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From the Beginnings of Sheep Husbandry
to Institutional Textile Industry

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edited by

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Front cover: Sheep arriving at Aššur, drawing by W. Andrae;
Sketch of the animal frieze on the ritual limestone basin, Ebla, Temple D.
Back cover: Logogram LANA

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19. Mycenaean Wool Economies in the Latter Part of the 2nd Millennium BC Aegean

Marie-Louise Nosch

The 2nd millennium BC Aegean witnesses the emergence of a highly specialised system of wool economy: the Late Bronze Age Mycenaean centralized palace economies with their constant recording of flocks, herders, wool, and textiles production. This system monitors production targets and surplus production, and with directional flows and production strategies ensures that the palace society's needs are met. Wool production, as attested at Knossos, is the largest sector of the palace administration and it employs the highest number of people, organized according to a strict division of labour. It is entirely focused on wool for textile production. Other secondary products, such as milk, skins, horn, lanolin, and meat certainly did play a role as well but they only occur sporadically in the palace records. Wool was major resource for the Mycenaean palace economies, especially at Knossos, while also flax seems to have played a significant role at Pylos.

Regrettably, textiles, as other organic remains, are not often preserved in the Aegean.² At Akrotiri, Thera, c. 50 fragments of wool thread and at Chania in Crete, a tiny carbonized textile ribbon most probably combining nettle, linen, and goat hair were recovered.³

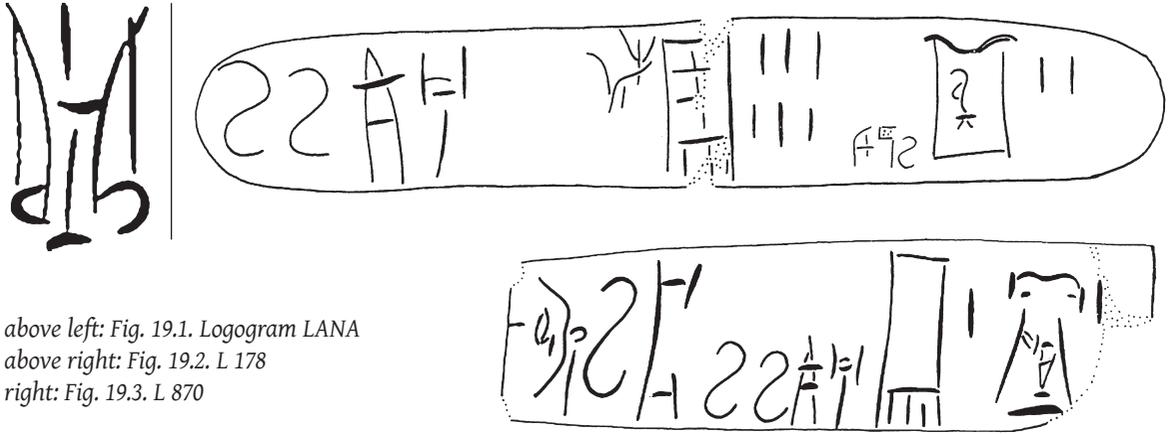
Experimental archaeology has demonstrated how time-consuming Bronze Age textile production was.⁴ It could have taken several months to make a textile, depending on the desired size and quality. In the Bronze Age, it can be safely assumed that most of the population, adults or children, elite or poor, were involved in various parts of the textile production, on a day-to-day basis. The sheep had to be tended and pastured, wool had to be sorted and combed, thread spun, textiles woven, sewn, and mended. This highly time-consuming nature is one of the reasons

¹ This paper is written with support from the Danish National Research Foundation's Centre for Textile Research (DG64) and with a fellowship from the Onassis Foundation, Athens. I thank Cécile Michel, Catherine Breniquet, Anna Michailidou and Richard Firth for their constructive and precise suggestions.

² Felt is not attested archaeologically but according to Michael Ryder, it can be made from the coat of the non-fleeced sheep and therefore was almost certainly the first form of woollen textile. Ryder 1993, especially page 309. However, this evolutionary scheme from felt to woven fabric is not supported in the archaeological finds, and it rather seems that felt technology is another development of wool use, for which the fibre selections and chaîne opératoire is quite different.

³ Spantidaki and Moulherat 2012, 189.

⁴ Andersson 2003; Andersson and Nosch 2003; Nosch 2012.



above left: Fig. 19.1. Logogram LANA

above right: Fig. 19.2. L 178

right: Fig. 19.3. L 870

why textile production seems so important to register and administer from the point of view of the Mycenaean palaces.

1. The Linear B documentation

The written evidence about the Mycenaean wool economy comes primarily from Knossos, and to a lesser degree from Thebes⁵ and Mycenae;⁶ Pylos records provide rich information about wool textile workers; the other Mycenaean documents from Tiryns, Midea, and Agios Vassileios have yielded only little or no textual evidence on sheep, shepherds, textile workers, textiles or wool. The available evidence is fragmented, unevenly preserved and, by its nature, evidently only informs us about the production in which the palace scribes had a professional interest. On the other hand, it is surprising how much evidence about the Mycenaean palace-controlled wool economy in the Late Bronze Age is preserved, and how much is known about it today.

2. Wool in the Aegean Bronze Age

In Linear B, wool is designated by the logogram *145, conventionally transcribed by the Latin word LANA (Figure 19.1).⁷

The word for ‘wool’ is not attested itself, only through its adjective *we-we-e-a/werweheha/* meaning ‘woollen’, related to Gr. εἴρος, in KN L 178 and L 870.

KN L 178 + 281 (Figure 19.2) (RCT/"124")
 we-we-e-a '*161' TELA³+PA 6 / u-po-we TUN+RI 2

6 woollen textiles of the type pa-we-a *161; underwear, 2 linen tunics.

KN L 870 + fr. (Figure 19.3) (I3/114?)
 o-]d̥a-ku-we-ta / we-we-e-a TELA³ 1 TUN+KI 1

⁵ Nosch 2001a; Del Frio and Rougemont 2012.

⁶ Varias Garcia 2012, 155–160.

⁷ On this logogram, see Nosch 2007.

The two tablets are both from Knossos but stem from two different phases, Late Minoan II (1425–1390 BC) of the Rooms of the Chariot Tablets, and Late Minoan III A2 or III B (see below).⁸

The wool logogram is also used as a metrogram, i.e. to indicate a quantity, and the weight value of this basic wool unit is 3 kg. The wool comes primarily from palace sheep flocks composed of wethers;⁹ the palace expected 1 unit of wool (3 kg) from 4 adult castrated sheep, i.e. around 750 g per animal. There are also records of breeding flocks composed of ewes and their lambs, and their wool target is only 10 animals: 1 unit of wool, i.e. c. 300 g per animal. This demonstrates a quantitative – and probably qualitative – difference between wool from wethers and wool from ewes and/or lambs. This difference becomes apparent on a tablet from Mycenae, Oe 111, which registers separately wool from sheep, *o-u-ka /owika/*, and wool from lambs, *wo-ro-ne-ja/wroneia/* (cf. ὄϊς and ἀρήν).¹⁰ Scribe 51 also seems to distinguish between new wool (*ne-wa*) and wool from the previous year (*pe-ru-si-nwa*) on Oe 111.

3. The nature of Mycenaean raw wool

Raw wool consists of hair, kemp, and under-wool on the sheep. Textiles can be made of many types of hair and wool – sheep, camel, goat, dog, or rabbit. However, in the Mediterranean Bronze Age records, we encounter, first and foremost, a highly intensive exploitation of sheep wool and a comprehensive management system of this exploitation.

A fleece is, in English, both the term for the dead animal’s skin and wool, and also for the wool taken (plucked) from a sheep. In this paper I employ the term fleece in this latter sense. The fleece is in classical Greek *πόκος* and this is probably also found in Linear B in *po-ka*:

KN Dp 997 + 7206 (I3/118)
 .a]po-ti-ni-ja-we-ja [
 .b]to-sa , / ne-wa , po-ka OVIS^f [

so many: new fleeces of/belonging to the Potnia, ewes (numbers broken)

These fleeces are associated with the major Mycenaean female divinity, Potnia, ‘the mistress’, and *po-ti-ni-ja-we-ja* is an adjective build on her name. She seems to play a role in the flocks of ewes and lambs, perhaps associated with reproduction and birth of lambs in Crete.¹¹

When wool is cleaned and prepared or occurs in smaller quantities than an entire fleece, it can be termed ‘tufts of wool’, *ti-ra /tilai/*, and on a tablet from Knossos, Od(1) 681, a male textile worker called *qo-ja-te* is recorded as having delivered tufts of wool to someone.

4. The Linear B records of wool

The Mycenaean wool economy is clearly documented in the records at Knossos and was a significant part of daily life in palaces, sanctuaries, households, and farmsteads. Wool production by flocks of sheep controlled by the palace was meticulously recorded by palace scribes who

⁸ Driessen 1999 dates the RCT tablets to LM II and argues that they were sealed by fire destruction in LM III A:1.

⁹ Cf. Killen 1964.

¹⁰ Varias Garcia 2012.

¹¹ Nosch 2000a.

