Loom Weaving in the Pre-Pottery Neolithic Near East

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The origin of loom weaving and its relationship to textile history is an interconnected study of agriculture, technology, animal husbandry, cultural exchange, and archaeology. Woven textiles are such an integral part of the human experience that we might easily forget just how complex the order of operations was in developing the materials, techniques, and tools used to create them. The history of woven textiles encompasses technological, agricultural, and societal advancements that began in the Paleolithic Era with the use of string made of plant matter, used to bind pelts together, to make nets for trapping, and to affix tool handles. Over the span of many thousands of years, mankind came to understand that individual strings could be made into plied threads through techniques like splicing, twisting, and spinning. In later periods, durable threads were then worked into larger and technically complex textiles. The development of the loom in the pre-pottery Neolithic Near East, specifically in the eighth millennium B.C., coincides with a period in human civilization that saw a reduction in dependance on hunting and gathering, the beginning of plant and livestock domestication, and the refinement of tools and raw materials that would become fundamental in the development of the textile handicraft. The research presented here discusses the evidence for the origins of the loom as it has been documented in the archaeological record.

At the most fundamental level, a loom is best understood as a tool, "generally as any frame or contrivance for holding warp threads parallel to permit the interlacing of the weft at right angles to form a web" (Broudy 1979: 14). Weaving is the process of perpendicularly interlacing two groups of threads: warps and wefts. The act of weaving takes place on a loom, from the most simple, composed of two sticks, to the more complex, such as a draw loom or a Jacquard loom (Phipps 2011: 85). The act of weaving on a loom to produce a textile is best understood as a *composite technology*, that is, a technology made up of discrete or separate parts

(Hardy 2008: 272, referencing Collins English Dictionary 1999) including the raw fiber materials used to create threads, the materials used to build a loom frame structure (of which there are many types), and the technical knowledge needed to manipulate the materials into a desired decorative or functional textile on a specific loom frame structure. One aspect of loom weaving that appears on a global scale is the concept of tensioning string between two beams. As complete looms are rarely found in the archaeological record, it is not possible to establish a chronological sequence for how far back the tradition of tensioning string between two beams actually extends. Each step in the process of weaving a textile on a loom requires specialized knowledge and specific orders of operation. Most importantly, perhaps, loom weaving a textile requires considerable time as it is a labor intensive process from start to finish. Combining all these factors, a loom is thus an efficient and effective tool for producing different types and different qualities of textile goods throughout the world (Strand 2018: 17).

In order to better understand how looms function, it is important to understand the process by which the warp threads are placed on the loom frame. Warping a loom (Figure 1: A-C), the name given to the process of creating a warp, can take one of two basic forms. The first process is when thread is placed directly on the beams of a loom, and the second is when thread is passed around pegs off-loom and then transferred back to the loom frame. For warps that are placed directly on the loom itself, the size of the loom frame generally dictates the final size of the woven textile, whereas in the second method of warping on pegs, it is possible to create a much longer series of warp threads for a correspondingly longer woven textile. When warping directly on a constructed loom, one or two people pass a bundle of thread back and forth after one end of the thread has been securely attached to one of the loom's beams. As the thread is passed back and forth and over and under, a repeated figure of eight emerges as the threads create one plane, mid-way between the two beams, which is known as the cross. The cross is a critical element in weaving as it determines the ultimate working order of the threads should they become disorganized at any point. When a longer warp is required, warping (Figure 1: A-C) takes place off the loom where one may use pegs in the ground, pegs attached to a wooden frame, or pegs embedded in a wall, in order to measure out the desired length of threads. When winding the warp, the threads are wound in such a way that at least one end has a cross, ensuring that the warp retains a parallel order when it is removed from the pegs and transferred to the loom. Once the desired length of warp has been reached and enough passes have been made to ensure that the number of warp threads are properly accounted for, the loops formed at either end, along with the crosses, are tied up with smaller lengths of thread to maintain order. This preparation ensures that the warp can be safely removed from the pegs, and then wound around a stick or looped like a crochet chain, to reduce the overall length and safely transfer the threads to the loom (Hecht 1989: 12). The addition of fixed points like sticks, beams, or weights to create warp tension is paramount when considering the development of loom weaving. In the words of the textile historian Eric Broudy, “The idea of stretching the warp between two bars is so fundamental to the weaving process that it occurs with various modifications in virtually all cultures that weave cloth” (Broudy 1979: 38).

Weaving, as noted above, is the process of perpendicularly interlacing two groups of threads: warps and wefts. It is important to understand the set-up and weaving process for a loom in order to clarify the concept of weaving as a composite technology and as a multi-step production process. Loom set-up can be accomplished in many ways, and for the purpose of this research the basic methods are covered and adaptations are noted if relevant. Warps are the first set of elements used in weaving. The term applies to both the individual threads and to the entire group of threads (or set) that functions in the structure of a textile. Placed on the loom first, the warp position is perpendicular to the weft. While the warp often forms the longer dimension of a textile, in some cultures, depending on the loom, it can be the shorter dimension element (Phipps 2011: 82). Wefts are the second set of elements on a loom that interlace with the warp. Woven perpendicularly to the warp, the wefts pass across the width of a textile. A continuous weft interlaces across the entire warp width and turns around at the selvedge end to return to the other side (Phipps 2011: 86). The frame of the loom is what holds the warp threads taut, as tension is required to create an optimal flat weave in a textile. With a basic loom frame structure and warp threads held together and under tension, it is possible to produce what is known as plain weave, otherwise known as tabby. Plain weave is a textile structure composed of one set of warps and one set of wefts, interlacing in a rhythm of over-one and under-one. Plain weave is the simplest of weave structures and is found worldwide. It is used to create fabrics of many qualities and can be woven as balanced, warp-faced or weft-faced, and varieties in between (Phipps 2011: 58-59). Weft fibers are placed perpendicular to the warp fibers by creating a shed with the fingers or a tool such as a heddle rod. (Figure 2) A shed is the opening for the passage of the weft thread created by lifting (or lowering) specific sets of warp threads across the loom. The composition of the shed, that is, which threads are lifted and which remain below, is dictated by the textile structure. A simple plain weave, for example, uses two sheds, one composed by lifting even-numbered warps and the other by lifting odd-numbered warps. Other more complex weave structures will use multiple sheds for the weaving process (Phipps 2011: 69). Multiple sheds necessitate multiple heddles, so that as textile weaving gained structural complexity, and was adapted for more efficient speed of use, the use of heddle rods to maintain patterning and organizational layout of a textile became more commonplace. By dividing layers of warp threads into different sheds, then tying those warp threads onto individual heddles with string (where a heddle could be a stick or branch), the weaving process became more streamlined and fell into a rhythmic process. The simpler and more time-consuming method of creating a shed would be using one's fingers to individually pick up warp threads and to place weft fibers beneath them, a practice common when weaving non-continuous patterns like in tapestry weaving (Strand 2018: 19).

A fundamental truth of archaeology is that one can never expect to find complete *in-situ* remains of the past as it was lived by the people of the time. As the tools used to create textiles were primarily made of organic perishable materials, such as wood, they are rarely preserved in the archaeological record (Strand 2018: 17). The evidence we do have on ancient loom types draws from a wide range of sources and contexts across multiple regions, and in order to better understand how loom usage came into practice, it is important to review these different sources of evidence. Archaeological finds of loom parts or tools related to weaving, like pin-beaters, weaving beaters, and weaving combs are all indicators of loom usage. Textiles, while rare, can provide insight and clues as to which types of weaving processes were used to create them. For example, the presence of a distinct starter selvedge border in a textile indicates that the textile might have been woven on a warp-weighted loom, while the presence of loop ends on a warp would suggest that the textile was created on a loom with a two-beam frame. Archaeological context is also critical, as sites might yield clusters of loom weights near a wall, which could suggest the actual placement of the warp-weighted loom. Visual imagery is another valuable guide, as many cultures associate weaving with origin mythologies and deities, showing both tools and looms employed in various contexts of daily and ritualistic life. It should be noted that while pictorial examples of multiple loom types exist in Egyptian friezes, on Greek vases, and in

Roman tomb murals, these images may not have been a true representation of the working looms used to produce everyday textiles, perhaps serving instead as generalized motifs for a loom. It is also possible that the looms represented in these visual contexts may have been in use for a long period of time, and were perhaps earlier in technological terms. A loom's construction can be simple, or as complex as needed to produce a desired textile, but for the purposes of this research, there are three distinct loom types that are documented with various forms of evidence from the Neolithic Near East. It is still an open question as to which of these loom types developed first, or if they developed concurrently. In the field of textile archaeology, many of the questions that are asked address the origin and meaning of a loom type, and where people began to use it, as well as how and why loom technology spread (Strand 2018: 20-21).

