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STUDIES ON ANCIENT ENVIRONMENT,
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IN HONOR OF STUART SWINY

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Chapter 10

Spinning and Weaving at Kourion in the Late Bronze Age

by Joanna S. Smith

INTRODUCTION

Weight measurements, dimensions, and contextual associations allow for the recreation of lost textiles through the tools used to make them. Stuart Swiny's 1986 publication of Episkopi *Phaneromeni* was forward thinking because it included measurements of the weights of spindle whorls and loom weights. At that time, few scholars published textile manufacturing tools in any detail, and even fewer understood that weight measurements provide keys to reconstructing the kinds of fibers and fabrics created with these objects.

I first began research into Cypriot textile production while I was a junior Fulbright Fellow at the Cyprus American Archaeological Research Institute (CAARI) in 1991–92. This topic was one of the many enjoyable and unexpected paths I encountered during my dissertation research. Stuart, then director of CAARI, was always up for a discussion about enigmatic objects and encouraged me in my analyses of textile tools and the contexts of production even when my ideas differed from the accepted interpretations found in publications.

This chapter analyzes textile tools found by the University of Pennsylvania expedition at the Late

Bronze Age settlement of Episkopi *Bamboula* in Area A, the part of the settlement with the most varied evidence for cloth working. Some tools look back to *Phaneromeni*. As at other Late Bronze Age settlements, the primary products of the warp-weighted loom at *Bamboula* were light-weight fabrics, many of which may have been weft-faced.¹

¹ The high chronology for the Cypriot Late Bronze Age is used here. *Bamboula* contexts mentioned here date to LC IIB (ca. 1375–1340/1315 BCE), LC IIIA (ca. 1200–1125 BCE), and LC IIIB (ca. 1125–1050 BCE). The objects from these excavations are divided between the museums of Cyprus and the University of Pennsylvania Museum of Archaeology and Anthropology (Penn Museum). Measurements and observations about use wear for the textile-related objects in the Penn collections were made by me together with students in a seminar at Penn, ARTH 521: Ancient Mediterranean Art: Textiles, Dress, and Bronze Age Interconnections (spring 2016). That data have been shared with the Mediterranean Section for their collections database. The spindle whorl included in figure 10.1 and table 10.1 in the Penn collection was studied by Kristen Pearson and by me. Study of the objects in Cyprus took place in the fall of 2018 and the spring of 2019.

EPISKOPHI BAMBOULA AND TEXTILE PRODUCTION

Episkopi *Bamboula* is a Late Bronze Age settlement on the west side of the Kouris River within the area known as the city-kingdom of Kourion in the Iron Age. This chapter draws on excavations by John Franklin Daniel of the University of Pennsylvania (1934–48) that were published by Jack L. Benson (1969; 1970; 1972) and Saul S. Weinberg (1983). Textile tools come from every part of the excavation area. Tools from Area A, in the eastern part of the settlement, are representative of tools found elsewhere on site and are of a greater variety, including concentrations of less portable tools.

Spinning

Spinning is a portable activity; thus, spinning tools alone do not indicate an area configured for the purpose of cloth production. The most common type of spinning tool at *Bamboula* is the spindle whorl (Benson 1972: 125, 132, 134–35, 138), a small, centrally pierced object that when placed on a spindle stick could act as a fly wheel to pull out and twist woolen, flaxen, and other fibers to make thread, yarn, or twine. Stratified whorls come from all five major settlement areas and many of the tombs excavated by the Penn team. Less common, and only found in tombs, are spindles and parts of possible distaffs (Benson 1972: 131–32).

Most centrally pierced small objects could have functioned as whorls, even if the piercing is slightly off center (from manufacture or wear) and even if the object weighs less than 10 g (Olofsson et al. 2015: 82–83). Terracotta whorls were common in the Early, Middle, and early Late Cypriot Bronze Ages. Examples at *Bamboula* (e.g., fig. 10.1d, g–i, Table 10.1d, g–i) compare with terracotta whorls at nearby Episkopi *Phaneromeni* (Swiny 1986: 98–107; see below). Many LC II and III whorls, however, were made of stone or ivory. Like terracotta whorls, these often bear incised decoration. A conical stone example from Ugarit inscribed with the word “whorl” (Sauvage and Hawley 2013) demonstrates that most or all such objects, sometimes published as buttons, should be examined for chipping around the hole and edges that typify

use-wear from spinning (Sauvage 2013) (as on fig. 10.1c, Table 10.1c; Penn Museum nd: no. 54-41-83).

The most common whorl at *Bamboula* is biconical and usually made of stone (e.g., fig. 10.1a–b, e–f, Table 10.1a–b, e–f). One example in ivory was found attached to an iron spindle (Benson 1972: 22–3, 131, no. B1389, pls. 10, 35). As with other whorl shapes, the piercings of these biconical objects normally are wider on one end than the other, a feature that helps whorls attach firmly to spindle sticks (cf. Swiny 1986: 99). The placement of spinning tools in tombs (including 57% of all whorls from the Penn excavations at *Bamboula*) points to strong connections between these objects and their owners.

Weaving

The most common form of weaving tool at *Bamboula* is the terracotta loom weight. A loom weight can be any object to which warp threads could be attached to weigh them down and hold them taut during weaving. Normally, such objects are pierced, so that threads attach to the weight through the hole or through a loop of thread attached through the hole. At *Bamboula*, most weights are truncated pyramidal in shape (e.g., fig. 10.2b–e, g–j, Table 10.2b–e, g–j [Table 10.2 can be found at the end of this chapter.]) and could have sometimes been used together with short cylindrical weights (e.g., fig. 10.2a, f, Table 10.2a, f) (Benson 1972: 137). All are worn, most have chips or larger fragments broken off in antiquity and have traces of wear at the tops of their piercings, signs of having been used on looms (fig. 10.2).

In contrast with spinning tools, only one loom weight was found in a tomb at *Bamboula* (Benson 1972: 22–23, 137, no. B1590). Unlike spindle whorls, which were often decorated and kept over generations, loom weights were normally expedient tools made, broken, and discarded on a regular basis. They always became reduced in size through the smashing together of weights on a loom.