Relative date	Deposit/archive	Wool and textile records	Absolute dates
Late Minoan II	Knossos Room of the Chariot tablets	Textile records in the L series by scribe 124	1425–1390
Late Minoan III A2 Or Late Minoan III B	Knossos main archive	Textile records in the L series and wool records in the Od series by scribes 103, 113, 115, 227; Wool yields in the Dk and Dl series recorded by scribes 118, 119, 120; textile workers in the A series by scribes 103, 108	1370–1340 / 1340–1190
Late Helladic III B	Mycenae, Petsas House	Ui 2	End 14th century
Late Helladic III B1 end	Mycenae House of the Oil Merchant	Wool tablets	1250
	Pylos	Textile workers in A series	1200
	Thebes	Wool tablets Of and Oh	1200
	Mycenae, House of Columns	L 710	1200

Table 19.1. The chronology of Linear B tablets recording wool and textiles.

calculated the possible wool yields and the ensuing textile production; some 100,000 sheep were tended by some 700 shepherds in Crete;¹² wool was allocated to groups of women and children who were commissioned to fulfil certain textile production targets; wool was also allocated in smaller quantities to specialised textile workers for the finishing and decoration of textiles; and wool was offered to the gods.¹³

Wool is recorded on tablets found in the following palaces:

- Thebes Of tablets recording allocations of wool to textile workers and sanctuaries.
 Oh tablets recording smaller quantities of wool.
- Mycenae Oe tablets recording allocations of wool to textile workers, and as remuneration.¹⁴
- Knossos Od tablets recording various transactions of wool such as allocation of wool to workers and to sanctuaries.¹⁵

5. The wool administration at Knossos

Knossos Od wool tablets are divided into several sets, each associated with a specific scribe and a particular scope.¹⁶

5.1. Totalling records of large quantities of wool at Knossos

Two tablets record extraordinarily large quantities of wool: 700 units of wool equal to 2,100 kg, or wool from 2,800 sheep. These two tablets are unusual because of the large quantities and because of their connection to the sign *PE* which is probably an abbreviation of a term qualifying the wool.

¹² Olivier 1967.

¹³ Killen 1964; Nosch 2007.

¹⁴ Varias García 2012.

¹⁵ Nosch 2007, summarised in Nosch 2011.

¹⁶ Nosch 2007 and 2011.

KN Od(3) 1062 + fr. (-)
 LANA PE 200 [

KN Od(3) 1063 (-)
]LANA PE 500

5.2. Wool in smaller quantities for finishing textiles at Knossos

Other tablets record smaller quantities of wool for finishing purposes, especially those recorded by scribe 115 and scribe 103.¹⁷ All these are found in the West Wing of the palace where they had fallen from the first floor when the West Wing collapsed.¹⁸ They record many kinds of wool transactions pertaining to the textile qualities *pa-we-a*, *te-pa*, *tu-na-no*, *pe-ko-to*.

KN Od(1) 539 + 7296 + 7602 (103/F10)
 o-pi ti-mu-nu-we LANA 2[

In the workshop of *ti-mu-nu*, 2 units of wool

5.3. Wool for a goddess in Knossos

Four tablets are also by scribe 103, but differ in that these tablets were found slightly further to the east within the West Wing (G1) and these records evidently concern some religious purpose since they record wool for *e-re-u-ti-ja* which is the Mycenaean Greek goddess Eleuthia.

KN Od(2) 714 (103/G1)
 .a a-*65-na []
 .b e-re-u-ti-ja LANA 1 []

KN Od(2) 715 (103/G1)
 .a e-re-u-ti-ja
 .b ta-wa-ko-to LANA 1

KN Od(2) 716 (103/G1)
 .a] e-re-u-ti-ja
 .b] LANA 4

6. The wool administration at Mycenae

At Mycenae, no records of sheep or rations for textile workers are preserved but highly detailed records of wool allocations provide an insight into the wool economy. C. Varias Garcia rightly observes that, although there are only 77 Linear B inscriptions preserved from Mycenae, at least 36 of them, almost 43%, deal with the wool economy.¹⁹ Wool is allocated for the same types of fabrics as at Knossos, *te-pa*, *pa-we-a* and *pu-ka-ta-ri-ja* (L 710, Oe 107; 111; 127; X 508) within the production and *corvée* system called *ta-ra-si-ja* which was based on the labour of women and both male and female children, and these allocations were administered by scribes 51 and 55.

¹⁷ Nosch 2007.

¹⁸ Firth and Nosch 2002–2003.

¹⁹ Varias Garcia 2012.

7. The Of and Oh wool tablets in Thebes

In Thebes, 16 tablets recording wool have been found. These Of tablets are primarily attributed to scribe 303. In the 1990s, a further 3 Oh tablets came to light in another Theban excavation but with a similar content. From the occupational designation *te-pe-ja*, 'te-pa makers' on Of 35, we know that at Thebes, too, woollen *te-pa* were made. These Thebes wool record tablets have many similarities with those from Knossos: at Thebes, wool is allocated to individuals, to groups, to divinities, and to two types of 'houses', *do- (*do-de* 'to the house') and *woikos (*wo-i-ko-de*) of a divinity.²²

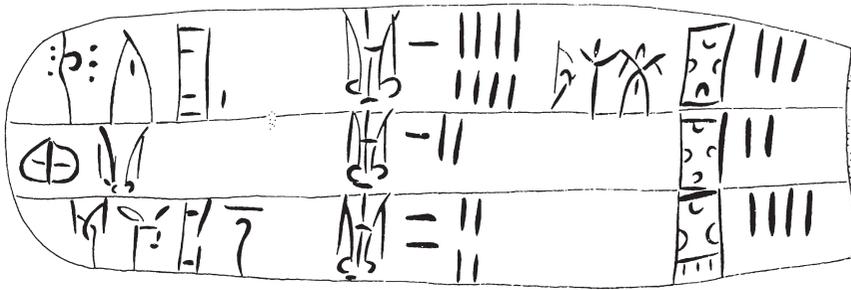


Fig 19.4. KN L 520

8. The woollen textiles in the Linear B Tablets²³

Knossos tablet L 520 (Figure 19.4) is a superb illustration of how the entire Mycenaean wool economy was based on the weight of wool and its equivalence in standard fabrics. L 520 is the meticulous record of the amounts of wool given to two villages, *do-ti-ja* and *ka-ma*, and to a 'collector' (see below) called *sa-mu-ta-jo*, for their manufacture of a total of nine textiles designated by the logogram *164.

KN L	520				(-)
.1	do-ti-ja ,	LANA 18	pe-re-ke	*164	3
.2	ka-ma	LANA 12		*164	2
.3	sa-mu-ta-jo	LANA 24		*164	4

8.1. The Linear B textile logograms and types of woollen textiles

Most Mycenaean textiles recorded in the palace archival documents are made of wool, and they seem to be primarily recorded as rather standardised textiles that do not require cutting or tailoring. Most textiles are recorded by the logogram for textile, in Latin *TELA*. This logogram is a generic sign for textile that can be altered according to the textile type by means of an endogram, which is a syllable inside the *TELA* logogram abbreviating the specific type of textile.

²² Nosch 2001a; Del Frego and Rougemont 2012.

²³ Killen 1964; 1966; 1974; 1979; 1984; 1988; Melena 1975; Duhoux 1976; Lujan 1996–1997; Del Frego, Nosch, Rougemont 2010; Petrakis 2012.

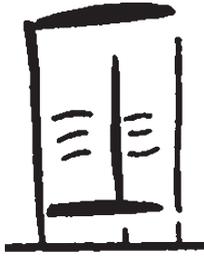


Fig 19.5. TELA+TE logogram

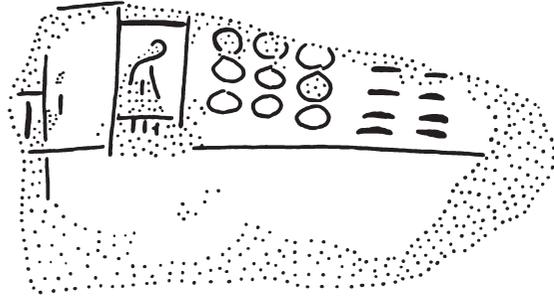


Fig. 19.6. KN L 5561

8.2. Types of Mycenaean woollen textiles

There are three primary Mycenaean textiles, *te-pa*, *pu-ka-ta-ri-ja*, and *pa-we-a*, they are attested in several palace archives, and can be subdivided into different kinds. These Mycenaean textiles are mostly in wool.

Te-pa or TELA+TE (Figure 19.5) is primarily attested at Knossos,²⁴ and a few at Pylos, Mycenae, and Thebes.²⁵ All *te-pa* are made of sheep wool. TELA+TE exists in several types: the standard TELA+TE *te-pa*; TELA+TE *pe/pe-ko-to*, and TELA+TE *mi/mi-ja-ro*. TELA+TE corresponds to 7 units of wool, that is, 21 kilos; the variety TELA+TE *pe-ko-to* requires 10 units of wool, i.e. 30 kg. There is generally no indication of decoration or dyes.²⁶ These fabrics are characterised by being heavy, large, and woollen.

Pu-ka-ta-ri-ja, or TELA+PU cloth, is exclusively attested to be made of wool. Its name may refer to a double thickness or perhaps the folded nature of the cloth.²⁷ *Pu-ka-ta-ri-ja* fabrics were, by far, the most abundant among the Knossian textiles but are also attested at Pylos and at Mycenae. Tablet L 5561 (Figure 19.6) from Knossos is probably a totalling record of TELA+PU textiles, and the mere number of 980 textiles demonstrates how important this woollen fabric was in the wool economy. 980 TELA+PU textiles required 2940 kg wool, or wool from 3920 sheep. This amount of wool can yield at least 9000 km of yarn (see below for calculations of yarn).

KN L 5561 + 5656 (-)
 .1]-ru-wa , TELA³+PU 980[
 .2]1 [
 inf. mut.
 .1 Perhaps ? o-]du-ru-wa, but]pu-ru-wa not excluded and probably better.

²⁴ L series, Lc(1) series, Le series, Ln 1568, Ws 8153, X 1432. Le 641 *te-pe-ja*.

²⁵ Pylos: La 624, Ad 921 *te-pe-ja-o*; La 1393; Un 6; Mycenae: Oe 107; Thebes Of 35 *te-pe-ja*.

²⁶ Except on Ln 1568, see Firth 2012.