The first loom type is a fixed tension two-bar loom with two variations (horizontal or vertical). Commonly called a horizontal ground loom (Figure 2), this loom utilizes four stakes (two each to hold the loom bars in place) and weaving proceeds from bottom to top. The horizontal ground loom is considered to be the oldest loom type by virtue of its depiction on a bowl dated to the Late Neolithic (ca. 5,000 BC) from Badari, Egypt (Broudy 1979: 38; Barber 1992: 83). The loom and depiction of weaving found on the Badarian bowl shows four corner pegs holding two beams at either end, with warp connecting the two beam ends. Additionally, this depiction shows the "in process" work on a piece of cloth on the loom with three bars painted across the middle, presumably to show the sheds (or heddles) as well as a weaving beater (Strand 2018: 21). There are remains of this loom type, including warp beams, heddle rods, and heddle jacks found in Egypt and Palestine, suggesting that by the 4th millennium BC, the addition of heddles to the weaving process was known to increase the speed and ease with which textiles were produced (Barber 1991: 84) because all or multiple warp threads could be lifted at the same time. Another pictorial example of a horizontal ground loom is depicted on an Uruk style cylinder seal dated to 3,200 BC which was excavated at Susa, in Iran (Ellis 1976: 76). Textile finds from this later Neolithic period show an average width of 1-1.2m, and it has been suggested by Barber that "the length of the cloth woven on a ground loom is limited only by the amount of thread spun" (Barber 1991: 84). That said, the length and width of a textile made on this type of loom was most likely determined by its specific intended use. Much of the available evidence of archaeological textiles shows that this loom type was predominantly used for plain weave tabby or a basket weave, while the most common fiber woven was flax. Textiles produced on the horizontal ground loom are commonly found in Egypt and are generally a tabby weave though more varied techniques, such as a linen sheet with weft looping from Deir-el-Bahari dated to ca. 2000 BC, have also been found (Barber 1991: 150).

The next loom is the second type of fixed tension two-bar loom where the set position is upright, with wooden posts supporting the two beams, and weaving proceeding from bottom to top, with or without the use of a heddle bar. This loom is commonly called a vertical frame loom. There are many possible modifications that can exist within this loom type, with the basic version described above, while Roman and Egyptian vertical looms may have had more elaborate shedding systems with multiple heddles (Strand 2018: 26, referencing Cizuk 2000; Kemp and Vogelsang-Eastwood 2001). In addition to those heddle and shedding modifications, there are also multiple warping options for this loom type such as tubular warping (Figure 3), where the size of the textile is dictated by the size of the loom as the warps are wound around the two beams. Another option is when the warp is fastened to a twined starting cord attached to a separate beam, so that a longer warp can be woven and then rolled up as the weaving progresses past the set frame size. When weaving on this loom type, one (or possibly two weavers, depending on the width) can sit in front of the frame while working. There are suggestions that this loom type originated in Syria or Mesopotamia during the Late Neolithic when sheep's wool was introduced as a fiber material. Because sheep's wool is easier to dye than bast flax fibers, it is hypothesized that, as dyed wool was more readily available, it may have inspired new techniques and traditions for weaving rugs and kilims with discontinuous weft patterns. This type of free-form weaving is easily accomplished on the vertical frame loom. That said, the earliest pictorial evidence we have for the vertical loom occurs in Egypt during the last part of the 2nd millennium BC. This loom type is still used widely today, especially for weaving rugs and tapestry. As the frame size can vary greatly in width and height, it is a very adaptable and convenient loom type (Strand 2018: 22-23).

The third and final loom type in this discussion is neither horizontal nor vertical, as such, but one that leans against a support, known as a warp-weighted loom. A warp-weighted loom (Figure 4) is a semi-vertical loom, with the warps suspended from an upper cross bar and held under tension by a series of stone or clay weights tied to groups of threads at the lower ends. Weaving proceeds from top to bottom on this loom in a reverse from the previous two types mentioned (Phipps 2011: 49). This loom was usually leaned against an interior wall or roof beam, or an exterior structure such as a tree. Similar to the vertical frame loom, a warp-weighted loom may be built as wide as needed to produce a desired textile. If the loom was narrow, one weaver would certainly suffice, while a wider loom may have had two weavers working side by side to pass weft fibers and beat the material into a flat textile (Strand 2018: 23). The most direct evidence of warp-weighted loom usage in the archaeological record are the loom weights that would have been attached to the warp threads to maintain tension. Loom weights of the Neolithic period would be made of either clay or stone depending on the region and time period. It is the loom weight's mass and thickness that ultimately determines functionality, and thus the various loom weight shapes found in the archaeological record (round, pyramidal, conical, bi-conical, and ring torus) may have been related more to cultural traditions and influences than technological function (Strand 2018: 23, referencing Cutler 2012). Barber has suggested that the warp-weighted loom was already being used in Hungary at the Tiszanjeno site where a set of pyramidal weights and two separate post-holes 185 cm apart were discovered (Cheval 2021: 1458, referencing Barber 1991). Textile finds from the site suggest that by the 6th millennium or possibly even the 7th millennium BC, that is, in the Early Neolithic period, warp-weighted looms were in use, spreading into Greece and northern Italy by the Late Neolithic, with further expansion west and north into Europe, England, and Scandinavia by the Bronze Age. Other than the loom weights, there is not much more evidence for warp-weighted looms. Visual depictions of the warp-weighted loom are late as compared to the two loom types noted above, with a Late Bronze Age rock carving in Northern Italy dated to ca. 14th century BC (Strand 2018: 24, referencing del Freo *et al.* 2010). The warp-weighted loom has been used historically to create many types of textiles, with some Scandinavian cultures employing this loom reliably up until the 20th century AD. This loom type is especially noted for producing twilled textiles. To attach the warp threads to a loom weight, a loop is tied with string through a perforation in the weight, and the excess warp threads are loosely chained in a crochet knot and then tied to the looped string. If using a loom weight without a hole, the string is tied directly around the weight, with a section looped around, forming a handle to which the warp threads are tied. When weaving a plain tabby or twill on a warp-weighted loom, alternate warp threads are divided and placed in front of and behind a rod or shed bar at the bottom of the loom. Two rows of loom weights are commonly used with one row hanging behind and another row hanging in front of the shed bar.

The first warp thread is attached to a weight in the front row, while the second warp thread is attached to a weight in the back row. This front to back attachment of the warp threads to loom weights continues as a cross is created. From there, heddle rods can also be attached in order to lift large groups of threads at once as weaving progresses (Strand 2018: 24, referencing Olofsson *et al.* 2015).

Of the three fundamental loom type types discussed above, remnants of the warp-weighted loom are the most frequently documented in the archaeological record. Hoffman notes that, "All ancient loom weights preserved have one characteristic in common: all have one or more holes, in the center or at the top. Their weight can vary greatly from 150g, the smallest Greek loom weights, to 1000g or more, with a large number ranging between 500g and 700g." (Hoffmann 1974: 20). These differences help to quantify and document a range of distribution across the Near East and Europe, though Hoffman also notes, "It is impossible to say definitively where the warp-weighted loom was invented, but a study of its distribution is of great interest [and the] loom weights themselves are the best source of information. These [seemingly] insignificant lumps of stone or fired clay help in tracing the loom through several thousands of years; other types of looms leave no permanent traces for posterity. The area of distribution of the loom cannot be defined [only] on the basis of the loom weights that have been found at any given time. The distribution of the finds depends on where the excavations happen to have been [carried out,] and knowledge of them depends on their publication" (Hoffman 1974:17). Until the early 1990's, the accepted origin of loom weights was western Anatolia ca. 3000 BC (Burnham 1965: 169-171), although that would change with Barber's claim that loom weights found in Hungary at the Tiszanjeno site dated to the 6th or perhaps even late 7th millennium BC (Barber

1991: 93-105). Since then, loom weights have been noted at many sites in the Near East and Europe, though none dated earlier than Barber's Hungarian site.

Loom weights were produced in many shapes and sizes, with variations most likely tailored to regional (and a weaver's) preferences. In early archaeological excavations and literature, loom weights were rarely reported as having any association with weaving. For many years, there had been no systematic study of known loom weight numbers, shapes, dimensions, net weights, or materials. Nielsen devised a preliminary system to address this gap in our knowledge (Figure 5: 1-9) with five headings for which the information on loom weights can be distinguished prior to the proper classification, these categories being: (1) material, (2) dimensions, (3) net weight, (4) the producers, and (5) trade. Documented loom weight materials are known to be (a) stones like granite, slate, and soapstone; (b) metals like bronze and lead; (c) unfired clay; and (d) fired clay. The documented heights of loom weights reach a maximum of 15 cm while their net weights range from 200g to 4000g, with the median range being 300g to 1200g. Weights from the Neolithic period are composed of stone and clay, usually undecorated, while metal and fired clay weights of the later Bronze Age are decorated as a general rule. The most numerous type, noted by Nielsen, would be the unbaked clay varieties, although they usually are found in excavations as partially or fully disintegrated lumps mixed with the matrix of the excavation site. Nielsen also notes that a loom weight's shape and ornamentation may have been found over a wide area of a region due to similar markings, but loom weights were most likely not commonly traded over long distances (Nielsen 2015: 129-130).

