Cord Diameter, Range	0.31–1.15 mm
Cord Diameter, Mean	0.63 mm
Ply Diameter, Range	Indeterminable
Ply Diameter, Mean	Indeterminable
Angle of Twist, Range	35.0°–50.0°
Angle of Twist, Mean	42.5°
Twists per cm, Range	12.0–16.0
Twists per cm, Mean	14.0

THE MORAVIAN PERISHABLE INVENTORY IN GLOBAL CONTEXT

The textile/basketry and cordage impressions from Pavlov I and Dolní Věstonice II are presently far and away the oldest indications of fiber-based technology in the world. Though the study of the impressed remains of Gravettian perishables is still ongoing, it is abundantly clear that the Pavlov I and Dolní Věstonice II specimens provide explicit evidence of the production and use of cordage, textiles, and/or basketry in at least one region of Europe a minimum of 7,000–10,000 years earlier than anywhere else on the planet. To date, the next oldest examples of fiber artifact production in any form derive from Ohalo II on the Sea of Galilee in the Near East (Nadel *et al.* 1994). At that site,

plant fibers of unknown genera or species were used to produce S spun cordage with a final Z twist. These items, which could be portions of netting or other fishing-related paraphernalia, date to ca 19,300 BP (Nadel *et al.* 1994: 451). Elsewhere in the Near East, no recovered perishables are older than the ninth or tenth millennia (cf., Adovasio 1975, Bar-Yosef 1985, Schick 1988).

Slightly younger charred cordage and/or netting fragments are reported from Mezhirich (Adovasio *et al.* 1992) in Ukraine and Kosoutsy in Moldova, though in neither case are these perishables older than *ca* 17,000 BP. Of broadly comparable age are the charred cordage fragments and impressions on clay from Lascaux (Leroi-Gourhan 1982, Leroi-Gourhan, Allain 1979). The Mezhirich specimen, likewise carbonized, is a minute single S spun ply which may derive from a length of two-ply, S spun, Z twist fiber cordage (Adovasio *et al.* 1992: 7). The spin and twist of the Kosoutsy and Lascaux specimens are problematic.

The oldest evidence of fiber artifact production from Asia, including late Pleistocene/Upper Paleolithic and so-called "Mesolithic" sites in China, Japan, and far eastern Russia, is presently no older than 13,500 BP (Derevianko, Medvedev 1995, Hurley 1979, R. S. MacNeish, personal communication 1994, Zhushchikhovskaya 1996). No basketry, textiles, or cordage of earlier or broadly comparable age are presently known from Africa or Australia.

In both eastern and western North America, the oldest basketry, textile, or cordage materials are attributable to the mid-twelfth millennium BP, though very few specimens have been recovered in well-dated contexts. Indeed, North American sites with perishable fiber artifacts of any subclass or type older than *ca* 11,000 BP number fewer than 10. Eight of these localities are summarized below (see Andrews, Adovasio [1996] for a more extensive treatment of this theme).

As of this writing, the oldest bona fide basketry (or fiber perishable) of any subclass or type from eastern North America derives from middle Stratum IIa at Meadowcroft Rockshelter in southwestern Pennsylvania (Andrews, Adovasio 1996, Stile 1982). The item is a wall fragment without selvage constituted of simple plaiting with single elements in a 1/1 interval. It is bracketed by radiocarbon dates of 12,800 ± 870 BP and 11,300 ± 700 BP and is associated with the Miller complex occupation at that site. The specimen lacks shifts, splices, and decoration. According to Stile (1982: 133), while the finished form of the plaiting fragment cannot be ascertained, it was manufactured of cut birch-like (cf., *Betula* sp.) bark strips.

According to Andrews & Adovasio (1996: 39), a far older but much more tentatively classified perishable from Meadowcroft Rockshelter derives from lowest Stratum IIa and is directly dated to 19,600 ± 2400 BP. The specimen consists of a single element of intentionally cut birch-like (cf. *Betula* sp.) bark which is quite similar in overall morphology to the strips employed in all later Meadowcroft plaiting. If the specimen is a portion of a plaited basket and even if one sigma is subtracted from the date (i.e. 17,650 BP), it is at once the oldest basket in North or South America

Plaiting is also represented in an apparently very ancient context at Petit Anse Island, Louisiana, in the Gulf of Mexico. Wilson (1889: 674–675) reports that a solitary specimen of plaited matting was recovered near the surface of a salt dome diapir 0.6 m below the tusks and bones of a fossil proboscidean 4.3 m beneath the then modern ground surface. According to Andrews & Adovasio (1996: 34), the specimen is twill plaiting (2/2 interval) with several perhaps intentional 2/3/2 shifts (Wilson 1889: Figure CVII). The specimen apparently represents a portion of a large burden basket or mat and lacks selvage or decoration. The Petit Anse specimen was made of southern cane (*Arundinaria macrosperma*) (Wilson 1889: 674). Though Wilson (1889: 675) questioned the antiquity of the Petit Anse plaiting fragment, especially given its context in a faulted salt diapir, a late Pleistocene age is not implausible given the demonstrated antiquity of the plaiting from Meadowcroft Rockshelter.