²⁷ So DMic. s.v. See the interpretation by Duhoux 1976, note 232 as ‘folded’ textiles. Melena 1987, 445, suggests the *pu-ka-ta-ri-ja* textiles “might represent some sort of loincloth or kilt.”



Fig. 19.7. TELA+PA
logogram

Type of textile	Logogram	Requirement in wool units	Equivalent in kg	Number of sheep needed for this textile
<i>pa-we-a</i>	TELA+PA	1.67	c. 5 kg	6–7
<i>Te-pa</i>	TELA+TE	7	21	28
<i>Tu-na-no</i>		3	9	12
<i>Pe-ko-to</i>	TELA+TE	10	30	40
<i>Pu-ka-ta-ri-ja</i> ²⁸	TELA+PU	1	3	4
	*164	6	18	24

Table 19.2. Mycenaean textiles and the necessary amounts of wool.

These 980 *pu-ka-ta-ri-ja* fabrics may be *pu-ru-wa* / *purwai*, ‘red’ as suggested by the reading by José Melena, and this may be the natural red-brown pigmentation of wool.²⁹ This red-brown colour may indeed be a characteristic feature for them; in any case, we find no other specification of decoration, edges, or dyes of *pu-ka-ta-ri-ja*.

Pa-we-a or variant *pa-we-a*₂ / *p^harweha* TELA+PA (Figure 19.7), in Homer φᾶρος, is one of the most well attested Mycenaean woollen fabrics at Knossos, Pylos, and Mycenae.³⁰ One piece of *pa-wo* equals 1.67 LANA units, i.e. about 5 kg raw sheep wool. The size of a *pa-wo* is probably c. 2 m², thus, a ‘wearable’ size.³¹ *pa-we-a* is recorded with many different qualifications concerning decoration and colour.³² A special feature of *pa-we-a* is that they can be made of linen (L[1] set), possibly of sheep wool, *o-u-ka/owika* /, or of lambswool (MY Oe 111).

At Knossos further wool fabrics are attested: *tu-na-no* TELA³³ is a woollen cloth type, and one *tu-na-no* required 3 units of wool (= 9 kg).³⁴ *to-mi-ka* TELA is another woollen cloth type with an unknown etymology.³⁵ *164³⁶ is a woollen cloth, too, and we do not know its Mycenaean name, but one piece of *164 required 6 units of raw wool, i.e. 18 kg.

J. Killen was the first to identify this quantitative relationship between wool and woollen textiles in the Linear B records and it can be summarised in Table 19.2.³⁷

9. Quantifying Mycenaean woollen textiles at Knossos

Table 19.3 displays a conservative estimate of the number of woollen textiles recorded at Knossos and their equivalent in wool and sheep whenever it is possible to calculate them, and restoring 1

²⁸ Melena 1987, 445 note 131.

²⁹ Melena 1996–1997, 418. Nosch 2004.

³⁰ See all forms in DMic. s.v. Outside the Knossos L(1) set, Lc and Ld series, *pa-we-a* is also found on MY Oe 127: *pa-we-a*₂; Oe 111: *pa-we-si*; KN L 104 *pa-we-pi*; L 651 *pa-we-o*; Wm 8499 *pa-wo*. Lujan 1996–1997, 337.

³¹ Nosch 2012.

³² Nosch 2004, 32–39. According to Killen 1979, 166 note 26, “the distinctive feature of *pa-we-a ko-u-ra* is that this was finished and decorated by groups other than those originally responsible for weaving it.”

³³ Lc(1) 525–532, 534, 543, 551–553, 555, 558, 582, 1580, 5746, 7289, 7392, 7549, Ln 1568, Lc 646: all by scribe 103 and most from F10 while 583, 646 and 1568 are from F14, and 1580, 5746, 7289, 7392 are from unidentified place. Wb 8711 has unknown provenance and scribe. See Firth 1996–1997, 101–102 concerning 582.

³⁴ Cf. DMic s.v. Lujan 1996–1997.

³⁵ DMic. s.v. Lujan 1996–1997.

³⁶ Killen 1997, 126.

³⁷ Killen 1964; 1966; 1974; 1979; 1984.

Cloth types	Knossos	Number of sheep	Number of wool units	Amount of wool in kg
<i>TELA+KU</i>	48+	192+	48+	144+
<i>TELA+PU</i>	2545+	10,180+	2545+	7635+
*168+SE	247	988	247	741
*164	10+	240	60	180
<i>to-mi-ka TELA</i>	215/251	860	215	645
<i>TELA+TE</i>	281/381	10,668	2667	8001
<i>TELA+PA</i>	950	6179	1545	4635
<i>tu-na-no TELA</i>	63	756	189	567
<i>TELA+TE pe-ko-to</i>	20	800	200	600
Total		30,743	7686	23,058

Table 19.3. Woollen textiles at Knossos.

Type of textile	Estimate of amount of clean wool in kg ³⁸	Length of thread spun on 18 g spindle whorl ³⁹	Spinning time	M ² of cloth with 10 threads/cm ²
<i>pa-we-a</i>	2.5	15 km	300 h	7.5 m ²
<i>te-pa</i>	10.5	63 km	1260 h	31.5 m ²
<i>tu-na-no</i>	4.5	27 km	540 h	13.5 m ²
<i>te-pa pe-ko-to</i>	15	90 km	1800 h	45 m ²
<i>pu-ka-ta-ri-ja</i>	1.5	9 km	180 h	4.5 m ²
*164	9	54 km	1080 h	27 m ²

Table 19.4. Yields of yarn.

unit of wool per textile for those textiles without any known equivalent (in *italics*).³⁸ With a total of approximately 100,000 sheep in Crete,³⁹ these wool figures do not seem excessive.

9.1 Quantifying Mycenaean textiles: thread, time, and fabrics

Mycenaean woollen textiles are characterised by the rather large quantities of fibre required for their fabrication.⁴² These quantities can be elucidated and combined with experimental archaeology (Table 19.4).⁴³

It seems that the Linear B records contain textiles which relate to special palace or commercial needs, rather than textiles for the everyday clothing of a Bronze Age family. The large quantities of wool per textile in Mycenaean records have parallels in the Near Eastern documentation, but

³⁸ Concerning the ta-ra-si-ja cluster of te-pa, pa-we-a, tu-na-no, te-pa pe-ko-to by scribe 103, the following quantification may be made: The total non-collector target Lc(1) 536 records the production of 2,529 units of wool = 7,587 kg, see Olivier 1967, 91–92. The total collector target is not preserved but there are deliveries of 453 pieces of pa-we-a from collector groups on Ld(1) 587, see Killen 1979, and this equals 915 units of wool = 2,745 kg. Since the non-collector sector of the economy normally amounts to about 70%, the figure seems quite plausible. This gives a total estimated target for the ta-ra-si-ja production of 3,444 units of wool, or 10,332 kg which could be provided by 13,776 sheep.

³⁹ Olivier 1967.

⁴⁰ Set to 50% of the total amount of raw wool.

⁴¹ The average output of thread per hour is: c. 50 m of yarn/h (18 g whorl); c. 40 m of yarn/h (8 g whorl); c. 35 m of yarn/h (4 g whorl). This time estimate only takes the actual spinning time into account; time for the cleaning, sorting and preparation of the wool has to be added.

⁴² Killen 1966; 1974; 1979; 1984.

⁴³ Andersson and Nosch 2003; Andersson *et al.* 2008; Andersson Strand *et al.* 2009.

the extremely large quantities such as 21 kilos for a *te-pa* or 30 kilos for a *te-pa pe-ko-to* are quite surprising and may represent a special Mycenaean feature.

10. Geographical and administrative organisation of the wool economy in Crete

At Knossos, production targets were set for the textile production each year. The targets and estimates were probably set based on data from the previous year's record, and the scribe estimated how much wool would be needed for the targeted textile production. The Knossian administration produced separate targets for villages in central Crete in the Lc(1) set, and targets for the villages in western Crete were produced by another scribe in the Lc(2) set.⁴⁴ This administrative division of Crete firmly shaped the concept of space in the minds of the Knossian administrators and scribes.⁴⁵ Three examples illustrate the production targets for woollen textiles for women of the central Cretan places *qa-mo*, *dawo*, and *ku-do-ni-ja*, modern-day Khania in western Crete.

KN Lc(1) 543 (103)
 .A TELA¹+TE 11[
 .B qa-mi-ja / tu[-na-no

Women at *qa-mo*, 11 pieces of *te-pa* ; x [numbers broken] pieces of *tu-na-no*

Eleven *te-pa* textiles required 77 units of wool = 231 kg of wool. This means wool from 308 sheep, and we know from other records that there were 656 sheep recorded near the village of *qa-mo*.⁴⁶

KN Lc(1) 526 (103)
 .A] `pe-ko-to´ TELA¹+TE 10 TELA²+TE 14[
 .B]dq-wi-ja / tu-na-no TELA¹ 3 LANA[

Women at *da-wo*, 10 pieces of *te-pa pe-ko-to*; 14 pieces of (regular) *te-pa*; 3 pieces of *tu-na-no*, and wool (numbers broken).

Ten *te-pa pe-ko-to* textiles required 100 units of wool; fourteen regular *te-pa* textiles required 98 units of wool; 3 *tu-na-no* textiles required 9 units of wool = 207 units of wool, or 621 kg. This means wool from 828 sheep. At *Da-wo* we have a total record of 2,440 sheep.⁴⁷

KN Lc(2) 481 (113)
 .A] `pa-we-a´ TELA³ 30[
 .B] , ku-do-ni-ja LANA[

↓ (115)
 v. to-]u-ka LANA[
 .B Trace of majuscule sign at left, perhaps]jϕ.

Thirty *pa-we-a* textiles required 50 units of raw wool = 150 kg. This means wool from 200 sheep. The note by the editors suggesting the reading]jϕ at the beginning of the tablet points towards an interpretation of this target as a production target for a collector since -jo is a common ending of

⁴⁴ Killen 1976.

