Earliest Evidence for Textile Technologies

EARLIEST EVIDENCE FOR TEXTILE TECHNOLOGIES

L. Bender Jørgensen, A. Rast-Eicher and W. Wendrich

Abstract. *Recent excavations at Çatalhöyük[1] in Anatolia, Turkey have recovered remains of textiles, cordage and basketry that add to finds from previous work at this Neolithic site. Along with occurrences from other sites in the Near East, North Africa and Europe, they enable charting the development of textile techniques. This paper argues that the woven textiles found in Çatalhöyük (6700–6500 cal. BC) fit in a long development in the Palaeolithic, Epipalaeolitic and Pre-Pottery Neolithic periods, during which strings and basketry techniques were used to produce a large variety of objects such as shelters, rigid containers, and flexible fabrics that may be termed textiles. Çatalhöyük is currently the earliest site where preserved woven textiles have been found and forms the starting point for our discussion of the emergence of textile technologies. Weaving appears across a wide geographical area in the first half of the 7th millennium cal. BC. We argue that two of the earliest attested basketry techniques, weft-twining, and weft-wrapping (soumak and related techniques), are closely connected to the development of weaving. The size and edges of textiles, matting and basketry provide the basis to reconstruct tools, loom types and production technology and give important insights in a society's gendered technological development, that are different from those provided by the study of lithic, ceramic or metal technology. Many find spots in the Near East, North Africa and Europe document this development.*

Résumé. *Les fouilles récentes à Çatalhöyük, en Anatolie (Turquie), ont permis de retrouver des vestiges de textiles, de cordages et de vanneries qui s'ajoutent aux découvertes faites lors de travaux antérieurs sur ce site néolithique. Avec d'autres sites du Proche-Orient, d'Afrique du Nord et d'Europe, ils permettent de retracer l'évolution des techniques textiles. Dans cet article, nous montrons que les tissus trouvés à Çatalhöyük (6700-6500 av. J.-C.) sont le résultat d'un long développement durant le Paléolithique, Épipaléolithique et Néolithique pré-céramique au cours duquel les cordes et certaines techniques de vannerie furent utilisées pour produire une grande variété d'objets tels que des abris, des contenants rigides et des tissus souples que l'on peut qualifier de textiles. Nous soutenons que deux des plus anciennes techniques de vannerie attestées, vanneries cordées et soumak, sont étroitement liées au développement du tissage. La taille et les bords des textiles, des nattes et de la vannerie permettent de reconstituer les outils, les types de métiers à tisser et la technologie de production, donnant des indications importantes sur le développement technologique, différentes de celles fournies par l'étude de la technologie lithique, céramique ou métallique. Si plusieurs sites au Proche-Orient, l'Afrique du Nord et de l'Europe confirment ce développement, Çatalhöyük est actuellement le site le plus ancien où l'on ait trouvé des textiles tissés préservés, constituant le point de départ de notre discussion sur l'émergence du tissage au cours des VII^e^-V^e^ millénaires av. J.-C.*

Keywords. *Neolithic Near East, basketry, cordage, twining, wrapping, weaving, Çatalhöyük*
Mots-clés. *Proche-Orient néolithique, vannerie, fils et cordes, vannerie cordée, vannerie à trames enroulées autour de montants (soumak), tissage, Çatalhöyük*

1. Alternative spelling: Çatal Hüyük.

INTRODUCTION

Plant-based materials rarely survive, while stone, bone, ceramic and metal are more prominent in the archaeological record. Textiles, matting and basketry must have been ubiquitous objects that had an essential function in ancient society, while both their use and their production have been underrepresented (see also Hurcombe 2014). As outlined below, textile techniques were used to produce everything from simple strings to sturdy containers, bags, mats, nets, fish-traps, narrow bands for carrying, large sheets for covering, sheltering, or clothing, in short objects that were used by all people of all ages, genders, professions and layers of society. The focus on lithic and ceramic technologies has resulted in a warped view of ancient production and use of material culture, in which textile technology is either disregarded or misunderstood.

The textile, basketry and matting finds from Çatalhöyük, which yielded the oldest preserved woven textiles to date, are put in temporal context with finds from the Near East, North Africa and Europe (table 1 and online catalogue)[2]. Doing so, provides a means to understand technological developments in which strings, matting and basketry techniques have led to the development of simple looms that ultimately enabled the production of woven textiles. An outline of loom types and the ways that matting and textile edges provide information on the type of loom used for its creation, provides insight in the development of this technology.

Fig. 1 – *Excavations on the East Mound of Catalhöyük, showing interior platforms covering mat-covered burials (photo C. Morgan).*

TEXTILES, MATTING AND BASKETRY FROM ÇATALHÖYÜK

Çatalhöyük is a well-known Neolithic tell site in Anatolia (fig. 5.27), situated on an alluvial fan in the Konya Basin, surrounded by marshlands, pools and river channels. The settlement was excavated from 1961–1965 by James Mellaart and again from 1993–2017 by Ian Hodder (Mellaart 1967; Hodder 2021; see http://catalhoyuk.com). It has been described as an early town, consisting of layers of mostly domestic buildings, lived in, abandoned and built over in a continuous occupation that has been linked to the physical expression of cultural memory (Hodder 2016, 2018; Lercari and Busacca 2020). Based on large scale excavations, the layout of the site and individual houses was reconstructed, as was the internal use of space. An important aspect is that the dead were buried inside the houses, under the floor of platforms (fig. 1). The dead were separated from the surrounding earth by matting or baskets that were preserved as impressions and phytoliths. In some cases, houses were destroyed by fire shortly after a burial; this has caused perishable objects like basketry and textiles to be preserved by charring (Helbæk 1963; Burnham 1965; Wendrich 2005; Wendrich and Ryan 2012; Rast-Eicher and Bender Jørgensen 2018; Bender Jørgensen et al. 2021; Rast-Eicher et al. 2021).

DATING

Carbon14-dates from Çatalhöyük have been calibrated several times over the years; while Mellaart placed the site

2. Table and online catalogue list all sites prior to 5000 cal. BC that we have been able to find where basketry, cordage, and textile from the Near East, North Africa and Europe are published. References to individual sites are in the catalogue.

Table 1 – *Finds of basketry, cordage, matting and textiles in the Near East, North Africa and Europe in chronological order until the late 6th millennium cal. BC.*