In the far west, recent radiometric research has revealed that plaiting recovered in the late 1960s from Spirit Cave, Nevada, is not approximately 1,500 or 2,000 years old as was originally reported (Wheeler, Wheeler 1969) but rather dates to 9,415 ± 25 BP (Fowler *et al.* 1997). While not dating to Paleoindian times, plaited specimens of this age are unique in the Great Basin. Fowler and her colleagues (1997) report that plain plaiting with paired two-ply, S spun, Z twist cordage wefts was used to construct burial shrouds for two interments. These shrouds, which consist of a head covering for one burial and a cremation bag for the other, are made of bulrush (*Scirpus acutus*) and most likely were produced with the aid of a three bar upright frame. The warp edges of these plaited specimens are set with two rows of close plain twining, and one of the bags is decorated. Interestingly, all of the other textiles examined from this horizon are fully twined and represent three different forms of this production technique.

While plaiting is represented in very early contexts at Meadowcroft Rockshelter, Pennsylvania (Stile 1982, Andrews, Adovasio 1996), Petit Anse Island, Louisiana (Wilson 1889), as well as somewhat later at Spirit Cave, Nevada (Fowler *et al.* 1997), most early North American basketry or textiles are twined.

Recently, an impression of what appears to be close diagonal twining with a Z twist weft was recovered in an alleged Clovis context at the Hiscock site in western New York State (R. Laub, personal communication 1996). This as yet not fully reported specimen is apparently associated with mastodon (*Mammut americanum*) remains that have direct dates ranging from 11,390 ± 80 BP to 10,990 ± 100 BP, rendering this unique item the only perishable fiber artifact potentially attributable to fluted point makers from eastern North America (Laub *et al.* 1996). By 9,950–7,950 BP, twining is widely represented in eastern North America (Andrews, Adovasio 1996: 4–36).

West of the Mississippi River, the 15 fiber artifacts recovered from Zones C1 and C2 at Pendejo Cave, New Mexico, if not intrusive from overlying Archaic levels, are among the oldest perishable artifacts ever recovered in the New World (Adovasio, Hyland 1993, Hyland 1997, Hyland, Adovasio 1995, 1997). These specimens, which apparently date between 11,900 ± 150 BP and 12,240 ± 70 BP, include five types of cordage predominantly produced with a final Z twist, a possible knotted netting fragment made with a fixed sheet bend or weaver's knot, and what may be a weft element of a simple twined basket or bag. All of the putatively early Pendejo Cave fiber artifacts are made of *Yucca* sp.

Of somewhat younger but broadly comparable age are the cordage remains from Fishbone Cave, Nevada, and Danger Cave, Utah, and basketry from several loci in the arid Great Basin. Orr (1974: 47–59) reports and illustrates the same cordage type (i.e., two-ply, S spun, Z twist) both in the form of string as well as twining wefts from the base of Level 4 at Fishbone Cave, Nevada. The level and the associated specimens are putatively bracketed by dates of 11,250 ± 250 BP and 7,830 ± 350 BP. The older date was allegedly run on an actual specimen of open simple twined matting with two-ply, S spun, Z twist cordage wefts, though recently the source of the date has been questioned (see Ellis-Pinto 1994). If accurately dated, the late twelfth millennium b.p. specimen from Fishbone Cave is the oldest directly assayed fiber perishable artifact in western North America.

Stratum D1, Sand 1, at Danger Cave, Utah, has yielded the oldest cordage and netting from the eastern reaches of the Great Basin (Jennings 1957: 227–234). The small but informative collection includes single-ply, S twist cordage; a length of untwisted fiber; and more significantly, two segments of two-ply, Z spun, S twist cordage knotted together with a lark's head knot. Presumably, this specimen is the remnant of a section of knotted netting which, with the solitary exception of the possible Pendejo Cave netting, is the oldest such construction in North America. All of the Sand 1 specimens date between 11,151 ± 570 BP and 10,270 ± 650 BP.

In the northern Great Basin, Cressman (1942) reports cordage of the two-ply, Z spun, S twist and single-ply, Z twist varieties from the bottom of Fort Rock Cave, Oregon. The cordage was apparently recovered with Fort Rock twined sandals and simple twined basketry with Z twist wefts. Though the ages of the basal deposits at Fort Rock Cave remain controversial, these perishable specimens are at least 11,000 years old (Andrews *et al.* 1986).

