Journal of Danish Archaeology vol. 7, 1988, pp 136–143

Danish Bronze Age Wools

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INTRODUCTION

The wools preserved in the Danish oak coffins, although relatively late in date, are of immense interest in providing the first direct evidence of wool usage. Most appear to represent a primitive hairy medium fleece at a transitional stage between the 'hair' coat of Neolithic sheep (see below) and the typical hairy medium-generalised medium fleeces that emerge in the Bronze Age and remain predominant until after the Middle Ages (Ryder, 1983a).

The remains illustrate the biological changes taking place in the coat of sheep as a result of selective breeding for wool suitable for textile use and the lack of such remains from areas closer to the centre of domestication in the Middle East makes them doubly important.

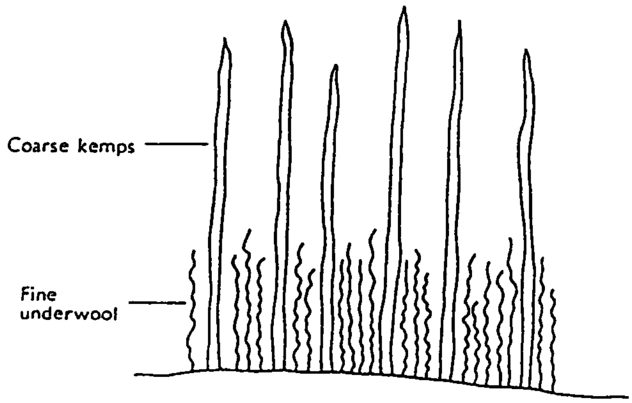

Fig. 1. Diagrammatic representation of the double coat of wild sheep and the first domestic type.

Neolithic 'hair' sheep

It has long been known that the coat of the first domestic sheep of the Neolithic period would have been the same as that of the wild ancestor. This comprises an outer coat of bristly kemp fibres, which obscure very fine underwool (Fig. 1). What has only been realised more recently is the length of time it took for a fleece to develop. The evidence for this comes from the wild Mouflon sheep of Corsica and Sardinia. These are now thought to be not truly wild sheep, but feral descendants of domestic sheep introduced by Neolithic settlers about 6000 b.c. (Poplin, 1979). Since these have a coat that is apparently no different from that of other wild sheep, such as the Bighorn of North America, which was never domesticated, it appears that no change took place during the 3000 to 4000 years that elapsed between domestication and their introduction to Corsica and Sardinia.

Ryder (1984) identified 'hair' sheep in skin remains from Sudan dated about 2000 B.C. P. Walton has recently reported on eight raw wool samples of this type from Borremose, Denmark (e.g. ref., C26449). These were from sheepskin capes of the pre-Roman Iron Age (Hald 1980) and the nature of the material means that the entire range of fibre diameters was represented. The modal diameters ranged, form 15 to 22 microns and some of the kemps were over 200 microns in diameter.

This primitive type of coat also survives in the kempy 'hair' breeds of tropical Africa and India. Domestication resulted in the occurrence of black sheep and white sheep in addition to the brown of the wild ancestor (which is the only colour in the Corsican Mouflon). The retention of the kempy coat in tropical 'hair' sheep can be interpreted as being due to the lack of a stimulus to breed for wool in a hot climate. In fact, in some tropical breeds the underwool has actually become reduced presumably as an adaptation to heat loss brought about through natural selection.

Since this section was written, Bennike, Ebbesen and Bender Jørgensen (1986) have drawn attention to an early claim of 'woollen' cloth of the late Neolithic from Wiepenkathen in Lower Saxony. Since no evidence is given for regarding this as woollen as opposed to worsted it would be better described as 'wool' and since no fibre measurements are given its identification as 'wool' is meaningless. My own experience of investigating such claims has been that the fibres have turned out to be of plant origin and not wool, or that the material is not as old as Neolithic. I have sought wool of Neolithic date for 30 years without success.