No	Site	Date	Thread/Cordage	Wrapping	Twining rigid basketry	Twining flexible fabric	Coiled Basketry	Matting	Netting	Woven textile
1	Ohalo II, Israel	21000 cal. BC	●						?	
2	Lascaux, France	19000 cal. BC	●							
3	Abu Hureyra, Syria	11220–10750 and 7760–7100 cal. BC						● imprint		
4	Wadi Murrabba'at, West Bank	10762 and 9812 cal. BC; new basket 8500 cal. BC	●	●	●	●				
5	Shanidar Cave Layer B-1, Iraq	9650 cal. BC						●		
6	M'lefaat, Iraq	9660–8840 cal. BC						●		
7	Gilgal I, West Bank Locus 11	9550–9100 cal. BC			●					
8	Jerf el-Ahmar, Syria	9500–8700 cal. BC					● imprint			
9	Jericho, West Bank	9300–7580 cal. BC. Dates of later layers not available.		●			●	●		
10	Qumran FQ37,West Bank	9300 cal. BC			●					
11	Friesack 4, phase I, Germany	9340–8670 cal. BC.	●							
12	Netiv Hagdud, West Bank Locus 1001	9310–8830 cal. BC	●		●					
13	Antrea, Karelia, Russia	8400–8300 cal. BC							●	
14	Takarkori rock shelter, Acacus Mts., SW Libya	8300–6100 and 6400–3000 cal. BC			●					
15	Tell Aswad, Syria (PPNB Moyenne)	8200–7500 cal. BC				●	● imprint			
16	Nahal Hemar, Israel	8200–7300 cal BCE	●	●		●	●	●		
17	Uan Afuda Cave, Libya	8000–7000 cal. BC	●			●				
18	Beidha, Jordan	7600–7500 cal. BC					●			
19	Tell Halula, Syria	7600–7300 cal. BC	●			●				
20	Cayönü, Turkey, Cell Building DS, phase c3	7500 cal. BC				●	●			
21	Jarmo, Iraq	7000–6500 cal. BC					● imprint	● imprint		● imprint
22	Tell Magzaliya, Iraq	7th millennium BCE					● imprint	● imprint		
23	Ali Kosh, Iran	8000–5800 BCE			● imprint		● imprint	● imprint		
24	El Kown 2 – Caracol, Syria	7100–6000 cal. BC					● imprint	● imprint		● imprint
25	Noyen-sur-Seine, France	7190–6450 cal. BC			●					
26	Ti-n-Hanakaten, Algiers	ca. 6800 BCE	●		●		●			
27	Çatalhöyük, Turkey, Middle levels	6700–6500 cal. BC (textiles and cordage)	●			●	●	●		●
28	Telul eth-Thalathat, Iraq	6600–6200 cal. BC					?	● imprint		● imprint
29	Shir, Syria	6600–6400 cal. BC				● imprint	● imprint			● imprint
30	El-'Oueili	6500–5400 BCE								● imprint
31	Ulucak Höyük, Turkey Level Vb	6400–6000cal. BC								●
32	Tell Kashkashok, Syria	6500–6000 cal. BC					● imprint	● imprint		● imprint
33	Tell es-Sawwan, Iraq	6200–5600 cal. BC								● imprint
34	Hama, Syria	6000 BCE					● imprint			
35	Umm Dabaghiyah, Iraq	6200–5750 cal. BC					● imprint	● imprint		
36	Nea Nikomedeia, Greece	6190–6050 cal. BC			●					
37	Tell Shimshara, Iraq	6000–5800 cal. BC								● imprint

No	Site	Date	Thread/Cordage	Wrapping	Twining rigid basketry	Twining flexible fabric	Coiled Basketry	Matting	Netting	Woven textile
38	Ilıpınar, Turkey Level X and VB3	6000 and 5450 cal. BC								●
39	Favella, Italy	5870–5620 cal. BC					● imprint			
40	Grotta Santa Croce, Italy	5600–5250 cal. BC					● imprint/ charred			
41	La Draga. Spain	5300–5000 and 5200–4900 cal. BCE					●			

between ca 6500 and 5720 BCE, by 2005 this was first revised to ca 7400-5900 cal. BC (Cessford 2005: 94); subsequently it was further corrected and currently the dating framework of the Çatalhöyük East mound is 7100–5950 cal. BC (Hodder and Kutlu 2021: table 1.2.).[3] This date range is further divided into Early, Middle, Late and Final phases. Basketry and matting have been found in layers spanning the Early, Middle and Late sequence (7100–6300 cal. BC), while all remains of twining, woven textiles and cordage date to the Middle phase, i.e., 6700–6500 cal. BC.[4]

USE

Almost all finds of textiles and basketry at Çatalhöyük derive from burials. The dead were tightly wrapped; some time afterwards their bones were re-wrapped or bound. Twined and woven textiles and strings made of grasses or bast fibres were used for this, as shown by a collection of lengths of narrow tape wound around a bundle of excarnated bones (Burnham 1965: plate XXXIIIa). Another example of secondary burial is a string tied around a skull, passing into the eye socket (Bender Jørgensen et al. 2021: 271, fig. 11.7). Cord and string were also used for other purposes e.g., for stringing beads. Basketry is well documented as containers or as matting, preserved as phytoliths and sometimes as imprints on clay balls rolled on plaited or coiled mats (fig. 2). Coiled baskets were used as containers, and in some cases re-used for burials.

Besides cordage and textiles, the dead were also wrapped or covered in hides. Even if they had not been documented during the excavations, little pieces of skin—according to the visible pores probably sheep or goat skin—were found (Bender Jørgensen et al. 2021: 100).

TECHNIQUES AT ÇATALHÖYÜK

Textile and basketry techniques at Çatalhöyük comprise coiling, plaiting, netting, twining, and weaving. Coiled baskets were made by fastening a small bundle of grass in a coil by winding a single leaf around the bundle and stitching it to the previous bundle (fig. 3d). Matting was made by plaiting, mostly in an over 1/under 1 technique termed basketry tabby (fig. 3a), or in at least one case in basketry twill, over 2/under 2, shifting one strand (fig. 3b). In some cases, matting also appears to have been made by either piercing plant culms (fig. 3c), or perhaps by widely spaced twining. Twining is a versatile technique that can be used for many purposes and in varieties such as warp- or weft twining. It can be densely packed or have open spaces between the binding warp or weft (fig. 4; Rast-Eicher and Dietrich 2015: figs. 93–127). If a twined object is stiff, rigid and coarse it is grouped as “basketry”; if it is soft, thin and flexible it is often termed “textile”. There are no indications that twining was used widely as floor matting or in burials. Instead, there was a preference for very fine tabby plaiting or coiling (fig. 3). The only evidence for twill plaiting is from impressions in clay and shows that these were coarse mats made from a stiff, ribbed plant material, such as reed (fig. 2d).

Textiles from Çatalhöyük appear in two techniques: weft-twining and tabby weaving (Rast-Eicher and Bender Jørgensen 2018; Bender Jørgensen et al. 2021). They are all

3. The Çatalhöyük West mound has a different chronology but as no remains of textiles or basketry have been found there, only the East Mound is discussed in this paper.
4. Rast-Eicher and Bender Jørgensen 2018 has 6700–6300 cal. BC; this has now been further narrowed down.

