Carol A. Christiansen

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Introduction

In a 1964 issue of *Nature*, Michael Ryder presented his hypothesis for the evolution of fleece in which he postulated that it was possible to determine the developmental level of fleece structure by analysing fibres found in yarns from archaeological contexts [Ryder 1964]. His assertion was based on his observation that over time, fleeces had become more uniform in quality, and specifically, more uniformly fine woolled. Ryder noted that a systematic levelling of fibre diameter had taken place from the extreme fine and coarse fibres found in primitive fleeces to the general regularity of wool diameter in modern fleeces. His methodology for calculating these changes consisted of measuring the diameters of 100 wool fibres taken from yarns of excavated textiles, then plotting their distribution in order to determine overall wool quality. Ryder developed definitions of fleece types based on these figures and distribution patterns (Tabl. 1), against which subsequent textile finds could be compared and defined. From fleece types he was able to chart the evolution of sheep breeds, showing how the modern Merino could have evolved from the primitive, wild Mouflon, based on changes in wool quality [Ryder 1983a: Fig. 2.6].

Ryder's model appeared to be a highly advantageous tool for textile archaeologists because it provided a framework for measuring and comparing the characteristics of wool quality of individual ancient yarns and textiles. More importantly, because of its strict evolutionary perspective, his model linked wool quality with developments in fleece modernisation, giving a general chronological framework within which woollen archaeological textiles could be placed. For example, a yarn displaying an asymmetrical diameter distribution was linked with a primitive breed of sheep, since primitive fleeces lacked the uniformity of wool found in modern breeds.

In the last 40 years, this model has been widely used by Ryder and other textile archaeologists, in an attempt to characterise the quality and developmental level of recovered woollen textiles. It has been applied to Bronze Age yarns in order to gain a better understanding of the quality of these very early textiles [Bender Jørgensen and Walton 1986; Ryder 1977: 177-8; 1983b; 1988; 1990]. Changes in fleece quality between Anglo-Saxon and Viking York [Walton 1989: 301-11, with Ryder: 308-11] and wool of the Norse period in North Atlantic settlements [Walton Rogers 1998; 1999] have been characterised according to Ryder's model. In addition, his model has been used to define wool from textiles of Saxon England [Pritchard 1984, Ryder 1993] and late medieval Scotland [Ryder and Gabra-Sanders 1992]. Ryder's work has also been applied to the characterisation of primitive sheep breeds surviving in rural areas of Europe [Goldmann 1998]. His model appears to be an accepted and often practised form of analysis for archaeological textile and historical wool studies.

In several fundamental ways, however, Ryder's model runs contrary to historical, archaeological, and ethnographic evidence for early textile manufacture. For the model to be valid, the fibre composition of both yarn and fleece must accurately reflect each other. For fleece-yarn equivalencies to have occurred in ancient textiles, Ryder adopted two overriding paradigms about early yarn production: that fine wool became separated from coarse fibres in harvesting wool by plucking [Ryder 1988; 1993: 310], and that wool was spun directly from the staple [Ryder 1964: 558; 1969: 500].

It is unlikely these two situations ever existed (and in fact, they are contradictory, for if only fine wool is plucked then the staple, as a cohesive form of wool, ceases to exist). Long-standing evidence for early wool processing by hand [Crowfoot 1931: 10, 36; Hansen 1947: 16] and for processing tools [Hoffmann 1964: 284-288; Guðjónsson 1979] have established that wool was regularly separated and re-mixed before it was spun. Recent ethnographic studies into the traditional practice of plucking wool reveals this method of fleece removal does not separate fine fibres from coarse [Christiansen, forthcoming; Lightfoot 1987: 12]. This

Fig. 1. Rooing wool in Faroe. The man on the left is removing the old fleece with his hands, the man on the right is using a knife to cut wool at the shoulder. *Photo: C. Christiansen*

evidence suggests a very different scenario for early yarn production than the one Ryder proposes in his model.

Wool Uniformity and Textile Production

Ryder recognised that fleeces have become more uniform in wool quality over time, beginning with wild sheep that have extremes in fibre diameter, to modern breeds with little variation in fibre quality. It would seem that attaining some level of wool uniformity is beneficial for textile production, since extremes in fibre quality make spinning difficult and yarn quality becomes compromised. Was the need for wool uniformity so great that sheep breeds were changed beyond recognition from their primitive ancestors? Dramatic developments in new sheep breeds with more uniform fleece structures during the growth in European woollen manufacture would seem to confirm this. However, it must be kept in mind that these significant changes in fleece development did not take place everywhere. Indeed, they have yet to occur in some parts of Northern Europe where local textile production remains dependent on primitive wool.