⁴⁵ Nosch 1997–2001.

⁴⁶ The number of sheep at *qa-mo* is not preserved on the totalling tablet Dn 5559, but there are records of individual flocks *qa-mo*: 110 sheep on Da 1317; 100 sheep on Db 1099; 100 sheep on Dg 1316; 100 sheep on Dg 1318; 46 sheep on Dv 5278; 80 sheep on Dv 5297; 120 sheep on D 8787.

⁴⁷ Dn 1094.

a personal male name in the nominative or the genitive form. ‘Collectors’ is the designation given by modern scholars to a highly debated administrative entity in the Mycenaean palace records appearing in the form of men’s names, often in the genitive form. The level of responsibility, power or influence held by these men is unknown, but they appear in approximately 30% of the records pertaining to textile workers, sheep, textile production, landholdings, and metallurgy; the ‘collectors’ exist in all Mycenaean palace administrations.

An example of the collectors’ involvement in the Knossos wool economy is the L(3) set which records the textile type TELA+PU, i.e. the *pu-ka-ta-ri-ja* textile. They contain information about Cretan villages and their missing deliveries of TELA+PU to the palace.

KN L(3) 473 + 8026 (207)
 .A o-pe-ro `pe` TELA²+PU 38
 .B qa-ra / i-se-we-ri-jo

KN L(3) 869 (207)
 .A o-pe-ro `pe` TELA²+PU 3
 .B ti-ri-to / pi[] vac.

o-pe-ro pe is the abbreviated expression for *o-pe-ro pe-ru-si-nwa*, ‘missing from previous year’. Thus, this is the result of the targets which have not been fulfilled, and the scribe keeps track of this. *i-se-we-ri-jo* is the name of a Knossian ‘collector’, and it is therefore plausible that he is responsible for the transaction, either because he did not make the people of *qa-ra* deliver their textiles, or because he is now assigned to taking up the case and ensuring the delivery of the missing textiles. A similar situation is recorded on L(3) 869 at *ti-ri-to* where 3 *pu-ka-ta-ri-ja* textiles are missing and the collector *pi*[] is responsible, or held responsible, for the deficit.

Woollen *pu-ka-ta-ri-ja*/ TELA+PU textiles are also recorded by scribe 214 and he gathers information about their sizes and qualities (Figure 19.8).

KN L(10) 735 (214)
 .1]a-ro₂-e TELA³+PU [
 .2] me-sa-ta , TELA^x+PU[

KN L(10) 7409 + 8304 (214?)
 .A] a-ro₂-e TELA³+PU 60[
 .B to-]sa / me-sa-ta TELA² +PU 100 [
lat. inf.] to-sa TELA[

The *pu-ka-ta-ri-ja* textiles are qualified as *me-sa-ta* /*messatai*, denoting ‘medium sized’, and *a-ro₂-a* /*aryoha*, meaning ‘of better quality’.



Fig. 19.8. KN L(10) 7409.

10.1 The *ta-ra-si-ja* wool textile production system

The *ta-ra-si-ja* textile production system was a system of obligatory wool work placed on village women and – for a lesser part – placed on collectors and their textile workers. It is debated whether the *ta-ra-si-ja* textile obligation governed all types of textile manufacture,⁴⁸ or whether it was an obligation restricted to the production of certain types of textiles (*pa-we-a*, *tu-na-no*, TELA+TE, *pe-ko-to*).⁴⁹ In any case, other modes of procurement, such as the fiscal system, were also employed to acquire textiles.⁵⁰ The *ta-ra-si-ja* obligation also existed for smiths and for chariot manufacture at Knossos.⁵¹

The basic principle of the *ta-ra-si-ja* textile obligations was that specialised workers (primarily female) were allocated raw wool in specific quantities, which were to be transformed into finished woollen fabrics of a predefined type. Since the totalling records of the *ta-ra-si-ja* production for one year are preserved,⁵² we know the annual volume of the *ta-ra-si-ja* textile obligation in terms of wool quantities and in terms of the workload for textile workers in Cretan villages (Lc[1] 536) and for the textile workers under a ‘a collector’ (Lc[1] 535).

KN Lc(1) 535 + 538 (103)
 .A ta-ra-si-ja pa-we-a [
 .B ke-ri-mi-ja tu-na-no [
 .C to-sa / pe-ko-to [
 .C Trace at right consistent with TĒLA[.

KN Lc(1) 536 [+] 7383 + 7731 (103)
 .A] `ta-ra-si[-ja´]pa-we-a[]TELA^x 200
 .B] `vest.[´] tu-na-no[]TELA¹ 48 a-ro-zo `ki-to´ TELA¹ 1
 .C to-]sa / pe[-ko-to TELA¹+TE]18 TELA² +TE 267

The total of *ta-ra-si-ja* textile obligations corresponds to the production of approximately a dozen Cretan villages.⁵³ Thus, *ta-ra-si-ja* is a compulsory obligation of wool work mandatory for about one third of the 31 Cretan villages attested in the sheep records Da-Dg.⁵⁴ It seems plausible that the extent of the obligation varied from year to year according to the textile needs of the palace economy.

At Pylos, too, *ta-ra-si-ja* may be recorded with textile production, in particular *te-pa*/TELA+TE, which is also an important textile type of the Knossian *ta-ra-si-ja*.

PY La 1393 (13)
 .1]ṣa-to , a-ri-wo , ta-ra-
 .2]TELA^x+TĒ 40 [

10.2 The wool textile scribes

Scribe 207 records the woollen textiles called *pu-ka-ta-ri-ja*, and other scribes deal with other types

⁴⁸ Duhoux 1976.

⁴⁹ Nosch 2006.

⁵⁰ Killen 2007.

⁵¹ Killen 2001. Nosch 2000b; 2006.

⁵² Olivier 1967.

⁵³ Nosch 1997–2001.

⁵⁴ Nosch 1997–2001, table 2; 2006.

of textiles, such as *to-mi-ka*.⁵⁵ Thus, these are highly specialised scribes; they were not necessarily only occupied with this task of recording a particular type of fabric, but clearly they rarely shared their assignment with others. The only Knossos scribe who collaborated systematically with other scribes is scribe 103, the most prolific Knossian scribe in the wool economy in terms of textile administration because he is the one responsible for recording most of the Knossian-controlled woollen textile production, in particular the *ta-ra-si-ja* production. His collaborators were scribes 115 (primarily recording smaller amounts of wool for finishing textiles) and scribe 113 (recording wool for textile targets in west Cretan villages):

KN Od 487 (115)
 .a]to LANA M 1 [
 .b]-ka LANA 2 [

Scribe 115's role in the administration is embedded within the bureaucracy to a degree that he was also present when the targets for the following year's textile production in western Crete were set by scribe 113 and the necessary wool quantities estimated, measured and allocated in the same administrative files, and on the back of these tablets, scribe 115 notes how much wool eventually will be necessary for the finishing and decoration when the textiles were ready:⁵⁶

KN Lc(2) 581 (113)
 .A] `pa-we-a` TELA⁴ 40[
 .B]no , / ko-u-re-ja LANA 30[
 ↓ (115)
 v.] to-u-ka LANA[

Front side of tablet, written by scribe 113:

]no (probably the end of the name of a collector or of a place name), female makers of (*pa-we-a*) *ko-u-ra* textile, 30 (or more) units of wool, for 40 (or more) pieces of *pa-we-a* textiles

Reverse of tablet, written by scribe 115:

For the finishing (*to-u-ka*), so much wool (numbers broken)

Scribe 113 registered the production target for a group of women known to produce *pa-we-a ko-u-ra* cloth: together they had to produce 40 pieces of *pa-we-a ko-u-ra* and, for this purpose they needed 30 units of wool. This amount equals 90 kg of wool. The wool is measured but probably not actually distributed *in natura* from the Knossos palace stores to this unidentified place in western Crete.⁵⁷ It seems more practical and plausible that the women would receive the wool directly from the palace-controlled sheep already present near their village.

10.3. Incoming woollen textiles: receipts and storage records in the Ld and Le series

Textiles are valuable products; if well maintained, they do not lose their value over time, if they are taken care of and protected against insects and humidity. As such, they represent a staple good in pre-monetary societies parallel to metals.

At Knossos, it is again scribe 103 who records the incoming *te-pa* textiles, their origin, producers,

⁵⁵ Nosch 1998.

⁵⁶ Killen 1979, 172.

⁵⁷ Nosch 2007.

and their number. On tablet Le 642, scribe 103 records that these woollen textiles are delivered to the palace within the framework of the *ta-ra-si-ja* system: the deliveries of *te-pa* from groups of women under direct palace control (such as the *ri-jo-no* women), or groups of women under a collector (such as *da-mo-ko[-ro]*).

KN Le 642 + 5950 (103)

- .1]ra-wo , de-ko-to `t̥a-ra-si-ja´ ne[
 .2]ja TELA¹+TE 2 ri-jo-ni-ja TELA¹+TE[
 .3]ri-jo TELA¹+TE 6 da-mo-ko[
 .4] vacat [

]ra-wo has received (within the framework of) *ta-ra-si-ja* , this year⁵⁸

The women of ? , 2 *te-pa*; the women from *ri-jo-no* , x (number broken) *te-pa*

The man / collector]ri-jo, 6 *te-pa*; the man *da-mo-ko[ro*, x (number broken) *te-pa*

We are fortunate to have the individual targets for many of these groups (series Lc, see above) in which their *te-pa* targets are set in quite large numbers, and this indicates that Le 642 and Le 654 below only list some of the *te-pa* textiles delivered, it is a preliminary inventory but not yet the fulfilment of the textile obligations.