The types of loom weights documented in the archaeological record fall into nine proposed categories (Nielsen 2015: 130-133). The nine groupings (Figure 5: 1-9)) are as follows. (1) *Weights of an irregular shape* which may be (a) made of hard natural stone with no hole; (b) made of soft natural stone (such as soapstone); or, (c) possibly reused pot sherds with a hole at the more narrow end; (2) *Weights in the shape of a ball* made of clay, where some shapes are lumpy and others are more cleanly spherical. These may have no hole or one or two holes close to the center; (3) *Weights in the shape of a dome* made of clay with shapes that are (a) a pure dome with one hole near the top, or, (b) slightly pointed at top with one hole near the top; (4) *Weights in the shape of a cone* have been found in clay and metal. These weights may have (a) a pointed top, slightly curved profile and one hole near the top; (b) a truncated top, slightly curved profile, and one hole near the top; or (c) a pointed or truncated top, slightly curved profile, with the lower part tapering, possibly from a point so high that the weight takes the shape of double cone with one hole near the top; (5) *Weights in the shape of a pyramid* made of clay or metal, also described as a trapezium. Their shapes are: (a) a pure pyramid with a square base and rounded corners, slightly curved edges, rounded top and one hole near the top; (b) a "classic pyramid" with a square base, a smaller square flat top, almost straight edges, and one hole near the top; (c) a non-typical pyramid, with a flat square top almost the same dimension as the larger square base, with straight edges (also known as "box-shaped weight"); (d) a variation of 5(b) with a rectilinear rather than square base, with two holes rather than one at the top: and (e) a rounded variation of 5(d); (6) *Weights in the shape of a slab* which have been found in [both fired and unfired] clay, and soapstone; seen in profile, this grouping has a generally flat shape like a slab. Seen from head on, the broad face can have many shapes, all of which are not properly documented, hence the grouping is based on the side profile; (7) *Weights in the shape of a lens* have been found in clay, and this category can be seen as a variable sub-type with a few common features: the circular form is the basic one when viewed from the front, and there are two holes present in the upper part. The sub-types are (a) a circle, sometimes with a flat base; (b) a circle with a truncated top traversed by a narrow and a wide groove and with holes spaced far from one another at the top; (c) a circle, extended at the top and bottom, with the top portion being flat and having grooves like 7(b); (d) a heart, with its cross-sections having rounded tips and one hole drilled through each "heart bow" from the broad face; (e) a heart, with cross-sections oval to almost round, with one hole drilled through the "heart bow", only drilled through the narrow face; (8) *Weights made in the shape of a ring torus* are found in clay and those shapes include: (a) a flattened ball, with a large hole drilled through the center and both faces either rounded off, or one face left flat with the edges slightly pointed or curved: and (b) a cylindrical tube of clay, turned while wet around a stick, with a big hole, straight edges, and both faces flattened; and finally, (9) *Rochetti* is an outlier, as the Italian term roughly translates to "roller for threads". This cylindrical [spool-shaped] small weight seems inadequate for use on a warp-weighted loom, but possibly better suited for warp-twining, a technique not associated with the looms described in this paper. All of these loom weight types reflect various local and regional choices based on material availability, technological advancements in ceramics and metallurgy, and physical requirements to keep warp tension maintained to optimal levels (Nielsen 2015: 130-133). The wide range of loom weight types found in the archaeological record reflects the adoption and adaptation of the warp-weighted loom across time and culture.

With the principle loom types established, along with the mechanics of warping a loom and creating a foundational plain weave, it is critical to note the history and importance of string as it relates to the greater advancement of textile production. String is formed through the act of twisting fibers in one direction to create a continuous elongated mass known by many alternative terms, including thread, yarn, or cordage. The technical process for this action is known as spinning. Spinning can be done by hand using the fingers or with the palm or heel of the hand against a knee, with a spindle and spindle whorl (supported or unsupported), with a hand-wheel, or a machine-driven wheel (Phipps 2011: 73). The process of spinning fibers together advanced textile production in untold ways. Virginia Postrel notes in *The Fabric of Civilization,* "Leaving aside silk… even the best plant and animal fibers are short, weak, and disorderly. Flax fibers can reach a foot or two, but six inches [may be] as long as a strand of wool will grow. Cotton typically only runs about an eighth of an inch, with the most luxurious varieties extending no more than two and a half inches." Drawing out these short fibers, known generically as *staple*, and twisting them together produces strong string, as individual fibers wind together in a helix, creating friction as they rub against each other. This process describes "spinning" at its most basic (Postrel 2020: 44-45). Another technical aspect of spun fiber is the ply of the string. Ply is a term that describes both the composition of a string, such as a two-ply string, and also the act of combining spun elements into yarns or threads, that is, to "ply" by respinning together. A plied string is one composed of two or more spun or plied elements, for example, two single spun strings respun together. This process can be repeated, for example, combining two sets of plied strings to form a four-ply string, which in turn can be spun again, making an eight-ply. Plied strings, like all strings, are described according to their direction of spin: they are called s-spun (twisted to the right) or z-spun (twisted to the left). Often the direction of the ply runs opposite that of its component elements; *i.e.* two z-spun single yarns may be plied in the s-direction. This would be annotated as 2Zs. Heavy strings and cordage (for example, those used as selvedge or heading cords) may be composed of three, four, six, eight, or more plys (Phipps 2011: 59).

Splicing presents an older and more globally distributed method of creating string when considering the order of operations in raw fiber processing. With spinning, the retted and processed fibers are drawn out in small tufts from a larger mass of fluffed up fibers, usually held by hand or placed on a distaff attached to a spindle. The fiber tufts are fed into the continuously rotating spindle, propelled by a whorl (essentially a weight), and these twisted fibers become string. Splicing does away with that entire order of operations as individual fibers are pulled from lightly retted bast plant stalks and are individually joined by hand. This technique can be further broken down into two distinct types. The first technique is called continuous splicing, where the strips of fiber are laid in at regular intervals. While the fiber strands are being twisted, new strands of fiber are laid in adjacently so that they are caught into the existing plied fibers, thus becoming one string. Building on that, two or more continuous spliced strings can be twisted together in a similar manner to create a thicker plied string, twisted in the opposite direction for strength. This would be considered a single-stage process. The second technique is called end-to-end splicing, where the ends of the fibers are joined together by twisting or twisting and turning back. The end of one string is joined to a second, and so on, until a desired length of string is reached. As these fiber connections are inherently weaker joins than if the string had been continuously spliced together, the end-to-end spliced string is then plied with a second string to maintain structure. This process is a two-step endeavor as splicing occurs before plying (Gleba and Harris 2019: 2329-2330). It should be noted that splicing was suggested over one hundred years ago by Fox as an ancient string-making technology based on his study of Pharaonic Egyptian textile finds, but it was not until the past 45 years that the technique of splicing string in antiquity was fully accepted by scholars (Gleba and Harris 2019: 2329, referencing Fox 1910). One of the earliest examples of splicing as it relates to weaving can be found in a collection of linen textiles, which includes a dress considered to be the oldest woven garment in the world, excavated by Flinders Petrie in 1913, from what was reported as a 1st

Dynasty tomb in Tarkhan, Egypt. Radiocarbon dating places these linen finds to ca. 3482-3102 BC (Gleba and Harris 2019: 2330, referencing Stevenson and Dee 2016).

In the field of textile archaeology, it was long assumed that the Near East and Europe relied on spinning as the fundamental technology for creating string from bast plant fibers while East Asia and the Pacific relied on splicing and knotting (Gleba and Harris 2019: 2339, referencing Hamilton 2007: 32). However, upon closer inspection, it has been revealed that the earliest textile finds from the Neolithic Near East, including Egypt and the Levant, are all made of bast plant fibers and that those textiles used spliced strings and threads. This includes the linen threads attached to a comb from the 9th millennium BC site of Wadi Murabba'at, Palestine (Gleba and Harris 2019: 2339, referencing Schick 1995) and the 7th millennium BC non-woven textiles from Nahal Hemar, Israel (Gleba and Harris 2019: 2339, referencing Schick 1988), in addition to woven textiles from Fayum, Egypt, dated to ca. 5000 BC (Gleba and Harris 2019: 2339, referencing Granger-Taylor 1998: 106). It also appears, in microscopic analysis, that textile finds from Çatal Hüyük in Turkey, dated to ca. 6500 BC, were made with spliced threads (Gleba and Harris 2019: 2339, referencing Burnham 1965, Fuller *et al.* 2014). It has been noted by Granger-Taylor that in Egypt, the use of continuous splicing as the primary technique for making string existed until around 3500 BC when the technique was switched to end-to-end splicing (Gleba and Harris 2019: 2339, referencing Granger-Taylor 1998: 105). Recent research has revealed that splicing remained a common practice until well into the Bronze Age in Europe with some indigenous Asian communities (in Korea, China, Japan, and the Philippines) still practicing the technique to this day (Gleba and Harris 2019: 2330).

While string may be spun by hand, it is not an effective use of time or energy resulting in higher yield. The spindle whorl is a tool that begins to address the time-consuming task of spinning fiber by harnessing the centrifugal force of a weighted object. This increases the speed and efficiency of spinning fiber while also freeing up one hand to continuously feed small amounts of loose fiber into the resulting mass of the twisting string. The spindle is a two-part tool of shaft and whorl (Figure 6). The spindle itself is a shaft with a pointed tip used for spinning fiber into string, often with a weight (or whorl) attached at the top (high-whorl) or bottom (low-whorl) of the shaft. Some spindles are used resting the lower tip on a recessed stable surface, or in a bowl, while others are suspended in the air as they twist (drop spindle). Turning the spindle can be done by hand, with a foot-powered spinning wheel, or using mechanically powered industrial equipment. Intact spindle shafts in the archaeological record are rare given that many shafts were made of organic material such as wood or reed. Whorls, on the other hand, are more easily identified in the archaeological record as they were commonly made of stone or fired clay. Whorls are weights used on a hand spindle to add momentum for spinning string. Depending on the fiber, the size of the whorl can vary. A small weight suffices well for spinning cotton, while a heavier one with a larger diameter is needed for wool (Phipps 2011: 72). There are two examples of intact spindles (including both shaft and weight) found in the southern Levant, one from Ashalim Cave and the other from Tell ‘Abu al-Kharaz in Jordan. Ashalim Cave is a burial site located in the Negev Desert west of the Dead Sea. Radiocarbon dating places the finds from the cave within the calibrated dates of 4325 - 4000 BC (Langgut *et al.* 2016: 981). The spindle shaft at Ashalim is made of wood and measures roughly 25 cm in length with a notch at the bottom end near the whorl. The whorl is made of lead, considered to be an uncommon material for whorls, and weighs 156g (Langgut *et al.* 2016: 983). Based on the radiocarbon dating, it has been argued that these finds constitute the earliest examples of intact spindles from the region (Langgut *et al.* 2016: 973).

