The Genesis of the Textile Industry from Adorned Nudity to Ritual Regalia

The changing role of fibre crafts and their evolving techniques of manufacture in the Ancient Near East from the Natufian to the Ghassulian

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Male/left figurine:Bir Safadi, Beer-Sheva, photograph by Clara Amit, courtesy of Jean Perrot and the Israel Antiquities Authority; Female/right figurine: Tell Halif, northeast Negev, Lahav Project; courtesy of Oded Borowski, Joe Seger and the Israel Antiquities Authority

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Chapter 1

Objective, methodology, environment and the Natufian to Ghassulian archaeological background

1.1 Objective

The objective of this research is to investigate the role played by fibre crafts in the life of the inhabitants of the southern Levant from incipient sedentism of the Natufian culture 13,000 cal BCE to the Chalcolithic period 5000-3900/3800 cal BCE. Insufficient research has been conducted on fibre technology as a collective phenomenon and its effect on the life of the inhabitants of the region on a long, chronological time-scale. The primary areas from which data is drawn are the Nile Valley and southwest Asia a region stretching from the eastern Mediterranean to the Indus Valley and from the Kara-Kum desert to the Arabian Peninsula. The southern Levant, the westernmost geographic component of this bloc is delimited by natural boundaries: the Sinai desert in the southwest, the Mediterranean to the west, the Litany river in the north, the Golan massif to the northeast, the Syrian-Arabian desert which slopes away to the east beyond the Transjordan mountains and tableland and the Gulf of Eilat, an arm of the Red Sea, to the south (Figure 1.1). The term fibre crafts subsumes cordage, primarily from plant sources, but also sinew, intestines, leather thongs and hair, netting of knotted, looped or interlinked cordage, basketry, matting, fabrics and ultimately textiles and their associate raw materials and tools of production. Thus, in order to provide a developmental sequence, whenever appropriate, earlier evidence from the Eurasian Upper Palaeolithic will be referenced, as well as later evidence from the Levantine Early Bronze Age I and illustrative representations of fibre-craft processes from 2nd millennium BCE Egyptian tomb paintings.

Fibre products, perishables, ephemeral in nature, are rarely encountered, and only under extraordinary environmental conditions. These are extreme aridity as prevails in the Nile Valley and southern Israel, saline conditions as at Hallstatt, Austria or Shahr-i-Sokte, Iran,

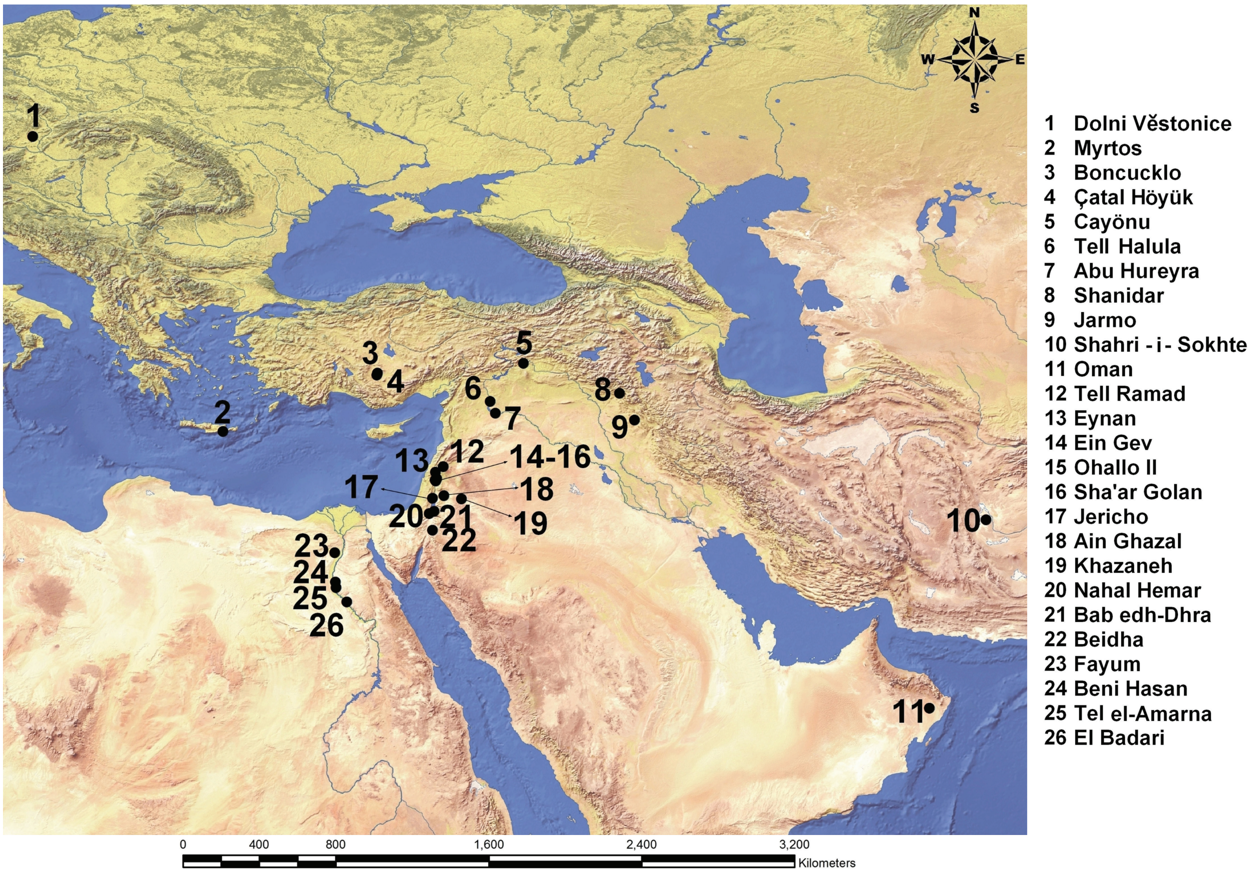

Figure 1.1: Map of sites relevant to research (courtesy of Eli Cohen-Sasson).

sub-marine conditions as of the submerged Pottery Neolithic coastal sites of northern Israel, waterlogged lacustrine conditions as encountered at Ohalo II, Israel, acidic bog conditions as found in Scandinavia and Chile, permafrost conditions as at Pazyzk, Russia or glacial conditions of the Oetzian Alps, and carbonizing conditions as encountered at Çatal Hüyük (Good 2001: 211; van der Kleij 1996: 32). More common than the perishables themselves are their fleeting presence as silica ghosts or more permanent impressions on white ware, bitumen or bone and most commonly ceramic, particularly on bases of ceramic vessels. Also observed, but rarely, pseudomorphs; replacement reproduction of former fibres in metal salts, that had had direct contact with metals other than gold. Occasionally microscopic amounts of actual fibres are retained within the matrix (Good 2001: 215). Overall, more fibre products are recovered from burial contexts, potentially undisturbed environments, than habitation sites with incessant use and attrition. Thus, it is apparent that the total assemblage is far from representative of their occurrences but more of the manner and use of the artifacts, the chemical and physical environment of deposition and the recovery techniques (Warner and Bendarik 1996: 3).

1.2 Methodology

1.2.1 Experimentation

I conducted self (as opposed to group/organized) experimental archaeology investigating multiple aspects of fibre technology from cultivating raw materials to replicating finished products (see Appendix B). This is not a new approach: isolated occurrences are recorded, drilling by McGuire (1896) and experimentation and replication in sprang, a fabric technique, by Siewertsz van Reseema (1926), but the approach has only become more common in the last two decades. The approach has the potential for yielding valuable insights. The objective of these experiments was neither authenticity nor aesthetics but an attempt to understand basic craft processes. It was a hands-on experience with formative technologies in order to evaluate advantages and limitations, the potential for increased efficiency and the degree of skill required in product manufacture. It provided familiarity with raw materials and the necessary conditions for workability, and also awareness of desirable attributes for optimal results. Timed experiments were conducted in variety of techniques to assess comparative efficiency. The Çatal Hüyük textiles, all linen, are the earliest textiles in southwest Asia. Controversy surrounds the loom type on which they were manufactured (Barber 1991: 99, 124, 130; Mallett 1990: 32; Wild 2003: 43). I conducted replication experiments in three modes on two loom types to clarify the issue.