Although the textile logogram is not preserved on this tablet, the scribe, the findspot and the place names demonstrate that the tablet recorded is *te-pa*/TELA+TE. The producers are groups of women under direct palace control (Amnisos women, *Se-to-i-ja* women, *Tu-ni-ja* women), or groups of women supervised by the collector called *we-we-si-jo*.

KN Le 654 (103)

- .1 *sup. mut.*
 .2]ṣi-ja [
 .3 a-mi-ni-si-ja [
 .4 se-to-i-ja `wa´ 2[
 .5 tu-ni-ja 2[
 .6 we-we-si-jo 1[

In line 4 were recorded *te-pa* cloth qualified as *wa*, which is an abbreviation of *wa-na-ka-te-ra*, royal, and this refers to the delivery of specific *te-pa* fabrics at *se-to-i-ja* which are recorded for a target on another tablet:

KN Lc(1) 525 (103)

- .a 'wa-na-ka-te-ra' TELA³+TE 40 LANA 100 [
 .b se-to-i-ja , / tu-na-no TELA¹ 3 LANA [

At *se-to-i-ja*: 3 *tu-na-no* (equivalent of 9 units of) wool, 40 royal *te-pa*, 100 units of wool.

Other tablets record the delivery and storage of woollen *pa-we-a* textiles.⁵⁹ The Ld(1) set is by scribe 116, and was found in F14 (which is also the place where many of scribe 103's tablets were

⁵⁸ ne[can probably be reconstructed as ne[-wa meaning 'new' but with the administrative sense of 'of the current year'. In other contexts we find the two contrasting concepts ne-wa and pe-ru-si-nu-wa, denoting deliveries from the current year or from the past year.

⁵⁹ Killen 1979, 156.

found). Some Ld(1) tablets record deliveries,⁶⁰ others the storage⁶¹ of textiles. An example is the delivery record from a collector on Ld(1) 598:

KN Ld(1) 598 + 661 (116)

.1 wi-jo-qo-ta-o po-ki-ro-nu-ka TELA 1 []
 .2 re-u-ko-nu-ka TELA¹ 37 ko-ro-ta₂ TELA 2 []

lat. inf. to-sa TELA 40 o TELA¹ 6[]

Front Side

From *wi-jo-qo-ta*: 1 textile with variegated edges; 37 textiles with white edges; 2 dyed textiles.

Lower edge of tablet

Total (delivery): 40 textiles, 6 textiles still missing

The collector *wi-jo-qo-ta* is involved in the Knossian textile industry, but scribe 116 states that *wi-jo-qo-ta* has only partially fulfilled his target since the delivery of 6 textiles is still outstanding.

Textile production targets were set for collectors in the Lc(1) set and totalled onto Lc(1) 535 (see above); when the finished textiles are returned to the palace, scribe 116 records each individual delivery, and eventually compiles a list of all textiles delivered from collectors (Figure 19.9):⁶²



Fig. 19.9. KN Ld(1) 587.

KN Ld(1) 587 + 589 + 596 + 8262 (116)

.1 to-sa , po-ki-ro-nu-ka TELA² 24 re-u-ko-nu-ka TELA² 372
 .2 ko-ro-ta₂ TELA² 14 *56-ra-ku-ja TELA^x 42 po-ri-wa TELA² 1

lat. inf. vac. [] to-şa TELA 149

Front side: Total: 24 textiles with variegated edges; 372 textiles with white edges; 14 dyed textiles;⁶³ 42 *56-*ra-ku-ja* textiles; 1 grey textile

Reverse: Total: 149 textiles

The front side lists a total of 453 *pa-we-a* which correspond to a wool expenditure of 2267 kilos of raw wool from more than 3000 sheep.

An example of a detailed storage record is Ld(1) 571:

⁶⁰ Ld(1) 584; 587; 591; 598; 5894.

⁶¹ Ld(1) 571–577; 579; 583; 585; 649; 5601.

⁶² Killen 1979, 155.

⁶³ Nosch 2004.

KN Ld(1) 571 (116)
 .a pe-ne-we-ta a-ro₂-a *158 1
 .b pa-we-a , / e-qe-si-ja , re-u-ko-nu-ka , TELA³ 25

pa-we-a textiles: of the *e-qe-ta* type, with white edges, 25 pieces; 1 textile (?) of the type *158, with *pe-ne-we-ta*, of better quality.

On this storage record, the scribe also mentions receivers/consumers of the textiles: the *e-qe-ta*. These are elite members, literally ‘followers’ of the king, and one of their benefits may have been the access to textiles from the palace storeroom for their personal use. Their woollen *pa-we-a* textiles, however, are of standard type: they have white edgings just like 82% of all the fabrics delivered from collectors that year, as recorded on Ld(1) 587. All Ld(1) storage records count finished textiles as multiples of five and this suggests that woollen *pa-we-a* textiles were stored in bales of five.⁶⁴

The Ld series contains multiple, rich descriptions of textiles; the relative standardisation apparent in the earlier stages of the palace textile administration disappears in these final records: here the textiles stand out as colourful and complex, in contrast to the mere logograms used in the targets. Still, regrettably, there are many terms which remain obscure to us but their mere presence, however, demonstrates the care and interest in the various details of a textile and the advances in terminology to grasp and define textile qualities.

11. Decoration of woollen textiles: dyes, natural pigments, other fibres, and the exploitation of natural resources

Woollen textiles are recorded in the Linear B tablets in terms of their number, decoration, and colour. Sometimes, the scribes also add information about the state of preservation of the textiles, their quality, or their size. Decoration is often expressed in terms of *-o-nu-ka*, which has been translated as ‘fringes’. However, fringes on a textile are generally the warp thread ends, i.e. the threads that are intertwined with the perpendicular weft threads; since the *o-nu-ka* part varies, it seems more plausible to suggest edges or another kind of added decoration.⁶⁵

Murex yields a colourfast dyestuff for woollen textiles; in particular, tablet X 976 records *po-pu-re-i-jo*, probably ‘royal’ (*wa-na-ke-te-ro*) purple dyes.⁶⁶ Murex as a source of purple dyestuff is a known technique in the Mediterranean area, and the archaeological contexts and findings of heaps of murex shells suggest that an intensive exploitation took place in the Bronze Age.⁶⁷ However, a more readily available, although not entirely colourfast, source of dyestuff is provided by the various plants yielding red dyestuff. Henna, madder, and alkanet are efficient plant providers of red dyestuff, and the various terms used to designate red textiles suggest that a number of sources provided the red colour.⁶⁸ Other woollen textiles were dyed yellow: the intensive cultivation of safflower, *ka-na-ko e-ru-ta-ra*, at Mycenae (the Ge series) and recordings of saffron (CROCus logogram) demonstrate a steady supply of yellow dyestuff.

⁶⁴ Killen 1987, 323.

⁶⁵ Firth and Nosch 2002–2003.

⁶⁶ Nosch 2004.

⁶⁷ Burke 1999.

⁶⁸ Nosch 2004.

Bronze Age goat hair is attested in the archaeological record on Crete.⁶⁹ Goat hair is in the Bronze Age especially valuable for ropes, as was demonstrated by Anna Michailidou.⁷⁰ Its use as rope is attested in Mesopotamia⁷¹ and all over in the ancient Near East as well as in 2nd millennium Egypt. Interestingly, rope, like wool for textiles, is measured in terms of weight, and not in terms of length. Michailidou concludes that “depending on the purpose of the rope, its length will have been of interest to its future users, but the fact that its weight is recorded points to the overriding importance of the weight, perhaps as an indication of the thickness and quality of the rope and therefore of its suitability for the use intended.”⁷² Massimo Perna has suggested that Linear B logogram *142 could represent goat hair.⁷³

12. The textile workforce in the Mycenaean wool economy

There is a great difference between fabrics in wool and fabrics in linen: linen and flax also require fundamentally different fibre processing before spinning; while wool particularly needs sorting and cleaning, flax needs a longer chain of mechanical and chemical processing and alterations before it can be spun. However, when both fibres are processed, cleaned and ready to be spun, then they follow similar work stages such as spinning, weaving, and finishing. Some Linear B tablets record linen textile workers but most tablets do not specify whether the workers deal with wool or flax, or both, but instead focus on the tasks and techniques, or their identity and location. The workforce in the palace-organised textile industry consists primarily of women and children.

As in textile production, textile workers are administered in categories based on where they are located, whether they are under the supervision of a collector, and their professional specialisation. Many of the groups overlap, but among the scribes, these distinctions seem fundamental.

12.1 *The textile workforce in Pylos*

At Pylos, the administration of textile workers is divided between scribes 1 and 4: scribe 4 records the workers in the Further Province and scribe 1 records those in the Hither Province.

PY Aa 89

(4)

a-ra-ka-te-ja MUL 37 ko-wa 26 ko-wo 16 TA 1

(in the Further Province) 37 female spinners (literally, distaff women), 26 girls, 16 boys, and 1 (female) TA supervisor.

All these women and children receive monthly rations of food. These rations are allocated monthly and are standardized into T2 (20 litres) of figs and grain, respectively, for adults, and T1 (10 litres) of the same food products for children.

⁶⁹ Spantidaki and Moulherat 2012, 189. There is also a fabric of goat hair from Arslantepe, dated 3000–2900 BC which corresponds to the first part of phase VI B: Frangipane et al. 2009, 19–20.

⁷⁰ Michailidou 2008, 186–189.

⁷¹ Waetzoldt 2007.

⁷² Michailidou 2008, 187.

⁷³ Perna 2004, 278–280.

PY Ab 578 (21)
 .A GRA 2 T 4 TA
 .B pu-ro , pe-ki-ti-ra₂ MUL 7 ko-wa 4 ko-wo 4 NI 2 T 4

At Pylos, 7 female combers, 4 girls, 4 boys, and 1 (female) TA supervisor. 240 litres of figs, 240 litres of grain

On tablet PY Ab 578 the ration distribution key is clear: the 8 adult women (7 workers + 1 supervisor TA) each receive 2 T-units of grain, amounting to 16 T-units, and the 8 children each receive 1 T-unit, and this gives a total of 24 T units of grain corresponding to c. 240 litres.