Elsewhere in the northern Great Basin, specifically, and western North America, generally, the oldest basketry is invariably twined and includes open and close simple twined bags, mats, burden baskets, trays, and sandals of a variety of configurations. Though rarely directly dated, the age of these materials extends to at least 10,950 BP or slightly earlier (Andrews *et al.* 1986).

In South America, the production of textiles or basketry – again invariably twined – is evidenced in early tenth millennium BP contexts in the Peruvian highlands (Adovasio, Lynch 1973, Adovasio, Maslowski 1980), while the production of cordage and cordage byproducts is substantially more ancient.

Presently, the oldest well-dated cordage in North or South America derives from Monte Verde in Chile (Adovasio 1997). At that remarkable location, 33 individual specimens of cordage and at least 11 separate cordage impressions were recovered or recorded in context firmly dated between 13,565 ± 250 BP and 11,790 ± 200 BP. The average age of the Monte Verde perishable materials is *ca* 12,500–13,000 BP (Dillehay, Pino 1989: 142), making this the longest and earliest perishable fiber assemblage (i.e. as opposed to individual specimens) from anywhere in the New World. One structural type is apparently represented in the Monte Verde cordage assemblage, single-ply, S twist. Regular indentations on several examples of this type, however, strongly suggest that some of these specimens are plies of two-ply, S spun, Z twist cords which have become untwisted.

Whatever the actual typological diversity of the Monte Verde cordage industry, this brief overview indicates that the production of fiber perishables is well-documented in late Pleistocene contexts in many parts of the world. As noted by Adovasio and co-worker (1996: 533), perhaps significantly, twining is the earliest basketry or textile production technique known from virtually all of the areas enumerated above with the possible exception of eastern North America, where plaiting exhibits a venerable antiquity. This seems to confirm, or at least strongly support, the hypothesis advanced some years ago (Adovasio 1970) that twining technology is at the heart of virtually all textile and basketry production, not simply as originally envisioned in North and South America, but apparently throughout the rest of the world.

Whatever its ultimate origin(s), it is now clear that the beginnings of fiber artifact production, generally, and cordage and basketry/textile manufacture, specifically, are millennia older than previously envisioned. While it may seem surprising that at least some Gravettian groups were sufficiently sedentary to produce finely woven basketry, fabrics, or netting, equally sophisticated weaving is documented for groups with a wide range of mobility patterns such as those from the late Pleistocene/early Holocene arid deserts of the Near East or western North America, the temperate to cold highlands of Peru, or the sub-tropical to continental climates of northern Asia and Japan. Moreover, while it is now certain that perishable fiber industries were part and parcel of the technological milieu of the first colonists to the New World, they also seem to have been a part of the Upper Paleolithic techno-economic suite for much longer than we have imagined. It may well prove that this archaeologically ephemeral technology is more critical to the overall functioning and character of the Gravettian than the more often preserved durable products of this highly inventive cultural complex.

MORAVIAN PERISHABLE TECHNOLOGY AND ITS IMPLICATIONS FOR UPPER PALEOLITHIC BEHAVIOUR

As noted in earlier treatments of the Pavlov I impressions (Adovasio *et al.* 1995, 1996, 1997) and despite the much larger sample reported here, the structural types described above almost certainly do not reflect the entire range of perishable fiber technology known to the Gravettian weavers. They do, however, provide direct and relatively extensive evidence for the production and/or use of a very wide variety of twined textiles or basketry, cordage, and cordage byproducts by the Eastern Gravettian populations at that site. Significantly, the cordage byproducts apparently include knotted netting.

These textile and/or basketry impressions from Pavlov I and Dolní Věstonice II also represent well-made items and are in no sense "primary essays in the craft." Indeed, the typological diversity coupled with the general regularity and narrow gauge of the warp and weft elements used in all of the textile/basketry types (see "Analytical Results," above) suggest a high level of standardization and considerable antecedent development, both for these specimens and the fiber industry at large.

The same observations may be extended to the cordage specimens which are not portions of textiles. Given the high quality and remarkable fineness of manufacture of the individual warp and weft elements comprising the textile/basketry specimens, it is scarcely surprising that cordage, generally, also exhibits a high level of sophistication.

