The Ties that Bind

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Fur-Fibre Cordage and Associated Material from Dorset Palaeo-Eskimo Sites in Eastern Canada

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The cordage from Avayalik Island is held at The Rooms, St John's, Newfoundland and Labrador. All other material described in this report is currently housed at the Canadian Museum of History (formerly the Canadian Museum of Civilization), Gatineau, Quebec, where a proportion of the holding is under the jurisdiction of the Government of Nunavut. We are grateful to the staff at both museums for facilitating our research.

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We are also grateful to all those photographers who have kindly given permission for the inclusion of their images, or who have placed their photographs in the public domain or made them available through a Creative Commons licence. Picture credits appear in brief in the captions and there is an extended version in the list of illustrations.

Front cover images
The landscape of southern Baffin Island, August 2004. Photo: Michael J Gradziel.
Arctic hare in Nunavut, c. 2010. Photo: Steve Sayles, CC BY-SA 2.0.
Two cords spun and plied from the fur of Arctic hare, excavated at Nanook. Photo: ASLab.

Introduction

A distinctive collection of fine cords has been recovered from Dorset Palaeo-Eskimo sites in the area of Baffin Island, between mainland Canada and Greenland. Over 160 separate examples have been recorded, each made to a standard thickness, from white animal fur. To the naked eye they resemble nothing so much as soft parcel string (Fig.1).

Fig.1. A bundle of cords from site KdDq-9, find 4799. Photo: ASLab. See also Figs.8-9.

The sites from which the cords have been recovered lie in the Canadian territory of Nunavut, Qikiqtaaluk Region, and in the province of Newfoundland and Labrador (Fig.2; Table 1). The greatest number comes from the southern end of Baffin Island and there is a sizeable group from the opposite side of the Hudson Strait, at Avayalik Island, while outliers have been found to the north at Nunguvik (northern Baffin Island), and to the south at Cape Ray (south-west Newfoundland). No cords have been recorded as yet on the Canadian mainland, but in the east, one, or possibly two, examples have appeared at Gården under Sandet (GUS, 'Farm beneath the Sand'), a Norse site in the western settlement in Greenland, where, uniquely, they have been worked into textiles (Østergård 1998, 62; Walton Rogers 1998, 68; Østergård 2004, 66, 71; Walton Rogers 2004, 82-3).

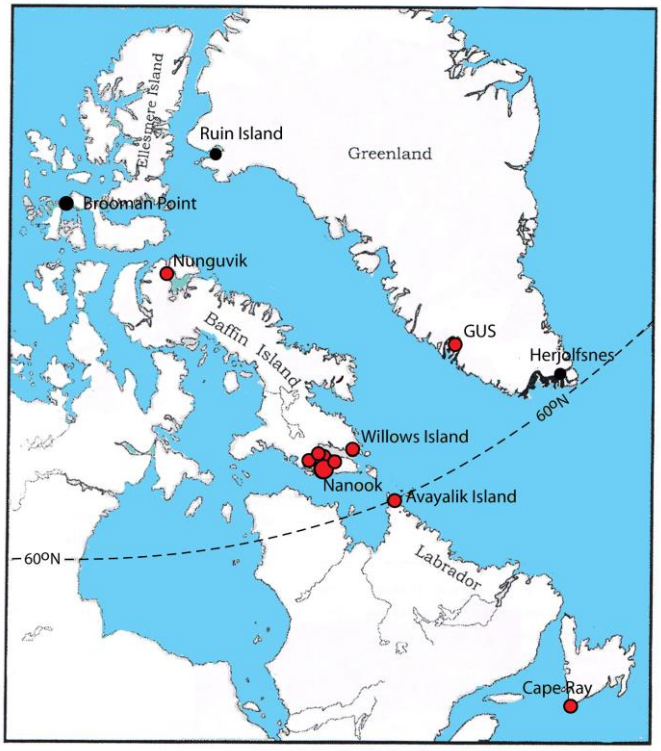

Fig.2. Sites which have yielded cordage (red) and other sites mentioned in the text (black). ASLab.

This report will summarise the results of the analysis of the cords by microscopy, carried out on behalf of the Helluland Project (Project Director, Patricia Sutherland). It will also incorporate observations made on related items from the same sites, which were examined for background evidence. These include fragments of animal pelts, skin clothing and loose fibres, along with cords and braids of non-fur materials. The full range of material, representing a total of 314 separate finds (Table 1), has been previously described in a series of unpublished interim reports from The

Anglo-Saxon Laboratory, dated between July 1999 and February 2017. The present publication now updates and supersedes these. It will consider only the method of analysis, technical results and comparative material. The context, dating and significance of the finds will be reported by Dr Sutherland in due course.