Evidence for string in the archaeological record has been difficult to identify due to the breakdown of organic material over time, but finds within the last 50 years have demonstrated that the concept of twisting plant fibers has existed since the Palaeolihic period. Indirect evidence for the existence of string also exists in the form of perforated beads, weights for nets, and cord impressed pottery (Hardy 2008: 272). String is a general-purpose technology that would have been advantageous to early mankind in nets, fastenings for lithic tools, bindings for portable goods, and any number of other applications. The earliest sources for string were bast fibers, which grow just inside the outer bark of trees and the outer stem of such plants as flax, hemp, ramie, nettle, and jute (Postrel 2020, 9-10). The earliest examples of string were identified from four specimens of fired clay found at Pavlov I, a site in Moravia, Czech Republic dating to ca. 26,000 years ago. These clay fragments bear negative reliefs of a textile or basketry fragment, though the original raw material is unknown. It is clear that the impressions were of a twined fiber. The process of twining fiber exists in both basketry and textile production, with the main difference being the rigidity of the raw material. A loom would not be required to produce a twined textile, and therefore the identification of the original material is arbitrary. It is noteworthy that both the warp and weft impressions left on the clay indicate the fiber material had been twisted using a simple technique to create cordage. Based on the existence of twisted cordage, it could be reasonably assumed that the inhabitants of this site were processing string and perhaps rope as well (Adovasio, Soffer, and Klima 1996: 526-529).

While the Pavlov I site is the oldest documented example of twining in textile-based technology in the Old World, it is not the only site with remnants of string, cordage, or rope. The earliest recorded examples of humans twisting fibers were made using plant matter from a group of plants composed in part of bast fibers. Bast is an umbrella term for plants that share similar characteristics such as long fibers found in the outer phloem of their woody stems that can be removed and processed into string. The process for removing the fibers from the plant requires many steps. Bast fibers have been utilized for thousands of years, especially in Europe and Asia, and include both wild and domesticated species such as flax (*Linum usitatissimum*), stinging nettles (*Urtica dioica*), ramie (*Boeheria sp.*), hemp (*Cannabis sativa*), and jute (*Corchorus sp.*) (Phipps 2011: 16). Examples of flax fibers have been excavated from a series of Upper Paleolithic layers at Dzudzuana Cave, Georgia. This is prior to flax domestication in the Neolithic period, which suggests that prehistoric hunter-gatherers were familiar enough with the fibers to make cordage possibly for stone tools, basketry, or even for sewing garments. Radiocarbon dating indicates that Dzudzuana Cave was inhabited in the Upper Paleolithic period, approximately 36 to 31 thousand years ago. Other noted reports of early plant fibers can be found at Dolní Věstonice, Czech Republic roughly 32 to 29 thousand years ago (possibly nettle, *Urtica*) (Adovasio, Soffer, and Klima 1996: 526) and an unidentified vegetal fiber species in Ohalo II, Israel approximately 21 to 19 thousand years ago (Kvadadse *et al*. 2009: 1359).

Flax, *Linum usitatissimum* (Linaceae), is an annual plant with characteristic slender, strong stems and rounded capsules which (in domesticated forms) do not cleave, but keep the oval, compressed, shining seed. The plant is diploid (2n = 2x = 30 chromosomes) and is generally self-pollinated. Therefore, within this crop, variation has resulted in the formation of many true breeding lines and aggregates of land races. Two species are notable. The first are the oil-producing varieties which are short (25-66 cm), branched, and usually bear larger seeds. These were possibly grown for a high yield of linseed oil. The second are the fiber producing varieties that are taller (80-120 cm) with sparse branches which usually have smaller seeds. There are also transitional varietal forms that were cultivated for both oil and fiber (Zohary, Hopf, and Weiss 2012: 101). In the cases where the crop is grown for fiber, it is commonplace to sew the seeds densely so as to discourage branching (Salmon-Minotte and Franck 2005: 107-108). Flax is one of the earliest cultivated crops for oil and fiber in the Old World and most likely the first cultivated plant used for weaving textiles. Until the Industrial Revolution, flax was grown extensively in diverse areas that ranged from the Atlantic Coast of Europe in the west, to Russia and India in the east, and Ethiopia in the south. After the Industrial Revolution, agricultural production of flax as a source of fiber decreased sharply due to the increase of cotton production and synthetic fibers (Zohary, Hopf, and Weiss 2012: 101).

Linum is a large genus with up to 230 species spread throughout temperate, Mediterranean, and steppe belts of the Northern Hemisphere. Wild flax, *Linum bienne,* is the most closely related progenitor of domesticated flax, *Linum usitatissimum,* sharing the same chromosome number (2n = 2x = 30 chromosomes). This wild flax is noted for its blue flowers, strong branches, and cloven capsules, with a wide distribution range that includes western Europe, the Mediterranean basin, North Africa, West South Asia, and the Caucasus. *Linum bienne* is a plant that requires significant amounts of water and is known to thrive in and around wet places like moist grassy areas, springs, seepage areas on rocky slopes, moist clay soils, and marshy lands. Sometimes it can be found as a weed along the edges of fields and cultivated crops (Zohary, Hopf, and Weiss 2012: 101). The flax plant has been a constant source of raw material to produce food, medicines, and textiles for more than 8,000 years, making it one of the oldest textile fibers used by mankind, if not the oldest (Salmon-Minotte and Franck 2005: 94). Botanical evidence for the cultural history of flax includes seeds, fragments of capsules, stems of flax and pollen, as well as flax products such as fibers and textiles. The fiber from the flax plant has long been utilized to make string, cordage, and paper, while the seeds produce linseed oil, with mechanical, medicinal, and nutritional value (Karg 2011: 507). Botanical and cultural remains suggest that flax may have been one of the first domesticated crops in the Neolithic “founder crop assemblage”, as indigenous plants producing oil and/or fibers were taken into cultivation at the start of agriculture in West South Asia and the Mediterranean basin during the middle-late Pre-Pottery Neolithic B period (Figure 7), that is, ca. 8800 - 6500 BC. While the archaeological record has not yielded evidence for the exact processing methods, oil and fibers were extracted in the earliest agricultural phases, and it is reasonable to assume that oil could be obtained through decantation; i.e. by crushing the seed, pouring hot water on the resulting meal, and scooping the oil once the liquid had cooled. In some cases, before crushing, the seeds may have been soaked in water in order to soften them. It would also be reasonable to assume that the flax stems were retted and broken in order to free the fibers from within the stem. It is very possible that both of these technologies (that is, the domestication of sustenance crops) preceded agriculture (Zohary, Hopf, and Weiss 2012: 100).

There are three main parts of a plant from which fibers used for textiles can be processed: stems, leaves, and seeds. Bast fibers, such as flax, hemp, jute, willow, ramie and certain other nettles (McDonald 2005: 17) belong to the first group. Bast fibers in flax (Figure 8) are located within the stem of the plant, running vertically, providing internal support to help keep the plant upright. The outer bark of the plant (cuticle and epidermis) cover and protect the inner bark (cortex or bast) where the fibers lie in bundles embedded in pectinous gums, waxes, and non-cellulostic materials. The stem is made up of woody matter with a lumen, a central narrow cavity or air space, which is surrounded by a thin pithy wall. In the case of flax, there are between 15 and 35 bundles within each stem and each bundle can contain between 10 to 40 individual fibers. These bundles are not evenly spaced along the stem nor are they evenly distributed from stem to stem although generally, bundles are found rising toward the middle and thinning toward the tip of the stem. Fibers located at the bottom end of the flax stem can be up to three times thicker than those found at the top. This is due to the thickness of the fiber wall in relation to the lumen. The thicker the wall, the smaller the lumen, and therefore the fibers in that area form thicker diameters overall. Where the fiber is thin at top, it is due to the tapering off of the lumen (Baines 1989: 14).

Considering that prehistoric hunter-gatherers were familiar with wild flax and the fibers that could be obtained from it, the process of extracting the fiber from the plants must have developed with considerable trial and error over time. Working backwards from today's understanding of flax processing, we can imagine the many thousands of years of knowledge that contributed to the methodologies still in use today. The harvesting and processing of flax to fiber requires many steps that are particular to the plant and are labor intensive. Flax is a fast-growing plant, generally reaching maturity in close to 100 days. Good farming practices treat flax as a rotational crop with a planting taking place on the same track of land every seven years (the regular floods along the fertile delta of the Nile in Egypt would be an exception to this rule). There are five distinct growing stages for the crop; flower bud formation, flowering, fruit formation, fiber maturity, and seed maturity. Normal sowing periods in Europe are from mid-March to mid-April and harvesting generally takes place from the end of July to the end of August. Pulling or plucking (harvesting) is carried out when the stalks and seed pods mature to a yellow-brown color, which ensures that the entire length of fiber inside the stem is intact (Salmon-Minotte and Franck 2005: 108-109).