The textiles and cordage specimens from Pavlov I and Dolní Věstonice II are clearly made of plant rather than animal fiber, though an exact identification of species, at present, is impossible. As noted by Adovasio and co-workers (1996: 532), pollen analyses at the Pavlovian sites indicate a mostly open landscape with both bast-yielding and other plants at the site (Klíma 1955, Opravil 1994, Svoboda 1994, Svoboda *et al.* 1996). Any number of these plants could have been used to provide suitable construction material. Mason and her colleagues (Mason *et al.* 1994) suggest that the fibrous bark of both alder (*Alnus* sp.) and yew (*Taxus* sp.) were locally available and, furthermore, that the herbaceous flora may have included milkweed (*Asclepias* sp.) and nettle (*Urtica* sp.), all of which have well-documented ethnographic and prehistoric uses as perishable production media. Additionally, nettle has a long history of use as a weaving fiber in central and eastern Europe (Barber 1991, Hald 1941). Ethnographic data indicate that this, as well as other bast fibers, were harvested and processed in the fall, after the plants had reached their maximal growth. If as yet unidentified fiber strands from the clay impressions can document similar uses at these sites, then such remains can corroborate cold weather occupation as previously postulated based on data from tree rings (Opravil 1994), edge-wear studies (Přichystal *et al.* 1994), and the distribution of the ceramics inventory (Soffer, Vandiver 1997).

Surprisingly, the collection from Pavlov I includes seven of the eight commonly produced twining types (see *Table 3*) known in the world and a minimum of five cordage types. Whatever the function (see below) of either the recovered or as yet undiscovered Eastern Gravettian perishable suite, it is intriguing that it is characterized by such a high level of typological diversity. Younger Mesolithic/Archaic and Neolithic/Formative perishable assemblages usually exhibit a far more restricted array of types with a clear preference for certain warp and weft manipulations as well as preferred initial spin and especially final twist directions – a feature which may attest to the antiquity of this technology. While there appears to be a slight preference for S over Z twist wefts and final S over Z twist cordage, the Eastern Gravettian weavers seem to have no clear-cut production preferences in either medium. Such a situation is highly unusual in later periods and there are admittedly no analogues to assess its uniqueness during the Upper Paleolithic.

It is tempting to hypothesize that the great variety of combinations of twining weaves and cordage types may reflect idiosyncratic production on the level of the household since this pattern is clearly congruent with the domestic mode of production identified for hunter-gatherers (Sahlins 1972). Such diversity, however, may also reflect the nature of Eastern Gravettian occupations. Specifically, if sites such as Pavlov I and Dolní Věstonice II served as seasonal aggregation loci for a number of independent social units who spent the remainder of the year elsewhere (Kozlowski 1985, Soffer 1989, Svoboda *et al.* 1996), then these sites should present evidence of greater technological variability than locales where multiple social units co-resided with each other on a more permanent basis. In other words, the collective items produced by a given set of related but independent social groups should be more diverse the less time these groups are in direct contact with one another. Although this scenario does account for both the variety of perishables as well as the volume and diversity of exotic raw materials reported for the lithic inventories at these sites, where up to 97 % of the tools were made from non-local materials (Svoboda *et al.* 1996), an unambiguous confirmation of this hypothesis awaits further research.

The hypothesis that these sites do represent residential locales, though, is supported by cross-cultural research which indicates that the production of textiles and basketry on one hand and cordage and cordage byproducts on the other, as well as the use of these perishable implements, is associated with both sexes (Murdock 1937, Murdock, Provost 1973). Given such patterns of production and use, the Moravian impressions appear to attest to the presence of both men and women. This observation supports the identification of these sites as residential locales.

Given the highly fragmentary nature and overall condition of the perishable assemblage described here, it is impossible to specify whether any of the seven named structural types represent twined bags, mats, or cloth fabrics. It is also virtually impossible to posit functions

for most of these items or the bulk of the other perishables. If they are portions of bags or mats, they may have served the "normal" role of these items; that is, as flooring or sitting/sleeping platforms in the case of mats, and as storage/transportation devices in the case of bags. They may also represent wall hangings. If they are portions of cloth fabrics, they could represent a wide diversity of forms ranging from blankets to items of clothing such as shawls, skirts, shirts, sash fragments, etc.

The presumed function of the associated free (i.e. not utilized as a component of a basketry or textile product) specimens of cordage are somewhat more easy to postulate. There is no doubt that these items performed the same functions as has cordage in virtually all societies where it has been produced. Thus, it is highly likely that the cords from Pavlov and Dolní Věstonice II served a wide range of lashing, binding, and tying needs, and perhaps provided the production medium for other compound constructions in addition to textiles and basketry.