1.2.2 Database: spindle whorls

This database has been compiled to evaluate the magnitude of tool assisted spun yarn and techniques of yarn production and also to track dimensional and raw material changes in the composition of assemblages. Spindle whorls are centrally perforated flywheel lodged on the shaft of a spindle (Appendix D) whose function is to augment the initial rotational spin inserted by the hand of the spinner thereby increasing the length of spun yarn. Intact spindles or identifiable shaft fragments are rarely encountered in the archaeological record. The whorls are the evidence of spindle-spun yarn. They first appear in the southern Levant, in the Yarmukian; it is also the only period in which they are decorated until post-Chalcolithic times (Garfinkel 1999: 29). The raw material of spindle whorls changes through time; those of the southern Levant from the Yarmukian to the Chalcolithic are primarily of sherd with a minority of fired clay and stone. During the Chalcolithic period, with intensification of yarn manufacture, a transition to more robust stone whorls is observed; 36.4% of various stone types with limestone 16.9% the predominant stone type. Basalt, 5.6% of the assemblage becomes increasingly common in the subsequent Early Bronze Age (EB) (Savage 2011: 99, Fig. 4). A local transition to wooden whorls is observed in Middle Bronze Age II with parallels in the Nile Valley.

I have examined, recorded and compiled a whorl database based on the specimens excavated at the Yarmukian site of Sha'ar Hagolan and the multi-period site of Hagoshrim; neither of the assemblages has been yet published. I have also examined all the spindle whorls from the Chalcolithic period held by the Israel Antiquities Authority (IAA) at their facility in Beit Shemesh and the unpublished material from Perrot's (1984) excavations of the 1950s from Abu Matar and Bir Safadi, as well as the partial assemblage from Macdonald's (1932) sites in the Nahal Besor stored at the Institute of Archaeology, University College, London. The whorl assemblage from Gilat was not available for examination. The considerable whorl assemblage from Teleilat Ghassul has dissipated, apart from the one or two ceramic and stone whorls shown in the display cabinets at the Pontifical institute in Jerusalem. Likewise, the Pottery Neolithic (PN) assemblage from Jericho has dissipated although there is detailed documentation (Wheeler 1982: 626-637).

Criteria for inclusion/exclusion in the database was based primarily on weight, less than 150 g and more than ten grams as determined by Barber (1991: 51) and Carrington-Smith (1975: 80) and the perforations, their position and profile. Whorl fragments of less than 40% of their estimated original size were excluded for statistical analyses. Blanks were not included although their number was noted.

The artifacts were weighed with a triple bar balance examined with a hand-held magnifying glass and measured with manual calipers. Categories were created and data recorded of diameter and thickness, internal and external dimensions of perforations and profiles, shape, raw materials, firing or temper when appropriate, drilling proficiency, surface treatment, absence/presence of decoration, manufacturing striations, use wear and contexts where given. The primary division of the data from each site was into raw material categories. Averages were calculated using Excel version 2013 for five variables: diameter, thickness, weight and the internal and external diameters of the perforation.

The Sha'ar Hagolan whorl assemblage used for statistical purposes is derived from Garfinkel's 1989-1990 and 1996-2004 excavations. Many other whorls were collected by kibbutz members during agricultural and piscicultural activities. Most are on display in the local museum or within its storage facilities. These too were examined; no significant difference between the two categories was noticed. The stone whorl assemblage was examined by Rosenberg (2011). The metrics were compared with those of the sherd and ceramic whorls. Hagoshrim, a multi-period site from the Pre-Pottery Neolithic C (PPNC) to the Hellenistic features spindle whorls from all periods. Many whorls are without clear contexts and attributed to two or more potential horizons. Only whorls from clear Lodian or Wadi Raba contexts were used for statistical analyses.

The Chalcolithic material was derived from 22 sites. The majority, 55.6% originates from two of the Beer Sheva valley sites, Bir Safadi and Abu Matar, 200 m apart. Whorls from the Golan sites (n=19) form a second cluster. Not all the Golan sites were excavated to the same degree (Epstein 1998: 166, PL. XXI); some whorls come from surface surveys and collections and others from excavations. The number of whorls varies between sites but there are no differences in typology or manufacturing skill. Epstein (1998 PL. XXI 10-33) published 24 whorls, four of which were blanks with incomplete perforations. There are twice as many referred to throughout her publication. There is considerable discrepancy in the Besor assemblages between what Macdonald (1932: 5) saw and documents in a perfunctory manner, what he deemed worthy of collecting, the materials examined and published by Roshwalb (1981: 112, 147, 186, 250, 270) and what I examined at University College, London.

1.2.3 Iconography

Two-and three-dimensional representations on cylinder seals, plaques, monumental statues, votive offerings, foundation offerings, wall paintings and tomb paintings have been scrutinized via the literature. They reveal clothing types and trends; fibre categories and techniques of production can also sometimes be determined from small details. Tool types of yarn or textile production can be discerned, as also basketry and composite cordage and basketry in furnishings and symbolic manipulation of basketry, netting and cordage.

1.2.4 Textual sources

In addition to scholarly literature I have accessed a wide range of both ancient and historical sources such as Mesopotamian economic and literary tablets shedding light on modes of production, raw materials and their processing and tools of production (Breniquet 2006). Also, adjunctive information is to be gleaned from laconic phrases accompanying Egyptian tomb graphics. Later sources such as the Bible, the Mishnah and the Talmud, locally or regionally focused, provide incidental information while Classical sources such as Herodotus, Xenophon and Pliny provide intentional information. Still later sources such as the Cairo Genizah (Goitein 1983. 1987), the Rambam and Rashi also yield valuable information. Not least are the Christian and Jewish pilgrims and Arab travelers many of whom left behind travelogues in which the peculiarities of the region are mentioned. The information is in the small details not in the overall theme of a given source. Although textual sources, and even some very important iconographic sources, are later than the research period, they are nevertheless very pertinent. Inherent properties of many fibres demand that they must be processed in a given sequence which cannot be otherwise, e.g., flax processing in early 20th century Belgium and Ireland (Baines 1989). The conservatism of fibre technologies and the inherent properties of raw material justifies the use of late sources particularly those which relate to southwest Asia and the Nile Valley. Folklore, which has only been committed to paper within the last few hundred years, often relates to domestic fibre-craft activities, also often retains echoes of associate physical damage caused by fibre processing techniques.

1.2.5 Ethnography

Ethnographical input from the same region of research or adjacent region to archaeologically attested artifacts has been employed to furnish parallels and elucidate tools and techniques of production. Ethnography from more distant regions has been employed to illustrate techniques that are no longer extant in the region (Frödin and Nordenskiöld 1918). Ethnoarchaeology, of which fibre crafts with rough and ready tools are just one aspect, has been a valuable source of information and a counterpoise to opinions of Western craft revivalists, using craft tools of mathematical precision (Kramer 1982; Ochsenschlager 1993; Watson 1979).

1.3 Geography, topography and climate

The causative factors for the distinctive, topographical character of the southern Levant are major tectonic activity, the erosional nature of the bedrock, predominantly limestone, and palaeoclimates (Orni and Efrat 1964: 2). The topography is the primary determinant for water regimes, augmented by two rainfall gradients, one west to east and the second north to south. This determines the flora and fauna, the potential for human settlement and carrying capacity, and the degree of interaction between discrete entities. Geographically, the southern Levant north of the Negev desert, can be subdivided, on an approximate north-south axis, into four distinct regions. A) A narrow coastal plain, becoming increasingly narrow towards the northern end, with low consolidated sand dune ridges (*kukar*) in the central sector blocking the egress of small streams and creating swamp conditions. B) The western mountain range. C) A deep fault, the local segment of the African-Syrian Rift Valley, approximately 1 km wide. D) The eastern mountain range running parallel to the western range. A sequence of interconnecting east-west valleys, e.g., Beit Shean and Jezreel, traverse the western mountain range. The eastern flank of the central sector of the western mountain range, the Judean Desert, is a rain shadow characterized by barren, marl terraces and chalk escarpments which fall steeply to the Rift Valley floor (Orni and Efrat 1964).

The Jordan River rises at the base of Mt. Hermon, 100 m above sea level, and flows through the centre of the Rift Valley traversing the swampy Hula basin and the Lake of Galilee and ultimately emptying into the Dead Sea, 400 m below sea level, a body of water with no natural outlet apart from evaporation, with a resultant 30% salinity and a total absence of marine life. The Jordan River has a number of traditional fording points, e.g., Jericho facilitating human interaction between Cisjordan and Transjordan (Orni and Efrat 35-52).