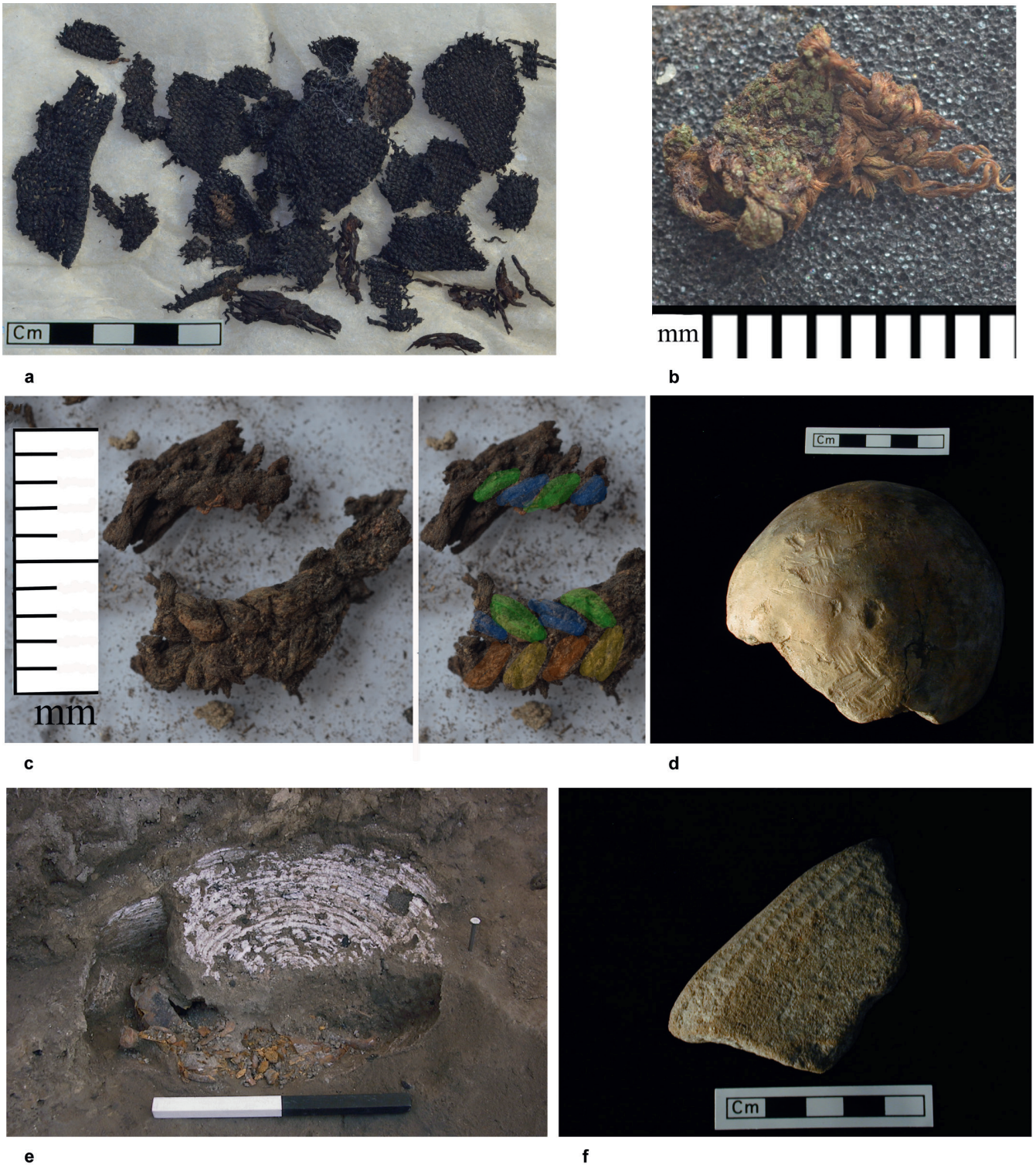

Fig. 2 – *Textile and matting evidence found in Catalhöyük. a. Charred textile fragments in the Leiden collection (Mellaart excavation); b. Textile found with beads, unit no 17457 X10; ca Herringbone weft twining, unit no 30503.s10; d. Clay ball with imprint of twill-plaited matting; e. Phytolith-covered imprints of an oval coiled mat covering a neonate, scale is 50 cm; f. Imprint of coiled basketry in clay (a-c. Photo A. Rast-Eicher; d, f. Photo M. Ashley for the Catalhöyük Research Project; e. Photo J. Quinlan for the Catalhöyük Research Project).*

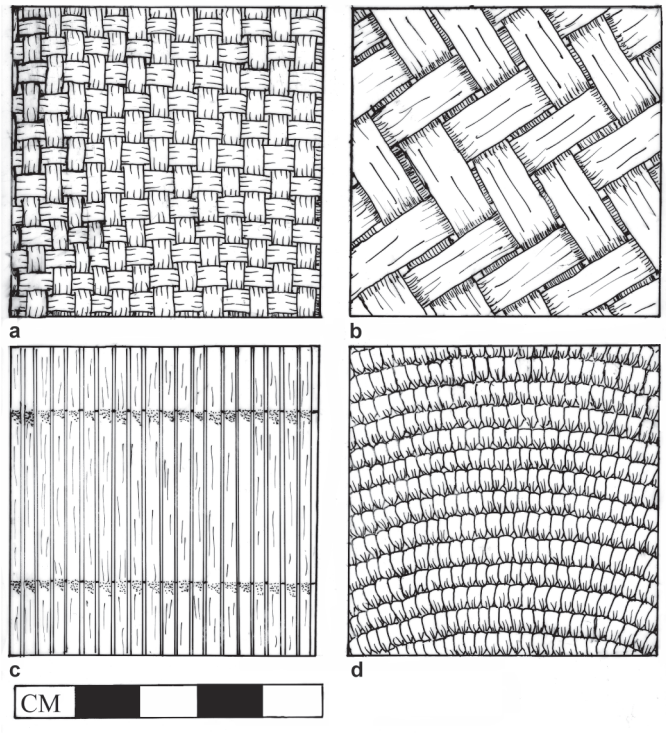

Fig. 3 – *Matting techniques attested in Catalhöyük (drawings W. Wendrich). a. Fine tabby plaited matting; b. Coarse twill plaited matting; c. Putative pierced/stitched matting; d. Fine coiled matting.*

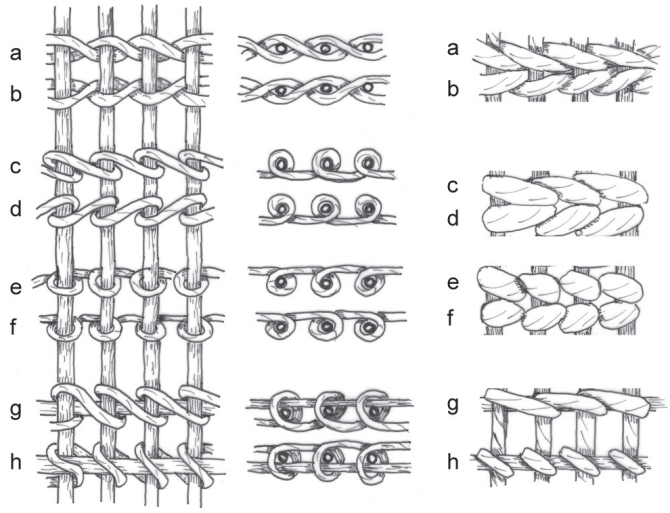

Fig. 4 – *Various twining and wrapping techniques, schematic drawing and cross section to the left, appearance to the right (drawings W. Wendrich). a. Schematic and appearance of twining in Z-direction; b. Schematic and appearance of twining in S-direction; c. Front view of wrapping over two warp strands in Z-direction; d. Front view of wrapping over two warp strands in S-direction; e. Rear view of wrapping over two warp strands in Z-direction; f. Rear view of wrapping over two warp strands in S-direction; g. Front view of wrapping with two passive elements in Z-direction; h. Rear view of wrapping with two passive elements in Z-direction.*

made of threads of spliced plant fibres[5]. In at least two cases, starting borders in the form of a starting cord reinforced by 3 threads have been observed; in one piece, the end of the web was made as herringbone weft-twining, combining the two techniques (fig. 2c)

EVIDENCE FOR EARLY TEXTILE TECHNIQUES: TEMPORAL CONTEXTUALIZATION

Remains of cordage, basketry and several forms of textiles have been reported from at least 41 Palaeolithic, Mesolithic or Neolithic sites from the Near East and North Africa, and from Palaeolithic and Mesolithic sites in Europe[6]. Textiles and basketry can also be attested by the presence of tools and in combination with actual fibre remains allows us to chart the first attestations of the various techniques such as coiling, wrapping, twining and weaving. The numbers in the text behind the site names refer to the map (fig. 5) and the complete catalogue that is published online. See also Table 1. The selection of sites is not exhaustive, because it was dependent on the archaeological research that identified these materials. The limitation to the Near East and sites in North Africa or Europe reflects our consideration of textile technology as a

5. Splicing is a way of making threads from plant fibres by rubbing and intermingling them before plying (Barber 1991: 47; Gleba and Harris 2018). Archaeologists consider ancient fibres usually to be either wool or flax; bast from trees is usually not considered. However, because fibres from Çatalhöyük recently have been identified as oak bast, a string from Wadi Murrabba'at and a textile from Ilıpınar as tree bast (Rast-Eicher et al. 2021), early identifications should be revisited.