Once the plants have been plucked from the soil, they are grouped in bundles before moving to the next processing stage, retting. The process of retting is a natural one where enzymes produced by bacteria and fungi present in the environment settle on the stalks of the harvested flax. Through a mixture of humidity and suitable temperature, the enzymes will break down the pectins of the internal fibers, causing them to separate from the core of the stem, and from one another. There are two methods of retting still in use today, derived from techniques that have been in use since antiquity; dew-retting (also known as ground retting), and water retting. With dew-retting, the aforementioned bundles of pulled flax are laid out on the ground for a period of up to six weeks. Dew-retting is considered to be the least labor intensive practice with fewer negative environmental impacts, even though the rate of retting can be affected by severe weather and heat. The second method used is water retting, where larger bundles of flax are fully submerged in water, either slow-running streams, rivers, ponds, or tanks. The retting period for this method is significantly shorter than dew-retting, with the process taking anywhere from three days to a week depending on the temperature. While water retting is a quicker process, one of the major disadvantages is that the water in which the bundles have been soaking in will be highly polluted after the process is complete (Salmon-Minotte and Franck 2005: 110-111). Once the bundles have been retted either by dew or submerged in water, they are allowed to dry completely. After the bundles have dried, they are beaten with a wooden club or stone tool to break down the now dried stalks (Strand 2012: 26).

The next process in the sequence of operations is called scutching, which describes the act of separating, with a wooden club, the internal fibers from the now dried stalks (Strand 2012: 26). During this process of scutching, certain by-products are produced; these are short fibers (or tow as it is known in English) sometimes utilized for lampwick, and seeds and woody matter, called shiv or shive. The goal of scutching is to extract the maximum possible amount of fibers from the retted straw, with the highest ratio of long fiber, usually called line, to tow. In modern times, the value of line to tow is generally ten times greater and for practical purposes, the longer fibers are much easier to spin into thread (Salmon-Minotte and Franck 2005: 113). In modern processing, the next step would be to hackle (comb) the fibers so that all parts of the stalks are removed and the now free fibers are all evenly distributed and laying in the same direction. It is interesting that this step of hackling/combing is not found in any ancient representations from the Neolithic or later periods. There are Egyptian wall paintings that detail each of the previously noted steps in flax processing, but no depictions of hackling or tools that suggest hackling have been found (Strand 2012: 27, referencing Vogelsang-Eastwood 1992). It has been suggested that, based on linen textile finds from central Europe dated to the Late Neolithic and Early Bronze Age periods, because of the shorter lengths of flax fiber from that time, hackling may not have been necessary, as long as the individual fibers were spliced together prior to spinning (Strand 2012: 27).

Hemp (*Cannabis sativa)* is a tall (2 - 3.5m), dioecious, wind-pollinated herb from the family Cannabaceae. Historically, hemp has been used and/or cultivated for three purposes. The first is for the long fibers obtained from the bast stems, the second is for the seeds, used either for the extraction of oil or feed for animals, and the third is for the psychoactive drug found in the hairs of the plant. Cultivated fiber varieties of hemp are tall, thriving in temperate and tropical climates. The domestication of hemp was predominantly an Asian development and occurred in temperate regions like the Caspian Basin, parts of Afghanistan, along the steppes of central Asia, and in the Himalayas. Domesticated hemp is closely related to and fully inter-fertile with wild and weedy forms, with wild forms varying only slightly from their domesticated relatives with a smaller achenes (seed). Hemp textiles are strong but coarse and were used in antiquity for basic clothing, sacks, rags, and sails, while hemp oil had technical applications such as varnish or soap.

The psychoactive drug is derived from special varieties of the *Cannabis indica* group, grown in warm climates. Only the flowering tops of the female plants contain psychoactive properties, which are harvested for preparation of marijuana or hashish (Zohary, Hopf, and Weiss 2012: 106). Attempts to establish the early history of hemp have not yet been settled by experts. Domestication is assumed to have taken place somewhere in temperate Asia, but no archaeological evidence has been found to corroborate that assumption. There is, however, linguistic and cultural evidence that points to hemp cultivation and production in China by at least 4,500 BC and evidence that hemp was the only or primary fiber used by the ancient peoples of Northern and North Eastern China before the introduction of silk and other fibers in the late Neolithic period (Zohary, Hopf, and Weiss 2012: 107, referencing Li 1974). In the Neolithic Near East, remains of a hemp textile were found at 8th century BC Gordion, Anatolia (Zohary *et al*. 2012: 107, referencing Bellinger 1962). Otherwise, there is no record of hemp domestication or of native species found in the archaeological record of that region (Strand 2012: 23).

Stinging Nettle (*Urtica dioica)* is one species out of approximately 500 members of the Urticaceae family. Of these globally dispersed species, the genera *Girardinia*, *Boehmeria*, *Laportea*, and *Urtica* are well known for their fiber-yielding properties. *Urtica* is commonly known as a weed with an unpleasant sting and is difficult to eradicate once established. It thrives in rich, damp soil, and shady habitats rich in phosphates and nitrates. The plant propagates itself by seeds or by the extension of rhizomes from the parent plant (Salmon-Minotte and Franck 2005: 331-332). The plant is known to thrive throughout a wide range of climates across the world, except for tropic and polar regions (Salmon-Minotte and Franck 2005: 336). Archaeological finds of textiles made of nettle fibers are extremely rare, but some finds indicate that nettle was used as a textile fiber in Northern Europe as well as in the Mediterranean region.

One example is a textile fragment from Khania, Crete, dated to the late Bronze Age in which a nettle thread was found (Strand 2012: 24, referencing Möller-Wiering, in press).

Jute (*Corchorus sp.*), which is today one of the most important plant fibers, has been in use from the Neolithic Period onwards. Sun Hemp (*Crotalaria juncea*) should also be mentioned: this species is native to South Asia but has been found in Shar-i Sokhta (modern Iran) as early as the Bronze Age (2,800-2,400 BC). In this case, Sun Hemp was used for nets, ropes and cordage and these textiles/raw materials indicate long-distance contacts. It is clear from the archaeological record that textiles/raw materials travel (Strand 2012: 24-25). Jute (*Corchorus sp.*), flax (*Linum usitatissimum*), and local sedges (*Scirpus sp.*) have also been recovered at this particular Bronze Age site, clearly demonstrating the knowledge and use of different plant fibers in one period (Strand 2012: 24-25, referencing Good 2007: 182).

Gossypium (cotton) is a large genus of the family Malvaceae containing some 50 species, distributed over large landmasses in tropical and subtropical warm environments. There are four primary cotton crops known for their use in ancient textile production, two from the New World and two from the Old World. It is the two Old World varieties, *Gossypium arboreum* and *Gossypium herbaceum,* that are relevant for the Neolithic Near East. The two Old World species are diploid (2n = 2x = 26 chromosomes) and are known to have originated on the Indian subcontinent. The earliest evidence of cotton fibers is dated to ca. 8,000-6,500 BP, the Ceramic Neolithic, in Mehrgarh, Balochistan (Zohary, Hopf, and Weiss 2012: 107-109, referencing Moulherat *et al*. 2002). Archaeological evidence supports reliable signs of cotton use (through seeds and fibers) in the Indus Valley as early as the 5th millennium BC. It is unclear if *Gossypium arboreum* or *Gossypium herbaceum* was dominant. Cotton seems to have moved to southwest Asia and the Mediterranean Basin much later. The earliest evidence for its existence in the Near East is textual as “trees bearing wool” were grown in Assyria by Sennacherib in approximately 694 BC (Zohary, Hopf, and Weiss 2012: 109-110, referencing Thompson 1949). To date, the earliest unequivocal evidence for cotton cultivation outside the Indian subcontinent comes from the late Sasanian (6th and early 7th centuries AD) site of Merv in Turkmenistan (Zohary, Hopf, and Weiss 2012: 108-109, referencing Nesbitt 1993, 1994).

Wool, by definition, is animal hair, particularly from sheep. Sheep have two distinct types of hair (Figure 9), including guard hair, which is coarse, thick, and long and undercoat hair, which is softer and finer, with some crimp. It is the undercoat hair (wool) that is used for spinning. Wool is composed primarily of the protein keratin and the surface of each individual hair is covered in microscopic scales. It is these scales that make wool so adept as a fibrous material as the scales catch on one another when the raw material is either spun into yarn or felted back onto itself. Sheep wool fibers can range from one to eight inches in length and from 0.0018 to 0.004 inches in diameter. The fiber is naturally coated in an oil, lanolin, which is generally washed away before use. Preparation of wool requires shearing the hair from the animal, cleaning it, orienting the fibers in a single direction or a single mass through combing or carding, and rolling the masses of fibers into ready lengths (roving) to facilitate the spinning process. Wool is much easier to dye than plant fibers and can be dyed before or after spinning or weaving (Phipps 2011: 86-87).

When sheep were first domesticated from wild breeds in the Neolithic period, their primary use was for meat. In early prehistory, sheep’s wool was not sheared, but rather pulled or plucked from the animal, or gathered from fleece sheddings during seasonal molts. Iron Age technologies, like metal shears, greatly increased the production of wool. Some of the earliest evidence for wool comes from sites in Anatolia, Mesopotamia, and Eastern Iran, the native territory of the aboriginal sheep (Phipps 2011: 87). During the 5th millennium BC there was a further development of animal economies on the fringes of Mesopotamia. The appearance of sheep increased and they were also maintained to a greater age which indicates perhaps that wool and milk were being used for the first time and can therefore be related to the “secondary products" revolution (Strand 2012: 29, referencing Sherratt 1983: 99). However, Vigne and Helmer conclude in their work that there is clear evidence for sheep’s wool experimentation in the Near East (at El Kowm 2 and Tell Sotto) by the 7th millennium BC (Strand 2012: 29, referencing Vigne and Helmer 2007: 19-20). The earliest archaeological finds of textiles made of wool date to 3700-3200 BC from the Maykop culture in the North Caucasus (Strand 2012: 29, referencing Shishlina *et al.* 2003: 331, 338).