Large areas of the southern Levant feature a Mediterranean type of climate, long dry summers and winter rains resulting in the development of *terra rossa* soils developed from weathered limestone. Springs occur along fault planes and where percolated ground water intersects at the bases of slopes with non-porous clay strata. Areas of relic vegetation feature open forests of oak and terebinth with graminae. The predominant associate fauna are small herbivores e.g., gazelle, and also carnivores: wolves and hyenas. Further south, towards the desert fringe, e.g., the Beer-Sheva basin, the wind borne loess soil is characterized by an impermeable crust which forms during rain resulting in rapid run-off and flash floods and the development of badlands type topography (Orni and Efrat 1964: 28). The limited vegetation is concentrated in the dry river courses. The low carrying capacity of the land inhibited permanent human settlement until late in the sequence.

The Jordan Valley, the salient feature of the southern Levantine landscape, is still subject to seismic activity as demonstrated by periodic earth tremors and the presence of hot mineral springs. The valley warmer than the adjacent areas is lush in its upper reaches while below the Lake of Galilee vegetation is restricted to dense gallery forests. The rich resources, animal and vegetable and perennial water has more than any other region of the southern Levant attracted human settlement. Ubeidiya dated to *c.* 1.4 million years ago and Gesher Benot Ya'akov, dated to *c.* 780,000 years ago attest to the earliest phases of a long tradition of settlement along the valley (Alperson-Afil 2008: 1733, 1739; Goren-Inbar *et al.* 2004: 725).

Transjordan, a geological and climatic continuation of its western counterpart, albeit with somewhat higher elevations is best described as a narrow tableland, *c.* 40 kms wide, that merges into the deserts to the east. The mountains of the southern section rise abruptly, wall-like from the valley floor fissured by gorges. Impermeable bedrock favoured the development of many springs and perennial rivers, which either singly or merged, discharge into the Rift Valley. The central sector features calcareous rocks and *terra rossa* top soils while the basalt cover of the Bashan, the northernmost geographic component, weathered in most instances to fertile basaltic soil (Orni and Efrat 1964: 106-122).

The southern Levant is a very small area; Mt. Hermon – Eilat, *c.* 500 kms, Tel Aviv to Amman 110 kms + 40 kms to the desert fringe. Yet it is characterized by major environmental differences over very short distances. The northern sector of the region apart from the Rift Valley, which is a tropical micro-climate, is a Mediterranean type climate. The southern segment is a component of the subtropical desert belt. Precipitation in the Mediterranean area ranges from 400 mm per annum in the southern coastal plain to 900 mm in the Hermon Massif (Orni and Efrat 1964: 159) and from 200 mm in the desert transitional zone to 15 mm at the head of the Gulf of Eilat. Mean winter temperature in the coastal zone range from 8-10^0 C to 24-26^0 C. Desert summer temperatures average 40^0 C with close to and below zero in the winter (Orni and Efrat 1964: 144, 150).

The above figures for both temperature and precipitation are modern reflected in a Mediterranean type environment north of an imaginary Beer Sheva-Gaza line: desert conditions south of the Beer-Sheva valley and semi-tropical conditions in the better watered parts of the Jordan Valley. The same basic division, refected in recovered flora and fauna existed from the genesis of the Natufian culture to the end of the Chalcolithic period (Davis 2012: 1284; Galili *et* *al.* 2002: 178-179; Kislev 1997: 226, Table 8.2; Kislev 2012: 1324; Lipschitz 2012: 1328; Tanno *et al.* 2013: 83, Table 1; Tchernov 1997: 238). Short term climatic fluctuations and long-term trends, that characterize the research period, with expansion and contraction of environmental bands and their carrying capacity are reflected in cultural expansion and impoverishment, translocation of populations and changes in cultural practices, economic orientation and diet. It would appear that during the Holocene most major settlements were located in the Mediterranean type vegetational zone until the 5th millennium with an attested wet pulse (Goldberg 1987: 26-27; Goodfriend 1991: 422-423; Grigson 2007: 242), and population expansion along the wadis of the northern Negev.

1.4 Overview of local, archaeologically attested, fibre manufacturing techniques

All the below briefly mentioned techniques are discussed in detail in appendices A and B.

Knots are the most basic fibre structure not requiring manufactured cordage but using unmodified elements from nature. Sheet bend and reef knots (square knots) used worldwide for netting purposes and also an unstable half knot are recorded at Nahal Hemar and an overhand stopper knot at Nahal Mishmar. Simple knots can be made with coarse elements whereas complex knots with looping, twisting and tightening require finer cordage.

Cordage is a generic word for twisted fibres, animal or vegetable, of limited length incorporating additional like elements during twisting to create a flexible structure of potentially unlimited length with greater tensile strength than the sum of its components. Single strand cordage will untwist. Thus, it is twisted with a second identical unit in the opposite direction to the original twist, to set the twist and to neutralize the twist force.

Single system structures, interlinking and looping, openwork fabrics are made from single lengths of flexible cordage worked into the previous link/loop to create a new link/loop. The fabrics are unstable. Greater coherency, density is created by making smaller links/loops or by inserting additional strengthening twists around the stem of the link/loop. Knotted netting is also an openwork single system structure but it is rendered more stable with the use of non-slip knots. Fabrics in these structures are manufactured from domesticated flax.

Two system structures, soumak (weft-wrapping), weft twining, interlacing (plaiting) and twill are characterized by passive warp elements, the long axis, and active weft on the transverse, short axis which interact with the warps and create a coherent whole. In weft-wrapping the active element crosses over two warps and returns under one, engaging in succession each warp, or number of warps. Pairs of weft twining elements work in unison. One is positioned above and one below each warp element, enclosing it, twisting about each other and then changing positions. Each warp is engaged in succession. The weft element in interlacing passes over and under each warp in succession but does not engage. In the following weft row the positions are reversed. When flexible warps are used a tensioning frame is required. All three techniques are used in matting, basket work and fabric manufacture with variations in element dimensions and flexibility. Marsh plants are used for basket work and matting and domesticated flax for twined fabrics. Twill is evolved interlacing with the weft element passing over and under a minimum of two warp elements. In each consecutive row the weft element moves consistently one warp element to the left or right thereby creating a diagonal pattern. Locally the technique is used only for matting purposes manufactured from split reeds.

Coiling is characterized by a passive foundation bundle, a single element or a composite bundle of like elements and a flexible active binder. The first coils, horizontally orientated are stitched through the previous coil or joined between the coils to the stitches of the previous coil. Bone awls or thorns are used in the manufacturing process. The structure dense, strong and rigid manufactured from various grasses is used for platters or baskets.

Spinning either tool-less twisting arranged fibres between the fingers or especially between palm and thigh or with a spindle yields yarn, fine cordage. In the supported-on-the-thigh technique the shaft of the spindle is rolled along the thigh of the seated spinner. The rotary motion twists the attached, attenuated fibres held in the hand of the spinner into single yarn. In the drop-spinning technique the standing spinner gives a short roll to the shaft on her raised thigh. The spindle rolls of the end of the thigh and continues to rotate in freefall, twisting the attached fibres into single yarn. Two single yarns are spun together into stronger 2ply yarn. Yarn spun in the drop-spinning technique is more time efficient, and the yarn more uniform and hence stronger.

Weaving is conducted on the horizontal ground loom. The warp threads are extended horizontally wound around and held taut between two transverse beams anchored to the ground by stakes and guy ropes thus, creating two discrete sets of warp threads, an upper and a lower. Two rods, the shed rod within the warp threads and the heddle rod lying across the face of the upper warp threads and connected to the lower warp threads by flexible leashes lift each warp set in succession.

These two actions create continuous triangular spaces, the natural shed and the countershed through which the weft thread passes, in one motion, from side to side. The product of this process is mechanized interlacing, a textile.

Three strand braid (plait) is a decorative alternative to twisted cordage. Each flexible strand alternates in function as warp and weft interlacing in succession to the right and left.

Sewing of coarse material is conducted with an awl and the stitching/lacing medium is poked through the perforation with the fingers, and finer material is worked with an eyed needle and three or four ply thread. All the stitches are essentially in-out structures for attaching two fabrics one to the other or spiral overcasting for strengthening edges. A single occurrence of decorative needlework, buttonhole stitch, binding an edge is attested at Nahal Hemar.