6. From what would be a 42nd site in our overview, La Marmotta in Italy, some objects have been preliminarily published (Mineo et al. 2023). The site is dated to 7700–7150 BP. Mineo et al. mention four woven textile fragments, 28 fragments of cordage and 2 threads, and 43 fragments of basketry, mostly made in coiling technique. The woven textiles are among the earliest in Europe. Putative paleolithic identifications based on imprints, tool marks or depictions have been excluded in this overview as being too tentative. The suggestion that an impression in the construction of a pillar at Early Neolithic Nemrik in Iraq (Kozlowski and Kempisty 1990) might indicate wickerwork, is not convincing, considering that nowhere in the region this technique has been attested archaeologically or ethnologically.

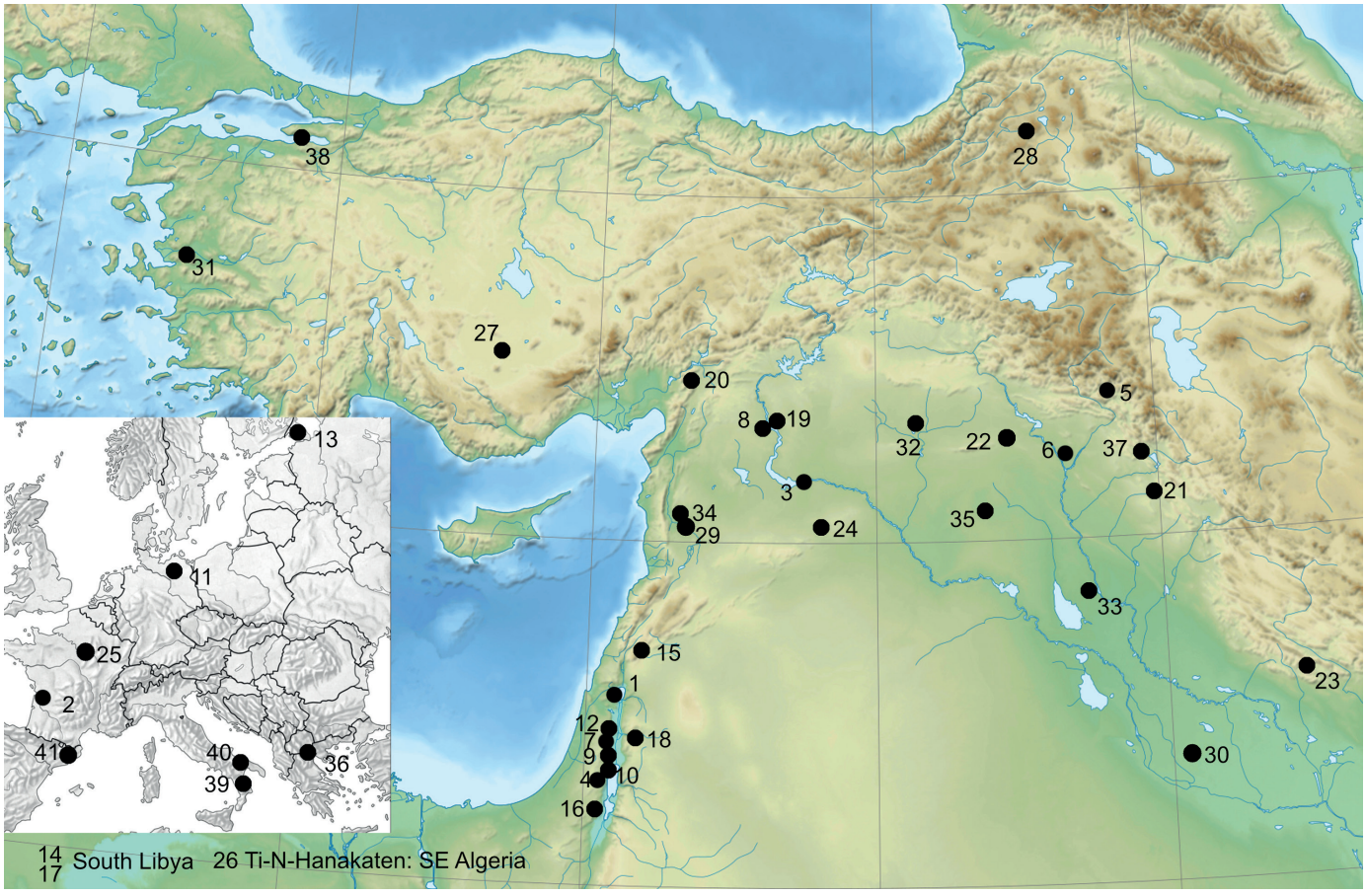

Fig. 5 – *Map of sites mentioned in the text and in the online catalogue (A. Rast-Eicher). 1. Ohalo II, Israel; 2. Lascaux, France; 3. Abu Hureyra, Syria; 4. Wadi Murrabba'at, West Bank; 5. Shanidar Cave, Iraq; 6. M'lefaat, Iraq; 7. Gilgal I, West Bank; 8. Jerf el-Ahmar, Syria; 9. Jericho, West Bank; 10. Qumran FQ37, West Bank; 11. Friesack, Germany; 12. Netiv Hagdud, West Bank; 13. Antrea, Russia; 14. Takarkori, Libya; 15. Tell Aswad, Syria; 16. Nahal Hemar, Israel; 17. Uan Afuda, Libya; 18. Beidha, Jordan; 19. Tell Halula, Syria; 20. Cayönü, Turkey; 21. Jarmo, Iraq; 22. Tell Magzaliya, Iraq; 23. Ali Kosh, Iran; 24. El Kowm 2, Syria; 25. Noyen-sur-Seine, France; 26. Ti n Hanakaten, Algeria; 27. Çatalhöyük, Turkey; 28. Telul eth-Thalathat, Iraq; 29. Shir, Syria; 30. Tell el 'Oueili, Iraq; 31. Ulucak Höyük, Turkey; 32. T. Kashkashok, Syria; 33. Tell es-Sawwan; 34. Hama, Syria; 35. U. Dabaghiyah, Iraq; 36. Nea Nikodemia, Greece; 37. Tell Shimshara, Iraq; 38. Ilıpınar, Turkey; 39. Favella, Italy; 40. Grotta Santa Croce, Italy; 41. La Draga, Spain.*

fundamentally human endeavor, developing in several places at once, rather than spreading through diffusion. The different textile techniques do not replace each other, but are superimposed on earlier ones, and most of the technological principles continued to be used, in some cases even until today.

The earliest evidence of perishable fibre use is strings and cordage, found at Ohalo II in Israel (fig. 5.1), Lascaux in France (fig. 5.2) and in Wadi Murrabba'at in Israel (fig. 5.4)[7].

Two occurrences of twining have been found at Wadi Murrabba'at, dating to the late 11th and early 10th millennia cal. BC (Schick 2010). Twining is also found at the 10th millennium site of Gilgad (fig. 5.7), at the 9th millennium sites Nahal Hemar (fig. 5.16) and Netiv Hagdud (fig. 5.12) in Israel, and Tell Aswad in Syria (fig. 5.15). Other early finds are from Tell Halula, Syria (figs. 5.19, 6a) and Çayönü, Turkey (fig. 5.20), both dating to the 8th millennium.

A technique that has been underexposed is wrapping, in various forms (fig. 4c-4h). It is a way to create a fabric or a structure by using one active strand, which lashes together either one or several passive systems. It has been attested recently in an approximately 10,500-year-old basket found at

7. A recent publication claiming evidence of Neanderthal string production from Abri du Maras, France (Hardy et al. 2020) is highly uncertain. The identification of irregularly twisted wood (not bast) fibre was done at very high magnification and would indicate an extremely fine yarn of about 1mm in diameter and certainly not a "3-ply cord".