Table 1. Sites and specimens

Province/ territory	**Region**	**Site name**	**Site code**	**Cords & braids**	**Pelts & raw fibre**	**Other**	**Total number specimens**
Nunavut	Baffin Island	Tanfield	KdDq-7-1	4	1		5
		Tanfield	KdDq-7-3	4	1	4 skin garment fragments	9
		Kimmirut (Lake Harbour)	KdDq-7-4	9		1 organic complex	10
		Nanook	KdDq-9	128	131	1 skin threaded with sinew	260
		Tanfield	KdDq-9-3	2			2
		Willows Island	KeDe-14	1	1		2
		Nunguvik	PgHb-1	4	2		6
	Bathurst Island	Brooman Point	QiLd-1			1 sinew cord & 1 braid	2
Newfound-land and Labrador	Labrador	Avayalik Island	---	17			17
	Newfoundland	Cape Ray	CdBt-1	1			1
TOTALS				170	136	8	314

Analytical procedures

Recording the structure

The structure of each cord was documented with a reflected-light binocular microscope at x10 magnification, using a flexible light source. The thickness of the cords was measured with

Vernier-scale calipers and the angle of twist of the ply recorded by aligning the cord with the 90-degree line on a protractor and reading off the degree by which the slant of the twist diverged from that line. The ends of the cord were then teased out and a sample of fibres removed, either with surgical scissors, or with tweezers if it was thought that a scissor cut might affect the appearance of the cord. The cord was then examined for any extraneous fibres adhering to the surface and these were sampled and recorded separately.

The specimens of unprocessed fibre were examined with the same microscope and the length and shape of individual staples were recorded. (Within this text the term 'staple', borrowed from wool studies, has been used for tufts which represent the full length of the animal's coat.) The presence or absence of intact fibre roots and tips was then recorded and also the presence or absence of decayed skin, which at x10 magnification was visible as black specks at the proximal end of the fibre. Fibre samples were then removed with tweezers for microscopy at higher magnifications.

Microscopy techniques

All fibre samples were first examined at The Anglo-Saxon Laboratory (ASLab) using the following procedure. Each sample of fibres was mounted in water on a glass microscope slide, covered with a 0.15 mm glass cover-slip, as a whole-mount preparation (longitudinal view). The prepared samples were examined with an optical microscope fitted with a mechanical stage, which allowed controlled viewing of fibres with incident light at x40 to x160 and transmitted light at x40 to x640 magnification. Diameters of fibres were recorded at x400 with a pre-calibrated eyepiece graticule, which could be rotated so that the scale lay across the fibre.

Select samples were prepared as casts of the external surface, by pressing the fibre into a soft transparent medium, such as a layer of polyvinyl acetate on a microscope slide. Further samples were prepared as cross-sections by embedding the fibres in a transparent nitrocellulose lacquer and slicing thin sections with a hand-held razor-blade. Casts and cross-sections were viewed with the same transmitted-light microscope.

Selected fibres were then examined with a second transmitted-light microscope fitted with a rotating stage and polarising facility, and viewed at magnifications of x40 to x400. The polarising light microscope was particularly useful for recognising plant debris associated with the fur fibres and the occasional intrusive synthetic fibre (Textile Institute 1975, 132-3, 136-41).

This method of analysis allowed the samples to be grouped by type and a preliminary assessment of the likely species was made at this stage, by reference to fibre atlases (Wildman 1954; Appleyard 1978) and modern specimens in the collection at ASLab. Representative samples of

each group were then sent to Philip Greaves at Microtex, who specialises in the identification of animal coat fibres. Over the timespan of the project, Dr Greaves has analysed approximately 80 fibre samples. He uses similar forms of transmitted-light microscopy to those at ASLab, although in his laboratory separate mounts are made in liquid paraffin (Refractive Index 1.48), in addition to those made in water. The following text represents a synthesis of our analyses.

Identifying animal coat fibres

The source species for animal coat fibres is conventionally identified by microscopy from the following diagnostic features (Wildman 1954; Appleyard 1978; Textile Institute 1975, 5-12, 51-68; Deedrick & Koch 2004; Carrlee & Horelick 2011).