Loom weights and loom parts can be portable. However, once a warp-weighted loom is set up for use with warp threads held down by loom weights, such a loom is unlikely to be moved. These tools thus become more similar to vats and other large



FIG. 10.1 Spindle whorls from the University of Pennsylvania excavations at Episkopi *Bamboula*, Area A. See Table 10.1 for specifics of each object. Objects a–b and d–i are in the Local Museum of Kourion in Episkopi, Cyprus. Object c is in the Penn Museum (photos by Joanna S. Smith except for object c, courtesy of Penn Museum).

	Stratum, Context date	Field no. / Benson 1972 no.	Shape, material and decoration, preservation	Diameter (cm)	Weight [reconstructed weight] (gm)	Moment of inertia (MI) (gm/cm ²)	Thread tension needed (gm)
a	A-B:3, LCIIB	S 85 / B1530	Biconical stone, whole	3.02–3.05	35.34	30.82	51–52
b	A-D:2(VI), Room 6, LCIIIA	S 12 / B1528	Biconical, stone, whole	2.95–2.96	30.18	24.79	45–46
c	A-D:2(VII,2), Room 12, LCIIIA	S 48 / B1504 (Penn Museum 54-41-83)	Conical, stone, incised, whole	3.38–3.42	13.48	19.71	24–25
d	A-E:2(VIII), LCIIB	S 2 / B1614	<u>Conical, terracotta, incised, red slipped, nearly whole</u>	3.75–3.92	39.30 [40]	76.83	57–58
e	A-E:2(VIII), LCIIB	S 11 / B1527	Biconical, stone, whole	2.73–2.75	24.47	17.34	38–39
f	A-E:2(VIII), LCIIB	S 27 / B1542	Biconical, stone, incised, whole	1.97–2.01	9.96	3.77	20–21
g	A-E:3(V), LCIIB	S 10 / B1605	<u>Biconical, terracotta, incised, red slipped, whole</u>	2.87–2.90	19.31 [19.50]	15.37	31–32
h	A-Unstrat	Mi 142 / B1602	<u>Biconical, terracotta, incised, red slipped, nearly whole</u>	3.40–3.44	27.32 [30]	33.28	45
i	A-Unstrat	S 18 / B1606	<u>Biconical, terracotta, whole</u>	4.30–4.33	36.65	64.42	53–54

Table 10.1 Details of spindle whorls shown in figure 10.1. Boldface type singles out the conical stone whorl. Underlined type marks four whorls that have parallels at Episkopi *Phaneromeni*. Regular type is used for biconical stone whorls, with and without incised decoration. The equation for calculating the moment of inertia (MI), where W = weight and R = radius, differs by the shape of the object. The equation for biconical and spherical whorls is $W([0.75 \times R \times R]/2)$. For conical whorls it is $W([R \times R]/2)$ (courtesy of Joanna S. Smith).

tools such as querns that would not have been moved easily. These less portable objects in textile production may have held value for several members of a community in a shared fashion more than for a single individual. Indeed, often more than one weaver worked together.

AREA A

Area A (fig. 10.3) is near a gate in a wall on the eastern edge of the mound closest to the river. Nine spindle whorls and ten loom weights account for 15% and 59% of the total of such objects from the Penn excavations at *Bamboula*. In addition, there are metal tools such as bronze needles, stone querns and pestles, and ceramic vats and pithoi. Their earliest contexts date to LC IIB. Activity in this area extended into LC IIIB, even as other parts of the settlement and its tombs were no longer in use (Steel 1996: 290; Weinberg 1983: 52). Of particular significance in Area A is House VII of LC IIIA date where the kinds of portable objects—and, less frequently, groups of them—suggest an area devoted at least partly to the making of textiles. Seals found with these objects (Smith 2012: 64, 70, 95–96, Appendix 2, cat. nos. 9–13) indicate that the work here was administered in some way.

Area A before LC III

The earliest deposits in Area A date to LC IIB. A biconical stone spindle whorl (fig. 10.1a, Table 10.1a) and a loom weight (fig. 10.2a, Table 10.2a) come from a secondary fill between House III and the wall on the edge of the site (Benson 1969: 6; 1970: 42–43). Four loom weights (fig. 10.2b–e, Table 10.2b–e) come from refuse pits that predate and lie below Houses V and VI (Benson 1969: 6; 1970: 42–43). No other plausible textile-related tools or installations were found with these discarded objects.

Area A in LC IIIA

Three houses from Stratum D of the LC IIIA period contain textile tools. House VI is near the gate. One stone biconical spindle whorl (fig. 10.1b, Table 10.1b) was in Room 6 along with a sunken,

inscribed pithos with a lid (Benson 1969: 9; 1970: 46–47; 1972: 102, 134, pl. 27; Weinberg 1983: 14). Debris in House IV (Benson 1970: 11) included a bronze needle-like tool with a large looped head, something of iron published as an “amorphous object,” and stone pestles (Benson 1972: 126, 131, 134, pl. 36).

House VII has at least three rooms that point to textile production activities taking place inside and possibly outside. This multi-room building (or buildings) is set apart from and slightly north of the main cluster of excavated structures in Area A (Weinberg 1983: 15–16). House VII did not continue in use in LC IIIB, and many of the smaller more portable objects may have been removed at the end of the structure's use life. Benson and Weinberg include uncatalogued and lost objects in their descriptions of the structure(s) (Benson 1969: 9–11; 1970: 46–47; Weinberg 1983: 15–18).

On the floor of Room 10 was a vat with a drain hole near the bottom, parts of two pithoi, two pithos lids, and four querns. Another pithos was sunk into a pit in the north corner (Benson 1972: 102, 134, 137, nos. B929, B933, B963, B1468, B1500, B1501). On the floor were a loom weight (fig. 10.2g, Table 10.2g) and a long-lived cylinder seal, which had been recarved multiple times (Smith 2012: 96, Appendix 2, cat. no. 13). Just east of Room 10 is Room 11 that contained pottery and two stamp seals (Smith 2012: 95, Appendix 2, cat. nos. 9–10). This pair of rooms links via a narrow corridor with Rooms 9 and 5 that had more pithoi, an amphora sunk into the floor, a stone basin, a pestle, and querns (Benson 1972: 102–3, 134, nos. B926, B928, B940, B965, B1479, B1498, B1499). Rooms 10, 9, and 5 are slightly sunken (Benson 1969: 10).