Wadi Murrabba'at Cave (fig. 5.4).[8] At Pre-Pottery Neolithic A and B Jericho (fig. 5.9) and the 9th millennium site Nahal Hemar (fig. 5.16) matting also was done in a similar wrapping technique with one active and two passive elements (fig. 4g, 4h; Crowfoot 1982: 548–549; Schick 1988: 33). The right side of figure 4 conveys the appearance of these several twining and wrapping techniques and it may be clear that researchers dealing with imprints or very brittle fragments, will not be able to discern one from the other. It is, therefore, likely that variations of wrapping techniques were much more common in the early basketry and textile corpus than we have considered until now.

Plaiting does not require any tools, but indications for plaited matting from rushes, sedges or reeds has been attested very early as well. Imprints of such mats have been found in Epipalaeolithic and Early Neolithic layers (12th-8th millennia cal. BC) at Abu Hureyra in Syria (fig. 5.3), in Proto-Neolithic burials at Shanidar cave, Iraq, (fig. 5.5) and in the Epipalaeolithic settlement M'lefaat, Iraq (fig. 5.6). Both date to the 10th millennium cal. BC.

The first stages towards the matting and basketry technique coiling have been attested at Jericho on the West Bank (figs. 5.9, 6b) and Nahal Hemar (figs. 5.16, 6c) in Israel, both dated to the 9th millennium cal. BC. At Nahal Hemar and Tell Aswad, Syria (fig. 5.15), this technique was used for round or oval mats like at Jericho, as well as for containers of various shapes. Tools typically used to fasten a bundle of material in a coil are a bone needle or awl, while a bone ring sawn from a long bone might have been used as a gauge to keep the width of the bundle consistent and together. In the earliest attested method akin to coiling, the coiled element is fastened by sticking strings together to form a fabric. This is the case at Nahal Hemar, where cordage was used to build containers by gluing the strings with collagen, indicating a type of animal glue made from bones or hide (fig. 6d). As there is no stitching, the objects are not coiled basketry in the usual sense of the term where a coiled foundation is held in place with a separate strand.

At the early sites of Abu Hureyra (fig. 5.3) and Shanidar cave (fig. 5.5), matting is made in what we term twill plaiting or basketry twill; this technique also has been found at later sites such as Jarmo (figs. 5.21, 6e), Tell Magzaliyah (fig. 5.22), El Kowm 2 (fig. 5.24) and the late phase of Ali Kosh (fig. 5.23) At these four sites and Çatalhöyük, the dating range is the 7th millennium cal. BC. Basketry tabby appears at 10th millennium cal. BC at Jericho (fig. 5.9) and all phases of Ali Kosh. These types of mats can be made by plaiting, or by using a simple frame, a mat loom or half-loom. The technique would then be termed basket weaving, rather than plaiting.

In Europe, organic finds derive from caves or wet environments. The examples listed in the catalogue and figure 5 show either dry conservation in a cave (Palaeolithic cord, fig. 5.2) or wet preservation (the early use of nets and twined basketry in Mesolithic fishing context, fig. 5.11, 5.13, 5.25, and an early Neolithic site, fig. 5.41); imprints of matting derive from a series of Neolithic sites (fig. 5.36, 5.39-5.40).

Firm evidence of weaving has been attested in the first half of the 7th millennium. Imprints of woven textiles on lumps of clay and wall plaster have been found at Jarmo (figs. 5.21, 6f) and El Kowm 2 (fig. 5.24), Telul eth-Thalatat (fig. 5.28), Tell Kashkashok (fig. 5.32), Tell el-'Oueili (fig. 5.30) and Tell es-Sawwan (fig. 5.33), all dated between 7000 and 6000 cal. BC. Preserved remains of tabby-woven textiles have been recovered from Çatalhöyük (fig. 5.27), Ulucak Höyük (fig. 5.31) phase Vb (6400–6000 cal. BC; Çilingiroglu et al. 2012: 141–142), and Ilıpınar (fig. 5.38) level X (ca. 6000 cal. BC; Roodenberg and Roodenberg 2008). A recent claim of early textile imprints from the PPNA site Körtik Tepe (Erdal 2015: 9) is not unequivocally documented. An impression in clay from Jerf el-Ahmar in Syria dated 9500–8700 cal. BC has been claimed as evidence for weaving (Stordeur 2015: fig. 95.6), but the scale and imprints of straight grass stripes on an unpublished photo show that it is coiled basketry[9]. As we have seen, the woven textiles from Çatalhöyük are dated 6700–6500 cal. BC. Currently, this makes them the earliest preserved woven textiles.

Yarn production is evidenced by the occurrence of spindle whorls, which, like evidence for looms in the form of loom weights have been dated to the second half of the 7th millennium, at the site of Ulucak Höyük (fig. 5.31) in Anatolia in the same context as a woven textile. However, we should be careful to assume that the loom weights were used for weaving: as Swiss finds show, they could have been used for large twined fabrics (Rast-Eicher and Dietrich 2015: 112)[10], similar to the ones found in Nahal Hemar (fig. 6a). As Tineke Rooijakkers has shown, the earliest attestations of spindle whorls are in Syria and Mesopotamia about the same time, at the end of the 7th millennium (Rooijakkers 2012: 103). It is important to emphasize that no textile tools were found in Neolithic layers at Çatalhöyük, although this site is often quoted as having provided the earliest evidence of the warp-weighted loom (Rast-Eicher and Bender Jørgensen 2018).