1.5 Pre-Natufian fibre traditions of the southern Levant

The Middle to Upper Palaeolithic transition occurred between 45,000-40,000 BP. Gilead (1988) argues that the entire period prior to the advent of the Natufian 13,000 cal BCE can be subdivided into two chronological phases: early and late. Early Upper Palaeolithic dates from *c.* 45-40,000 BP to approximately the 24th millennium with the onset of the Last Glacial Maximum and the late until the advent of the Natufian culture. He reasons that there are no significant changes in the economy, social organization or symbolic behavior that warrants periodization beyond a long chronological continuum. Other scholars, e.g., Bar-Yosef (1970) subdivide the period into Upper Palaeolithic and Epi-Palaeolithic which subsumes two sequential major traditions, the Kebaran and the Geometric Kebaran based on lithic techno-typological considerations and also includes the Natufian culture. Goring Morris (1995: 143) adds to the over-arching schema, a series of regional cultural complexes prior to the Geometric Kebaran.

This sub-section will address the issues of portable containers, cordage and netting. The knowledge of cordage and of at least one knot type was proven, based on the presence of use wear notches on shells, used for display purposes, recovered from the Qafzeh Cave, dated 92,000 BP (Bar-Yosef Mayer *et al.* 2009: 307, Fig. 5) and twisted plant fibre fragments, recognized as cordage, from Ohalo II dated 23,000 BP (Nadel *et al.* 1994: 451, Fig. 4; Weiss *et al.* 2004: S125). Modern or historically recent hunter-gatherers, practicing residential moves, generally frequent a given number of locales in cyclic regulated, temporal sequence, mitigated by climatic fluctuations and resource availability. Each local is generally resource specific and the band arrival is timed to exploit each during periods of maximum abundance (Kelly 2007: 273). Campsites are established and most members return daily. There is a broad division of labour; males hunt with specialized tools and females gather seeds, fruits, nuts, tubers, small invertebrates, rodents, eggs etc. (Lee 1979: 123, 493; Liebenburg 1990: 12). The male contribution to the diet is generally of larger items that can be transported across the shoulders; the female component of the diet necessitates containers. If small seeds or nuts are a sizable component of the gathered material closed or impermeable containers are required. Small grass seeds constituted a major component of the Ohalo II botanical assemblage. (Piperno *et al.* 2004: 670).

Nadal (2003) documents and suggests an ovoid, domed reconstruction of the six brush huts from Ohalo II. The huts, measuring 2.5-4.5 m in length are constructed from tamarisk, oak and willow (Nadal 2003: 36). One hut features several stones immediately adjacent to the perimeter, proposed supports of the branches of the framework (Nadel 2003: Fig. 13). Post holes were not attested. Vedder (1966) documents the construction of brush huts of similar form and dimensions of the hunter-gatherer Bergadamas and Bushmen of Southwest Africa. Two opposed branches are planted in the earth and tied at the top with a length of flexible bark. Additional branches are planted in an irregular semi-circle and tied to the first two. Cross supports were either tied to or interlaced with the verticals. The Efe Pygmy, hunter-gatherers of Zaire, construct their huts on a similar principle; a framework of saplings, interlaced horizontals and shingling with large leaves. No use of stones is recorded (Bailey 1989: 666-667, 670). The huts of both of the Bushmen and the Pygmies are constructed by females. The similarity in form and the raw materials used in their construction suggests that the principle of interlacing may also have been known to the inhabitants of Ohalo II and the same principle applied in the manufacture of gathering baskets. However, this does not exclude the possibility that skin containers were also used for gathering purposes.

For the inhabitants of the marginal zones with limited access to tall, straight plant material suitable for baskets, I suggest that skin bags sewn with sinew cordage were the containers used for gathering purposes. The San, currently inhabiting marginal areas, do not make baskets (Lee 1979: 157); their containers are skin bags, string net bags or multi-purpose large pieces of leather. The Upper Palaeolithic attests to an increase in bone tools (Belfer-Cohen and Bar-Yosef 1981: Fig. 6; Rabinovich and Nadal 1996; Tejero *et al.* 2015) with points and awls the predominant tool type. Awls are associated ethnographically, worldwide, with leather working and basketry. Artifacts made of skin are pierced with awls and laced with sinews (Campana

1989: 54-55). Rabinovich and Nadel (1996) suggest that the use wear and polish of the tips and shafts of the points recovered from Ohalo II indicate that they were also use for hide working. Sinews, preferably from the lower leg, were readily harvestable from most medium sized mammals. The above evidence from Ohalo II demonstrates that over the millennia small food items were transported to campsites and processed there, thereby attesting to the use of appropriate containers. The above suggestion for the raw materials and the mode of manufacture is consistent with the faunal profile and bone tool assemblages of the sites. However, this does not contradict the fact that in arid regions, around any water hole or source of moisture, reed-like vegetation does grow and can be exploited.

Gilead (1991: 114) suggests, following San practices, that ostrich eggshells, with approximately one litre capacity, were used for transporting water. The ostrich was a component of the Negev fauna until at least 1929 CE (Roots 2006: 70). The San transport the eggshells within larger containers, e.g., *Karros'* of worked hide (the un-shaped female covering garment cum sleeping blanket) or within individual, tightly fitted carriers or slings of cordage or leather straps (Lee 1979: 122).

Women not only carried gathered material but also carried babies. Amongst foragers and traditional societies babies are breast fed on demand until the age of three to five years (Testart 1982: 524) although some groups wean somewhat earlier (Bentley 1985: 85, 103; Kelly 2007: 190; Silberbauer 1972: 307). Mother's milk is not a supplementary food but *the* major food element of infant's diet. Thus, food and babies move in tandem. The babies have to be attached to the mother's back in order to free two hands for gathering. It may be a leather baby bag carrier, knotted around the waist and across one shoulder, an inner pocket, of the multi-purpose hide *kaross*, as observed amongst the San (Lee 1979: 127, PL. 11.1) or strips of hide or cordage. The mode is unknown but it had to have been efficient, the survival of the collective depended on it (Lee 1979: 494), as clearly attested by Kelley's analysis (1983: 282, Table 2); the majority of calorie intake of mid-latitude hunter-gatherers is of vegetal origin.

Three of the brush huts from Ohalo II attest to floor areas immediately adjacent to the perimeter covered with layers of aligned, but overlapping bundles of alkali grass (*Puccnellia convultus*). Nadal *et al.* (2004: 6825) argue that the grasses were transported to the site for bedding purposes with ethnographic analogies from the 20th century (Thomas 1932: 98). This type of behavior was undoubtedly a precursor to the subsequent development of matting as household furnishings. It is suggested that the grasses, species specific, were harvested, tied up into transportable bundles and carried to the site (Nadel *et al.* 1994: 457; Nadel *et al.* 2004: 6824). In the light of the cordage fragments recovered from the site and also the faunal profile the binding material may have been vegetal cordage but equally so hide thongs.

Nadel *et al.* (1994: 451-452) recovered three fragments of twisted vegetable fibres from the floor of Hut 1 at lacustrine Ohalo II, identified as derived from the leaf or stem of a monocotyledonous plant (Nadel *et al.* 1994: 452). Twisted fibres are alien to lacustrine environments (Nadel *et al.* 1994: 454, citing unpublished data from Danin). Thus, the fragments appear to have been intentionally manufactured and are the earliest candidate for cordage in the southern Levant. Danin (1983: 128) presents a short list of local plants suitable for the manufacture of cordage. Monocots from an Ohalo II type environment that also appear on Danin's list are sedges, rushes and oats (*Avena sterilis*). Crowfoot (1933: 196, Fig. 2) documents the inhabitants of the Hula basin, *c.* 10 kms to the north, manufacturing cordage from papyrus, (a sedge), for matting purposes. Oat seeds were recovered next to the grindstone of Hut 1, the same hut from which the cordage fragments were recovered (Nadal *et al.* 2012: 996). The early 20th century inhabitants of northern Scotland manufactured oat cordage, and worked them up into coiled basket panniers, kishies (Sentance 2001: 39) employing a similar principle to that observed at the Pre-Pottery Neolithic B site of Nahal Hemar (See 4.2.1.6; Schick 1988: 32). Thus, within the potential, environmental cordage spectrum and limitations imposed by plant type identification both, oat stem or papyrus are equally viable raw material candidates.