Material investigated

This account, in addition to presenting new measurements (Table 4), reassesses the previous findings of Ryder (1964) – one sample only from Guldhøj – Ryder (1969) and Ryder (1983b). The first unpublished material measured in 1985 comprised seven yarns from Early Bronze Age textiles in a woman's grave in Melhøj (Bender Jørgensen *et al.* 1982). These all had the reference number B12381–91 and came from four different types of cloth (A to D). They are listed at the end of Table 4 as numbers T530 to T536.

A further 27 yarns from E. Munksgaard were measured in 1986. These were all of early Bronze Age date (1800 to 1000 b.c.) and the sites and periods represented are shown in Table 1.

Snoldelev, Copenhagen Co.	no. 6281-85 – per. III
Smørumovre, Copenhagen co.	no. B 2109-22 – per. II
Garderhøj, Copenhagen co.	no. B 3716-26 – per. III
Hagendrup, Holbaek co.	no. 13751-54 – per. II
Løserup, Holbaek co.	no. 9835 – per. II
Haraldsted, Sorø co.	no. B 9987-93 – per. II
Skallerup, Praestø co.	no. 6145-59 – per. III
Hejnsvig, Ribe co.	no. B 10584 – per. II
Torup, Ribe co.	no. 10089 – per. II
Briksbøl, Ribe co.	no. B 9175 – per. I
Melhøj, Aalborg co.	no. B 12381-91, samples from A5, A3, C33 and C34 – per. III

Table 1. Sites and periods of yarns measured in 1986.

Method

The method has been described before, e.g. in Ryder 1969 and Ryder (1983b). It involves the use of whole microscopic mounts of the fibres in which the diameter of 100 fibres is measured using a projection microscope. The widths of fibre images magnified 500 times and projected on to a bench are measured with a mm scale. Doubling of the measurements obtained gives the fibre diameter in microns (thousandths of a mm).

The fleece type criteria have been summarised by Ryder (1969) and Ryder and Gabra-Sanders (1985). The skewness and the maximum fibre diameter in distributions like those in Figure 2 are used to define the type of fleece represented.

The development of a fleece

The main change involved in the development of a fleece involved the narrowing (thinning) of the outer coat kemp hairs, and it could be that selective breeding for a softer (and therefore finer) coat began while skins were still being worn as clothing. At the same time, the underwool coarsened so that the mean fibre diameter changed from about the 15 microns of the wild sheep and the Mouflon, to 20 microns, which has been the typical value for wool ever since (Fig. 2).

An intermediate stage can perhaps be seen in the wool used in some of the earliest textiles found in Denmark. This was originally thought to have been mixed with deer hair (Steensberg 1939) but it is now realised that the 'deer hairs' are really sheep kemps. Three of the Danish Bronze Age yarns described by Ryder (1969) – from Skrydstrup – appeared to be of this intermediate type in having only kemps and fine wool (Table 2). Red deer hairs are three times the width of sheep kemps.

The first Danish Bronze Age wool supplied for measurements comprised only one cloth (from Guldhøj ref. no. 5067). This was described by Ryder (1969) as a hairy medium wool (Fig. 2) and attention was drawn to the unusually high proportion of fine fibres (Table 3). The hairy Soay sheep surviving on St. Kilda off north West Scotland was later found to have a hairy medium type of fleece, while the woolly variety of the Soay has a generalised medium distribution (Ryder, 1966). The Danish textile evidence therefore supported skeletal evidence that the brown Soay sheep is a survival from the Bronze Age.

The remaining Bronze Age wools described by Ryder (1969) came from England, Germany, and Norway. These were all naturally-coloured and comprised one hairy medium wool, two with only fine fibres, which were interpreted as coming from a hair medium fleece, and four generalised medium wools.