Range of fibre diameters and whether the diameter changes along the fibre length;
Cuticular scale pattern and its variation along the fibre length (Fig.3);
Cross-sectional shape of fibres of different thickness (Fig.4);
Presence/absence, type and frequency of medullae (central channels) (Fig.5);
Presence/absence, type, density and frequency of pigmentation granules (Fig.6).

Where whole staples have been preserved, the length and shape of the staple can also help with the identification.

Scanning electron microscopy (SEM) has gained ground over the years as a method of fibre identification (Ryder & Gabra-Sanders 1985; Meeks & Cartwright 2005; Rast-Eicher 2016). This is an excellent technique for producing images of the cuticular scale pattern and it can also be used to record the cross-sectional shape. (For this reason, SEM is a particularly important tool for the identification of mineralised fibres, where light cannot penetrate the fibre.) Because SEM produces only surface images, however, it cannot reveal internal features such as medullae and pigmentation without special preparation techniques.

The virtue of transmitted-light microscopy is that, in non-mineralised fibres, it allows the rapid recording of all features simultaneously. Its disadvantage is that the observation of the different features requires frequent adjustment of the focus, which means that only a video could faithfully record what the analyst is seeing. For difficult specimens, a combination of techniques would be ideal, but where animal furs with unusual medullae or distinctive pigmentation patterns are concerned, transmitted-light microscopy remains the main diagnostic tool (Carrlee & Horelick 2011).