Considering the evidence presented here for the development of string technology, plant and animal domestication, and tools for weaving such as looms and loom weights, the list of sites where Neolithic textile remains have been found in the Near East is short. The earliest sites (Figure 7) where actual textile remnants have been found include Nahal Hemar, Israel (Rooijakkers 2012: 93, referencing Schick 1988), Çayönü, Turkey (Rooijakkers 2012: 93, referencing Vogelsang-Eastwood 1993), Tell Halula, Syria (Rooijakkers 2012: 93, referencing Alfaro 2002), and Çatal Hüyük in Turkey (Rooijakkers 2012: 93, referencing Burnham 1965). Other evidence in the form of textile impressions exists from this period and the relevant sites include El-Kowm, Syria (Rooijakkers 2012: 93, referencing Maréchal 1989: 62), Jerf el-Ahmar in Northern Syria (Rooijakkers 2012: 93, referencing Jamous and Stordeur 1999: 97), and Jarmo in Iraq (Rooijakkers 2012: 93, referencing Adovasio 1975-1977: 223-230; Barber 1991: 79). Many assumptions about the development of textile production will be clarified in time by further research, but based on the evidence at hand, it can be surmised that bast fibers, particularly flax, were critical to the development of woven textiles before and after the Neolithic period. Unless new evidence is found to disprove this, the archaeological record demonstrates only that linen from flax was at least an Early Neolithic development, whereas the processing of wool and hemp was much later in date across the Neolithic Near East (Reichert 2020: 165).

Figures 1 - 9

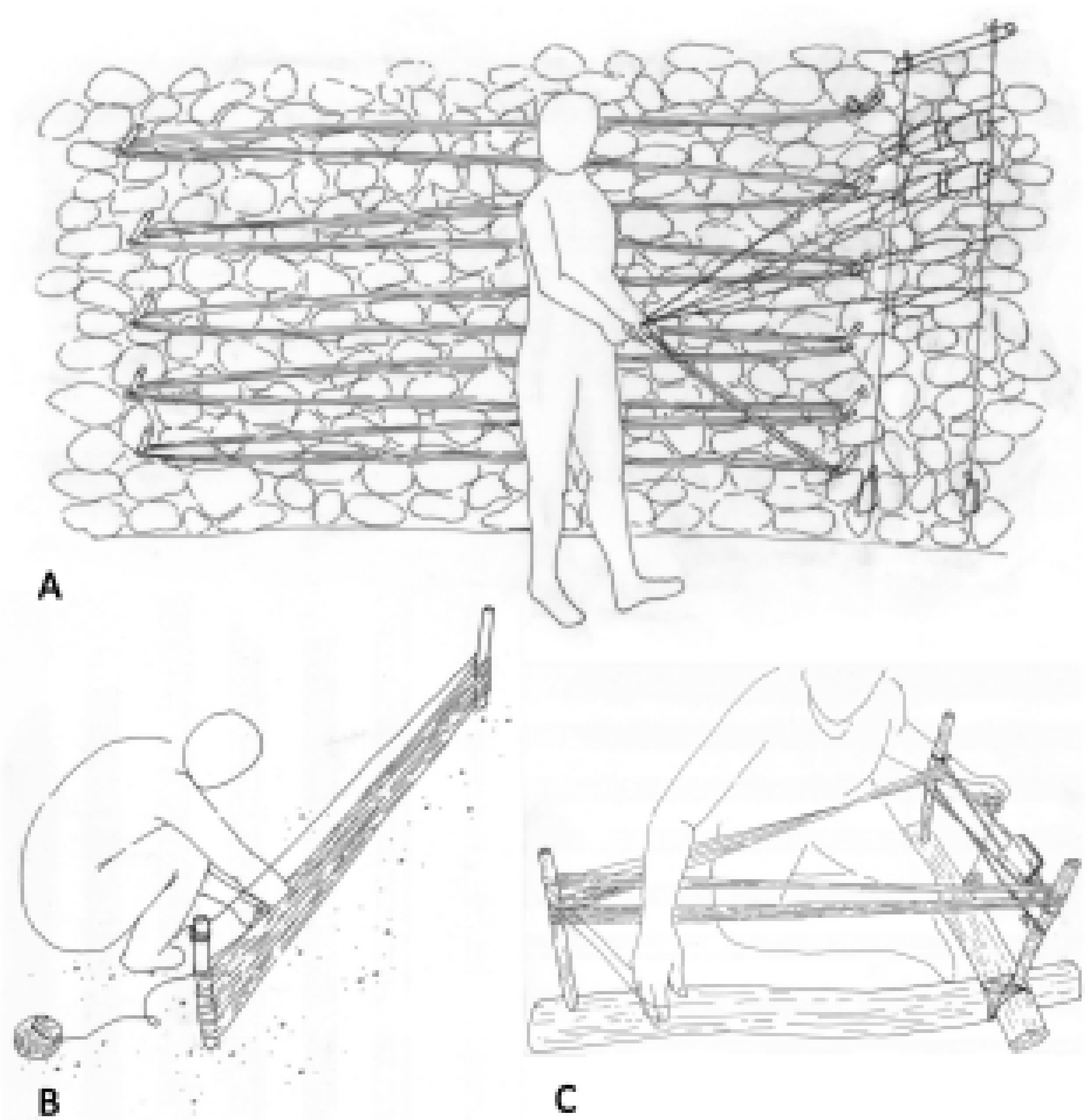

Figure 1: A. Warping on pegs fastened to a wall; B. Warping on supported uprights; C. Warping on a warping frame (illustration: Annika Jeppsson; © Annika Jeppsson and CTR), from Strand, "Early Loom Types in Ancient Societies", *First Textiles: The Beginnings of Textile Production in Europe and the Mediterranean* 2018: 18, Figure 2.1.

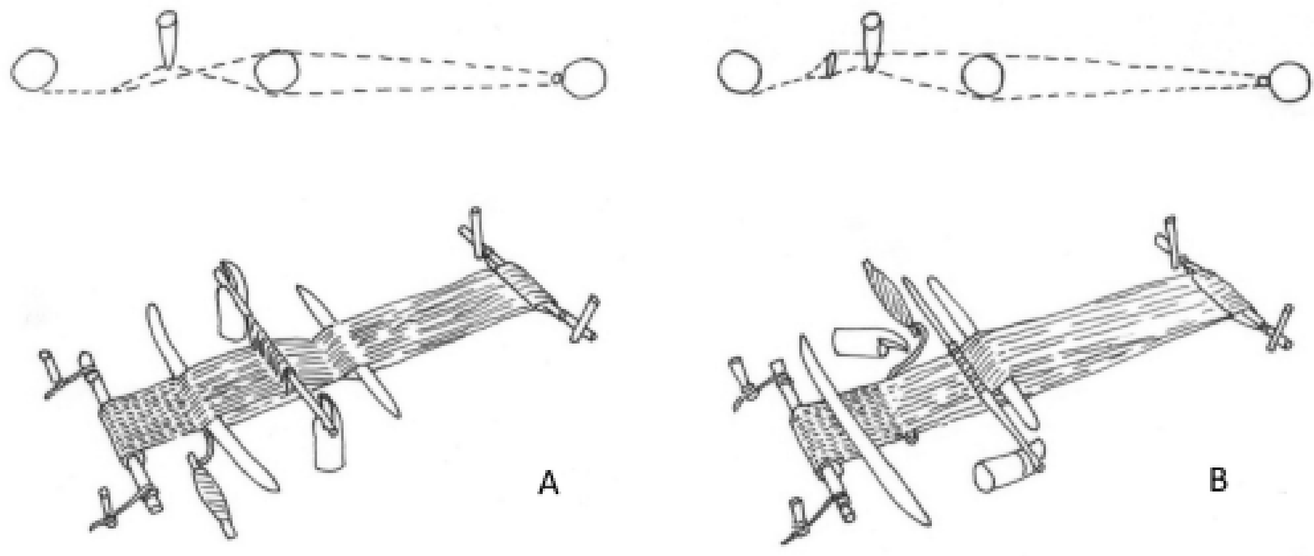

Figure 2: Horizontal ground loom (illustration: Annika Jeppsson, after Broudy 1979; © Annika Jeppsson and CTR), from Strand, "Early Loom Types in Ancient Societies", *First Textiles: The Beginnings of Textile Production in Europe and the Mediterranean* 2018: 21, Figure 2.4.

Figure 3: Vertical frame loom with a tubular warp, Land of Legend (photo: Ulla Mannering; © Ulla Mannering), from Strand, "Early Loom Types in Ancient Societies", *First Textiles: The Beginnings of Textile Production in Europe and the Mediterranean* 2018: 22, Figure 2.6.