Symbolic behavior is attested in the presence of perforated sea shells for display purposes at almost all Upper Palaeolithic sites. Dentalia, which subsequently becomes the characteristic shell of the Natufian culture is present, but in very small number (Bar-Yosef 1987; 182*-183*). Occasionally shells are attested with traces of ochre (Gilead 1991: 141). Also attested are a variety of pierced teeth also for display purposes (Belfer-Cohen and Bar-Yosef 1981: Fig. 6). The sizes of the perforations indicate that they were strung with fine cordage. I suggest that the probable stringing material was plied sinew. Danin's (1983: 127-129) list of local potential plants for cordage manufacture all yield products that are very coarse.

The Kebaran site of Nahal Ein Gev I, dated 18, 575±852 BP (Marom and Bar-Oz 2008: 216), features an under-floor burial of an adult female in a very tightly flexed position (Bar-Yosef 1973; Gilead 1995: PL. 2). Such a position can only be achieved if the corpse is tightly bound almost immediately after death (Arensburg 1977: 209 n. 5). The later Geometric Kebaran site of Neve David, at the foot of the Carmel range, features a male burial also in the same position (Bocquentin *et al.* 2011: 43-44, Figs. 3, 4).

In the subsequent Natufian culture this burial position becomes common place. Suitable binding material would have been coarse strong plant cordage or leather thongs.

Evidence for the use of netting for fishing purposes, net sinkers with opposed notches, is attested at two sites: Ohalo II and the Steps of the Jordan, a riverine site (Marder *et al.* 2015: 13; Nadal and Zaidner 2002: Fig. 4). Zohar (2003: 124) argues that the small number of *in situ* net sinkers, six at Ohalo II, vis-à-vis the fish assemblage indicates that it was only a minor capture technique. In contrast, the preliminary report of the Steps of the Jordan, a Geometric Kebaran site (Marder *et al.* 2015: 13), documents a single net sinker only, but Sharon (personal communication 2015) states that they were present in every layer. Worthy of note, fishing with nets is an advanced fishing technique, undoubtedly preceded by many archaeologically invisible techniques e.g., tickling, use of flares, collective splashing and driving of shoals into shallow water and minimal damming.

1.6 History of Research

1.6.1 Technological change

Pertinent to this research, tracking innovations and developments in fibre technologies, are overarching studies pioneered by Leroi-Gourhan (1993(63), 1943(71) 1945(73)) researching ancient technologies as a point of access for understanding former human cultures. Material culture, the remains of interaction between humans and raw materials, direct evidence of former technologies, reflects mental capacities, cognitive processes, choices, pre-planning, scheduling, operational sequencing and manual skill (Renfrew and Zubrow 1994). Lemonnier (1993) examined the factors in ancient and contemporary traditional societies that engendered adoption, rejection or modification of new technologies. He maintains that when there are two equally viable choices, the choice will not be based on the inherent benefit of the technology but on social or ideological considerations. In contrast, Leroi-Gourhan (1993) argues that functional efficacy is the primary factor for technological change.

1.6.2 The Egyptian sphere

The arid climate of Egypt, optimal conditions for long term archaeological preservation, the location of the tombs and cemeteries above the flood plain and the funerary custom of providing the deceased with grave goods consistent with his station in life has provided the archaeologist with an unprecedented rich assemblage of perishables: tools, products and representations of artifact type and manufacturing processes. One of the earliest publications of quotidian fibre-craft artifacts and tools was published by Petrie *et al.* (1890: 27-28, PL. IX.26) and by Petrie (1917: 53-54, PL. LXVI) following the excavation of the workmen's village of Kahun/ Lahun dated to *c.* 1900 BCE. Despite the limitations of the publication, this was the first acknowledgement of the artisans and their tools, who and which, had crafted the splendours of Egypt. His publications were followed by that of Peet and Woolley (1923) who excavated a considerable assemblage of perishables, including tools of textile production, from the new capital of El Amarna and its nearby workmen's village. The sites, dated *c.* 1350 BCE, were abandoned after a little more than a decade, leaving the non-portables or non-essentials *in situ.* The sites were subsequently re-excavated by Kemp. The textile assemblage from the workmen's village features non-tailored, plain weave textiles, predominantly from plied yarn. All bar one are of linen. Kemp and Vogelsang-Eastwood (2001: 35, 53, 58-60, 87, 449) conclude this reflects quotidian sartorial practices of the population in general of the period and that wool was seldom used before the Graeco-Roman period. Brunton and Caton-Thompson (1928) excavated hundreds of Badarian burials, dated 4400-4000 cal BCE (Holmes and Friedman 1994: 105-142); most featured matting, some also featured furs, leather and a few textiles. No correlation was established between sex or age and material type. The burials appear to reflect a transitional period from clothing of animal products to textiles. Worthy of note, the oldest representation of a loom, with all its components, was recovered from a female burial. Thereby, establishing the loom type of the period and correlating a technical aspect of textile manufacture with the shroud recovered from the Cave of the Warrior, Israel. Slightly later Caton-Thompson and Gardiner (1934: 41-54, PLS. XXV-XXVIII) excavated Kom K in the Fayum, a seasonal agricultural site dated to the mid-5th millennium (Linseele *et al.* 2014: 2), and published an assemblage of basketry lined subterranean silos and the oldest Egyptian textile fragment recovered to date. The textile, of linen, has structural affinities with those of the Badarian assemblage.

Crowfoot (1931) attempted to correlate tomb textile scenes, primarily from the Middle Kingdom (2000 BCE), a stratified urban society, with contemporary textile practices of Egypt and northern Sudan. She established a continuum in yarn orientation and spindle and loom morphology but not in raw materials or quality. The tomb scenes reflect production of linen textiles by attached craftswomen for elite consumption whereas; the production of the 1930s was in coarse wool for domestic consumption.

1.6.3 The Mesopotamian sphere

The Mesopotamian sphere lacks the environmental conditions conducive to fibre product preservation apart from the textile assemblage from the desertic, saline environment site of Shahr i-Sokhte, Iran, mostly dated to the 3rd millennium (Good 1999: 4). The assemblage features two fragments dated 3100 BCE, the earliest, unequivocal, *in situ,* direct evidence for woolen textiles. The main sources of information, primarily clothing traditions of deities, elite and prisoners, date from 3300 BCE forth with developed sculpture and writing. Economic texts define locations of textile production, sex and number of workers and their rations but not techniques of manufacture (Collon 1995: 503). A pseudomorph on a bronze axe, a component of a foundation offering at Susa, Iran dated to the mid-4th was identified as linen (Lecaisne 1912: 163). Breniquet (2006: 167) correlates a Sumerian literary text that incidentally details several stages of flax processing and tool use with an artifact, considered a comb suitable for aligning flax fibres, recovered from the Pre-Pottery Neolithic B basal horizon at Tel Ramad, Syria. Two economic studies of the long-distance trade during the early 2nd millennium of which textiles were a major component were published by Larsen (1967) and Veenhof (1972), discussing transport costs, margins of profits taxes and duration of the trading expeditions. The studies established that woolen textiles were of major importance to the economy. They are provenanced primarily to structured workshops attached to land owning institutions, crown, temple or nobility fuelled by disenfranchised local women and juveniles and foreign captive, female labour (McCorriston 1997: 518-9, 527, 533). It was not possible to establish from the textual data, neither techniques nor tools of manufacture, textile dimensions and time in their manufacture.