While it is admittedly highly tenuous evidence, the identification of a sheet bend or weaver's knot on eight of the impressions indicates, or at least strongly hints at, the production of knotted netting. Although this identification, in turn, implies the potential use of such nets for the capture of animals, it should be stressed that the mesh size of the putative Pavlov nets is quite small, making them suitable only for the capture of small-sized taxa. This observation is corroborated by the high numbers of fur-bearers like foxes and hares recovered from such sites as Dolní Věstonice, Pavlov, and Předmostí (Musil 1994). It is also in good accord with cross-cultural ethnographic data which indicate the use of nets to capture small terrestrial fauna, including fur-bearers, throughout the world (Roscoe 1990, 1993, Satterthwait 1986, 1987, Steward 1938). Since this method of hunting does not select for particular age classes of prey but instead captures whatever is available in a given area, it has testable implications which can be examined with the extant zooarchaeological record. Specifically, it is anticipated that if these taxa were hunted with nets, their respective skeletal inventories should reflect catastrophic rather than attritional mortality profiles. While ethnographic literature also documents the widespread use of nets for fowling and fishing, the lack of fish remains and the paucity of avian skeletal elements at Moravian sites suggests that fish and birds were not an important component of the Upper Paleolithic diet in Central Europe (Musil 1994).

The fine gauge of virtually all of the Gravettian weaving strongly suggests that perhaps the coarser or larger gauge fraction of the perishable industry has not been preserved or recovered to date. Given the great skill of the Gravettian weavers in producing finer items, it is (or was) certainly within their capability to produce more substantial perishable products which could well have included larger mesh hunting nets suitable for the capture of terrestrial mammals. Ethnographic data show that nets, in addition to capturing small-sized mammals in the 3–20 kg weight range, were successfully used to capture a wide range of larger-sized herbivores from kangaroos in Australia (Satterthwait 1986, 1987) to antelope, deer, and mountain sheep in North America (Frison *et al.* 1986). This suggests that, if practiced, net hunting may have been used to procure larger-sized taxa in Upper Paleolithic Moravia, as well.

If netting was manufactured and used by Eastern Gravettian groups, it has potentially profound implications for reconstructing subsistence behavior and attendant social organization because net-hunting is an entirely different kind of activity than the taking of individual animals or even the systematic predation of large aggregates of animals via lances and spears, spear throwers, and darts. As detailed below, net-hunting obviates a number of the skills and qualities required of the "traditional" hunting model (i.e. stalking and dispatching with lance or spear) and can yield a short-term windfall of food.

First, cross-cultural research indicates that net hunting is a communal effort, which, because of the relative lack of expertise necessary for success as well as the minimal danger involved in such a non-confrontational harvesting technique, can and does utilize the labor of the entire co-residential social unit (Satterthwait 1986, 1987, Steward 1938, Turnbull 1965, Wilkie, Curran 1991). Not surprisingly, it is in fact the one hunting method strongly associated with the labor of females and juveniles (Murdock 1937, Murdock, Provost 1973). Second, it is a hunting method associated with large harvests in short periods of time and, thus, with the production of a surplus (Satterthwait 1986, 1987). Although such surplus in some cases is obviously associated with participation in a market economy (e.g. the Ituri forest [Wilkie, Curran 1991]), in other cases, such as in Aboriginal Australia (Satterthwait 1986, 1987) or New Guinea (Rosco 1990, 1993), it is associated with large gatherings, feasting, and ceremonialism. Third, this method of capturing prey does not require the elaboration of stone tool kill weaponry because immobilized animals can be dispatched in relative safety and security at close range by a wide variety of methods such as stabbing, clubbing, etc.

These observations have a number of implications for Upper Paleolithic Moravia. The communal nature of net hunting is in accordance with the hypothesis that Dolní Věstonice, Pavlov, and Předmostí were aggregation sites where large numbers of people co-resided seasonally and where short-term food surpluses would have been necessary to meet expanded nutritional needs. Furthermore, they may also explain the relative paucity of effective long-distance kill weaponry in the Eastern Gravettian lithic and bone tool inventories which do, however, contain an abundance of implements suitable for thrusting at short ranges.

The sum of these data suggest to us that the advance and spread of the Eastern Gravettian technocomplex in Upper Paleolithic central and eastern Europe may not be about the development of particular lithic tools for the hunt, such as Gravettian or Kostenki points, whose "kill power" and use as hunting weaponry is suspect to begin with, but about the socially stimulated development and use of communal net-hunting practices.

ACKNOWLEDGMENTS

The authors wish to thank E. Dinan for providing invaluable assistance with computerizing the clay specimen inventory and for the requisite background and cross-cultural research concerning the use of nets in hunting. We would also like to thank J. S. Illingworth who assembled much of the numerical data, assisted with the production of *Tables 3* and *4*, and made the analytical phase of this research flow a little more smoothly. Initial identification of the presence of textile fibers was provided by E. E. Roberts. *Figures 1* and *2* were drafted by S. Holland. *Figure 3* was produced by S. L. Snyder. This paper was edited by W. J. Meyer, Jr.. O. Soffer wishes to acknowledge the National Endowment for the Humanities for providing a summer stipend and the Research Board of the University of Illinois for support of this project. This research was also supported by a grant to O. Soffer from the International Research and Exchange Board with funds provided by the U.S. State Department (Title VIII program). The views and statements expressed above and any errors or biases found within this document are solely the responsibility of the authors and in no way should be attributed to any of the above-mentioned funding agencies or organizations.