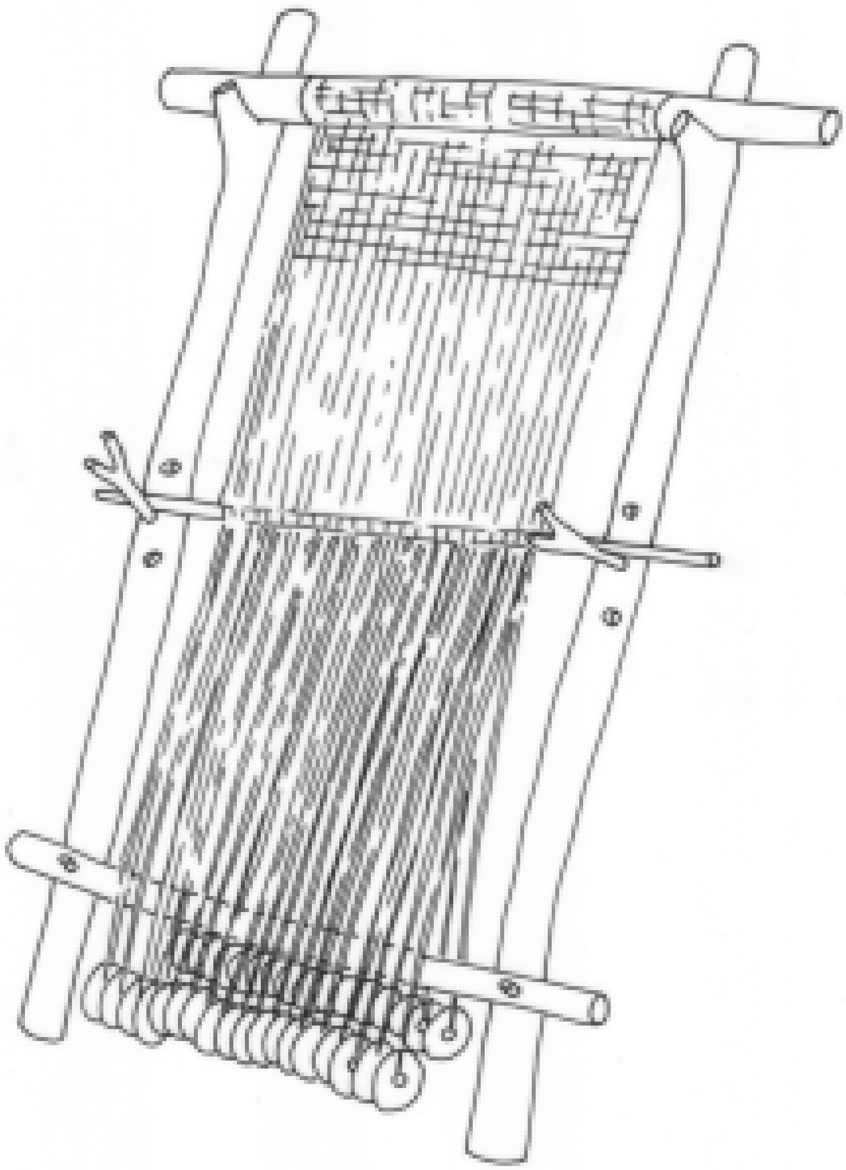

Figure 4: Warp-weighted loom (illustration: Annika Jeppsson; © Annika Jeppsson and CTR), from Strand, “Early Loom Types in Ancient Societies”, *First Textiles: The Beginnings of Textile Production in Europe and the Mediterranean* 2018: 23, Figure 2.8.

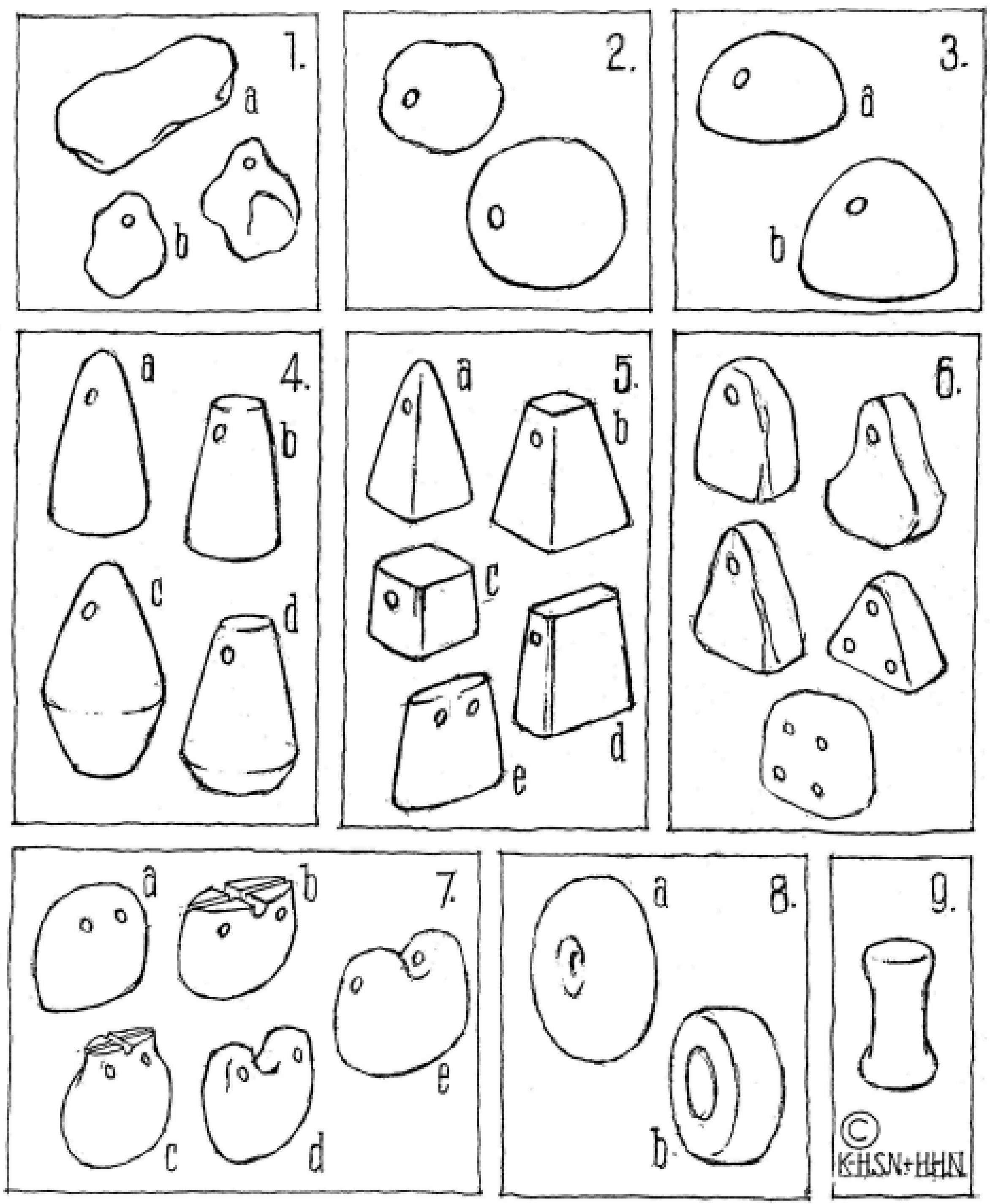

Figure 5: Types of loom weights (illustration: K-H Stærmose Nielsen and H Holm Nielsen), from Nielsen, "A Preliminary Classification of Shapes of Loom Weights", *Northern Archaeological Textiles* 2015: 131, Figure 23.2.

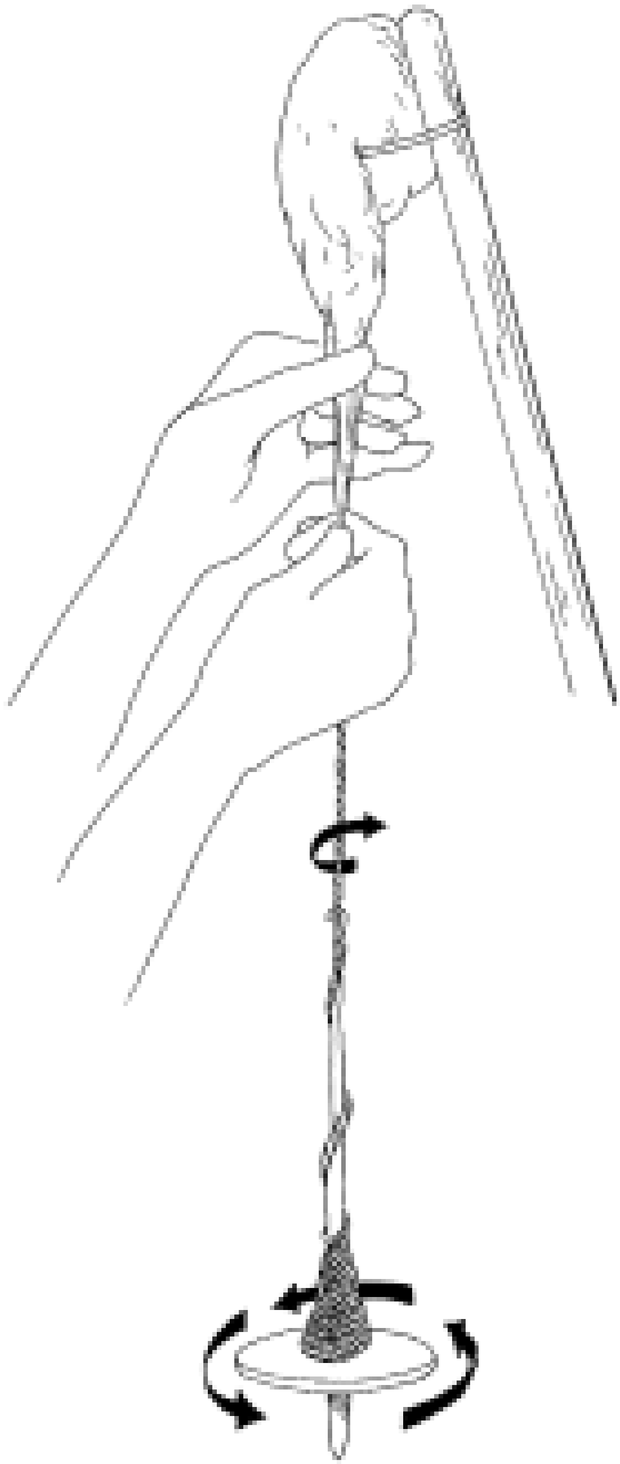

Figure 6: Spindle-spinning (illustration by Margaret Davidson), from Tiedemann & Jakes, "An Exploration of Prehistoric Spinning Technology: Spinning Efficiency and Technology Transition", *Archaeometry* 2006: 296, Figure 2.