Ryder (1983 b) described a further 12 Bronze Age wools from Denmark supplied by E. Munksgaard. The description, source and museum references numbers are given in Table 3 together with the fibre diameters

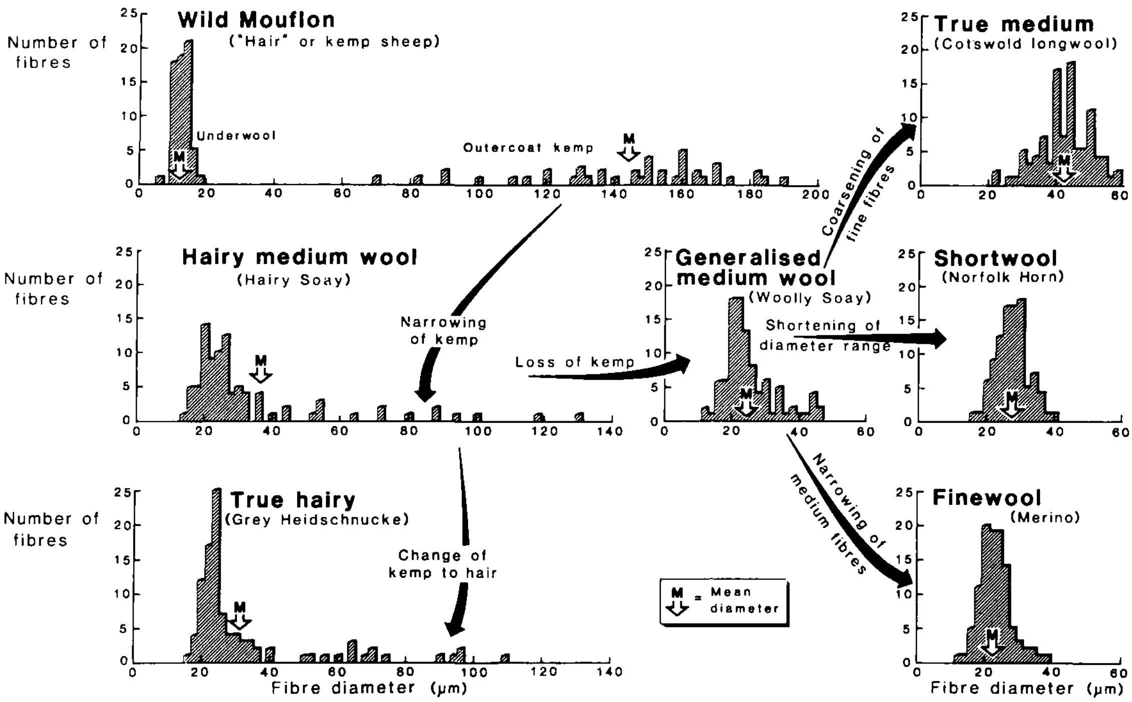

Fig. 2. Changes in the distribution of wool fibre diameter during fleece evolution. The diameter distribution of each main fleece type is shown as a histogram. The coat of the earliest domestic sheep would have been the same as that of the wild ancestor (top) having an outer coat of bristly kemps (to the right of the distribution). The first evolutionary change was a narrowing of the outer-coat kemps to give the Bronze Age hairy medium fleece which is characterised by a skewed distribution (i.e. most of the fibres are fine) with a few hairy fibres greater than 60 microns in diameter. Further narrowing of these fine kemps changed them into wool fibres of medium diameter and produced the generalised medium wool, which also appeared in the Bronze Age, and which is characterised by a skewed distribution in which the maximum fibre diameter is about 55 microns. Most of the material in the present investigation had not even reached the typical hairy medium stage of development. The changes leading to the modern fleece types around the edge of the diagram took place in later periods and will not be described again here. From Ryder 1983 a.

measured. Five of these were clearly hairy medium wools, while seven having only fine fibres were again interpreted as coming from a hairy medium fleece. The complete lack of any fibres of medium diameter indicates the absence of generalised medium fleeces.