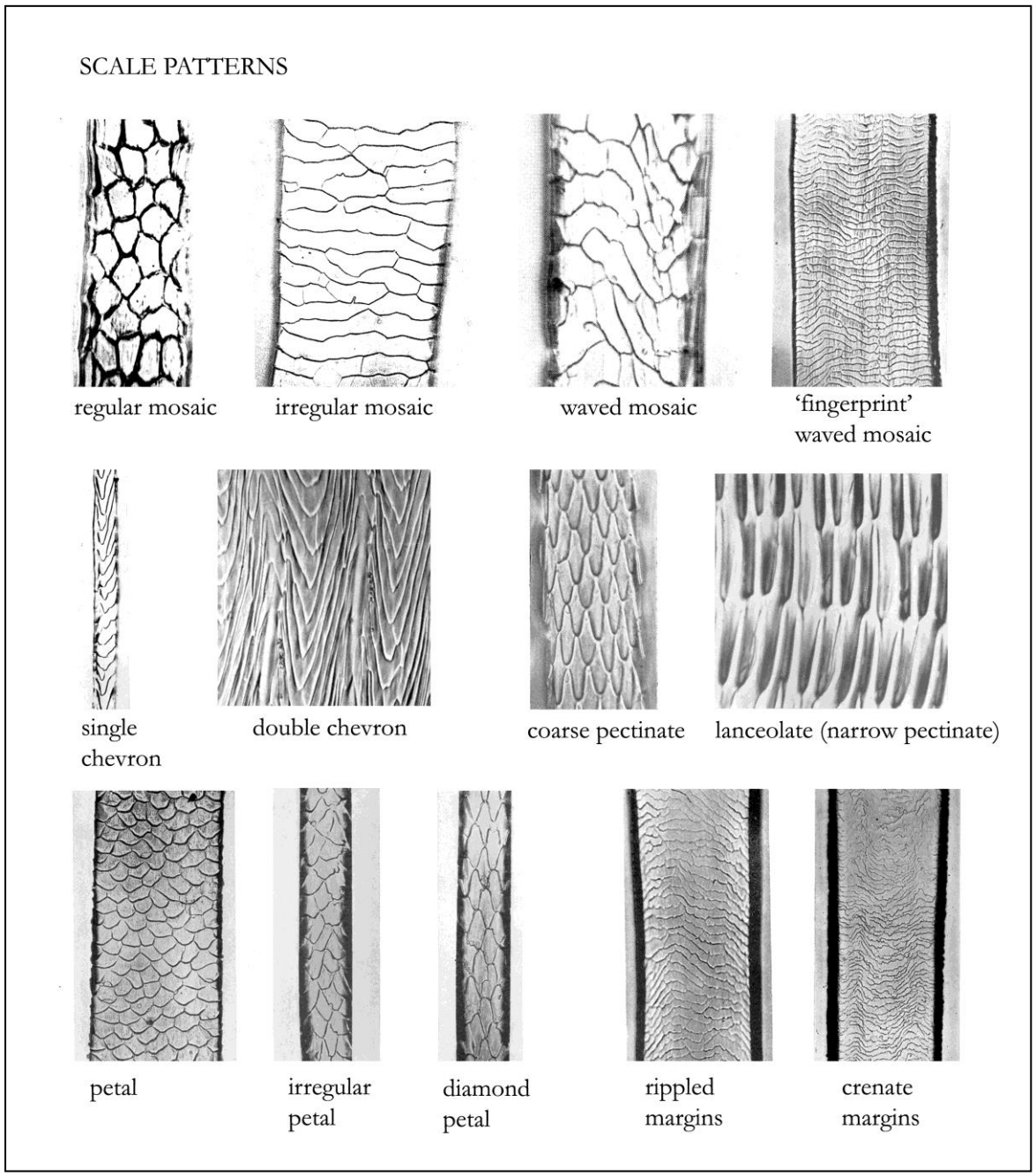

Fig.3. Scale patterns in the cuticle mentioned in the text. Adapted from Appleyard 1978.

When it comes to the publication of scale patterns, the complex images obtained from transmitted-light microscopes cannot match the clarity of the SEM image and the present report will therefore concentrate on written descriptions, supplemented by photomicrographs of the two main fibre types present in the collection.

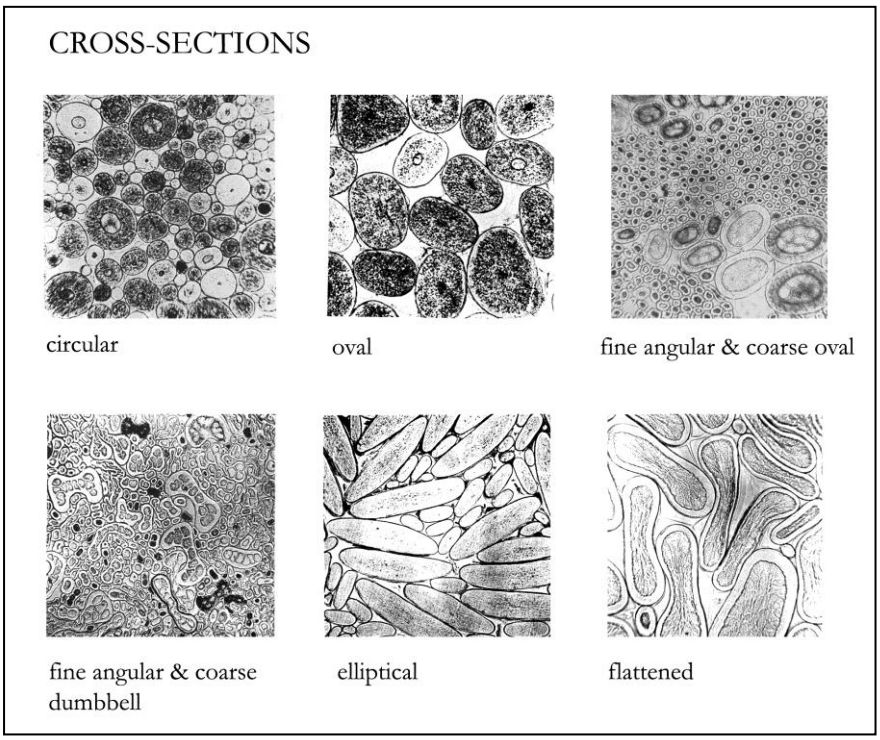

Fig.4. Fibre cross-sections mentioned in the text. Adapted from Appleyard 1978

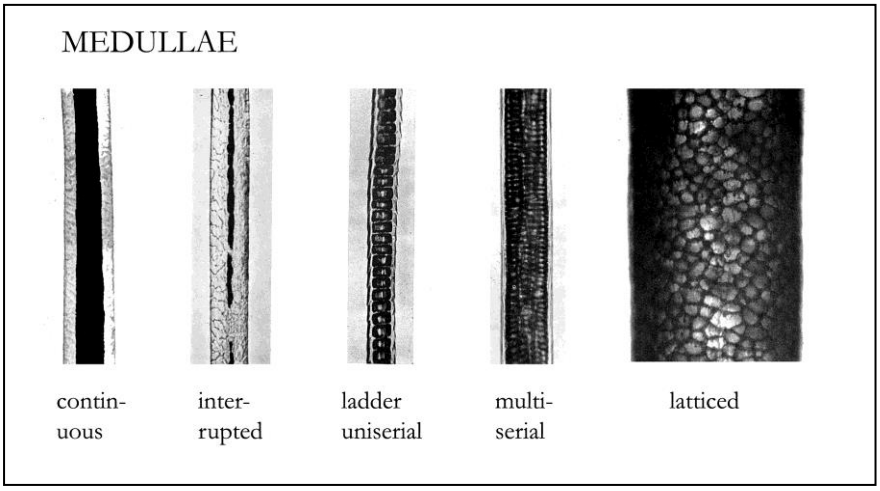

Fig.5. Medulla types mentioned in the text. Adapted from Appleyard 1978.