REFERENCES

ADOVASIO J. M., 1970: The origin, development and distribution of Western archaic textiles and basketry. *Tebiwa: Miscellaneous Papers of the Idaho State University Museum of Natural History* 13/2: 1–40.

ADOVASIO J. M., 1975: Fremont basketry. *Tebiwa: Miscellaneous Papers of the Idaho State University Museum of Natural History* 17/2: 67–76.

ADOVASIO J. M., 1977: *Basketry technology: A guide to identification and analysis.* Chicago.

ADOVASIO J. M., 1997: Cordage and cordage impressions from Monte Verde. In: T.D. Dillehay (Ed.): *Monte Verde: A late Pleistocene settlement in Chile. The archaeological context and interpretation.* Vol. 2. Pp. 221–228. Washington.

ADOVASIO J. M., HYLAND D. C., 1993: *Paleo-Indian perishables from Pendejo Cave: A brief summary.* Paper presented at the 58th Annual Meeting of the Society for American Archaeology. St. Louis.

ADOVASIO J. M., HYLAND D. C., SOFFER O. 1997: Textiles and cordage: A preliminary assessment. In: J. Svoboda (Ed.): *Pavlov I–Northwest.* Pp. 403–424. The Dolní Věstonice Studies, vol. 4. Brno.

ADOVASIO J. M., LYNCH T. F., 1973: Preceramic textiles from Guitarrero Cave, Peru. *American Antiquity* 38: 84–90.

ADOVASIO J. M., MASLOWSKI R. F., 1980: Textiles and cordage. In: T.F. Lynch (Ed.): *Guitarrero Cave.* Pp. 253–290. New York.

ADOVASIO J. M., SOFFER O., DIRKMAAT D., PEDLER C., PEDLER D., THOMAS D., BUYCE R., 1992: *Flotation samples from Mezhirich, Ukranian Republic: A micro-view of macro-issues.* Paper presented at the 57th Annual Meeting of the Society for American Archaeology. Pittsburgh.

ADOVASIO J. M., SOFFER O., KLÍMA B., 1995*: Paleolithic fiber technology: Data from Pavlov I, Czech Republic, ca 27,000 B.P.* Paper presented at the 60th Annual Meeting of the Society for American Archaeology. Minneapolis.

ADOVASIO J. M., SOFFER O., KLÍMA B., 1996: Upper Paleolithic fibre technology: Interlaced woven finds from Pavlov I, Czech Republic, c. 26,000 years Ago. *Antiquity* 70: 526–534.

ANDREWS R. L., ADOVASIO J. M., 1980: *Perishable industries from Hinds Cave, Val Verde County, Texas.* Ethnology Monographs no. 5. Department of Anthropology, University of Pittsburgh. Pittsburgh.

ANDREWS R. L., ADOVASIO J. M., 1996: The origins of fiber perishables production East of the Rockies. In: J. B. Peterson (Ed.): *A most indispensable art: Native fiber industries from eastern North America.* Pp. 30–49. Knoxville.

ANDREWS R. L., ADOVASIO J. M., CARLISLE R.C., 1986: *Perishable industries from Dirty Shame Rockshelter, Malheur County, Oregon.* Ethnology Monographs no. 9 and University of Oregon Anthropological Papers No. 34. Eugene.

BALFÉT H. 1952: La vannerie: Essai de classification. *L'Anthropologie* 56: 259–280.

BARBER E. J. W., 1991: *Prehistoric textiles.* Princeton.

BAR-YOSEF O., 1985: *A cave in the desert: Nahal Hemar.* Jerusalem.

CHAPMAN J., ADOVASIO J. M., 1977: Textile and basketry impressions from Icehouse Bottom, Tennessee. *American Antiquity* 42: 620–625.

CRESSMAN L.D., 1942: *Archaeological researches in the northern Great Basin.* Carnegie Institution of Washington Publications no. 538. Washington.

DEREVIANKO A. P., MEDVEDEV V. E., 1995: The Amur River Basin as one of the earliest centers of ceramics in the Far East. In: *International Symposium on the Origin of Ceramics in Eastern and Northeastern Asia. Exploring the Sources of Jomon Culture. Abstracts.* Pp. 13–14. Sendai, Japan.

DILLEHAY T. D., PINO M., 1989: Stratigraphy and chronology. In: T. D. Dillehay (Ed.): *Monte Verde: A late Pleistocene settlement in Chile. Paleoenvironment and site context.* Vol. 1. Pp. 133–145. Washington.