Room 12 is separated from Rooms 10 and 11 by a thicker wall that could have supported a second story. In this room was a deep pit. On the floor were a stone conical spindle whorl (fig. 10.1c, Table 10.1c) and parts of an iron blade (Benson 1972: 130, no. B1386). On the accumulated deposits in the room were two saddle querns and part of an object published as a bronze rod (Benson 1972: 128, no. B1313).

Room 6, abutting Room 3, forms a stairway (Weinberg 1983: 16), which suggests that some spaces not connected directly on the ground floor

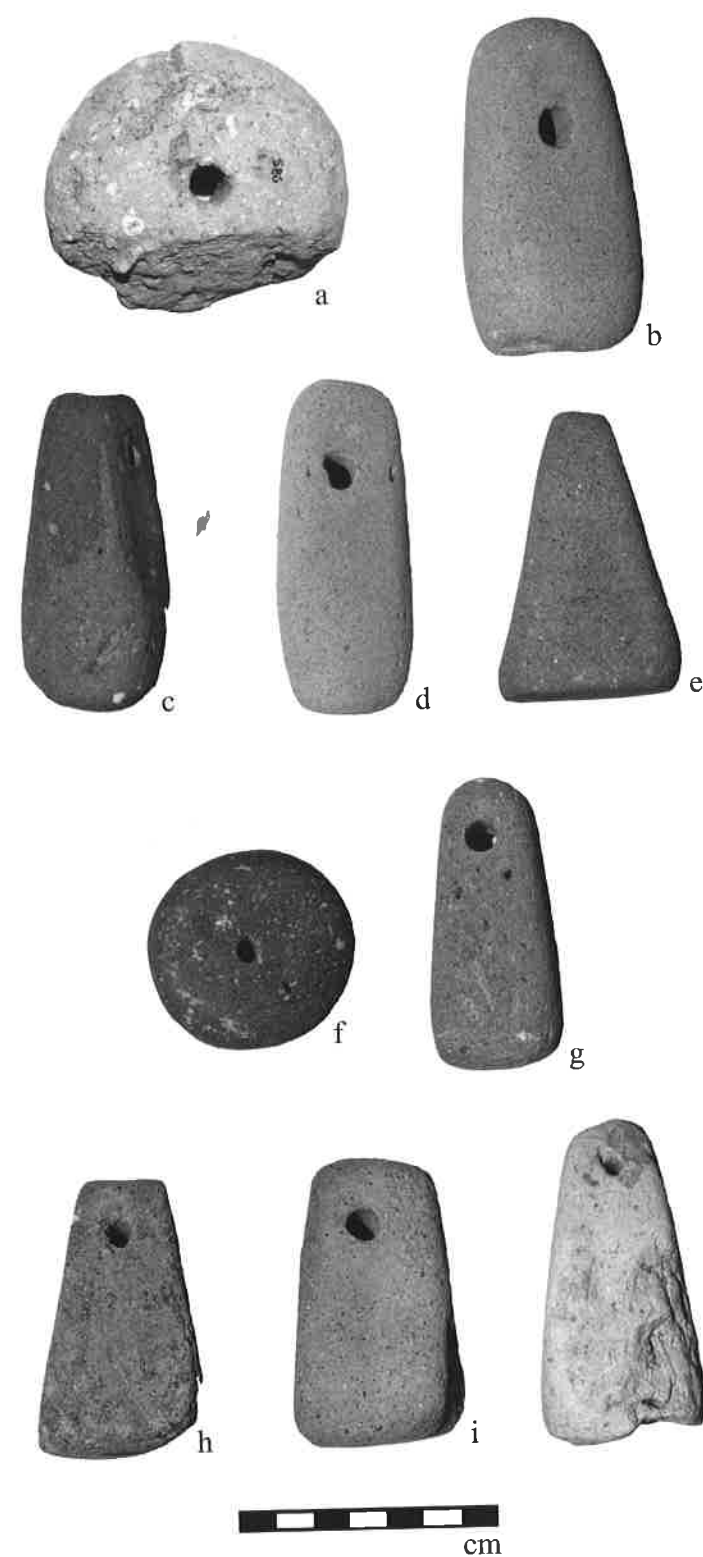


FIG. 10.2 Loom weights from the University of Pennsylvania excavations at Episkopi Bamboula, Area A. See Table 10.2 for specifics of each object. All objects are in the Local Museum of Kourion in Episkopi, Cyprus (courtesy of Joanna S. Smith).

may have been open to one another above. It is also possible that deposits from a second storey are from activity that took place on the roof. Room 8, next to Room 3, contained a pit holding a pithos that in turn held smaller vessels and a large stamp seal (Smith 2012: 95, Appendix 2, cat. no. 11). More vessels were on the floor, along with a newer cylinder seal (Smith 2012: 95–96, Appendix 2, cat. no. 12), a whetstone, and a quern (Benson 1972: 134–35, B1497, B1546). Room 3 also had a pit that held a bronze needle, two pestles, and an alabaster vessel fragment (Benson 1972: 125–26, 134, nos. B1244, B1274, B1466, B1467). On its floor were another pestle, a jug, and fragments of objects published as metal slag (Benson 1972: 100, 134, 138, nos. B876, B1478, B1620, B1621). Debris from an upper storey, or possibly from the roof, contained more pottery vessels and a loom weight (fig. 10.2f, Table 10.2f). Indeed, weaving often took place outside in courtyards or on roofs.

Area A in LC IIIB

Stratum E of the LC IIIB period also contained both whorls and weights. In the fill of House V was a spindle whorl (fig. 10.1g, Table 10.1g), but little else suggestive of textile working (Benson 1969: 14; 1970: 50–51). Possibly connected with textile work is an iron knife given an early Late Bronze Age context within House V by the excavator (Daniel 1938: 269, fig. 9). This curved blade was assigned a more plausible LC IIIA–IIIB date in the final publication (Benson 1970: 63; 1972: 130, no. B1382). Between the street and the wall in accumulation at the edge of the settlement (Benson 1969: 12; 1970: 48–49) there was one loom weight (fig. 10.2j, Table 10.2j) in a secondary fill.