Of the total of 23 Bronze Age wools measured up to that stage the hairy medium type predominated with 16, and there were three more with coarse kemps and fine wool, which could be regarded as an even more primitive intermediate type, whereas there were only four of the less primitive generalised medium type.

In addition to the lack of medium fibres in the hairy medium wools, another primitive feature was the predominance of samples in which the mode (most frequent fibre diameter) was less than the more recent value of 20 microns, and closer to the 15 microns of the wild ancestor. For example three quarters of those described by Ryder (1983 b) had finer values: 2 × 18, 5 × 16 and 2 × 14 microns.

The results of the 1985 and 1986 measurements are shown in Table 4. Unlike the samples of Ryder (1983 b) a high proportion of the fibres in nearly all samples contain natural pigmentation.

Bender Jørgensen *et al.* (1982) compared the Melhøj cloth with that from Skrydstrup. Only one example from the latter site has been measured (Table 2) and this had fine fibres with mean diameters of 20.5 and 24.2 microns (coarser than in the wild ancestor) and kemps ranging from 100 microns to over 200 microns (equivalent to the wild ancestor). Ryder (1969) interpreted this as being intermediate between the wild type and the hairy medium type of fleece.

Source	Site	Date	Pigment	Diameter Range	Mean Diameter	Mode	Distribution	Fleece Type
K. Schlabow (Neumünster Textilmuseum)	Unterteutschenthal (Germany)	Early Bronze Age	xx	12–32 36, 42, 46, 48	22·3	18	skewed-to-fine	gen. medium
K. Schlabow (Neumünster Textilmuseum)	Harrislee (Germany)	1600 B.C.	(a) xx	8–26 2 of 32	16·6	16	almost symmetrical	fine
			(b) xxx	10–28 2 of 40	18·7	14	skewed-to-fine	gen. medium
British Museum	Rylstone, Yorkshire (England)	—	(a) xxx	10–30 44, 48, 62, 74 (fine, medium and hairy fibres)	21·00	18	skewed-to-fine	hairy medium
			(b) xxx	10–34 42, 44 (fine and medium fibres)	19·6	18	skewed-to-fine	gen. medium
			(c) xxx	12–30 (fine only)	19·4	18	symmetrical	fine†
Danish National Museum (B5067, Draegter T.244)	Guldhoj, Vester Varndrup (Denmark) [(a)]	1200 B.C.	(a) xxx	10–32 (96%) 40–44 (3%) 74 (1%)	18·7	18	skewed-to-fine	hairy medium
			(b) xxx	8–28 (97%) 50 (1%) 62, 88 (2%)	16·3	14	skewed-to-fine	hairy medium
					wool	kemp		
Danish National Museum (B5067, Draegter T.244)	Skrydstrup (Denmark) [(b)]		head band xx	13–26 + kemp	20·5	102	—	apparently intermediate between wild type and hairy Soay
			skirt xx	+42–54 + kemp	24·1	222	—	
			large cloth xx	+42–54 + kemp	24·3	174	—	
Universitets Oldsaksamling, Oslo	Bloheia (Norway) [(c)]	1200 B.C.	no info.	8–27 35, 43	14·7	15	skewed-to-fine	gen. medium

In this and subsequent tables: the letters (a), (b), (c) and so on indicate different yarns; pigmentation is indicated as follows:
x slight
xx moderate
xxx heavy

* one micron = 0·001 mm.

† the three Rylstone yarns could be from the same fleece type, and the differences be due to the exclusion of coarser fibres from the sample. See discussion in text.

(*a*) Broholm, H. C. and Hald, M. (1940). *Costumes of the Bronze Age in Denmark*. Oxford.
(*b*) Figures from Steensberg, C. M. (1939). Undersøgelser over Harr fra Skrydstrupgraven, *in* Broholm, H. C. and Hald, M. *Skrydstrupfundet*. Copenhagen. pp. 31–41.
(*c*) Figures from Rosenqvist, A. M. (1964). Investigations of woollen fibres in the Oseberg find, *Proc. Int. Conf. on Conservation*. Delft. pp. 133–6.