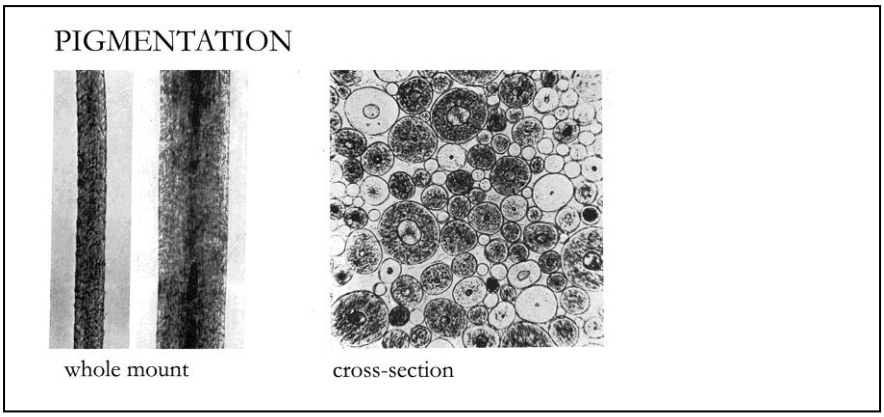

Fig.6. Pigmentation (inherent colour) appears as granules in the fibre, which can be seen in whole mount and cross-section. Adapted from Appleyard 1978.

The coats of animals of related species can often have similar characteristics. There can, for example, be difficulties in distinguishing hare from rabbit; dog from wolf and fox; deer from caribou; and goat from sheep. When a full range of diagnostic fibre types is present, in good condition, the individual species can be differentiated, but archaeology does not always provide samples of this quality. In addition, certain unrelated species share some fibre types. It can be surprisingly difficult to distinguish cattle from bear, for example, if the main diagnostic types do not happen to be present in the sample. Despite these difficulties, some of the identifications obtained by microscopy are beginning to be confirmed by new biomolecular analyses.

In our experience of commissioning biomolecular analyses from external laboratories, the physical condition of the fibre is not a guide to the likely success of the analysis: well-preserved fibres can yield negative results while poorly preserved or part-mineralised ones can sometimes perform rather better. So far, protein analysis has produced the best outcome. Our identification by microscopy of sealskin and sheepskin in mineral-preserved samples from a Viking-Age burial at Cumwhitton, Cumbria, England, has been confirmed by Peptide Mass Fingerprinting (PMF, a form of protein fingerprinting) (Solazzo *et al* 2014). This procedure, first developed by Klaus Hollemeyer (Hollemeyer *et al* 2002), confirmed the presence of sheep's wool and cattle hair in well preserved material from a single context at Reykholt, Iceland (Solazzo unpublished results on behalf of Isabella von Holstein; Walton Rogers 2012a, 217, find no. 2001-26-076), and was able to confirm sheep's wool in one sample and exclude cattle and muskox in a second, in caulking materials from the Sørenga boats from Oslo harbour (Solazzo unpublished reports on behalf of The Anglo-Saxon Laboratory, 2011-12; Walton Rogers 2016).

Tests on samples sent to ancient DNA (aDNA) laboratories in North America and the United Kingdom have proved to be less successful, although specimens from the Avayalik cords, recognised by microscopy as fox and dog (see below), were identified as from the family Canidae by Hendrik Poinar at McMaster Ancient DNA Center, Hamilton, Ontario (unpublished results on behalf of the Helluland Project, 2006). More recently, the identification of Arctic hare fur by microscopy (Walton Rogers 1998, 68; 2004, 82-3) has been confirmed by aDNA analysis in one of the Greenland textiles mentioned above (KNK 1950x776), although the ground weave, identified by microscopy as goat-hair, was re-classified by aDNA as sheep's wool (Sinding *et al* 2017, 606-8). Regrettable attempts to discredit the results of microscopy performed by H M Appleyard (Appleyard in Walton Rogers 1998, 71-2) by the same aDNA laboratory (Sinding *et al* 2015; repeated in Sinding *et al* 2017) have proved to be based on a confusion over samples, combined with a misreading, or misrepresentation, of the original report (Walton Rogers 2014; see Appendix 1 below).