* More objects were found associated with House VIII (Benson 1969: 12).

Within a deposit that contains fill and debris from activity in House VIII generally (Benson 1969: 13–14; 1970: 48–49) were three spindle whorls (fig. 10.1d–f, Table 10.1d–f). Also from this fill were bronze tweezers, pestles, an object published as a curved iron knife, and fragments of other iron and bronze objects (Benson 1972: 127–28, 130–31, 134, nos. B1299, B1314, B1383, B1390, B1461, B1471). Loom weights are more tenuously connected with activity at the house because both were found in deposits that consist of the construction or walls of the house, rather than objects plausibly used in the house. Their uses for weaving would have been in LC IIIA or earlier. Among materials used for the house's construction (Benson 1969: 12, 1970: 48–49) was one loom weight (fig. 10.2h, Table 10.2h), a pestle, and a quern (Benson 1972: 134, nos. B1470, B1480, B1503). From Room 2 of House VIII, amidst debris from fallen house walls (Benson 1969: 14–15; 1970: 50–51), was another loom weight (fig. 10.2i, Table 10.2i).

TEXTILES PRODUCED IN AREA A

In the main part of Area A, in Houses IV, V, VI, and VIII, the tools suggest that textile production was an activity nearby, but that people discarded their tools, reused them in building materials, and only rarely left them behind in deposits representing activities within the structures. The deposits in House VII taken together reveal this to be an abandoned structure (or structures) with wet-working in a sunken section and dry-working with fibers in other parts, with some weaving possibly in the open air.

Wet-working includes the vats in Rooms 10 and 5. These large containers stand half a meter in height and measure about 80 cm in diameter (Benson 1972: 103, nos. B963, B965). They could have been similar in function to the more ovoid

“bathtubs” that were used for the processing of wool (Mazow 2013; 2014: 42–45). The presence of grinding stones and a whetstone point could also point to metallurgical work alongside textile production, a cooperative feature found elsewhere, as at Kition where craftspeople used similar grinding tools and shared resources, including scrap metal used for fixing dyes (Smith 2002: 303). However, my restudy of objects from *Bamboula* showed that the objects published as slag from this context (Benson 1972: 138, nos. B1620, B1621) are instead fragments of basalt objects that can be fit together. The flatter part could have rotated within the depression of the larger part, rather like a heavy, slow pottery wheel. In addition to grinding tools, further evidence suggestive of dyework is preserved on one

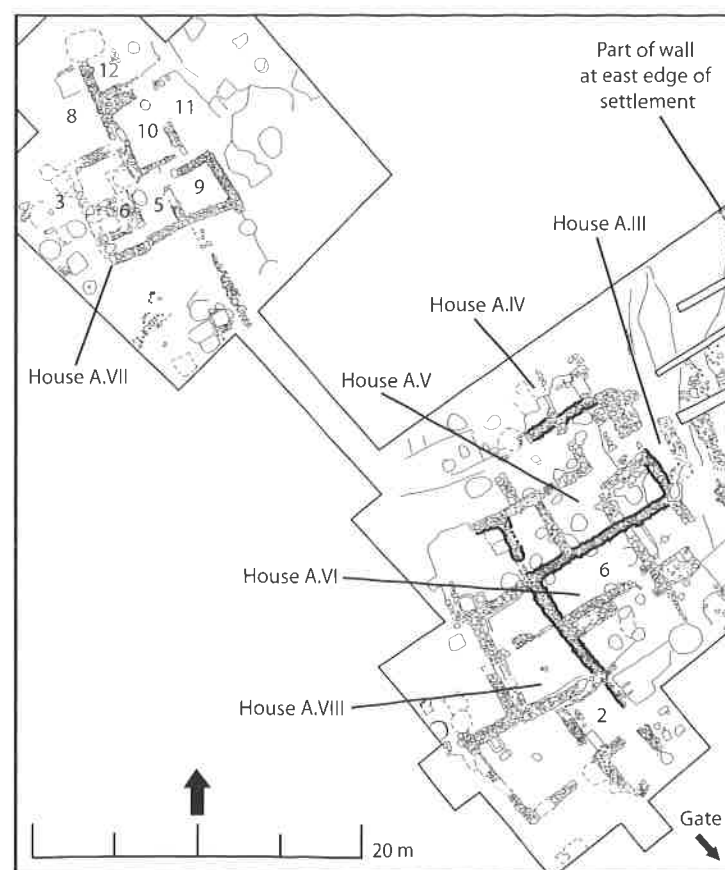


FIG. 10.3 Plan of the University of Pennsylvania excavations at Episkopi Bamboula, Area A, showing only the areas of excavation that are central to the discussion of textile tools. Only the “Houses,” “Rooms,” and other features mentioned in the text are labeled. Thick outline has been added to emphasize the divisions among “Houses” as determined by the excavator and publishers (after Weinberg 1983: fig. 24; courtesy of Joanna S. Smith).

of the two small stamp seals, which has traces of a blue pigment on its carved surface that is not part of the original composition of the object (Smith 2012: 64). The three stamp seals might have been used to stamp out maker's marks or surface patterning.

Dry-working involved spinning, weaving, and the working of cloth surfaces after weaving, as in needlework. Other possible textile tools of metal include blade fragments that might be parts of iron weaving swords used to beat in the weft (Mazow 2017). At *Bamboula*, iron blades were found only in Area A and in tombs. My restudy of objects from *Bamboula* showed that the iron “knife” (Benson 1972: 130, no. B1386), as well as the bronze “rod” (Benson 1972: 128, no. B1313) from House VII Room 12 are a fragmentary iron blade with a bronze rivet and a bronze blade fragment. This study also showed that the iron “knife” from a fill in House VIII consists of two joining parts of a blade (Benson 1972: 130, B1383). Furthermore, the “amorphous” iron object from House IV (Benson 1972: 131, no. B1391) turned out to be three joining fragments of the pointed tip of an iron blade.