Table 2. Wool fibre measurements (from Ryder 1969).

Source and Museum No.	Range	Fibre diameter mode	Mean ± S.D.	Coeff. of var.	Pearson coeff. of skewness	Proportion medullated fibres	Proportion pigmented fibres	Fleece type
Lille Dragshøj –								
Weft 19467	12–24, 70, 90, 138	16	18·5±15·4	0·83	0·51	0·03	0·62 (DG)	HM
19467 (a)	10–22, 44, 80, 140	14	16·6±14·6	0·88	0·51	0·04	0·26 (LG)	HM
Rønhøj	10–24, 70	18	17·0±6·2	0·36	0·25	0·00	0·56 (MG)	HM
Trindhøj (a)								
19911–12 blanket	10–22, 54, 72	16	16·7±7·3	0·44	0·39	0·04	0·06 (WG)	HM
Blanket (b)	10–24, 52, 92	16	17·8±8·7	0·49	0·44	0·10	0·00 (W)	HM
Blanket (c)	12–24,	16	17·4±2·5	0·15	0·22	0·02	0·00 (W)	(F)
Guldhøj B5074 –								
Belt	12–34	20	20·2±3·6	0·18	0·25	0·05	0·00 (W)	(F)
Stocking top	12–32	18	18·7±3·6	0·19	0·35	0·00	0·92 (BG)	(F)
Stocking sole	12–28	16	17·6±2·8	0·16	0·78	0·00	1·00 (B)	(F)
Skrydstrup B12968 blanket B	12–28	20	18·6±3·1	0·17	0·24	0·00	0·52 (MG)	(F)
Borum Eshøj B686 net	14–30	22	22·2±3·3	0·15	0·11	0·00	0·97 (BG)	(F)
Sandbaek 25743 cloth	10–20	14	14·8±2·5	0·17	0·09	0·00	0·97 (BG)	(F)

Colour: B=black; BG=black grey; DG=dark grey; MG=medium grey; LG=light grey; WG=white grey; W=white.
Fleece type: HM=hairy medium; F=fine fibre diameter distribution (but probably not fine fleece).

Table 3. Wool fibre measurements (from Ryder 1983b).

Natural Colour

Soay sheep, like the wild ancestor, have a white belly and the upper parts can be either dark brown (in animals carrying the black gene) or light brown (in animals carrying the brown gene). The self-colour gene produces a coloured belly, so that animals also carrying black gene appear all black, while those with the brown gene appear completely brown (Ryder *et al.* 1974); 11 of the 30 Bronze Age yarns measured up to 1985 were brown.

Black sheep are therefore not uncommon in the Soay, so it is interesting that three of the samples described by Ryder (1983 b) were white.

Grey sheep are unknown in the Soay breed, yet eight Bronze Age yarns described by Ryder (1983 b) had a mixture of coloured and white fibres, plus a further seven measured in 1985 in which the proportion of coloured fibres ranged from 47% to 93%. These were interpreted as a brown and white mixture since Soay sheep frequently have a scattering of white fibres in the brown fleece. It is true that grey can be produced by blending the black and white wool of a piebald fleece, which are common in the Soay, but the fibre diameter distributions support the assumption that the wool was spun direct from the fleece until the Middle Ages. In addition, in the Soay, white wool could have come from the belly, white wool however, did not become common until the Iron Age, when in fact grey predominated.

Harvesting

Also shared by the Soay breed with the wild ancestor is a natural spring moult. This meant that wool could be obtained by plucking during the moult before the invention of shears in the Iron Age. Such a method of harvesting a moulting fleece persisted until recent times in such places as Shetland. Because there is a risk that a moulting fleece will be shed and lost before the animal is plucked, once shears were available the way was open for sheep with a tendency towards continuous growth to be selectively bred. This led to the modern situation in which wool is harvested by shearing.