Yet achieving some level of wool uniformity was still an important step in textile production. For primitive wool, this was accomplished by processing the fleece before spinning rather than wholesale changes to the breed. This situation continued for two reasons: cloth manufacture remained relatively small-scale and environmental limitations meant that primitive fleece structure had to be maintained for survival of the animal. Where modern breeds with uniform fleeces could be sustained, even in parts of Scandinavia by the 19th century, they eventually replaced the traditional, primitive breeds. In many remote areas of Northwestern Europe primitive breeds continued to flourish, since modern sheep could not endure the harsh climate. Textile finds from these areas, or from early contexts like the Bronze Age, must be analysed with primitive fleece structure and traditional manufacturing methods in mind. Their effect on the fleece can be profound, resulting in yarns that only partially characterise the qualities found throughout the fleece.

The Process of Rooing Wool

Very primitive breeds of sheep moult their fleece and it was possible to harvest the wool by plucking it. Throughout his research in fleece development, Ryder has maintained that only fine fibres were removed during the plucking process and that coarse fibres remained on the animal until they fell off naturally later in the year [Ryder 1993: 310]. Ryder used this assumption to explain why some very early yarns such as those from Bronze Age textiles, which, according to his evolutionary scheme should include some hairs in their composition, were made of only fine wool [Ryder 1988].

In some remote areas of Northern Europe, the practice of plucking or rooing wool has continued to be practised, allowing for research into the way rooing was carried out and the affect it had on fleece structure. Initially the sheep is immobilised by tying the legs and the moulting wool is pulled, staple by staple

Fig. 2. Two similar staples of naturally cast Faroese wool. One is intact (left), the other has been separated by hand into its two distinct fibre types, coarse (middle) and fine (right). Note the colour difference after separation. *Photo: C. Christiansen*

(Fig. 1). In some cases, it is possible to peel away large sections of the fleece at one time. The natural moult tends to occur in stages on the fleece and some wool cannot be rooed, but must be cut away, usually with a knife.

Observations by the present author in Shetland, Faroe and Western Norway confirm that during the rooing process, all wool from the previous year's fleece is removed, including coarse hair fibres (Christiansen, forthcoming). Photographs of Shetlanders rooing sheep over the last 100 years similarly show the entire previous year's fleece being taken off and the sheep left with only the short, new fleece. The moulting process occurs to all fibres within staple *at the same time* and naturally cast or rooed staples contain their full range of fibre qualities (Fig. 2).

Ryder may have based his erroneous assumption on the often-cited Highland Society report of 1790, wherein Shetland wool was praised for its fineness and a link was made between fine wool and the rooing process [Report 1790: 5]. The report, in effect, was a promotional effort by Sir John Sinclair, who hoped to receive monetary support from the Society in order to create a native British flock of fine-woolled sheep. Shetland wool was considered one of the more worthy candidates for crossbreeding experiments, since it contained some of the finest wool in Britain. It appears, however, that Sinclair exaggerated the quality of plucked wool in order to promote it, for his claims about the lack of hair fibres in rooed Shetland wool were adamantly refuted by Shetlanders and others at the time [Christiansen 2000: 20; Carter 1979: 213-214]. Indeed, the main reason a crossbreeding programme using Shetland sheep never materialised was because coarse fibres were thoroughly mixed within the staple and could not be removed completely during rooing, a problem that caused ongoing consternation to Sinclair.

The nature of primitive wool also may have contributed to confusion about coarse wool remaining on the animal until a later time. In primitive fleeces the incoming wool is usually very coarse because it is effectively the tips of the new staples. The hairy tip is often very darkly pigmented, which may make it appear that recently rooed animals are covered with the coarse hairs of the previous year's fleece. Rooing, therefore, does not perform the dual function of harvesting and separating fibres by their quality. It simply removes wool that has already become naturally detached from the animal, regardless of fibre quality. Rooed wool, in itself, could not have contributed to the extreme concentration of fine wool Ryder found in some yarns of Bronze Age date.

The Evidence for Wool Processing

The second assumption Ryder subscribes to in his model is that historically, wool was spun directly from the staple [Ryder 1964: 558; 1969: 500]. There are two significant problems with this idea. The first is that it fails to acknowledge the most fundamental trait of primitive fleeces: that they are highly variable in wool quality, both throughout the fleece and within each staple. These qualities were known to have particular designations [Hansen 1947: 15-16] and were used for different purposes. In Shetland fleeces the finest wool is found in a narrow band at the top of the throat and was rooed first and kept separate for spinning extremely fine lace yarn. Coarser parts of the fleece were used to make the woven backing and long pile threads of heavy rugs. Wool for both these extremes in fabric quality could, and did, come from the same fleece.