Other than the curved iron knife from House V, these possible sword blades are small fragments and none preserve the distinctive squared tips of weaving swords. However, their association with Area A and with textile tools in that part of the settlement is suggestive of their potential purpose for working with cloth, either for weaving or cutting. Furthermore, combat swords could be repurposed for working with cloth (Mazow 2017: 11). At *Bamboula*, the only squared tip on a flat metal object is found on an iron tool published as a “chisel” (Benson 1972: 130, no. B1381, pl. 35; Penn Museum nd: no. 49-12-366). It was found in a much-disturbed tomb about which little was recorded (Benson 1972: 25). Sword fragments with distinctive squared tips have been found in Cyprus in textile workshops of the Archaic and Classical periods at Polis Chrysochous (Marion) (Smith 2019).

The dimensions of the spindle whorls and loom weights in Area A, representative of the *Bamboula* settlement, fill out the picture by detailing the nature of the products made there in the LC II–III periods.

Fibers

Measurements of whorl weight and diameter are keys to determining the types of fibers spun. Calculation of the moment of inertia (MI), the relationship between the force to produce rotation and the change in velocity of a rotating object (cf. Sauvage 2013), allows for the comparison of whorls of different shapes and materials. MI numbers at *Bamboula* in Area A have a wide range, from the largest whorl used to make heavy and thick yarn at 76.83 g/cm² to the smallest used to make light and thin threads at 3.77 g/cm² (Table 10.1).

Experimental work at the Center for Textile Research (CTR) shows that different kinds of fibers may be spun using the same whorls. Differences in results are due to the skill and technique of the spinner. More predictably, the weight and diameter of the whorl determine the tension on fibers and their spin (Andersson Strand 2015: 80–83). A whorl of larger diameter will spin more slowly than a narrower example and thus will make a less tightly spun fiber. The stone conical whorl from House VII (fig. 10.1c, Table 10.1c) is a good example. It is lighter in weight compared with many whorls from Area A, yet its large diameter would cause its fibers to be less tightly spun and thus less thin than narrower whorls. Differences of shape may also suggest the fiber spun. For example, flax tends to slide off during spinning, which leads to the hypothesis that whorls of greater diameter would be more suitable for spinning this fiber (Andersson Strand 2015: 83).

CTR experiments also showed that the equivalent warp tension on a thread spun with whorls of 4, 8, and 18 g would be 13, 18, and 25–30 g, using mostly wool, but also flax in the case of whorls of 8 g (Andersson Strand 2015: 140–41, fig. 4.5.3). These numbers, if one equates a whorl of 18 g with a fiber needing 30 g of warp tension, suggest that as the weight of the whorl increases by 1 g, the tension needed for the spun fiber when used as a warp thread increases by 1.25 g. If an 18 g whorl more closely equates with a fiber needing 25 g of warp tension, the extrapolated increase in tension for the warp fiber should be correspondingly less for whorls more than 18 g. Among the whorls at *Bamboula* there is one close in weight to 18 g, the

smallest biconical terracotta whorl of ca. 19.50 g (fig. 10.1g, Table 10.1g). Another is close in weight to 8 g, the smallest biconical stone whorl of 9.96 g (fig. 10.1f, Table 10.1f). Using the extrapolated number of 1.25, these whorls of 19.50 g and 9.96 g would be appropriate for spinning threads needing warp tensions of about 31–32 g for the heavier example and 20–21 g for the lighter example. Other whorls from Area A made threads needing from 24–25 g up to 57–58 g tension when used for the warp (Table 10.1).

Fabrics

No sets of loom weights were found at *Bamboula*. Nevertheless, using the weight and width/thickness of each weight, it is possible to calculate whether any of these individual weights could have been used together, what weights and densities of cloth were the likely products of weavers, and whether the fibers made with any of the whorls would have been suitable for the warps held down with these weights on a loom. The warp-weighted loom needs at least two rows of weights, which results in a tabby weave. A twill would need four rows of weights. The discussion here assumes a tabby set-up, where each row has half the number of the total warp threads. The width of a single row of weights determines the width of the fabric woven on the loom (Mårtensson et al. 2009).

Groupings of weights that could have been used together emerge through the creation of hypothetical set-ups, shown in the center columns of Table 10.2, with 2, 5, 10, and 20 warp fibers per centimeter in a tabby weave, or about 1, 2.5, 5, or 10 per centimeter in a row. By multiplying the maximum width or thickness of the weight by the number of warp threads per centimeter per row it is possible to determine how many threads would be attached to each weight in each case. For the cylindrical weights, there is only the option of a width measurement. The preference by some weavers for this shape might have drawn from its less variable nature. For the truncated pyramidal weights, calculations are based on both the maximum width (measured for the hole-to-hole orientation) and maximum thickness, because weights of this shape could hang with either dimension serving as the width of the object on the loom.

For these hypothetical set-ups, the tension exerted on a warp fiber is easily determined by dividing the weight of the loom weight by the number of fibers in a set-up. CTR experiments showed that the optimal number on a weight was 20–25 threads, with a normal range of 10–30 threads (Andersson Strand 2015: 142). In the center columns of Table 10.2, four different groupings of weights, each with generally more than 10 but fewer than 30 threads attached to each weight, emerge for making tabby fabrics of different weights with either 5 or 10 threads per centimeter (2.5 or 5 per centimeter per row). The groups are shown in Table 10.2 with different typefaces. A denser warp, with up to 20 threads per centimeter (10 threads per centimeter per row), is unlikely because more than 30 threads would need to be attached to each weight.

However, comparing the warp tensions required in these set-ups to the warp tensions needed for the threads spun with the whorls from Area A (Table 10.1) shows that if the fibers from these whorls were used for warps on the warp-weighted looms, then the thread count per centimeter was normally less than 5, making for open weaves. Indeed, the CTR experiments showed that on Cyprus fewer than 10 threads were often attached to each weight (Smith et al. 2015: 333, 343).