1.6.4 Ethnography and ethnoarchaeology

Avitsur (1976) conducted a broad-spectrum study of traditional fibre crafts and techniques of manufacture within the southern Levant correlating many of his observances with Biblical and Talmudic sources. Crowfoot (1921, 1931, 1933, 1934, 1938, 1943, 1944, 1945, 1948, 1951, and 1954) who ranged from Sudan to Gaza and Transjordan, focused primarily on spinning, weaving and non-loom fabric techniques, correlating her field observations of loom type, spindle morphology and the predominant spinning technique with Egyptian tomb representations thereby, establishing a broad regional, technical continuum. Differences were observed between ethnographic products in raw materials, yarn diameter and thread density and archaeologically recovered Egyptian textiles. Observed spin direction in the southern Levant also differed from archaeologically recovered yarns and contemporary yarns of the Nile Valley. Weir (1970) focused on local spinning and weaving traditions within village environments and subsequently conducted a study of the local Bedouin culture of which spinning and weaving was but one aspect (Weir 1976) adding details and photographic documentation to Crowfoot's groundbreaking studies. Goren (1999) studied the Bedouin population of Sinai detailing rudimentary leather processing, rope laying, basketry, spinning and weaving adding incremental insights into the technical processes of the archaeological materials of the southern Levant. Wulff (1966) investigated during 1940's dozens of traditional crafts and skills throughout Iran; fibre crafts were but one of the many. A minor, elementary technique documented in the manufacture of reed blinds sheds light on a fabric technique observed at Pre-pottery Neolithic B Tell Halula, Syria. Thesiger (1964) conducted research in the Iraqi marshes: his work is a major contribution to understanding reed matting processing and time in manufacture, and its role in architecture. Further afield, in New Guinea, MacKenzie (1991) studied and documented in detail, contemporary tree bast processing and cordage manufactured on the thigh and its extensive use in looping techniques, formative, fabric manufacturing techniques attested at Nahal Hemar. Hurcombe (2014) has conducted recent interactive studies focused on fibre/fabric/textile manufacture including skin processing throughout the Old World as far east as Uzbekistan, including use wear analysis of fibre related archaeological tools and replication studies. Lee (1979) and Liebenberg (1990, 2006) undertook long term research amongst the Bushmen, detailing hunting and gathering tools and their manufacture and hunting and gathering strategies. These studies are instrumental in shedding light on local pre-Natufian entities albeit with the following caveat.

The pre-Natufian world was inhabited by hunter-gathers exploiting a variety of environments, those with richer resources and those with poorer resources. In contrast, modern residual hunter-gatherers inhabit restricted, resource poor territories, not attractive to more complex societies. These societies are far from pristine: their life-ways and technologies have been influenced at the collective level by interaction with sedentary societies and at the individual level with government officials, missionaries, traders and anthropologists. These societies are not replicas of pre 13,000 BCE societies: as sedentary societies they too have been subject to change. Cognizant of the limitations of the data and the caution demanded in extrapolation the data nevertheless is invaluable as a tool in attempting to understand former societies and behaviors (Kramer 1979: 3).

Ethnoarchaeological studies in rural Iran and Iraq (Kramer 1982; Ochsenschlager 1993; Watson 1979) have contributed greatly to understanding fibre crafts as an integral component of the economy, worked around other daily tasks with imperfect or *ad hoc* tools balancing their practices and products against technical input from Western craft hobbyists. It is understood that archaeology is a discipline, working with incomplete data, trying to reconstruct the lifeways of former societies. It is also understood that not everything practiced in the past can be observed in the present (Leclerc and Tarrette 1988: 280). Nevertheless it is accepted by ethnoarchaeologists that the prehistoric past can be partially understood through the ethnographic present.

Fortunately all the fibre techniques and products attested in southwest Asia and the Nile Valley from the Natufian to the Ghassulian have been observed and documented, as live traditions, within the last 100 years albeit, primarily in remote regions far from the geographic focus of this research.

1.6.5 Raw materials

Two general agricultural studies of fibre crops (Dempsey 1975; Weindling 1947) detail problems associated with cultivation, necessary conditions, and yields and processing. Weindling's figures coming from early 20th century Russia lacking mechanical aids and chemical fertilizers are particularly pertinent for understanding flax cultivation in the Neolithic and Chalcolithic periods in the southern Levant. Helbaek (1959) investigated wild flax and documented its evolution and dispersal and environmental adaptations as a cultivated plant via seed size analysis, under rain-fed conditions and irrigation.

Baines (1989) only addressed linen, essentially in the European sphere, and published with archival photographs of pre-mechanical sowing, cultivating and processing. Flax processing has changed little over the millennia. Its intrinsic properties determine this. Thus, her study is of major importance. However, its observences and conclusions must be used with caution since the environmental conditions of Western Europe are differ radically from the Nile Valley or the southern Levant. The study is combined with a historical trajectory of the development of spinning and weaving tools and practical instructions of all aspects of hand spinning. Dewilde (1987) was the driving force behind the establishment of the National Linen Museum at Courtrai, Belgium. His detailed publication focuses on flax cultivation in Flanders in the late historical period. He came from a family of generations of flax workers and thus the data is based on in depth familiarity with all aspects of cultivation and processing to the fibre stage. His study is the only study that documents in detail magical practices associated with flax cultivation, some overtly sexual in character. Van Driel-Murray (2000), Nile Valley orientated, discusses leather processing, techniques and limitations, correlating this with a very limited presence in the archaeological record, and cultural problems with representations which fail to feature essential, but messy stages of processing.

1.6.6 Tools of production

Liu (1978) conducted a global survey of spindle whorl typology, primarily ethnographic, within the cyber limitations of the time, establishing criteria that differentiated them from beads. Crewe's (1998) island wide analysis of Cypriote spindle whorls established, via consistent patterns of use-wear attrition on the terminals that spindles with low positioned spinning whorls had been the standard spinning practice since the earliest appearance of spindle whorls on the island, *c.* 2400 BCE. Hitherto, this had only been observed as an Aegean phenomenon from the 1st millennium BCE. Keith (1998) tried to establish via a comparative spindle whorl attribute analysis from a late 4th millennium site in southwest Anatolia, the period of the Uruk Expansion, with those of Uruk to identify the ethnos of the women of the non-local, resident merchant community. There was insufficient correlating data to achieve the research aim. Hochberg's (1980) unique, slim global study of spindles and associate spinning techniques and a second study (1979) of spinning anecdotes and folklore were self-published through lack of public interest. They are the only studies of their kind and hence of considerable value, but must be used with caution as they have not been subject to the same rigorous review as scientific publications (Hochberg 1979: 62 contra Allen 2009: 7). Frödin and Nordenskiöld (1918) travelled far and wide from the Guyanas to Tierra del Fuego attempting to establish a developmental spinning sequence and correlations between spinning techniques and spindle and whorl morphology. A developmental spinning sequence was established but they failed to establish a correlation between spindle morphology and spinning technique or between spindle whorl raw material and spinning technique. Despite, the failure of their primary research aim they document live traditions of residual fabric and yarn manufacturing techniques still exant in remote areas of the New World subsequently attested in the Old World archaeological record. The study, invaluable fibre-craft data, was published in German, the scientific language of the era, and unfortunately never translated.

Spinning bowls, quality adjuncts for linen yarn manufacture in the drop-spinning technique, were first published by Petrie (1890: 25, PL. IX.58) as a peculiar element of the ceramic corpus of the Middle Kingdom Workmen's village of Kahun. It was Nagel (1938: 188) excavating the New Kingdom Workmen's Village of Deir el Medineh I, Egypt, who identified their function. He was able to correlate between built-in stands for small containers of water on the spinning wheels of French flax spinners and the practice of constantly wetting the unspun fibres with the fingers and thumbs and the needs of Egyptian hand spinners of the Pharoanic periods using spinning bowls to achieve the same effect. The earliest evidence for this artifact type is recorded in the southern Levant in the Chalcolithic period, although not identified when excavated (Levy 2006: 96-100, Fig. 73; Levy and Gilead 2012: 133-134, Fig. 4; Perrot, Tsori and Reich 1967: 223, PL. 42. 9, 10). Breniquet (2008: 123) expressed reservations regarding their identification. Spinning bowls, one intact and fragments of at least 58 more, were recovered from the predynastic site of Tell el-Farkha in the delta (Mączyńska 2012: PLS. 1-10) and an additional bowl curated in the Museum Egizio, Turin, labeled from the 'predynastic village' of Heliopolis (Spinazzi-Lucchesi 2018: 116-118, PL. 11.1) would appear to confirm the identification and the precocious technical nature of the Ghassulian textile industry. Dothan (1963) tracked the Late Bronze Age (*c.* 1600 BCE) re-appearance of spinning bowls, in the southern Levant, their geographic dispersion and chronology and analysed typology, and fabric and firing characteristics, correlating their function with earlier Middle Kingdom Egyptian tomb representations and wooden tomb models. Allen (1997) surveyed spinning bowls in the Egyptian sphere observing very limited typological variability over a thousand year span suggesting optimal raw material-tool compatability.