8. Naama Sukenik, personal communication.

9. We thank Danielle Stordeur for showing us this photo with scale.

10. Cat. 561 (Tafel 53) has been found with loom-weights.

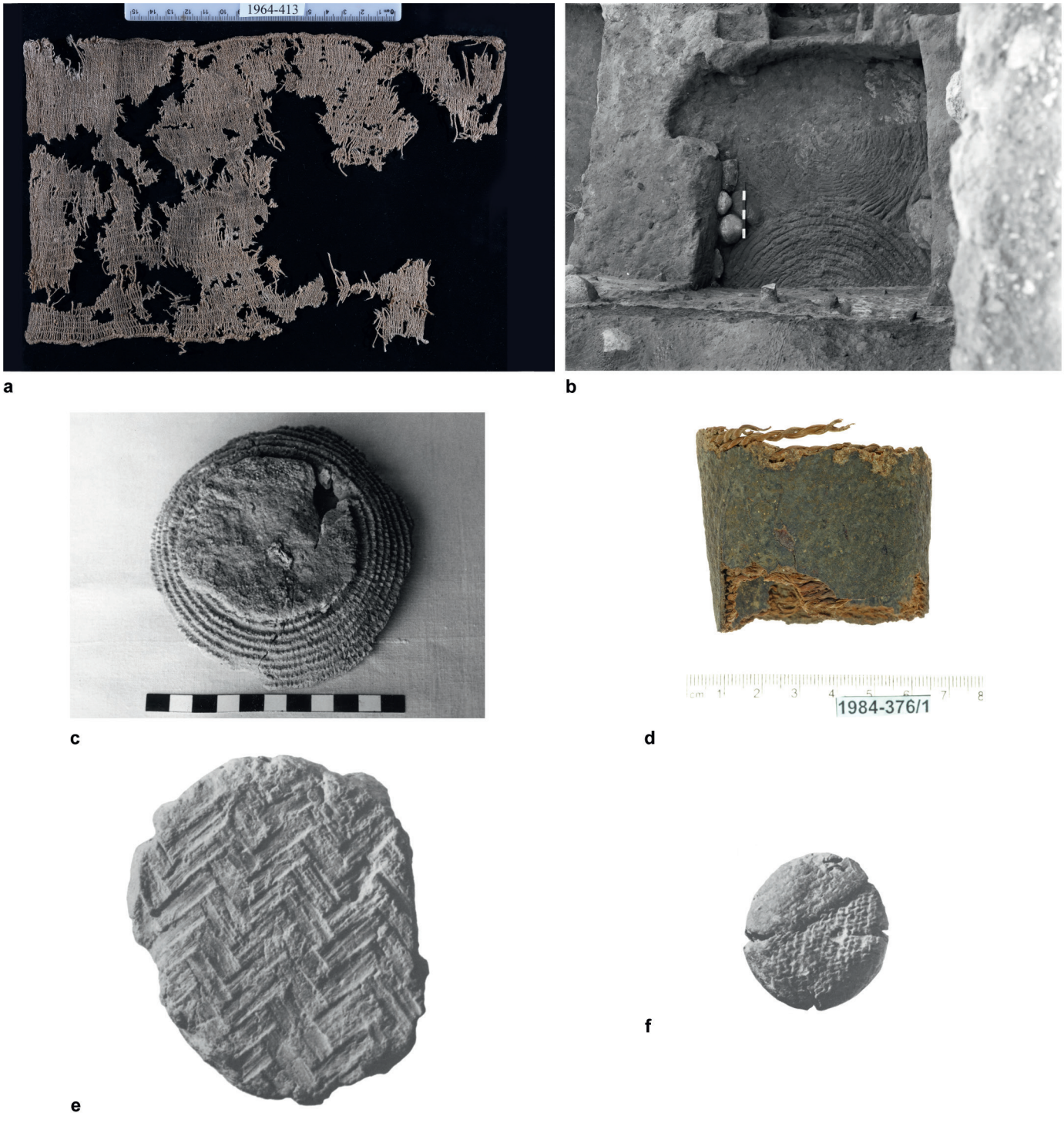

Fig. 6 – *Compared basketry from Near Eastern sites. a. The Nahal Hemar twined 'napkin'; b. Coiled floor mats from Jericho; c. Coiled container from Umm Dabaghiyah level III; d. Container of collagen-covered cordage from Nahal Hemar; e. Matting in basketry twill from Jarmo; f. Imprints of tabby-woven textiles from Jarmo (a, d. Photo Clara Amit, courtesy of the Israel Antiquities Authority; b. Photo D. Corbett, courtesy © UCL, Institute of Archaeology; c. Photo NN. DK_2_3_2_058, courtesy the Diana Kirkbride-Helbaek Archive/ University of Copenhagen; e-f. Photo NN, courtesy of the Oriental Institute of the University of Chicago).*

TECHNOLOGICAL PRINCIPLES

Before we proceed to discuss the technological development of basketry and weaving, it is important to consider the close relation between raw materials and techniques. Making rigid containers (baskets) from rigid materials such as willow branches requires different techniques than if the available raw materials are flexible (e.g., grasses; tree basts).

The importance of rigidity versus flexibility is especially visible in "stake-and-strand" basketry, which can be either woven or twined and often is made in a combination of these techniques. In this type of basketry in which all materials can be the same plant species, for instance, willow rods, the basket maker has carefully selected the size, thickness and flexibility of the rods, so that the thicker, stiffer ones are used for the "warp" ("stakes") and the thinner more flexible ones for the "weft" ("strands").

Providing rigidity to flexible materials can be done in various ways. Perhaps the most widely used is coiling, where bundles of flexible plant materials such as long grass are fastened by winding around or stitching through the previous bundle, thus building a mat or basket by wrapping and sewing the spiralling coil. As we have seen, in the earliest attested method of coiling, a container was made by gluing the coiled element with collagen or bitumen. Previously described as asphalt, recent research has shown that while the glue used at Gilgal was identified as bitumen, that at Nahal Hemar consists of collagen (Schick 2010: 245; Solazzo et al. 2016). A filler can simply be sand, silt or clay, either mixed in naturally or by human action. It is no feat of imagination to consider this technique akin to both stitched coiled basketry and coiled pottery production[11].

In order to understand the differences in technical approaches, the elements of textile and basketry techniques are divided into active and passive systems. In this way, both the actions of the producer, as well as the rigidity/flexibility of the materials can be represented. Active systems are usually handled more by the basket-maker or weaver than passive systems, while active systems are usually also more flexible than passive systems. Even if the purpose is to create a fabric that is equally flexible in all directions, the production process involves an active and passive system. In weaving these are the warp (passive) and weft (active).

11. A similar technique called tournage a la corde is still used in parts of France, see https://www.plumetismagazine.net/technique-poterie-tournage-corde (accessed 15. April 2023)

LOOM TYPES

Weaving requires that the warp is temporarily made rigid by putting tension on the warp threads so that the weft can be inserted. This requires a loom, a mechanical device that creates tension on the warp, and facilitates weft insertion using beams, shed rods and heddles, while sheds and counter-sheds, separating the warp threads in two groups, could have been involved as well. The term half-weaving is used when tension is applied to keep one system (the warp) tight and a shed rod is used to separate odd and even warp threads (a shed), while the counter-shed is woven individually by hand. There are many ways in which weaving can be accomplished, but early loom types most likely were:

- The horizontal matting loom (fig. 7a);
- The horizontal ground loom (fig. 7b);
- The back-strap loom (fig. 7c);
- The vertical warp-weighted loom (fig. 7d).

Such simple looms were used for weaving textiles, most often in simple tabby (Barber 1991; Andersson Strand 2018). They were also used for matting, for instance with a warp of string and a weft of plant stems (Wendrich 1999: 312–317). Bed matting is a form of half weaving where a bed frame is used to give tension to the warp (fig. 8). Twining, twisting a pair of strands around the warp and each other, also requires the use of a loom, unless the passive system is rigid by itself. Only in plaiting the two systems are equal: they have the same size and flexibility, are made of the same material and the strands have the same function in creating the fabric: all are active.

The question of loom types used to create early woven textiles has been discussed by several scholars, but physical evidence is sparse. At PPNA Jerf el Ahmar, an engraving might represent a ground loom (Stordeur and Jammous 1997: 40; Breniquet 2008: 302, fig. 90.1), perhaps for making matting, because the "warp" appears quite coarse. The engraving displays five cross-bars. Further potential evidence of a loom has been found at El Kowm 2. Based on cones of plaster found in two holes in the ground close to a wall, Claudine Maréchal and Danielle Stordeur have suggested that they are remains of a ground loom (Maréchal 1989: 63-66; Stordeur 2000: 50, fig. 14). Catherine Breniquet argued that the two holes and cones represent a backstrap loom rather than a ground loom, as the latter would have needed four holes in the ground (Breniquet 2008: 142–144, fig. 34). These are yet the only suggestions of evidence of Neolithic looms; unfortunately, none of them is unequivocal. Loom weights found in