Since the hairy fibres tend to shed at a different time from the wool fibres, it is often possible to obtain by plucking, wool which contains fewer hairs than it would if shorn. The Guldhøj sample described by Ryder (1964) was interpreted as being obtained in this way, and the greater number of such samples described by Ryder (1983 b) supported this conclusion.

Another possible method of harvesting wool free from hair is by combing during the moult. This provides a possible use for the bone, so-called 'weaving combs' that have long been known to be unsuitable for use in weaving because of their concave section (Ryder 1983 (a) p. 750). Combing is the traditional method of obtaining the extremely fine underwool from cashmere goats in China. In Inner Mongolia sheep, too, are combed to obtain the finer wool in the same way (Ryder 1983 (a) p. 298). The comb used is like a small rake with a short handle, although a traditional Chinese design has hooked teeth.

Although I worked with goats as early as 1961, it was not until the spring of 1984, after I had started working on cashmere production, that I actually combed the underwool from British feral goats (Ryder 1985 a). Combing is relatively easy, but it appears virtually impossible to obtain underwool completely free from hair.

Modern de-haring of cashmere fibre prior to processing is a difficult process requiring complicated machinery. It is therefore most remarkable that shawls of a goat underwool from Kashmir dating from around 1800 are completely free from hair. One would not imagine that it would be possible to remove all the hair by hand yet an eye-witness description given by Moorcroft (1841) proves that this is actually what happened. It took a woman two hours to remove individual hairs by the fingers from 2 oz (56.7 g) of combed fibre. The similar complete lack of hairs from much of the material described in the present study leads one to suggest that this custom goes back to the Bronze Age.

The pre-requisites for combing are that the underwool moults at a different time from the hair, and that there is a relatively large difference in diameter between them. The fact that there is rarely perfect asynchrony in the moult explains why there is virtually always some hair in raw cashmere fibre today.

The need for a big difference in diameter between the hairy fibres and the wool means that the more primitive the fleece, going back from the hairy medium type towards the Mouflon, the more easy it would have been to comb, e.g. the Early Bronze Age or Neolithic sheep discussed above. On the other hand, the particular Mouflon sheep I worked with during the 1960's tended to shed their kemp hairs at about the same time as the wool so that separation was virtually impossible. This