A part of the Messenian workforce is designated by ethnic designations from Asia Minor, suggesting that these textile workers have a foreign origin, and had come to Pylos either through migration, captivity or the slave trade. This suggests that the Mycenaean wool economy depended on accessible and extensive labour which could even be acquired from outside. An example is the group of women from the island of Cnidus:⁷⁴

PY Ab 189 (21)
 .A GRA 6 T 7 TA DA
 .B pu-ro ki-ni-di-ja MUL 20 ko-wa 10 ko-wo 10 NI 6 T 7

At Pylos, 20 women from Cnidus, 10 girls and 10 boys, 670 litres of figs, 670 litres of grain, the supervisors TA and DA

12.2 The textile workforce in Knossos

At Knossos too, the administration of textile workers is divided among the scribes:⁷⁵ Scribe 103 records textile workers in Central Crete;⁷⁶ Scribe 102 records textile workers in the central southern part of Crete near Phaistos;⁷⁷ and yet another scribe records the textile workforce in western Crete.⁷⁸ Scribe 108 records textile workers under a collector.⁷⁹ (see also above).

12.3 The textile workforce in Thebes

The tablets at Thebes record wool allocated to individuals, to groups, and to a *do- (*do-de* 'to the house') probably a kind of workshop. Some Theban tablets record wool allocations to groups of women workers with occupational designations such as *a-pi-qo-ro*, *amphipoloi*, 'servants', or to *a-ra-ka-te-ja*, 'spinners', or to *te-pe-ja*, 'te-pa makers'. They are even qualified as new/*ne-wa* or old/*pa-ra-ja*, respectively. Other wool allocations go to groups of women workers qualified by a man's name, a so-called 'collector' name, such as the designation *ma-ri-ne-we-ja-i* built on *ma-ri-ne-u* (Of 25) *pu₂-ke-qi-ri-ne-ja* built on *pu₂-ke-qi-ri* (Of 26).

The Theban tablet Of 24 also reveals an important item of information on the administration of the textile workforce: the supervisor title DA, which appears anonymously at Knossos and Pylos, is here at Thebes given to a man called *ko-tu-ro₂*, and this suggests to us that at the other palace sites, this DA title is also reserved for men.

⁷⁴ Chadwick 1988.

⁷⁵ Killen 1972, 425–433.

⁷⁶ The Ak(1) set from the west wing (F14).

⁷⁷ The Ak(3) set from I2 (Spiral Cornice Room, in the northern part of the palace).

⁷⁸ Ak 7827, 7830 and perhaps X 8330, see Killen 1993, 171–172; Nosch 2000b, 103.

⁷⁹ The Ak(2) set was found in the West Wing (F7).

TH Of 34

(303)

.1 a-pi-qo-ro , ne-wa , ko-tu-ro₂ , DA , LANA 3 [[PA]] [
 .2 a-ra-ka-te-ja , pa-ra-ja LANA 1 [

12.4 The textile workforce in Mycenae

At Mycenae, there is a list of at least 25 women, sometimes recorded with their daughters (*tu-ka-te-qe* ‘and daughter’) and some of these women are also known from other tablets where they appear with textile workers (Fo 101 by scribe 53), but on this tablet, V 659, they all are recorded for *de-mi-ni-ja*, δέμνια ‘beds’.

MY V 659 (61/House of the Oil Merchant)

.1 wo-di-je-ja , de-mi-ni-ja 1
 .2 ma-no , a-re-ka-sa-da-ra-ka 2
 .3 ri-su-ra , qo-ta-qe 2
 .4 e-ri-tu-pi-na , te-o-do-ra-`qe´ 2
 .5 o-to-wo-wi-je tu-ka-te-qe 2
 .6 a-ne-a₂ , tu-ka-te-qe 2
 .7 pi-ro-wo-na ki-ra-qe 2
 .8 pu-ka-ro ke-ti-de-qe 2
 .9]-ri-mo-qe 2
 .10]ma-ta-qe 2
 .11]*82 1
 .12]-qe 2
 .13] vac.

inf. mut.

lat. dex.] , i-ri-[•]1 ke-ra-so , ki-ra-qe 2

MY Fo 101

(53/House of the Oil Merchant)

.0	<i>vacat</i>			
.1	a-ne-a ₂	V 3	pa-ŋq-ki	V 1
.2	ma-no	V 1	a-na-*82	V 1
.3	to-ti-ja	V 1	we-i-we-sa	V 1
.4	ke-ra-so[]	V 1		
.5	pi-we-ri-ši	S 1	tu-mi-[]V 1
.6	ko-ma-ta	V 1	na-ta-ra-ma	V[1
.7	pe-ta-[•]	V 1	pu-ka-ro	V[1
.8	o-ta-ki	V 1[] vacat [
.9	e-ro-pa-ke-ja	OLE + WĒ 1		
.10	a-ke-ti-ri-ja-i	V 4		
.11-14	<i>vacat</i>			
.15	to-so	OLE + WĒ 2 S 1 V 1		
.16	<i>vacat</i>			

This tablet records a total of 68.8 litres of olive oil distributed in various quantities to different textile workers at Mycenae, such as the *e-ro-pa-ke-ja* (female makers of? fabric or decoration), and *a-ke-ti-ri-ja-i* (dat. pl. de *ἀσκήτρια), ‘female finishers’. The oil could be for professional use to facilitate weaving, as suggested by C. Shelmerdine,⁸⁰ but it seems to me more likely that the

⁸⁰ Shelmerdine 1997, 390, notes 27 and 28.

olive oil is part of the ration system.⁸¹ This is supported by noting that the male supervisors *a-ne-a₂* and *pi-we-ri-si* in lines 1 and 5 receive larger portions of oil just as the male *DA* supervisors at Knossos and Pylos receive larger rations of figs and grain.

12.5 Wool and male labour

When discussing the wool economy, the general focus is on the significant labour of women and children. However, men, too, play a noteworthy role. The male contribution to the wool economy is, first and foremost, as shepherds. There are c. 700 shepherds recorded at Knossos, and certainly also hundreds at Pylos and at the other Mycenaean palace centres but very little evidence is preserved. Within the textile industry, boys take active part in the production and there are about the same number of boys and girls working for the palaces. Finally, men work as supervisors under the abbreviation *DA* in the textile work groups, and men are also collectors. A few men are mentioned as specialised wool textile workers, such as fullers and weavers. We know of their existence from the land registry documents: in a tablet from Pylos, Un 1322, one (or more) weaver(s) *i-te-we*, *histewes*, receive(s) a remuneration of figs and grain, like the textile women, but the transaction for the male weavers is termed *o-no* from the Greek root *ὀνίνημι*, which suggests another remuneration or dependency system.⁸² At Mycenae, wool is also given as *o-no* to dependents of the palace who are not working in textile manufacture (MY Oe 108 and 109). C. Varias Garcia concludes that there are “two types of palatial economic control in the Oe series: the *ta-ra-si-ja* system for making cloth and the *o-no* system, which supplies wool to non-textile workers as payment for their work.”⁸³ Thus, male textile workers are not administered together with the women and children, they do not receive rations in the same way, and men in the textile industry seem generally of a different social position. Of particular interest here is the royal (*wa-na-ka-te-ro*) fuller (*ka-na-pe-u*), which is a typical occupation in the wool economy. The royal fuller holds a plot of land.⁸⁴

PY En 74.23 (1)
 pe-ki-ta , ka-na-pe-u , wa-na-ka-te-ro , o-na-to , e-ke , to-so-de , pe-mo
 GRA T 2

pe-ki-ta (personal name), the royal fuller, has a plot (*o-na-to*), so much grain: 20 litres

Another male fuller called *a-ka-ta-jo* also holds land but is not qualified as royal:⁸⁵

PY Eo 269.B (41)
 a-ka-ta-jo-jo , ka-na-pe-wo , to-so-de , pe-mo , GRA 3 T 2

Of *a-ka-ta-jo* (personal name), the fuller, so much grain: 320 litres.

There is an extensive wool economy at Mycenae, too, since several male fullers, *ka-na-pe-we*, are recorded in the palace archives, both as receivers of the unidentified commodity *190 (Oi 701, 704) and as receivers of wool, probably for occupational purposes (Oe 119, 129). Likewise, at Thebes, wool is given to men both with and without occupational designations.

⁸¹ Tournavitou 1995, 266–267; Varias Garcia 2012, 159.

⁸² Gregersen 1997.

⁸³ Varias Garcia 2012, 159.

⁸⁴ PY En 74; 609; Eo 160; 276.

⁸⁵ Eo 269.B, En 659.18.

Like fuller, another wool occupational designation exclusively associated with male workers, is the *pe-re-ke-u*, a braider or perhaps weaver; the designation occurs at Thebes, Mycenae, and Pylos; we can be certain that this occupation deals with wool because it derives from the verb *pe-re-ke* attested at Knossos as the process which transforms wool into the textile type classified *164 (see the tablet, above, Fig. 19.4).

13. Aegean Bronze Age wool and weights⁸⁶

It is significant that in the Mycenaean weight system, there exists a special unit for the wool, equivalent to 1/10 of a talent (= 3 kg), or 3 double mina ($3 \times 2 \times 500 \text{ g} = 3 \text{ kg}$).⁸⁷ It is not a fractional sign but a sign of its own in the form of logogram *145 LANA.⁸⁸ As such, *145 corresponds to a commodity, and it also corresponds to a quantity (of wool). The LANA unit can be divided into 3 M subdivisions equal to 1 kg, and other commodities, too, use this fraction M.⁸⁹

Textiles in the Mycenaean culture are counted and measured in terms of wool weight when scribes plan and set targets for future production. This is surprising, because the weight of a textile is only one of many qualifying parameters; indeed it is surprising that fineness/coarseness, pigmentation, thread quality, density, etc., are not highlighted as quality parameters or as identification markers in the Linear B documents when recording a planned production. Some of these data, however, are recorded once the fabrics had been manufactured and stored.