The columns at the right in Table 10.2 show how many threads would be attached to each weight if using thread made by each of the whorls in Table 10.1. This is determined by dividing the weight of the loom weight by the warp tension needed for the fiber. Dividing the width of each weight as it hung on the loom by the number of fibers attached to it then reveals the number of threads per centimeter in a single row. Doubling those numbers shows how many threads there were per centimeter in an overall tabby weave. Only the smallest whorl (fig. 10.1f, Table 10.1f), used to spin thin, tight fibers, possibly of wool, could have been used with all the loom weights to make a tabby fabric of 3 or more threads per centimeter. The conical stone whorl (fig. 10.1c, Table 10.1c), used to make somewhat less tightly spun fibers, possibly of flax, would have been suitable to make such a tabby fabric with six of the weights (fig. 10.2.a–d, h–i, Table 10.2.a–d, h–i). The smallest biconical terracotta whorl could

have been used to make such a fabric with four of the weights (fig. 10.2.a–c, i, Table 10.2.a–c, i). Only the largest of the loom weights (fig. 10.2a, Table 10.2a) could have been used with fibers made with nearly all the whorls to make a tabby weave of 3 or more threads per centimeter.

CONNECTIONS WITH EPISKOPHI PHANEROMENI

Some terracotta whorls at *Bamboula* are of shapes, sizes, materials, decorations, and surface treatments that are typical of whorls of the Middle or early Late Bronze Age at Episkopi *Phaneromeni*. These objects are usually heavily worn. They were rarely placed in tombs of those buried at *Bamboula* (e.g., Benson 1972: 24, 135, B1536, pl. 37). If used in the settlement at *Bamboula* in LC II–III, they were refound and reused or, perhaps less likely, they were passed down over generations. Some or all of these whorls, however, could represent disturbed material from an earlier deposit. In Area A, there are four examples, two of which were unstratified (fig. 10.1h–i, Table 10.1h–i). Building debris in House V contained a terracotta whorl (fig. 10.1g, Table 10.1g) and Red Polished and earlier ceramics mixed with LC IIIB vessels (Benson 1970: 50–51). Only one terracotta example in Area A, the largest whorl (fig. 10.1d, Table 10.1d), is from a plausible use-related LC IIIB context.

This largest and heaviest whorl (fig. 10.1d, Table 10.1d) is very worn, with traces of red slip and diagonal incisions near its largest diameter; it compares with whorls of *Phaneromeni* Type 3 (cf. especially Crewe 1998: 115, no. TC 26; Swiny 1986: 114, 132, no. TC 26, Table 8, fig. 70). Less directly comparable to a specific whorl at *Phaneromeni* is a very worn, flattened, biconical piece of wide diameter (fig. 10.1i, Table 10.1i), with a resemblance to *Phaneromeni* Type 4 (Crewe 1998: 116, no. TC 60; Swiny 1986: 114, 133, no. TC 60, Table 8, fig. 70). One biconical whorl (fig. 10.1h, Table 10.1h) has better preserved red slip and traces of incised decoration (cf. especially Swiny 1986: 112, 136, no. TC 128, Table 6, fig. 69). An even smaller example of a biconical whorl has well-preserved decoration and only a few traces of slip (fig. 10.1g, Table 10.1g). It compares to the smallest of whorls at *Pha-*

neromeni (Swiny 1986: 112, 135–36, nos. TC 92, TC 125, Table 6, fig. 69). It has symmetrical decoration with an incision around the midpoint as in Swiny's whorl Type 2b, but, unlike those whorls, the ends are framed with an incised line. Some asymmetrically decorated examples, Swiny's Type 2a, have this feature (e.g., Swiny 1986: 132, no. TC 16, fig. 69).

If the well-worn large conical whorl was still used in LC IIIB it would have made fibers much thicker and heavier than those used for warps on the warp-weighted looms at *Bamboula*. Only the smallest terracotta whorl would have spun threads that could have been used as warp fibers on the warp-weighted loom at *Bamboula*.

Unlike the whorls, no loom weight at *Bamboula* looks to be an object once used at or during the life of Episkopi *Phaneromeni*. However, calculations of the warp tensions exerted by loom weights at *Phaneromeni* show that there were overlaps in the fabrics that could have been made on the warp-weighted loom at both sites. In his publication of *Phaneromeni*, Swiny noted that Type 1a looked to be the same size as some examples from *Bamboula* (Swiny 1986: 108).

Swiny divided the terracotta loom weights from *Phaneromeni* into three types, providing average estimates for weights and listing dimensions that correspond with the largest width as hung on a loom (Swiny 1986: 107–8). The most common, Type 1a, at ca. 200 g and a width of 5.2 cm would have been used with fibers similar to those used with weights highlighted in italics in Table 10.2 (fig. 10.2c, h, Table 10.2c, h). Type 1b, at ca. 550 g and a width of 6.6 cm would have been for weaving heavier fabrics with fibers similar to those appropriate for the heaviest weight from *Bamboula* (fig. 10.2a, Table 10.2a). Type 1c, with a weight of ca. 1000 g and a width of ca. 8.6 cm would have been for textiles much heavier than any known to have been made on the warp-weighted loom at *Bamboula*. The warp-weighted loom generally was used at *Bamboula* to make lighter weight fabrics.

EPISKOPHI AND CYPRIOT TEXTILES OF THE LATE BRONZE AGE

The data from *Bamboula* together with *Phaneromeni* shows how weavers in the LC II and

III periods increasingly used the warp-weighted loom to make light weight rather than heavy fabrics. Extant evidence for fibers made at *Bamboula* shows that these fabrics were open weaves that would only have been stable fabrics if they were weft-faced. The iron and bronze blade fragments from Area A may have been parts of swords used to beat these weft fibers in, so that they completely covered the warp fibers. Similar products have been reconstructed through experimental work with tools from Apliki and Kition (Smith et al. 2015) and work to date at Enkomi (Sauvage and Smith 2016). Bone pin beaters for beating in the weft have been found at both Kition and Enkomi. Even lighter weight fabrics were the products at Phlamoudhi (Smith 2017).