Four major works have been published on looms. Roth's (1918) work, the product of a global, ethnographic survey, correlated some of the technological observances with Classical period representations and loom accessories with archaeological findings from early 1st century CE England. Hoffman's study (1964) was restricted to a single loom type, the warp-weighted loom, primarily within the Scandinavian culture sphere via archaeological evidence, historical economic texts and by accessing the last practitioners in a remote Norwegian island. Her in-depth study is the primary tool for understanding the functioning and idiosyncrasies of one of the primary Old World loom types, attested from Greenland to Afghanistan and to the Egytian Eastern Desert. Broudy (1979), the artisan-academic spouse of a professional weaver, tracked a developmental, historical trajectory of not only all major loom types of both hemispheres but also documented a series of lesser known formative tools and techniques of fabric manufacture amongst the indigenous populations of North America, thereby, creating an awareness of alternate technical possibilities to the warp weighted loom-horizontal ground loom dichotomy of southwest Asia. Lamb (2005) published a historical and technological study of loom types still current around the Mediterranean but focused primarily on North Africa. She concludes that loom technology has remained virtually unchanged since its invention: Features of looms that appear more complex are not; they simply enlarge the scope or speed up the finction. Kissell (1918) surveyed and tracked spinning tools and techniques and also loom types from an evolutionary angle, analyzing each and defining drawbacks, labour investment, product quality and assessing efficiency of each stage and comparing it with subsequent deveopments. Patterson (1956) conducted a Euro-centred historical survey of spinning and weaving and raw materials from the Hellenistic period to the Industrial Revolution.

Campana (1989) conducted a comparative survey of the bone artifact assemblage of the Levantine Natufian with that of the Proto-Neolithic of the Zagros, detailing manufacturing techniques and identifying function categories via use-wear striae analysis; he concluded that all were primarily for fibre-craft purposes.

1.6.7 Cordage

No major work has been published on ancient cordage. McKenna's *et al.* (2000) study primarily concerns modern usage of fibre rope (in excess of 4 mm in diameter) detailing and categorizing structure and mechanics, raw materials and properties. The first chapter gives an overview from historical periods, recording archaeological findings and representations of manufacture and usage from the Nile Valley and representations from the Mesopotamian sphere featuring haulage of monoliths for the construction of royal monuments by gangs of slaves with ropes as thick as a man's wrist. Glory (1958) conducted an archaeo-ethnographic survey and published an article following his discovery of decomposed, encased, lignified cordage dated 17,000 un-cal BP at Lascaux. His study details representations of cordage usage attested in French cave site paintings and also indirect evidence for sewing with fine cordage from regional Upper Palaeolithic burials with perforated shell headdresses. His structural analysis of the rope was subsequently found to be more complex and revised by Soffer *et al.* (2000: 815). He further pursued the subject, accessing via colleagues ethnographic data from East Africa, where the hand manufacture of tree bast cordage was common practice.

Warner and Bednarik (1995) argue for the presence of cordage from the European Middle Palaeolithic citing as evidence the presence of intentionally perforated small artifacts necessitating cordage for stringing. Hardy (2008) discusses the antiquity of cordage and its crucial role in human development and the mode of acquisition of automatic, motor skills used in fibre crafts referencing in particular New Guinean societies, defined as string-based cultures. Myking *et al.* (2005) surveyed current traditional methods of processing and manufacturing lime bast cordage and its widespread archaeological and historical presence in northern Europe. Ashley (1944) published a compendium of knots, structures, strengths and weaknesses, fields of use and also detailed instructions in their construction *sine qua non* for use with cordage. The study brings to the fore that despite the great antiquity of cordage and knots, land orientated humankind employs a very limited repertoire of knots; the vast majority is associated with marine activity.

1.6.8 Netting

There are no major, comprehensive works on ancient netting. Netting is sometimes addressed as an adjunct to fishing (Brewer and Friedman 1989), occasionally to fowling, sometimes as a carrying net or as an element of clothing. One short article (Yates 1875) discusses three aspects, fishing, fowling and hunting with woodcuts taken from marble reliefs. All the sources are Classical.

Ethnographic studies were initiated amongst the hunter-gatherer communities of the Congo basin, practicing year-round communal net hunting focused on small mammals to determine if a correlation could be established between Eurasian Upper Palaeolithic sites featuring small prey and netting impressions, and proposed efficient communal net hunting employing a large labour force, particularly female labour. Congolese ethnography could not substantiate the proposal: hunting groups averaged 14, female participation was attested amongst some groups, averaging 30% of the netting crew, and snare and trap hunting proved more time and meat yield efficient than net hunting (Lupo and Schmitt 2002). Net hunting was defined as high cost technology in manufacture and maintenance. This echoes what I have established through experimentation regarding fishing nets (see Table 4.1).

Sattethwaite's (1987) study of Australian Aboriginal netting practices, labour investment in net manufacture, hunt size and organization and catch sizes is based on historical accounts from the 18th and 19th centuries and the rare museum artifacts. By the beginning of the 20th century communal netting had ceased. Net hunting targeted large animals and birds, kangaroos and emus, and also seasonal water fowl. The single curated emu net measures 52 x 0.8 m of two ply cordage, 5 mm in diameter, with meshes ranging from 19-29 cm. The time in the manufacture of similar nets, but slightly smaller kangaroo nets, are quoted from historical sources, as 97-112 single person days. Sattethwaite's estimation of at least one year is based on experimentation and also includes time spent in collection and processing of the fibres. He correlates the periodic drives and communal net hunts with social gatherings and communal feasts.

Both cultural spheres feature common net making and hunting practices and cultural attitudes towards their nets. Nets have a high cultural value; among certain tribes of the Congo basin they are used to pay bride price. Nets are owned by the senior males of households but used communally, set end to end. The cordage for the nets is made primarily by females and the nets primarily by males although women sometimes assist. Women participate in hunting in some communities primarily as beaters. Males only dispatch the prey.

1.6.9 Basketry

Mason (1904) published the earliest, comprehensive study of basketry; addressing raw materials, techniques and usage, but relating primarily to material from North America. Adovasio (1977) initially focused on North America but subsequently southwest Asia, South America and Eastern Europe established criteria for identification and classification of basketry techniques and modes of analysis and documentation. Adovasio *et al* (2001: 57) postulate that twining is the primal mode of two system fibre interaction; the archaeological evidence from both the Old and New Worlds appears to support this. The earliest Old World evidence for basketry, and manufactured in the twining technique, is attested at the Moravian Upper Palaeolithic sites of Pavlov and Dolní Věstonice, as impressions on fired clay (Soffer *et al.* 2000: 513). In the southern Levant waterproofed, bitumen coated, close twined baskets are attested from the first half of the 10th millennium at Gilgal and Netiv Hagdud (Schick 2010: 245-248) and without bitumen coating from the subsequent Pre-Pottery Neolithic B at Nahal Hemar dated 8200-7300 cal BCE (Schick 1988: 33; Solazzo *et al.* 2016: 1). Baskets worked in the twined technique, and a single occurrence of one in the simple looping technique, were recovered from the foraging and pastoral phases 8300-3000 un-cal BCE at Takarkori, a Libyan Saharan rock shelter (Di Lernia *et al.* 2013: 1837, 1848, 1852, Table 1) and likewise from the 8th-4th BCE un-cal millennium rock shelters of Algeria (Aumassip 1980-1981: 122).

Wendrich (1999) conducted archaeo-ethnographic research in Egypt, attempting to establish a technique-raw material correlation between manufactured organic artifacts, primarily baskets but also matting, cordage and netting recovered from the workmen's village at El Amarna (1350 BCE) and Qasr Ibrim (6th-3rd centuries CE) and practices of the contemporary populations of the same regions. A certain continuum in the division of labour was observed but changes in raw materials and techniques introduced in the Graeco-Roman period superseded the practices of millennia. Her primary contribution to research is her innovative use of video technology, documenting timed sequences of manufacture, and efficiency of hand gestures, permitting evaluation of skill and time in manufacture and hence economic and cultural value. Bobart's (1938) Old World study encompasses archaeological representations from the 3rd millennium forth, from both Mesopotamia the Nile Valley and Europe, data from historical texts and ethnographic sources including basketry techniques in land and water transport, furniture and architecture and symbolic manipulation in royal propaganda. Sentance's (2001) comprehensive, ethnographic global study surveys techniques, form, raw materials and function with technical schematics and as many colour illustrations as aspects discussed.