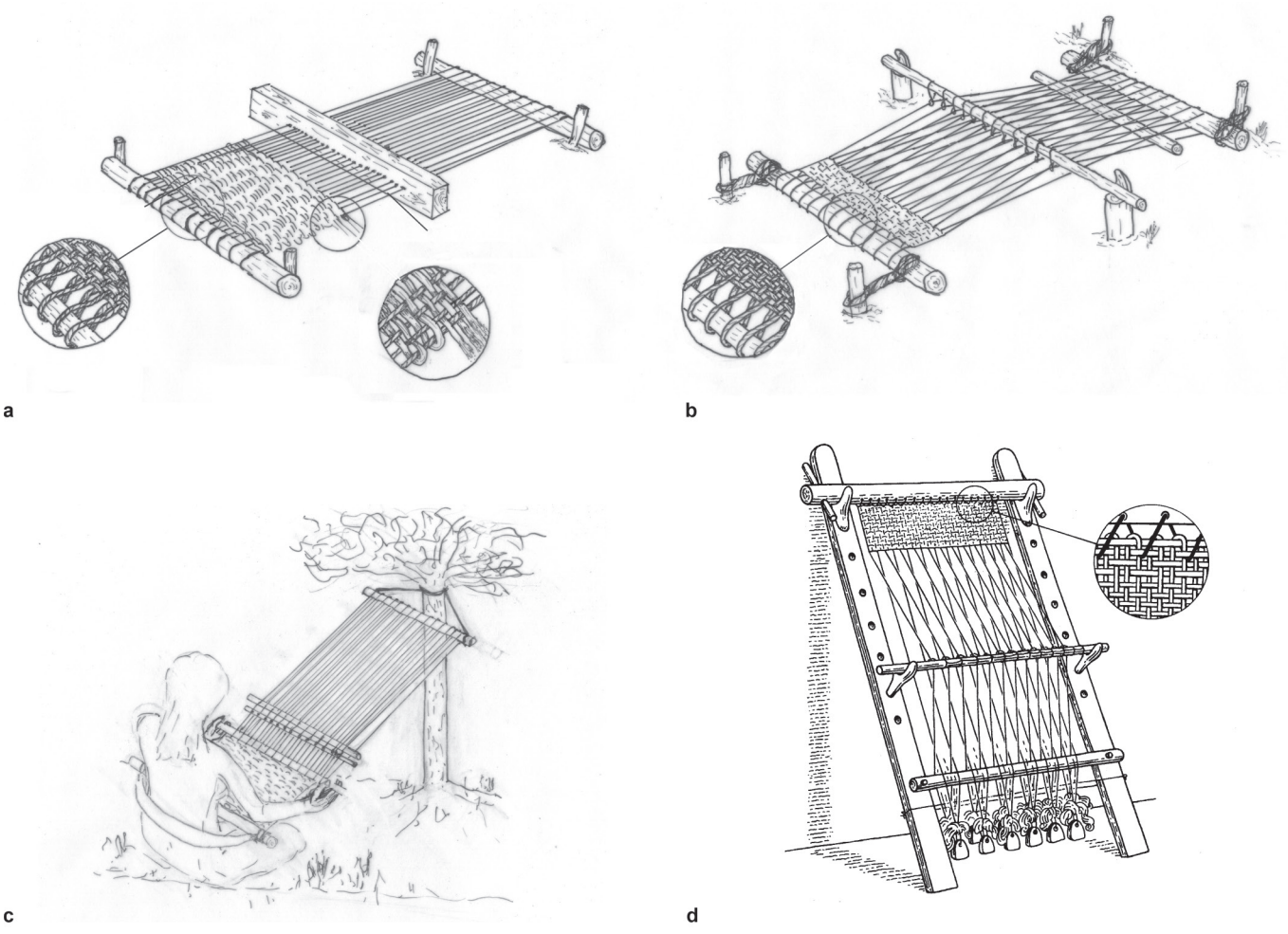

Fig. 7 – *Basic loom types. a. Mat loom with beater beam; b. Loom with adjustable tension and shed stick/beater; c. Back strap loom with shed stick/beater; d. Warp-weighted loom with heddle, shed stick and weights on the warp threads (a. Drawing W. Wendrich, P. Wöhlicke; b, d. Drawings P. Wöhlicke; c. Drawing W. Wendrich).*

levels Va (6200-6000 cal. BC and IVb (5900-5800 cal. BC) at Ulucak Höyük are as yet the earliest evidence of the warp-weighted loom, which could have been used either for twining or for woven textiles (Çilingiroğlu 2009: 14; Schoop 2014: 431; Gleser 2016: 84). Loom weights were also reported from Mersin in layers dated 6000-5800 cal. BC (Gleser 2016: 84).

Several finds dated to the 5th and 4th millennia have been used as evidence for early looms. An early 4th millennium dish found at Badari, Egypt, shows a horizontal ground loom with four corner pegs, two warp beams and three bars across the warp that are interpreted as shed, heddle and beater (Barber 1991: 83; Levy 2020: 132). A cylinder seal from Susa, also dated to the 4th millennium, shows a similar item, although without crossing bars (Barber 1991: 84, fig. 3.3; Breniquet 2008: 304, fig. 91.1).

A group of wooden and bone artefacts recovered from Chalcolithic Nahal Mishmar have been interpreted by Pessah Bar-Adon as parts of a ground loom (Bar-Adon 1980:177-182; Barber 1991: 86; Breniquet 2008: 140–141; Levy 2020: 134, fig. 6.34). Five wooden items were identified as two warp beams, two shed bars and a curved heddle bar, and the bone items as shuttles or a kind of pin beater. Neither Elizabeth Barber, Catherine Breniquet nor Janet Levy are satisfied with Bar-Adon's identification (Barber 1991: 86; Breniquet 2008: 140–141; Levy 2020: 134, fig. 6.34, arguing that the two warp beams are of unequal length and that two shed rods and a curved heddle bar would be impractical. Barber suggests that the items could have been derived from two back-strap looms (Barber 1991: 86). This is supported by Breniquet (Breniquet 2008: 143), while Levy rejects it on the

grounds that there is no local tradition of back-strap looms while the horizontal ground loom is attested from the mid-5th millennium (Levy 2020: 134). Although the Chalcolithic layers of Nahal Mishmar are considered to belong to the late Chalcolithic, a mat from Nahal Mishmar has been ^{14}C-dated to ca 4350 BCE (Aardsma 2001).

A Chalcolithic burial in the Cave of the Warriors (Israel) supplies further clues of early looms in the form of a group of well-preserved textiles that include a large wrapping sheet, 700 × 200 cm; a smaller rectangular cloth (kilt), 140 × 88 cm, a sash, 200 × 20 cm, and a strip or bandage of 134 × 8 cm (Schick 1998). Tamar Schick has discussed how these textiles were made. Schick appears to accept Bar-Adon's interpretation of the wooden objects from Nahal Mishmar as parts of a horizontal ground loom but adds that it would only allow the production of narrow textiles, up to 50 cm wide. To make the large wrapping sheet a much larger loom would be needed, with beams longer than 2 m. The length of the large sheet is comparable with the lengths of Egyptian textiles from the Old Kingdom, but not the width and Schick argues that an enormous loom and three–four weavers would have been needed to produce it. The large sheet has tasseled warp fringes at both ends, and short lengths of weft fringes at one side close to the ends (Schick 1998: 7–12). The rectangular cloth starts with a looped edge, tasselled fringes at the end and weft fringes at one selvedge (Schick 1998: 13–15). The sash had simple selvedges without any weft fringes, but warp fringes at both ends as well as two bands of herringbone weft twining[12] and a looped and knotted finishing border (Schick 1998: 15–17). The twined bands end in a few weft fringes tied into a knot along with warp fringes (Schick 1998: 17, figs. 3.48, 3.50). Details like the weft fringes of the wrapping sheet and kilt can be recognised also in Pharaonic textiles. They were made on the left-hand side and can be recognised in images displaying weaving on a ground loom (Van't Hooft et al. 1994: 19, fig. 7). As weft fringes appear on twined textiles from Neolithic Europe, some of which unequivocally were made on a warp-weighted loom (Rast-Eicher and Dietrich 2015: fig. 125), this detail cannot be used as evidence for a specific loom. This also applies to the bands of herringbone weft twining at the ends of textile C from the Cave of the Warrior (Schick 1998: 17, fig. 3.48). Similar herringbone weft twining was found at Çatalhöyük (fig. 2c), but also in a Bronze Age wool blanket from Pustopolje in Bosnia-Herzegovina that—as it has a starting border and was found in a region where loom weights occur in contemporary finds—was found to have been made on a warp-weighted loom (Grömer et al. 2018: 364).