It is, therefore, impossible to define a primitive fleece as a single type or to assume characteristics of individual yarns reflect the quality of an entire primitive fleece. To illustrate this point further using Ryder's fleece definitions, the author spun yarns from fine wool found at the throat and coarse wool from the britch of a single Shetland fleece. The histograms of the fibre distributions show how two yarns from the same fleece can reflect very different wool qualities, and indeed, have two different classifications according to Ryder's model (Fig. 3).

The second problem with the notion that wool was spun directly from the staple is that it wholly disregards the evidence for wool processing prior to spinning. Evidence for woolcomb use [Hoffmann 1964: 284-288; Guðjónsson 1979; Christiansen, forthcoming] refutes this notion outright, since they were the main tool used in the preparation of wool. In addition, there is linguistic evidence to indicate that other methods which did not require tools, such as teasing and separating staples by hand, were known and practised [Hansen 1947: 16].

Woolcombs were an extremely handy tool. When applied to primitive wool they performed several important functions: not only did they make fibres parallel, but they also helped to divide the staples by wool quality. The more extreme the fibre qualities within the staple were, the more distinct this separation could be. As one comb passed through the staples, the shorter fine fibres stayed nearer the tines of the static comb, while the coarse long fibres were passed to the comb in motion. Once the combs had been exchanged several times and the wool thoroughly combed, the process of drawing pulled the long coarse fibres first, leaving the shorter, fine wool on the tines. In this way, large numbers of primitive wool staples could be separated into their mainly two distinct fibre qualities and worked separately.

Measuring Wool Processing

Clearly, there are problems when applying Ryder's model to all periods throughout Europe, particularly where primitive wool was known to exist or where there is evidence of wool processing. This does not mean, however, that we should disregard Ryder's contribution to wool studies altogether. Yarns are indeed characteristic of fleece quality in some way, but I would argue that they most often reflect *selected* wool. In other words, fibre composition in yarns is more likely a measure of wool processing than overall fleece morphology.

One body of evidence where this may be illustrated is textiles from Norse settlements in the North Atlantic region. Yarns from textiles excavated from the Gården Under Sandet (GUS) site in West Greenland have been analysed according to Ryder's methodology [Walton Rogers 1998]. In the majority of cases, one system (Z-spun) contained significantly coarse fibres while the other system (S-spun) was made of a broader range of fine to coarse fibres. In these cases the mean diameter of the S-spun yarns was nearly half that of the Z-spun yarns. Walton Rogers noted that a similar pattern occurred with textiles from other Norse sites and questioned whether different sheep or processing methods were used to achieve this situation [1998: 66].

These findings are not surprising when one takes a close look at the natural composition of primitive wool available to the Norse and the way in which processing affected the staple. Typically staples were composed of short/fine and long/coarse fibres which often had a pigment distinction between the two types. When separated, staples such as these divided into two different fibre types, as well as colours (Fig.3). After being spun separately, these two parts of the staple made very different yarns and would resemble the quality of Z- and S-spun yarns that Walton Rogers found in the Greenland samples.

Conclusion

The evolutionary stance that Ryder's model takes is fundamentally based on the notion that some level of wool uniformity was needed for the creation of textiles, and this requirement inevitably led to fleece uniformity. Although wool uniformity tends to be a desired state for textile production, it can be achieved by a number of methods, only one of which is the process of gradual morphological change through breeding and culling strategies. In areas of extreme environmental limitations in Northern Europe this was not a viable option, since it would lead to the death of livestock. Instead, other ways of making primitive wool more uniform for spinning were devised. These mainly involved hand processing methods which became so highly developed in some areas that specialised tools such as woolcombs were created for this purpose.