1.6.10 Matting

Ancient matting as ancient cordage and netting lacks a major work. Some scholars as Wendrich (1999) subsume matting under basketry although it is morphologically and functionally a distinct category. Matting is attested sporadically across southwest Asia in burial contexts from the 11th millennium (Solecki *et al.* 2004: 61) until the 3rd millennium (Woolley 1938: 29) and more intensively in the Nile Valley from the 5th to the third millennium (Brunton 1937: 27). A consistent use of matting in domestic architecture, above the roof beams and below the mud plaster is attested across southwest Asia from the Neolithic into the 20th century.

Crowfoot (1938) conducted ethnoarchaeology in Mandatory Palestine correlating observed potting practices using worn out coiled platters made of plant fibres and mat impressions on excavated vessel bases. Crowfoot (1933) also established a correlation between a Middle Kingdom tomb representation of mat production on a horizontal ground mat loom and current matting practices in Cairo and also at Abu Dis, Israel. In 1933 (Crowfoot) briefly observed contemporary matting manufacture using flexible papyrus fibre cordage in the Hula basin in Mandatory Palestine on a loom type with continuous warp in a mode not attested elsewhere. Twined mats used in the construction of the huts of the mat makers can be discerned from the photographic documentation.

1.6.11 Yarn directionality and technological changes in production

Yarn analysis demonstrates that all yarn will be initially spun to either the left or the right. Minar's (2002) study demonstrates that there is no connection between either left or right handedness or between the intrinsic orientation of plant fibres and initial spin direction although Elizabeth Barber digresses (2018 personal communication). The cultural tenacity and longevity of spin direction in culture areas is derived from the learning mode; spinning skills are acquired by observation and imitation with corrective intervention by role models or members of a group of practice augmented by re-inforcing approval of successfully executed tasks. Likewise disapproval of spinning directions that do not conform to the cultural norm, as could occur with a left handed spinner. Tiedemann and Jakes (2006) investigated the transition from thigh-spun 2ply yarn to spindle-spun 2ply yarn. The findings demonstrate that yarn spun with a spindle is spun at twice the rate of that spun on the thigh but not in the period of transition. They speculate that the change could have been engendered by the use of a new raw material or by intra societal pressures on the producers by the consumers.

1.6.12 Clothing and footwear

Gilligan (2010) investigated the archaeological invisible pragmatic aspect of quotidian clothing of the Eurasian mid-latitude Upper Palaeolithic proceeding from human's known threshold to sustained exposure to cold. He tested his expectations against palaeoclimatic data, including wind factors and cold peaks and the need for insulating multi-layered, fitted clothing with increased frequency and sophistication of bone tools including eyed needle for sewing and appropriate lithic tools for cutting and shaping this type of clothing. He concluded that adaptation to sustained environmental cold conditions required consistent use of fitted clothing. Social aspects of clothing were grafted onto a physical necessity. Soffer *et al.* (2000: 512, 524-525) in contrast, focused on representations of female figurines wearing symbolic clothing, Venus figurines, from the same time span and culture areas. They hypothesize that the detailing of these fibre-craft artifacts, bands, headwear and halters, the product of female labour, is indicative of the high cultural value placed on these artifacts and the high esteem in which the manufactures were held. They further hypothesize that the carvers of the figurines were either also fabric or basket makers or had instructed the carvers in the reproduction of accurate structural details of the fibre products. Collon (1995) studied the clothing traditions of Mesopotamia, from the 4th millennium forth recorded on reliefs and statuary. She concludes most is tendentious royal propaganda featuring the elite, deities and priests in formal attire in ceremonial situations, the military in action with specific wear, non-local dignitaries in ethnic wear and naked prisoners. The clothing conventions of the majority are unknown. In contrast, Egyptian representations from the 4th millennium forth feature the sartorial traditions of the elite but also those of the males and females of the laboring class and craftsmen (Vogelsang-Eastwood 1993). The clothing of 'Otzi, the Iceman' dated to 3300 BCE was subject to intensive research; all, apart from the twined grass cape, were of skins (Spindler 1995). Hlavacek *et al.* (2004) reconstructed the footwear and carried out testing in Alpine conditions, demonstrating that they were both comfortable and durable and attuned to the demands of the terrain.

1.6.13 Fabrics and textiles

The earliest major archaeological textile study (Carrington-Smith 1975), an unpublished doctoral dissertation focused on the Aegean, tracked all aspects of fibre-craft developments from the 7th millennium to the Mycenaean period (1400-1200 BCE) including patterns of loom weight form and dispersion and a detailed survey of local dyes. The most comprehensive study of Old World fabrics and textiles (Barber: 1991, 1994) tracks the evolution of flexible fabrics from the Eurasian Upper Palaeolithic to the Aegean Iron Age, from Britain to Uzbekistan. She excludes basketry and matting from her study. The large assemblage of textiles and tools from the Workmen's village of El Amarna, Egypt (1350 BCE), occupied and abandoned after less than twenty years, a veritable time capsule, has been excavated since the early 20th century. The findings were published in full by Kemp and Vogelsang-Eastwood (2001) establishing the minimal role of animal fibres in local sartorial traditions even amongst the skilled laboring class. Emery (1966) working from inert archaeological, museum material established an overriding structural classification of all flexible fibre products and established standardized terminologies of techniques and cloth types.

1.6.14 Southern Levant, attire, fabrics, textiles and representations

Numerous fragments of textiles large and small, cordage, basketry, and matting from all chronological and cultural phases have been recovered from the southern Levant, primarily from the arid regions but also from the Mediterranean zone. Most fall in the time range beyond this research. Here they are only mentioned briefly since they are discussed in full in the relevant chapters. Elaborate headwear and sashes of strung bone and shell beads and girdles of fox canines were recovered from the Natufian sites of the Carmel and Galilee (Belfer-Cohen 1995: 13; Garrod and Bate 1937). They were carefully assembled artifacts from animal products, collected and segmented or extracted and perforated. The unique geological conditions of the region favoured their *in situ* preservation. This formative, sartorial tradition does not continue into the Pre-Pottery Neolithic A. In contrast the Pre-Pottery Neolithic A Jordan Valley sites feature a clay figurine with a schematic representation of structured headwear (Bar-Yosef and Gopher 1997: Fig. 6-1.1) and a limestone figurine featuring a girdle with pendant strings (Noy 1999: Fig. 15). Both elements of attire are the by-products of cordage and both have passed through two manufacturing phases.

The archaeological fibre-craft wealth of the Pre-Pottery Neolithic B was recovered from a single Judean Desert cultic site, Nahal Hemar, with superlative conditions of preservation. It features fabrics predominantly in the two system twining technique, in four variants, looping, knotted looping, interlinking and knotted netting all manufactured from fine 2ply yarn of domesticated flax, including at least three items of headwear in an elaborate knotting technique. The advent of domesticated flax, requiring generations of empirical experience for successful cultivation and skill in processing, engendered the breakthrough. The Pottery Neolithic features clay figurines with representations of canonical, albeit brief, items of attire but no fabrics (Garfinkel 1999(b): 47-63; Stekelis 1966: PLS. 51-53). New tools, spindles were used in their manufacture. It is reasonable to assume that they were manufactured from linen although only three flax seeds have been recovered to date (Kislev and Hartman 2012: 1321).

The Chalcolithic period features a wealth of linen textiles, including very large textiles, all in plain weave (tabby) from spliced flax fibres, s-spun and S-plied. The earliest discoveries from the Cave of the Treasure were published by Bar-Adon (1971, 1980) and his analysts, essentially working in the dark. A representation of the loom type of production, the horizontal ground loom, appears on a ceramic vessel from the same period from a female burial of the Badarian culture, Egypt (Brunton and Caton-Thompson 1928). The textile on the loom features a weft fringe, a feature attested on the largest of the textiles from the southern Levant (Schick 1998). Representations on the wall painting The Procession from Teleilat Ghassul feature masked figures wearing gowns of full body dimensions (Cameron 1981; Drabsch 2015). The convergence of strong comparatively rapidly spindle-spun yarn in the drop-spinning technique and the invention or diffusion of the horizontal ground loom with shed and heddle technology engendered the genesis of the local textile industry.