Sample Identity		Fibre diameter (microns) Range	Mean ± S.D.	Mode	Pearson coeff. skewness	Distribution	Percentage Medullated fibres	Percentage pigmented fibres
T557	(a)	9–22, 26	15.8 ± 3.0	15&16	−0.026	skew fine	0	1%
B9175	(b)	7–25, 30, 87, 169	18.5 ± 17.2	15&16	0.433	skew fine	3%	1%
T549	2 ply	6–19, 24	11.4 ± 3.4	12	0.365	skew fine	0	67%
B2019–22						symmetrical	0	58%
T551	wa	8–21	13.9 ± 2.9	14	0.206	skew fine	1%	65%
13751–54	we	8–23, 26	15.0 ± 5.9	13&14	0.315	skew fine	0	54%
T552	wa	6–20, 24, 26	11.7 ± 3.5	11	0.388	skew fine	0	68%
9835	we	7–19, 21, 62	12.9 ± 5.7	12	0.287	skew fine	2%	50%
T553	(a)	5, 8–21, 25, 76	15.1 ± 6.9	15	0.119	skew fine	5%	55%
B9987–93	(b)	7–28, 54, 61, 112	16.1 ± 11.9	14	0.472	skew fine	0	89%
T555	(a)	10–30, 33 (2), 36, 39	16.9 ± 5.4	13	0.616	skew fine	1%	93%
B10584	(b)	9–28, 35, 74	17.5 ± 7.2	14	0.632	symm./skew fine	0	80%
T556	yarn	8–24, 29	15.9 ± 3.8	14&15	0.096	skew fine	0	71%
T548	(a)	7–20, 49, 54	14.1 ± 6.0	12	0.491	skew fine	0	74%
6281–85	(b)	7–19, 23, 31	13.6 ± 3.7	12	0.478	continuous	31%	4%
	cow	11–37, 52	20.5 ± 7.5	15	0.616	symmetrical	0	79%
T550	(a)	8–21	13.4 ± 3.2	12	0.522	symmetrical	0	78%
B3716–26	(b)	7–18, 20	13.2 ± 2.6	11	0.077	skew fine	0	94%
T554	Y1	10–29, 34, 40, 65	19.2 ± 7.1	17	0.656	skew fine	0	95%
B6145–59	Y2	9, 12–27, 29, 37, 51	19.1 ± 5.3	16	0.225	skew fine	0	65%
A11 B1238–91	(a)	7–22, 24, 29	14.7 ± 3.8	12&13	0.492	skew fine	1%	73%
T544 (A3)	(b)	5–22, 25, 34, 53	14.5 ± 5.9	15	0.335	symmetrical	0	57%
T545 (A5)	(a)	4, 6–19	11.8 ± 2.9	12	−0.079	skew fine	1%	64%
	(b)	5–16, 20, 54	12.4 ± 5.0	11	0.427	skew fine	0	80%
T546 (C33)	(a)	8–31, 67	15.9 ± 7.5	11	0.568	symm./skew fine	0	55%
	(b)	4–19	10.5 ± 2.8	8	0.558	skew fine	0	63%
T547 (C34)	(a)	6–18, 22, 36	12.3 ± 4.3	12	0.189	skew fine	0	48%
	(b)	6–24	11.7 ± 3.1	10	0.273	skew fine	0	76%
pile	(c)	8–23, 32	14.8 ± 4.0	12	0.708	skew fine	0	65%
T530 (A2)		8–33	15.6 ± 4.6	15	0.170	skew fine	0	84%
T533 (B5)		6–26, 29, 37	14.3 ± 6.2	11	0.844	symmetrical	0	47%
T531 (C27)		7–20	13.7 ± not calc.	11&12	0.349	skew fine	0	57%
T532 (C42)		4–27, 29, 35	14.5 ± 5.4	11	0.775	skew fine	0	77%
T534 type C (pile)		8–26, 28, 31, 33	16.7 ± 4.5	13&16	0.360	skew fine	0	88%
T535 (D1)		7–26	13.1 ± 4.6	9	0.833	skew fine	0	93%
T536 (D3)		5–28, 32	12.4 ± 5.1	10	0.833 Sic			

Table 4. Fibre measurements.

emphasises the fact that all animals vary, and indeed without such variation selective breeding would have been impossible.

General discussion and interpretation

Although only seven of the 34 wool samples shown in Table 4 have any hairs, it would be easy to identify all these as hairy medium wools, the inference being that those having a true fine diameter distribution, lacking even medium fibres, represent the underwool that has in some way been obtained completely free from hair.

There are four samples with a skewed distribution and single fibres over 50 microns in diameter which could be regarded as generalised medium wools. The remainder, with a symmetrical distribution, if not to be regarded as fine generalised medium wools, would be true fine wools. Since true fine wools are unlikely in northern Europe at this early date, an alternative explanation must be sought.

The fibres represented are finer than any wool fibres from domestic sheep measured before. The finest fibre is only four microns compared with ten in the relatively fine wools listed by Ryder (1983 b). The smallest mode is only eight microns compared with 14 microns, and the smallest mean is only 10.5 microns compared with 14.8 microns previously recorded.

Two possible interpretations come to mind: (a) that these fine fibres are the underwool combed from goats, and (b) that they were similarly obtained from the coat of a sheep more primitive than the hairy medium (i.e. intermediate between the Neolithic (Mouflon) type and the hairy medium) if not from the Neolithic type itself.