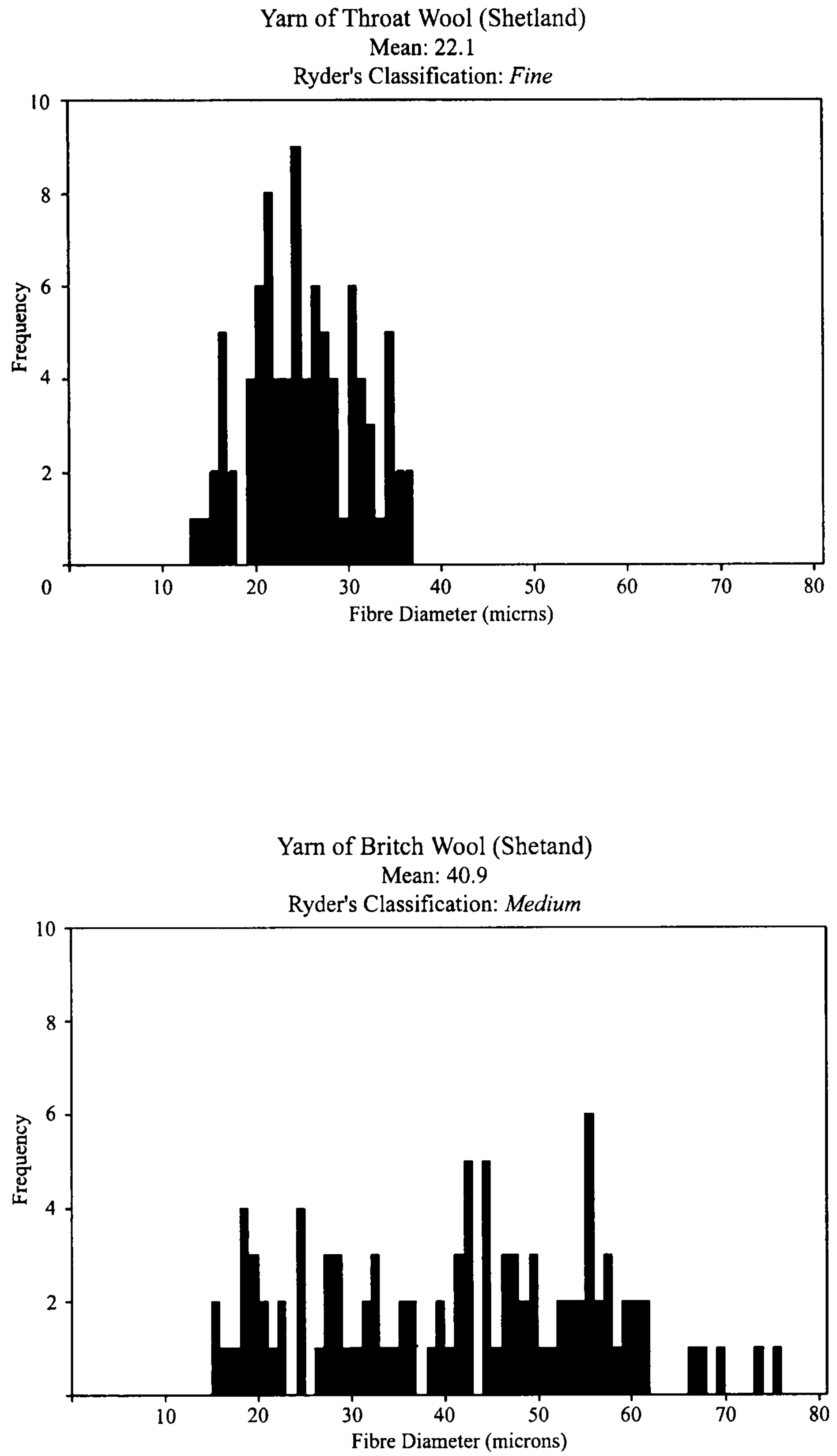

Fig. 3. Fibre diameter distributions and fleece classifications of yarns made from two different parts of a single Shetland fleece.

Table 1. Ryder's Definitions of Fleece Types [based on Ryder 1969, 1979, 2000].

Type	Mean	Distribution	Maximum Diameter
Fine	20 μ	symmetrical	35 μ
Fine/Generalised Medium	20 μ	skewed-to-fine	35 - 45 μ
Short Wool	25 μ	symmetrical	40 μ
Generalised Medium	25 μ	skewed-to-fine	55 μ
Medium	30 - 40 μ	symmetrical	60 μ
Hairy Medium	30 μ	skewed-to-fine	> 60 μ<100 μ
Hairy	30 - 40 μ	continuous	> 100 μ

Both plucking and processing dramatically altered the nature of the fleece, to the extent that it was completely deconstructed *to the level of the staple*, by the time spinning took place. Viewed against this evidence, it is difficult to see how ancient yarns could directly represent the composition of the primitive fleece they were made from.

Yet ancient yarns do reflect a particular quality that, in all probability, was a conscious attempt on the part of the spinner or weaver. Ryder's methodology may yet have an important contribution to make in understanding what early wool-workers were trying to achieve and the way primitive fleeces were processed and early yarns constructed. But rather than typify fleece quality, these ancient yarns appear to be revealing the way in which fleeces were manipulated and wool was worked prior to spinning.

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Carol Christiansen
Dept. of Textiles, UMIST
PO BOX 88, Sakville Street
M60 1QD Manchester
Great Britain