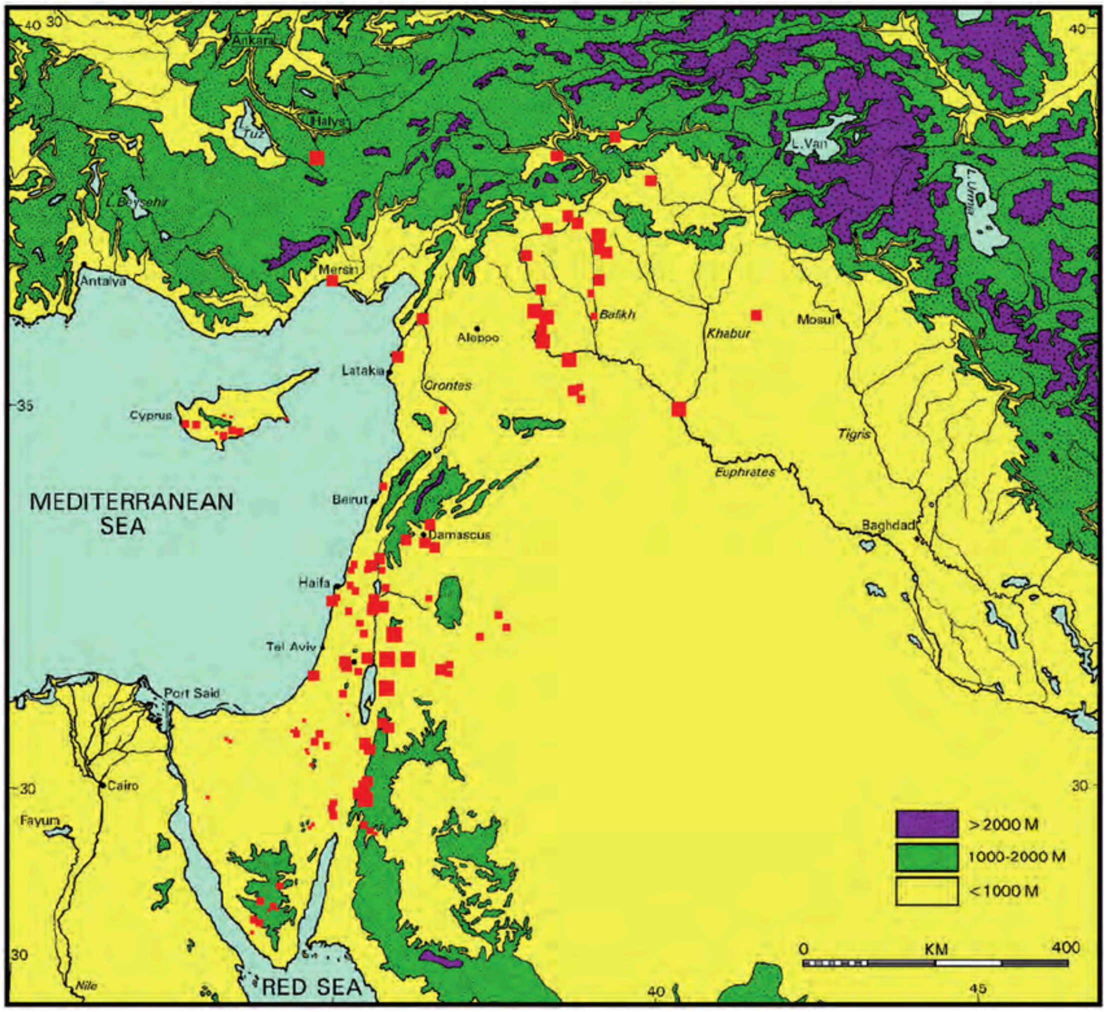

Figure 7: Map of PPNB sites in the Near East (size of squares approximates relative sizes of sites), from Goring-Morris & Belfer-Cohen, "The Neolithic in the Southern Levant: Yet another 'unique' phenomenon….", *La Transition Néolithique en Méditerranée* 2014: 65, Figure 3.

Figure 8. Flax drawing after Strand, “The Textile *Chaîne Opératoire*: Using a Multidisciplinary Approach to Textile Archaeology with a Focus on the Ancient Near East,” *Paléorient* 2012: 23, Figure 1, (courtesy of Gleba, 2008).

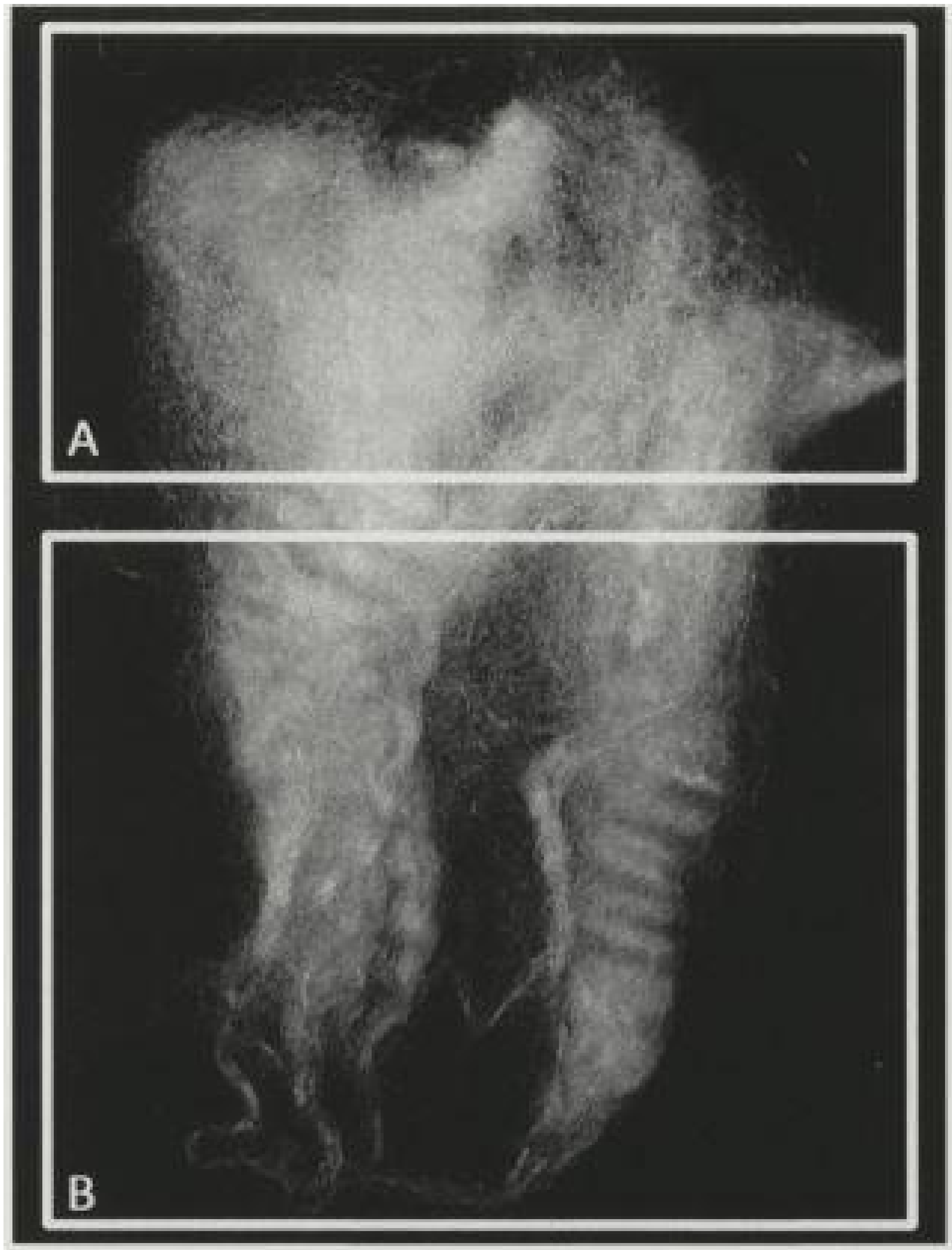

Figure 9. (A) Sheep under wool (short fibers) and (B) sheep hair (long fibers), after Strand, “The Textile *Chaîne Opératoire*: Using a Multidisciplinary Approach to Textile Archaeology with a Focus on the Ancient Near East”, *Paléorient* 2012: 30, Figure 6.

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A NOTE ON THE SUPPLEMENTAL BIBLIOGRAPHY FOR THE LOOM WEAVING IN THE PRE-POTTERY NEAR EAST:

The Supplementary Bibliography for this paper reflects the readings I engaged in as preparation for the beginning of the actual research.