The idea that the fibres are from goats is supported by their relative straightness as well as their diameters (Ryder 1970; 1985 a). It is very likely that goats were run with sheep at this time (bone remains are frequently described as sheep/goat) and it could be that their underwool was harvested along with that of sheep. The two kinds of fibre could well have been mixed for usage, which would further complicate the picture. It is thought that animal fibres were first used as felt (Ryder 1983 (a) p. 735) a use which could have been suggested by the observation of matted fibres in a moulting coat. Spinning could have been suggested by a similar observation (Ryder 1983 (a) p. 736). I am not aware of any felt remains that could confirm its manufacture before that of cloth and the present material probably represents the earliest cloth. An explanation for the complete lack of hairs has already been discussed in the section on harvesting. Such careful removal would not have been necessary with felt.

Further support for the inclusion of goat fibres came from the surface cuticular scale pattern as seen with the Scanning Electron Microscope, which is a feature used in identification. Scanning Electron Micrographs were prepared by Mrs. T. Gabra-Sanders of samples T531, 534 and 536 as well as T544 to T556. Although a few apparently goat fibres were detected in this way, the majority of these fine fibres were from sheep. A few goat fibres could readily get into wool as contaminants from goats grazed with sheep, and so the exciting possibility that goat underwool was used in Bronze Age Europe awaits confirmation.

A major difficulty is that although cashmere used for comparison is quite distinct from wool, 'ordinary' goat underwool is less different from sheeps' wool and until work now in progress reveals what the detailed characteristics of ordinary goat underwool are, a conclusive investigation of this nature will not be possible. Another difficulty is that in much of the archaeological material the scale pattern is not clear owing to dirt on the fibre surface.

An unusual feature of these fine fibres is that some (less than 20 microns in diameter) had a medulla – the central hollow core, which is characteristic of hairy fibres, and invariably absent form the fine wool of modern fleeced breeds. That fine goat fibres sometimes contain a medulla cannot be taken as a conclusive feature for identification because modern 'hair' sheep, too, sometimes have a medulla in the fine fibres. This observation, however, supports the conclusion that where sheep are identified in this material, the fleece type cannot be far removed from the Neolithic 'hair' type. It also explains the mystery of medullated Bronze Age fine animal fibres quoted by Ryder (1963 p. 540). In fact, 20 years of selective breeding for medullation in a modern true hairy type caused the finer fibres to acquire a medulla, which was absent at the outset (Ryder 1985 b).

It can be recorded that from SEMs the Guldhøj sample (Ryder 1964) is definitely sheeps' wool, whereas one of the Melhøj samples (C27) and B3716 – 26 (a) from Garderhøj could contain goat fibres. In the latter (T554) as well as T548 and T554, there is close similarity in the fibre measurments between the two yarn systems.

The main conclusion that these wool samples represent the earliest stage in the development of a fleece is in keeping with the Early Bronze Age date. Typical hairy medium and generalised medium probably emerged in the Late Bronze Age and these predominate from the Iron Age until the Middle Ages.

Summary and Conclusions

(1) Most of the Danish Bronze Age wools examined contained very fine fibres completely free from hair.

(2) The fineness of the fibres leads to the interpretation that they comprise the underwool of a primitive type of fleece little if any different from that of the wild/Neolithic type.

(3) The nature of the samples indicates harvesting during the spring moult, possibly by combing, as with modern cashmere from goats.

(4) The complete lack of hair in many samples indicates painstaking removal of these with the fingers.

(5) The straightness of many of the fine fibres compared with wool suggested that some might be the underwool of goats and Scanning Electron Micrographs supported the identification of a very few fibres as being from goats.

(6) The majority of the fibres, however, were wool from sheep and so a few goat fibres could have got into the wool as contaminants from goats grazed with sheep. There is no suggestion that all the material was goat or that goat fibres were used as well as wool, either separately or as a blend (mixture).

(7) Some of the fine fibres had a central medulla, a rare feature of underwool from 'hair' sheep and goats, which has been reported previously in unidentified animal fibres of Bronze Age date.

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