DRIVER H. E., 1961: *Indians of North America.* Chicago.

DROOKER P. B., 1992: *Mississippian village textiles at Wickliffe.* Tuscaloosa.

ELLIS-PINTO C., 1994: *Three new dates for basketry from the Winnemucca Lake Caves, Pershing County, Nevada.* Paper presented at the 24th Meeting of the Great Basin Anthropological Conference. Elko. Nevada.

EMERY. I., 1966: *The primary structures of fabrics: An illustrated classification.* Washington.

FOWLER C. S., DANSIE A. J., HATTORI E. M., 1997*: Plaited matting from Spirit Cave, Nevada: Technical implications.* Paper presented at the 62nd Annual Meeting of the Society for American Archaeology. Nashville.

FRISON G. C., ANDREWS R. L., ADOVASIO J. M., CARLISLE R. C., EDGAR R., 1986: A late Paleoindian animal trapping net from northern Wyoming. *American Antiquity* 51: 352–361.

HALD B., 1941: The nettle as a culture plant. *Folk-live* 6: 28–49.

HURLEY W.M., 1979: *Prehistoric cordage: Identification of impressions on pottery.* Aldine Manuals on Archaeology no. 3. Washington.

HYLAND D. C., 1997: *Perishable industries from the Jornada Basin, South-Central New Mexico.* Unpublished Ph.D. dissertation. Pittsburgh.

HYLAND D. C., ADOVASIO J. M., 1995: *Perishable industries from Pendejo Cave, New Mexico.* Paper presented at the 60th Annual Meeting of the Society for American Archaeology. Minneapolis.

HYLAND D. C., ADOVASIO J. M., ILLINGWORTH J. S., 1997: The perishable artifacts. In: J. Libby, R. S. MacNeish (Eds.): *Excavations at Pendejo Cave.* Albuquerque. (in print).

JENNINGS J. D., 1957: *Danger Cave.* Anthropological Papers no. 27. Department of Anthropology, University of Utah. Salt Lake City.

KLÍMA B., 1955: Přínos nové paleolitické stanice v Pavlově k problematice nejstarších zemědělských nástrojů. *Památky archeologické* 46: 7–29.

KLÍMA B., 1995: *Dolní Věstonice* II. ERAUL no. 73. Liège.

KOZLOWSKI J. K., 1985: The Gravettian in central and eastern Europe. In: F. Wendorf, A.E. Close (Eds.): *Advances in World Archaeology.* Vol. 5. Pp. 131–200.

LAUB R. S., TOMENCHUK J., STORCK P. L., 1996: A dated mastodon bone artefact from the late Pleistocene of New York. *Archaeology of Eastern North America* 24: 1–17

LEROI-GOURHAN A., 1982: The archaeology of Lascaux Cave. *Scientific American* 246/6: 80–88.

LEROI-GOURHAN A., ALLAIN J., 1979: *Lascaux Inconnu.* Paris.

MASON O. T., 1904: Aboriginal American basketry: Studies in a textile art without machinery. In: *Report of the U. S. National Museum 1902.* Pp. 169–548.

MASON S. L. R., HATHER J. G., HILLMAN G. C., 1994: Preliminary investigation of the plant macro-remains from Dolní Věstonice II, and its implications for the role of plant foods in Palaeolithic and Mesolithic Europe. *Antiquity* 68: 48–57.

MURDOCK G. P., 1937: Comparative data on the division of labor by sex. *Social Forces* 15: 551–553.

MURDOCK G. P., PROVOST C., 1973: Factors in the division of labor by sex: A cross-cultural analysis. *Ethnology* 12: 203–226.

MUSIL R., 1994: The fauna. In: J. Svoboda (Ed.): *Pavlov I, Excavations 1952–53.* Pp. 181–209. ERAUL no. 66. Liège.

NADEL D., DANIN A., WERKER E., SCHICK T., KISLEV M.,E., STEWART K., 1994: 19,000-year-old twisted fibers from Ohalo II. *Current Anthropology* 35: 451–457.

OPRAVIL E., 1994: The vegetation. In: J. Svoboda (Ed.): *Pavlov I, Excavations 1952–53.* Pp. 163–167. ERAUL no. 66. Liège.

ORR P. C., 1974: Notes on the archaeology of the Winnemucca Caves. In: D. R. Tuohy, D. L. Rendall (Eds.): *Collected papers on aboriginal basketry.* Pp. 47–59. Nevada State Museum Anthropological Papers no. 16. Canson City.

PŘICHYSTAL A., ŠKRDLA P. SVOBODA J., TOMÁŠKOVÁ S. 1994: The lithics. In: J. Svoboda (Ed.): *Pavlov I, Excavations 1952–1953.* Pp. 23–94. ERAUL no. 66. Liège.