Workshops for textile production in Late Bronze Age Cyprus are of varying size and complexity (Sauvage and Smith 2016; Smith 2002; Smith and Tzachili 2012). The assemblage in House VII suggests that it was at least partly used for textile production. This work may have been administered using cylinder seals, which in turn suggests that the work and products concerned craftspeople and customers outside a single household; the greater numbers of imported objects in Area A than in other parts of the settlement may reflect that products made there may have reached consumers outside the Kouris River Valley or even beyond Cyprus.

The disjunction between fibers used with loom weights and fibers spun with whorls is a problem common at other Late Cypriot sites (Smith 2017; Smith et al. 2015). Thicker and heavier fibers perhaps were used for wefts. Lighter weight whorls of wood may have spun finer fibers that would have made for very light weight warp-weighted loom products of higher thread counts, like those in the hypothetical set-ups. It is also likely that weavers used other loom types, especially for making heavy fabrics. Just as the extant whorls and weights help to recreate some spun fibers and woven fabrics, these same objects at *Bamboula* and elsewhere testify to the unseen presence of lost tools, especially lost looms.

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	Stratum, Context date	Field no. / Benson 1972 no.	Shape, material, preservation	Maximum width / thickness (cm)	Weight / weight reconstructed (gm)	Warp threads per cm per row: possibilities a/b/ etc. on weight	Tension on warp thread possibilities a/b/etc. (if alternate weight) (gm)	No. threads made with whorls in Fig. 10.1 and Table 10.1 on weight	Warp threads per cm per row based on options for Fig. 10.1 and Table 10.1 whorl threads on weight	Resulting approximate warp threads per cm in tabby weave:
a	A-B:3, LCIB	S 86 / B1593	Cylindrical, short, low-fired terracotta, 66–75%	4.34	235.49 / 357 if 66% (314 if 75%)	1: 4/5 2.5: 10/11 5: 21/22 10: 43/44	89.25/71.40 (78.50/62.80) 35.70/32.45 (31.40/28.55) 17.00/16.23 (14.95/14.27) 8.30/8.11 (7.30/7.14)	a. 6/7 b. 7/8 c. 14/15 d. 6/7 e. 9/10 f. 17/18 g. 11/12 h. 8 i. 6/7	1.38/1.61 1.61/1.84 3.23/3.46 1.38/1.61 2.07/2.30 3.92/4.15 2.54/2.76 1.84 1.38/1.61	2-3 3+ 6-7 2-3 4+ 8 5 3+ 2-3
b	A-B:6, LCIB	S 21 / B1583	Pyramidal, truncated, terracotta, 97%	4.76 / 4.9	243.86 / 251	1: 4/5 2.5: 11/12/13 5: 23/24/25 10: 47/48/49	62.75/50.20 22.82/20.92/19.30 10.91/10.46/10.04 5.34/5.23/5.12	a. 4/5 b. 5/6 c. 10/11 d. 4/5 e. 6/7 f. 11/12 g. 7/8 h. 5/6 i. 4/5	0.84/1.05//0.82/1.02 1.05/1.26//1.02/1.22 2.10/2.31//2.04/2.24 0.84/1.05//0.82/1.02 1.26/1.47//1.22/1.43 2.31/2.52//2.24/2.45 1.47/1.68//1.43/1.63 1.05/1.26//1.02/1.22 0.84/1.05//0.82/1.02	2 2+ 4-5 2 2-3 5 2-3+ 2+ 2
c	A-B:6, LCIB	S 16 / B1580	Pyramidal, truncated, terracotta, 75%	3.81 / 3.84	124.35 / 166	1: 3/4 2.5: 9/10 5: 19/20 10: 38/39	55.33/41.50 18.44/16.60 8.74/8.30 4.37/4.26	a. 3/4 b. 3/4 c. 6/7 d. 2/3 e. 4/5 f. 7/8 g. 5/6 h. 3/4 i. 3/4	0.79/1.05//0.78/1.04 0.79/1.05//0.78/1.04 1.57/1.84//1.56/1.82 0.52/0.79//0.52/0.78 1.05/1.31//1.04/1.30 1.84/2.10//1.82/2.08 1.31/1.57//1.30/1.56 0.79/1.05//0.78/1.04 0.79/1.05//0.78/1.04	1-2 1-2 3+ 1 2-3 3-4 3 1-2 1-2
d	A-B:6, LCIB	S 20 / B1582	Pyramidal, truncated, terracotta, 97%	3.76 / 3.43	122.38 / 126	1: 3/4 2.5: 8/9/10 5: 17/18/19 10: 34/35/ 37 /38	42.00/31.50 15.75/14.00/12.60 7.41/7.00/6.63 3.71/3.60/3.41/3.32	a. 2/3 b. 2/3 c. 5/6 d. 2/3 e. 3/4 f. 6/7 g. 3/4 h. 2/3 i. 2/3	0.53/0.80//0.58/0.87 0.53/0.80//0.58/0.87 1.33/1.60//1.46/1.75 0.53/0.80//0.58/0.87 0.80/1.06//0.87/1.17 1.60/1.86//1.75/2.04 0.80/1.06//0.87/1.17 0.53/0.80//0.58/0.87 0.53/0.80//0.58/0.87	1+ 1+ 2-3+ 1+ 2+ 3-4 2+ 1+ 1+

→ Table 10.2 Details of loom weights shown in figure 10.2. Weights that could have been used together on a loom because they would have exerted a similar tension on warp threads are marked by different typefaces. Object g, in boldface italic, could potentially have been used either with the weights shown in boldface or the weights shown in italics, depending on the orientation of the weight on the loom and hence the number of warp threads attached to the object. Object a shown in regular font could not have been used alongside other published weights from *Bamboula* (courtesy of Joanna S. Smith).