Another striking feature in the Bronze Age wool economy is the well-consolidated relationship between the weight of a fleece and the weight system. In Knossian palace records, in particular the Dk and Dl series, 4 sheep yield the standard quantity LANA 1 of c. 3 kg, based on a fleece weight of 750 g. Similar fleece weights of 700–750 g are found in contemporary Near Eastern archives.⁹⁰ The integration of a fleece weight into the weight system is striking since fleeces naturally vary in weight. A ‘standard sized fleece’ does not exist in the real world. Furthermore, a fleece weight is increased by dirt, grease, and coarseness, and these elements in fact potentially decrease its value. It is significant that in the Mycenaean wool economy fleeces are not counted individually but compiled 4 by 4 and counted together in the wool unit LANA, which itself is only subdivided into 3 parts (M). Thus, the concrete counting has been replaced by an abstract counting and measuring system for wool. In fact several scholars have suggested that there existed a separate, parallel weight system

⁸⁶ de Fidio 1998–1999, 39–63. Michailidou 2008, 179–191, 228–236, 244–261. Alberti 2005, 599–602 and table I.

⁸⁷ de Fidio 1998–1999, 39–63. See this work for full references of the weighing systems in the various cultures of the ancient Near East.

⁸⁸ The logogram is actually a monogram composed of two merged syllabograms, one of which is certainly the syllabogram for *ma-*, while the other element is either a *re-* or a *ro-*, and sometimes neither of them, or simply omitted. Thus, the Mycenaean scribe clearly imitates the *ma-* but does not have another specific sign in mind such as *re-* or *ro-*, and we can assume that the merging of the two syllables to the Mycenaean scribe had become entirely stylized into a logogram. In Linear A records, the same logogram exists but in Linear A it is clearly a combination of *ma-* and *ru-*. I thank John Killen for pointing this out to me, per litteras 8 January 2013. See also Melena 1987, 401 and Petrakis 2012a, 529–531.

⁸⁹ Alberti 2005, 602: “La presenza di unità ‘parallele’ e di unità ‘speciali’, destinate alla misurazione di alcune categorie particolari di beni, accanto a unità ‘standard’, usate per misurare qualsiasi tipo di derrata, denota la sopravvivenza di alcune forme di calcolo concreto (concrete counting) all’interno di un sistema computazionale che si va sempre più astraendo dall’oggetto contato (abstract counting).”

⁹⁰ A tablet from Alalakh (AT 361) demonstrates the same relationship with 1 sheep giving the weight of 75 Syrian shekels of wool, equivalent to 1 ½ minas, that is a fleece of 704.7 g. 1 Syrian shekel = 9.396 g. See de Fidio 1998–1999, 39–63. Wiseman 1953, 100. The same is attested at Nuzi, see Petruso 1986, 32.

for wool in the Minoan and Mycenaean administration.⁹¹ In addition, Nicola Parise also suggested that some weight units were specially used for textiles, in particular the unit equivalent to 6 units of wool or 18 kilos. This is the weight of the textile type *164 (see above).⁹²

It is a stimulating hypothesis that fleeces and woollen textiles could have developed their own weight units for the quantities that were natural and pertinent to this production. Another sign of this is the special wool fraction *PA* used only at Thebes instead of the conventional *M* fraction. R. Firth has made the convincing suggestion that *PA* designates a special kind of treated wool, i.e. the washed wool.⁹³

Another approach is to consider the possibility that the original major weight systems were indeed based on wool weights, and developed fractional values from this original system which then became indispensable to other commodities and materials as well. However, the combined wool logogram and metrogram *145 LANA is well integrated into the Late Bronze Age eastern Mediterranean system of the talent and the mina. Thus, instead of parallel systems, we should rather observe how textile production and wool assessment also constitute an integral part of the system of weight.⁹⁴ As Pia de Fidio concludes: “The measuring of wool with its specific fractional units gives us a further strong indication of the existence of an economic sector that was indeed to some measure ‘special’, that was based on the accountability of the production of wool and its manufacture, and above all was well connected, by virtue of the identity in some of its choice of weights, to the greater international trade circuits of the Bronze Age.”⁹⁵

14. Quantifying the Mycenaean wool economy

The wool economy was extremely labour consuming, and this impacted strongly on other branches of the economy since the wool labour force must be provided with food rations, perhaps also shelter, and other necessities. Secondly, the 100,000 sheep required close tending, and the some 700 shepherds probably demanded remuneration, control measures, and administration.

Thirdly, the extensive wool labour force required a management structure, and here the Mycenaean palaces had rather unanimously adopted the *DA* and *TA* supervisors,⁹⁶ and on another level, the collector system. The *DA* receives the quantities T5 and T5 of grain and figs monthly, but the *TA* receives only the same monthly rations as regular female adult textile workers, and the *TA* is therefore interpreted as a female supervisor. The remuneration or profit gained by collectors is unknown.

⁹¹ Parise 1986; Petruso 1986; de Fidio 1998–1999; Alberti 2005, 602: “...è stata proposta l’identificazione di una serie parallela di *x*, specializzata nel conteggio della lana... Le grandezze di questa serie, denominata *l*, sono in relazione non solo con *x* ma anche con le grandezze del sistema ricavato dai testi micenei, cioè con la serie della doppia mina (*M*) e del talent (*L*), serie che può ben essere intesa, almeno a un certo punto del suo sviluppo, come un’altra serie parallela di *x*”.

⁹² Parise 1987. However, this suggestion is based on just one type of (not widely attested epigraphically) textile and a (not widely attested archaeologically) weight unit. See also the comment by Alberti 2005, 602: “Un ragionamento simile, basato sulla combinazione di pesi, segni di valore e fonti, ha portato Nicola Parise all’identificazione di una serie speciale per tessuti, basata però solo in modo estremamente indiretto su quella di *x*: il multiplo maggiore, *r*, pari alla quantità di lana necessaria per una singola pezza di tessuto, equivale a 6 *l*.”

⁹³ Firth 2012.

⁹⁴ de Fidio 1998–1999, 62.

⁹⁵ de Fidio 1998–1999, 63.

⁹⁶ *TA* is attested at Pylos and Knossos; *DA* is attested at Pylos, Knossos and Thebes.

14.1. Quantification of the wool economy at Knossos

It is difficult to quantify the Knossian wool economy precisely and it will always remain based on plausible guesswork. However, Knossos has the most extensive wool records preserved and here it is possible to come very close to the individual wool worker and shepherds, and gain much information about sheep. There are an estimated c. 100,000 sheep under palace control in Crete. They each yield an average of 0.75 kg raw wool which amounts to an annual Cretan wool production of 75,000 kg, or 75 tons of raw wool. It were estimated that c. 40% of weight of the raw wool is discarded or used as isolation and padding/filling materials in mattresses and cushions, or used for felt; also, much of the weight of raw wool is made up of non-textile components such as grease, sweat, dirt etc. It may therefore be assumed that there remained 40 tons of clean and sorted wool annually left for textile production.⁹⁷

14.2. Quantity of wool at Mycenae

C. Varias Garcia has calculated that there are 1371 kg of wool preserved on the Mycenae Oe tablets found in Room 2 in the House of the Oil Merchant.⁹⁸ This corresponds to raw wool from 1828 sheep. However, it may be 1371 kilos of clean and prepared wool, and in that case it could have come from about double as many sheep.

14.3. Wool yarn production: volume

Spinning experiments have demonstrated that an experienced spinner can spin c. 600 m from 100 g of clean, combed, and prepared wool.⁹⁹ These experiments are based on spinning a quite coarse thread on a drop spindle with a whorl weighing 18 g. This would amount to 6 km/1 kg of cleaned and prepared wool, or 6,000 km from 1 ton of cleaned and prepared wool. If, quite hypothetically, the annual Cretan yield of 40 tons of clean wool was spun into thread on an 18 g spindle whorl, it would result in 240,000 km of yarn. This Cretan yarn would reach 6 times around the globe.

14.4. Wool yarn production: time

Spinning experiments have shown that an experienced spinner can spin c. 50 m per hour including time to sort the wool, prepare bundles of wool, spin, and wind the yarn. This experiment was based on wool spinning on an 18 g spindle whorl, a rather heavy tool which produces a fairly coarse yarn. Thus, we can set the yarn production time to 50 m per hour. However, spinning finer threads would take longer, even for an experienced spinner. Likewise, when spinning warp yarn which is being held in tension and subjected to weft beating, the spinner would probably spend more time and energy on spinning. Thus 50 metres per hour is an average set for the purpose of these calculations. This amounts to 50 km/1000 h, or 100 km yarn in 200 days (assuming a ten hours working day). If, again quite hypothetically, all the annual Cretan yield of 40 tons of clean wool were spun into thread on an 18 g spindle whorl, it would result in 240,000 km of yarn and it would take 480,000 days, or more than 1300 years for 1 person to produce this yarn!

⁹⁷ Olivier 1967. This can be compared to historical end-19th century figures for wool production in Crete. The annual yield was of 356.7 tons of raw wool produced in Crete in the year 1894/5, according to Karpát 1985, 224. This increase in wool production is primarily due to breeds carrying much more wool than in the Bronze Age. I thank Richard Firth for this reference.

⁹⁸ Varias Garcia 2012, 157.

⁹⁹ Andersson *et al.* 2008.

However, if the palace employed 1000 spinners, they would be able to transform all 40 tons into yarn within 480 days. Even though these figures are quite speculative, they highlight well why so many workers are needed for textile manufacture.