ROSCOE P. B., 1990: The bow and spreadnet: Ecological origins of hunting technology. *American Anthropologist* 92: 691–701.

ROSCOE P. B., 1993: The net and the bow in the Ituri. *American Anthropologist* 95: 153–155.

SAHLINS M., 1972: *Stone Age economics.* New York.

SATTERTHWAIT L., 1986: Aboriginal Australian net hunting. *Mankind* 16: 31–48.

SATTERTHWAIT L., 1987: Socioeconomic implications of Australian aboriginal net hunting. *Man* (N. S.) 22: 613–636.

SCHICK T., 1988: Nahal Hemar Cave: Cordage, basketry, and fabrics. *'Atiqot* (English series) 18: 31–43.

SCHOLTZ S. C., 1975: *Prehistoric plies: A structural and comparative analysis of cordage, netting, basketry, and fabric from Ozark Bluff shelters.* Arkansas Archaeological Survey Research Series no. 9. Fayetteville.

SHAW G. R., 1972: *Knots: Useful and ornamental.* New York.

SOFFER O., 1989: Storage, sedentism, and the Eurasian Paleolithic record. *Antiquity* 63: 719–732.

SOFFER O., VANDIVER P., 1997: The ceramics from Pavlov I – 1957 excavation. In J. Svoboda (Ed.): *Pavlov I–Northwest.* Pp. 383–402. The Dolní Věstonice Studies, vol. 4. Brno.

STEWARD J. H., 1938: Basin-plateau aboriginal sociopolitical groups. *Bureau of American Ethnology Bulletin*: 120.

STILE T. E., 1982: Perishable artifacts from Meadowcroft rockshelter, Washington County, Southwestern Pennsylvania. In: R. C. Carlisle, J. M. Adovasio (Eds.): *Meadowcroft: Collected papers on the archaeology of Meadowcroft rockshelter and the Cross Creek drainage.* Pp. 130–141. Minneapolis.

SVOBODA J. (Ed.), 1991: *Dolní Věstonice II – Western Slope.* ERAUL no. 54. Liège.

SVOBODA J. (Ed.), 1994: *Pavlov I, Excavations 1952–53.* ERAUL no. 66. Liège.

SVOBODA J., LOŽEK V., VLČEK E., 1996: *Hunters between East and West: The Paleolithic of Moravia.* New York.

TURNBULL C. M., 1965: *Wayward servants.* Garden City. New York.

VANDIVER P. B., SOFFER O., KLÍMA B., SVOBODA J., 1990: Venuses and wolverines: The origins of ceramic technology ca 26,000 B.P. In: W. D. Kingery (Ed.): *The changing roles of ceramics in society: 26,000 B.P. to the present.* Pp. 18–81. Ceramics and Civilization, vol. 5. Westerville.

WENDRICH W., 1991: *Who is afraid of basketry: A guide to recording basketry and cordage for archaeologists and ethnographers.* CNWS Publications no. 6. Centre for Non-Western Studies. Leiden.

WHEELER S. M., WHEELER G. N., 1969: Cave burials near Fallon, Churchill County, Nevada. In: D. L. Rendall, D. H. Tuohy (Eds.): *Miscellaneous papers on Nevada archaeology* 1–8: 70–78. Nevada State Museum Anthropological Papers no. 14. Carson City.

WILKIE D. C., CURRAN B., 1991: Why do Mbuti hunters use nets? Ungulate hunting efficiency of archers and net-hunters in the Ituri rain forest. *American Anthropologist* 93: 680–689.

WILSON T., 1889: Ancient Indian matting from Petit Anse Island, Louisiana. *Annual Report of the U. S. National Museum, 1888*: 673–676.

ZHUSHCHIKHOVSKAYA I. S.: 1996: Current data on the early pottery of Primorie region, Russian Far East. *Journal of Korean Historical Society* 21: 301–312

Olga Soffer
Department of Anthropology
University of Illinois
Urbana, Illinois 61801
USA
E-mail: o-sofer@uiuc.edu

James M. Adovasio
Mercyhurst Archaeological Institute
Mercyhurst College
Erie, Pennsylvania 16546
USA
E-mail: adovasio@staff.mercy.edu

David. C. Hyland
Mercyhurst Archaeological Institute
Mercyhurst College
Erie, Pennsylvania 16546
USA

Bohuslav Klíma
Institute of Archaeology AS CR
Královopolská 147
61200 Brno
Czech Republic

Jiří Svoboda
Department of Palaeolithic and
Palaeoethnology AS CR
69129 Dolní Věstonice
Czech Republic
E-mail: ps@isibrno.cz