	Stratum, Context date	Field no. / Benson 1972 no.	Shape, material, preservation	Maximum width / thickness (cm)	Weight / weight reconstructed (gm)	Warp threads per cm per row: possibilities a/b/ etc. on weight	Tension on warp thread possibilities a/b/etc. (if alternate weight) (gm)	No. threads made with whorls in Fig. 10.1 and Table 10.1 on weight	Warp threads per cm per row based on options for Fig. 10.1 and Table 10.1 whorl threads on weight	Resulting approximate warp threads per cm in tabby weave:
e	A-B:6, LCIIIB	S 17 / B1581	Pyramidal, truncated, terracotta, 100%	4.97 / 4.21	147.44 / 148	1: 5 2.5: 10/11/12/13 5: 21/24/25 10: 42/50	29.6 14.80/13.45/12.33/11.38 7.05/6.17/5.92 3.52/2.96	a. 2/3 b. 3/4 c. 6 d. 2/3 e. 3/4 f. 7/8 g. 4/5 h. 3/4 i. 2/3	0.40/0.60//0.48/0.71 0.60/0.80//0.71/0.95 1.21//1.43 0.40/0.60//0.48/0.71 0.60/0.80//0.71/0.95 1.41/1.61//1.66/1.90 0.80/1.01//0.95/1.19 0.60/0.80//0.71/0.95 0.40/0.60//0.48/0.71	1 1-2 2-3 1 1-2 3-4 1-2 1-2 1
f	A-D:2 (VII,2), Room 3, LCIIIA	S 1 / B1592	Cylindrical, short, terracotta, 94%	3.45	112.81 / 120	1: 3/4 2.5: 8/9 5: 17/18 10: 34/35	40.00/30.00 15.00/13.33 7.06/6.67 3.53/3.43	a. 2/3 b. 2/3 c. 4/5 d. 2/3 e. 3/4 f. 5/6 g. 3/4 h. 2/3 i. 2/3	0.58/0.87 0.58/0.87 1.16/1.45 0.58/0.87 0.87/1.16 1.45/1.74 0.87/1.16 0.58/0.87 0.58/0.87	1+ 1+ 2-3 1+ 1-2 3+ 1-2 1+ 1+
g	A-D:2 (VII,2), Room 10, LCIIIA	S 15 / B1579	Pyramidal, truncated, terracotta, 97%	4.37 / 3.55	134.14 / 138	1: 3/4/5 2.5: 8/9/10/11 5: 17/18/21/22 10: 35/36/43/44	46.00/34.50/27.60 17.25/15.33/13.80/12.55 8.12/7.67/6.57/6.27 3.94/3.83/3.21/3.14	a. 2/3 b. 3 c. 5/6 d. 2/3 e. 3/4 f. 6/7 g. 4/5 h. 3 i. 2/3	0.46/0.69//0.56/0.85 0.56//0.85 1.14/1.37//1.41/1.69 0.46/0.69//0.56/0.85 0.56/0.92//0.85/1.13 1.37/1.60//1.69/1.97 0.92/1.14//1.13/1.41 0.56//0.85 0.46/0.69//0.56/0.85	1 1+ 2-3 1 1-2 3-4 2-3 1+ 1
h	A-E:1 (VIII), LCIIIB	S 22 / B1584	Pyramidal, truncated, terracotta, 86%	4.81 / 4.22	153.56 / 179	1: 4/5 2.5: 10/11/12 5: 21/24 10: 42/43/48	44.75/35.80 17.90/16.27/14.92 8.52/7.46 4.26/4.16/3.73	a. 3/4 b. 3/4 c. 7/8 d. 3/4 e. 4/5 f. 8/9 g. 5/6 h. 4 i. 3/4	0.62/0.83//0.71/0.95 0.62/0.83//0.71/0.95 1.46/1.66//1.66/1.90 0.62/0.83//0.71/0.95 0.83/1.04//0.95/1.18 1.66/1.87//1.90/2.13 1.04/1.25//1.18/1.42 0.83//0.95 0.62/0.83//0.71/0.95	1+ 1+ 3-4 1+ 1-2+ 3-4+ 2-3 1+ 1+

	Stratum, Context date	Field no. / Benson 1972 no.	Shape, material, preservation	Maximum width / thickness (cm)	Weight / weight reconstructed (gm)	Warp threads per cm per row: possibilities a/b/ etc. on weight	Tension on warp thread possibilities a/b/etc. (if alternate weight) (gm)	No. threads made with whorls in Fig. 10.1 and Table 10.1 on weight	Warp threads per cm per row based on options for Fig. 10.1 and Table 10.1 whorl threads on weight	Resulting approximate warp threads per cm in tabby weave:
i	A-E:3 (VIII), Room 2, LCIIIB	S 14 / B1578	Pyramidal, truncated, terracotta, 97%	4.47 / 4.74	234.23 / 242	1: 4/5 2.5: 11/12 5: 22/23/24 10: 44/45/47/48	60.50/48.40 22.00/20.17 11.00/10.52/10.08 5.50/5.38/5.15/5.04	a. 4/5 b. 5/6 c. 9/10 d. 4/5 e. 6/7 f. 11/12 g. 7/8 h. 5/6 i. 4/5	0.89/1.12//0.84/1.05 1.12/1.34//1.05/1.27 2.01/2.24//1.90/2.11 0.89/1.12//0.84/1.05 1.34/1.57//1.27/1.48 2.46/2.68//2.32/2.53 1.57/1.78//1.48/1.69 1.12/1.34//1.05/1.27 0.89/1.12//0.84/1.05	1-2 2+ 4-5 1-2 3 5 3+ 2+ 1-2
j	A-E:2 (St.2b), LCIIIB	S 84 / B1586	Pyramidal, truncated, low-fired terracotta, 94%	4.53 / 4.43	135.36 / 144	1: 4/5 2.5: 11/12 5: 22/23 10: 44/45/46	36.00/28.80 13.09/12.00 6.55/6.26 3.27/3.20/3.13	a. 2/3 b. 3/4 c. 5/6 d. 2/3 e. 3/4 f. 6/7 g. 4/5 h. 3/4 i. 2/3	0.44/0.66//0.45/0.68 0.66/0.88//0.68/0.90 1.10/1.32//1.13/1.35 0.44/0.66//0.45/0.68 0.66/0.88//0.68/0.90 1.32/1.55//1.35/1.58 0.88/1.10//0.90/1.13 0.66/0.88//0.68/0.90 0.44/0.66//0.45/0.68	1 1+ 2+ 1 1+ 3 2 1+ 1