Although not stated explicitly that the Cave of Warrior textiles were made on a ground loom, Schick does not moot any alternatives (Schick 1998: 20–21). Orit Shamir argues that the loom of the Chalcolithic southern Levant was the ground loom (Shamir 2015). This is based on Bar-Adon's identification of parts on such a loom at Nahal Mishmar; like Levy, Shamir refutes Breniquet's suggestion of a back-strap loom and emphasises that no loom weights have been found in Israel before the Middle Bronze Age (Shamir 2015: 18–19).

MAKING STRING INTO FABRIC

As we have seen, the making of string and cordage goes back a long way to the Palaeolithic period, first applied to bind various items and tools (e.g., harpoons) and to make objects such as nets—knotted as well as knotless. Some forms of twining and wrapping are net-like too and may well have developed as variations of simple netting, in two-dimensional as well as three-dimensional forms (flat fabrics or bags). As the early stages of collagen or bitumen-strengthened coiling show, cords could be made into two-dimensional and three-dimensional shapes in other ways too.

Making string and cordage require few if any tools; ethnographic investigations show that it can be made by hand-rolling plant leaves or culms, without any tools (Crowfoot 1931: 9; Wendrich 1999: 298–300). As indicated above, stitched coiling at most requires awls or needles, and perhaps a gauge for bundle circumference. Plaited mats can be made in similar simple ways, although a kind of frame would be helpful for larger mats (Wendrich 1999: 318–323, 366–374, video sequence 42:10-47:34). This would also be the case for making large pieces of twining.

A LOOM FOR TWINING

Ethnographic work in Egypt has charted how twined mats are produced on a simple loom (Wendrich 1999: 318–323), much like the ground loom commonly used in Pharaonic Egypt (Barber 1991: 83–91) and in ancient Mesopotamia as shown by Catherine Breniquet (Breniquet 2008).

The loom for twining used by mat-maker Amrit in el-Amariyya consists of two cross bars that are kept in place by four

12. Schick's term is counter-weft twining.

Fig. 8 – *Matting looms (photos W. Wendrich). a. Mat-maker Amrit in el-Amariyya (Egypt) making a twined mat on a simple loom; b. Bed frame in which the warp is fastened first, after which the weft is woven in Daraw (Egypt); c. Matting workshop with a horizontal ground loom with heavy beater beam, cotton string warp and a weft of individual plant stems (rushes), Dakhla Oasis (Egypt).*

pegs (fig. 8). The tension of the warp cannot be adjusted because the bars are simply hooked behind the pegs (Wendrich 1999: video sequence 40:52 to 47:45). The string is all made by the hand-rolling method. After mounting the warp (the passive system) the mat-maker works with two strands of string (active systems), alternatively pulled around the warp strands. The selvedges are formed by wrapping both strings around the outer warp string. The end border is made by pulling the cross bars out and, starting in the middle, pulling each end loop through the next one. The mats made by Amrit are closely twined, but his loom could also be used for open-spaced twining. It is tempting to see such a simple loom as the precursor of the ground loom. The ground loom (as well as other loom types) differs in two main ways: the warp tension can be adjusted, and—most importantly—the warp can be separated in layers with the aid of heddles, a series of loops tied around the individual warp threads, either made continuously from a string, or each tied to a heddle rod. It is the invention of heddles that allows to greatly decrease the time it takes to create a textile and it has led to weaving becoming the primary technique to create textiles.

LOOMS FOR WEAVING

As the textile remains from Çatalhöyük, and the imprints of tabby-woven textiles from Jarmo and El Kowm 2 show, weaving and thus the use of looms was known during the first half of the 7th millennium cal. BC. This is emphasised by the slightly younger woven textile from Ulucak Höyük (6400–6000 cal. BC), imprints from Telul eth-Thalathat, Shir, Tell el-'Oueili, Tell Kashkashok and Tell es-Sawwan, and the preserved textile from Ilıpınar Level X (6000 cal. BC).

As for the loom type used: starting and finishing borders of the textiles provide fundamental evidence. A starting border from Çatalhöyük recorded by Harold Burnham was not made as a separate band but as a starting thread (Burnham 1965: 172, fig. 3; Bender Jørgensen et al. 2021: fig. 11.14). The fact that some of the Çatalhöyük textiles appear to end (or begin) with one or two rows of twining (fig. 2c) may give us another clue. Both are clearly different from the woven starting borders of the Neolithic woven textiles in Europe (Rast-Eicher and Dietrich 2015: 85–86). Unfortunately, no borders have been observed among the other woven textiles of the 7th and 6th millennia BCE. Evidence for earlier textiles than the ones found in Çatalhöyük consists of imprints without remains of a border. As there are no Neolithic loom-weights at Çatalhöyük (Rast-Eicher and Bender Jørgensen 2018: 102–103), we must assume the use of a vertical frame or a ground loom, like the one used for twining at present day el-Amariyya or the well-known ground loom for weaving.

CONCLUSION

The techniques for basketry and weaving documented in Çatalhöyük are well embedded in a long chronological development of basketry and textile technology in the Near East and the Mediterranean, while finds in Europe start early, but are few and mainly linked to fishing equipment. This is mostly due to preservation bias, with waterlogged sites yielding very early fish traps. Starting with string, the evidence bears out that tying and wrapping (soumak-type techniques) are among the earliest techniques employed for creating stiff containers and flexible bags. Parallel to this development, another approach to creating containers, that of coiling string held in place with collagen or bitumen, potentially has led to pottery production. Coiled basketry and matting, created by fastening a bundle of grass in a coil, by sewing it to the previous coil with a separate strand, is a very early and versatile technique that also may have inspired ceramic production. Twined basketry, matting and textiles all have been attested in the early Neolithic and are related to weaving in that they require a rigid, or fixed and flexible system of strands, thus leading to the employment of simple looms. Weaving won out in popularity over twining and wrapping to create textiles when the use of heddles provided a means to greatly increase speed and productivity.

The first preserved woven textiles have been found in Çatalhöyük and, together with imprints from Jarmo and El-Kowm 2, suggest that the weaving technique was known by the first half of the 7th millenium BCE. The starting border of the Çatalhöyük textiles, compared to ethnographic comparative material, suggests that the Çatalhöyük textiles are likely to have been made on a simple loom, probably a ground loom.

Many of the arguments surrounding the earliest textile technology are based on evidence from imprints in clay (on pot bases, or argillaceous floors). However, it is notoriously difficult to discern coiling, twining and wrapping (soumak) from imprints (especially if fine threads have been used) and even experienced textile archaeologists sometimes need to change their original interpretation, based on finds of actual extant remains in the same site or region[13]. This is one of the reasons that the prominence of wrapping, a technique that loses its importance in later periods and is rarely present in ethnographic materials, has been underestimated.

Textile techniques are not inherently gendered and evidence for the existence of basketry, matting or textile technology does not automatically mean that these were all made by women. Conversely, ceramic and stone tool production, as well as butchery and hide working cannot be considered mainly men's work. Arguments for gendering technology should be made based on finds context, carefully and explicitly, to keep them open to alternative interpretations. What is eminently clear, however, is that the scant evidence for textile techniques represents an all-encompassing object world, in which women's contributions were undoubtedly fundamental.

13. In 1988 Schick identified coiling at Netiv Hagdud (Schick 1988), which was subsequently revised to twining (Schick 2010: 247).

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