14.5. Quantifying the volume of rations to Mycenaean wool workers

For the estimates of rations, attention must be turned to Messenia and the calculations based on the Pylos inscriptions. The general estimate is that there are c. 750 women working for the palace in Messenia.¹⁰⁰ In addition to these would have been about the same number of children, probably from about the age of five to adolescence, and with a slight majority of girls.¹⁰¹ The standard monthly ration is T2 = c. 20 litres of grain and T2 = 20 litres of figs respectively for an adult worker and half these quantities for a child worker. If we thus estimate a workforce of 400 women and 400 children in Messenia occupied with wool, the annual expenditure in rations would be 144,000 litres of grain and 144,000 litres of figs.¹⁰² This amount of grain would weigh c. 144 tons, and would take up space of 144 m³,¹⁰³ while the same amount of figs would weigh c. 100,000 kg/100 tons, and would take up space of 159 m³.¹⁰⁴

At Knossos, there seems to be much more emphasis on wool fibre production and processing and it is plausible that most, if not all, 500–1000 recorded Cretan textile workers were part of the wool economy. Regrettably, we have no secure data about how, if, and when rations were given to these women and children, but there are scattered indications of monthly allocations of food.

*

The Mycenaean Greeks had all the necessary natural resources for their wool textile production: the political organisation of the Mycenaean state had human resources for systematic breeding and for the cultivation and exploitation of plants for dyestuff; human resources and technical skills were necessary for the transformation of animal fibres into textiles; and the palace system required textiles for dependent personnel, for trade, and to maintain its own prestige. The complex system of skills, natural and human resources and networks can be perceived through the L and O series of Linear B tablets. The understanding of the functioning of the textile industry also demonstrates how closely the wool and textile records are connected to the other series of Linear B texts, such as the records of labour, landholdings, and sheep.

As is demonstrated in this paper, we are biased by the unequal distributions of Linear B tablets among the centres: Knossos has rich evidence for sheep breeding and wool textile production; Pylos has fewer preserved records of sheep and of textile production, but ample evidence for the organisation of textile workers; Thebes and Mycenae have a little evidence of wool distribution

¹⁰⁰ Killen 1984; Chadwick 1988; Nosch 2003. However, not all are engaged in wool textile production, and Killen has observed that a large number of the textile workers were occupied with the laborious processing of flax, especially those located in the Further Province at a distance from Pylos. See Killen 2012.

¹⁰¹ Nosch 2001b.

¹⁰² 400 adult rations × 20 litres of grain × 12 months = 96,000 litres of grain.

400 adult rations × 20 litres of figs × 12 months = 96,000 litres of figs.

400 child rations × 10 litres of grain × 12 months = 48,000 litres of grain.

400 child rations × 10 litres of figs × 12 months = 48,000 litres of figs.

¹⁰³ Assuming that 1 litre grain weight c. 1 kilo and measures c. 1 decimeter².

¹⁰⁴ Calculated for figs, dried, uncooked. 1 kg dried uncooked figs has a volume of c. 1.5 litres according to <http://www.aqua-calc.com/calculate/weight-to-volume>.

but no preserved records of sheep. Since Pylos also has many fragments recording flax cultivation, this has led E. Stavrianopoulou to conclude that there was a fibre specialisation in the Mycenaean textile industry, with Knossos as a primary wool producer and Pylos as a linen producer and flax cultivator.¹⁰⁵ This conclusion is, on the one hand, logical, based on the current source situation. However, on the other hand, in my view it primarily translates the unequal distribution of Linear B tablets and not textile fibre specialisations among the palaces.

Regarding the position of wool within the Mycenaean palace economies and administration, it is significant that wool does not seem a part of the Bronze Age taxation system; instead, palaces mobilise hundreds of men for animal breeding and the plucking of wool, and set annual production targets for groups of women workers in villages. These are characteristic features of ration-paid work, or *corvée* work.

As regards wool consumption, the rather standardised wool textile products secured a coherent system in which these woollen textiles played a role in the economy. Some of them were probably used as remuneration or reimbursement to dependents or workers. Others are given to dignitaries for their services and fidelity such as the *e-qe-ta*.

The Mycenaean ruler seems to have had his own sector of the wool economy. Some woollen *te-pa* from the place *se-to-i-ja* are qualified as *wa-na-ka-te-ra*, royal *te-pa*. The wanax at Pylos has a royal wool fuller attached to his staff. The royal designation is also related to some activity related to purple in Crete, which again must have been applied to woollen cloth. However, it is worth noticing that *te-pa* textiles are quite common and generally not of the highest quality.

Sheep and wool are parts of the wealth of sanctuaries. Some smaller quantities of wool are allocated as 'donations' to divinities like the wool for the goddess Eilithya attested in the Knossos Od(2) set, or wool to *po-ti-ni-ja/Potnia*, *e-ra/Hera* and *e-ma-a₂/Hermes* at Thebes; some of the sheep breeding activities in Crete take place under *po-ti-ni-ja/Potnia* and *e-ma-a₂/Hermes* as well.¹⁰⁶ At Thebes, wool for the king and wool for the Mistress Potnia are recorded by the same scribe, on the same tablet:

TH 36 Of (303)
 .1 no-ri-wo-ki-de ku LANA 1 a-ke-ti-ra₂ ,
 .2 po-ti-ni-ja , wo-ko-de , a-ke-ti-ra₂ ku LANA 1 wa-na-ka[

The estimates of the volume and quantification of the wool economy remain speculative and based on hypotheses, but nevertheless give guidelines as to the resources of labour, animals, grains and fgs, time, and storage space involved in the Mycenaean wool economy. These estimates are based on experimental archaeology and knowledge generously shared by craftspeople with scholars. They allow us to make the following observations. First, the wool yields from palace sheep are very high and it is unlikely that it was all spun by palace-paid workers and transformed into textiles, since there are simply not sufficient workers for this and textile workers represent an expenditure in terms of rations. Secondly, a significant part of the wool must have been in surplus, and this wool may have been integrated into other economic circuits as remuneration: to textile workers for their own home-production; as remuneration to shepherds and to other palace dependents.

¹⁰⁵ Stavrianopoulou 1989. Stavrianopoulou 1989, 70: "Unsere Untersuchung zusammenfassend, können wir feststellen, dass wir im Gegensatz zu der Wollindustrie von Knossos von einer Flachsindustrie bzw. Leinenindustrie von Pylos sprechen dürfen".

¹⁰⁶ Nosch 2000a.

Thirdly, rations for textile workers represent a major expenditure; thus we can safely assume that this expenditure was worthwhile and would increase the value of wool considerably.

The intensive links between textiles and textile workers in Mycenaean times may have engendered a series of diseases and occupational hazards related to textile production. The intensification of sheep breeding and accumulation of animals could provoke rapid spread of animal diseases, some of which could be transferred to humans. Anthrax, also called ‘wool-sorters disease’ is caused by such bacteria, and it is likely that it already existed as a problem in Bronze Age wool economies. The term *ἀνθραξ* in Greek means charcoal, probably reflection the cutaneous reactions as dark skin areas. The etymology of anthrax is obscure. The bulk of names for diseases in Greek have an Indo-European etymology, but anthrax may have an Egyptian etymology.¹⁰⁷ This is not easy to explain. Anthrax was still a major challenge in European wool economies in the 19th century AD and it was Louis Pasteur who in 1881 discovered how to prevent the illness anthrax of sheep spread by the *Bacillus anthracis*.

Flocks of sheep are divided according to their gender, age, and wool yields in the Bronze Age, and are identified by their location and shepherd. Textile workers, too, are identified according to their gender, age, and occupation, and by their location and, sometimes, collector.

There is, furthermore, a gendered division of labour in the Mycenaean wool economy with men tending animals, monitoring the wool yields, and taking over supervision tasks; men also have a few specialized occupations in wool textile production as weavers and fullers; women and children are engaged in fibre processing, combing, spinning, weaving, and finishing. There is approximately a similar number of men and women engaged in the wool economy. Women and children tend to have more specialised occupations and technical designations; men are found as shepherds, supervisors, or in specific occupations, such as fullers and weavers, but the weaving occupation is shared by men and women.

The division of labour in textile production is based on the techniques and on fibre processing, and less on fibre type; there are several processes common to wool and flax, such as spinning, weaving, and finishing. The extra work with mechanical and chemical flax processing is indicated by the specific allocation of women and children for working with this fibre, the *ri-ne-ja*, linen workers, but there are no corresponding wool workers.

For most Mycenaean textiles, there is a striking absence of data on the textile fibre qualities and types. This can be explained by the administrative practices, and by the standardization of the textile repertoire and partly by the dominance of woollen textiles, *te-pa*, *pa-we-a* and *pu-ka-ta-ri-ja*, particularly at Knossos. Only *pa-we-a* can explicitly be made from either plant or animal fibres. Archaeological textiles of both wool and linen exist in the Aegean Bronze Age.

Wool from prehistoric sheep comes in many different hues: white, grey, black, and reddish. This provides excellent opportunities for patterns and decoration, and the Linear B archives yield a rich terminology for decorations and decorative techniques. However, the impression of fairly standardised wool products remains. *Pu-ka-ta-ri-ja* is the most abundant Mycenaean wool textile type, recorded in several palaces and also recorded at Mycenae (X 508) to be sent to Thebes. Thus, we see fairly standardized wool textiles being circulated between the palace centres as a significant part of the Mycenaean wool economy.

¹⁰⁷ It may have an Egyptian etymology according to Grmek 1983, 36 note 3. See also Chantraine 2009 s.v.

Abbreviations

BAR	British Archaeological Reports
BSA	Annual of the British School at Athens
BICS	Bulletin of the Institute of Classical Studies
SIMA	Studies in Mediterranean Archaeology
SMEA	Studi Micenei ed Egeo-Anatolici

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