While biomolecular analyses have great potential for the advancement of archaeological science, the best outcome must surely be achieved if analysts adopt a more cautious and co-operative approach.

A note on terminology

The method for indicating the direction of spin and ply is the standard one used in British archaeology. As illustrated in Figure 7, the yarn is held vertically and the direction of twist identified as Z (where the fibres lie north-east to south-west) or S (north-west to south-east). Continuous filaments such as sinew, which have not been twisted, are indicated by I. For a two-ply cord, the spin direction of the base yarn is conventionally given first, followed by the ply, Z2S, S2Z, I2Z, etc. If multiple cords are re-plied together, the third stage is added on the end as Z2S3Z, Z2S4Z, Z2S6Z, etc.

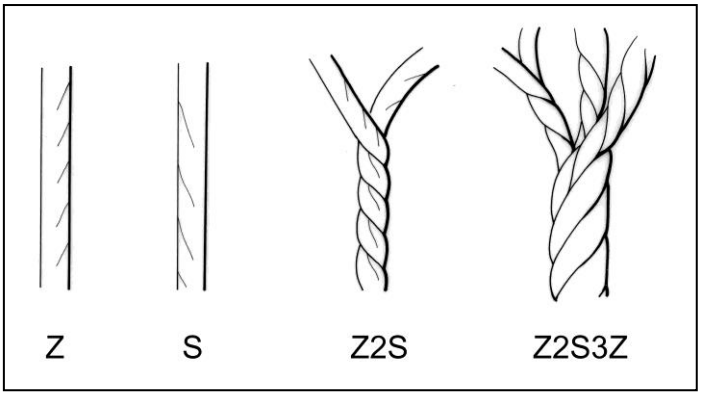

Fig.7. The spin direction of single yarns and the ply of cords. ASLab.

A 'union' is a textile in which yarns of different fibres have been combined, usually warp of one fibre and weft of another. A 'blend' indicates that two or more different fibres have been mixed together before spinning.

The Oxford English Dictionary defines fur (singular) as 'The short, fine, soft hair of certain animals, as the sable, ermine, beaver, otter, bear, etc' and furs (plural) as 'skins of such animals with the fur on them'. Within the present text, it has been applied to the coats of those non-domesticated mammals that are sought after by trappers, traders and furriers (Veale 1966; Rast-Eicher 2016, 127-8). 'Pelt' has been used for any undressed animal skin with fur still intact; and 'hide' for the skins of larger mammals. A 'double-coated' pelt is one with a clear distinction between fine and coarse fibres.

The microscopy of animal coat fibres has its own vocabulary, best explained through illustrations. Figures 3-6 show representative examples of the main terms used in the text.

Site codes and find numbers

Within this report, objects have been mostly referred to by the site code (KdDq-9, PgHb-1, QiLd-1, etc), followed by the find number. The finds had been given 3- or 4-digit numbers on excavation, but since these frequently had to be subdivided into different items, a new series of numbers was introduced partway through the project, H-00 for sub-samples of raw fibre, T-00

for cordage and S-00 for skins. The Avayalik Island material had no site code and the finds have been referred to by the site name and the museum catalogue number.

Results: fibre identification

The results have been listed in Appendix 2 and will be summarised here by raw material. All notes concerning the natural habitat and range of the animals mentioned in the text come from on-line resources, such as Simon Fraser University's *Wildlife of the Canadian Arctic,* www.sfu.ca/geog351fall02/gp2/WEBSITE/2_content_w.html and the International Union for Conservation of Nature's *Red List of Threatened Species*, www.iucnredlist.org.

Contaminants

All open-air archaeological excavations, no matter how carefully controlled, are subject to contamination from extraneous material blown on to the site or brought in on the excavators' clothing, shoes, head-hair and equipment. The first task of any organics analyst is to locate and identify the modern contaminants.

Two specimens from Nunguvik, PgHb-1 finds 18025 and 18027, were white multi-ply yarns (structurally Z6S3Z). At x400 magnification the fibres proved to be consistently very fine, around 11 microns diameter, with an irregular cross-section, and they showed the speckled appearance of titanium dioxide particles that is typical of man-made fibres. Dr Greaves identified the fibres as polyester and described them as 'of fine denier, delustered and of low orientation, suggesting that they may have come from a textured apparel garment, perhaps of lower quality' (Microtex report 1943, 2 November 2001).

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A single long fibre from Nanook KdDq-9, H-114, proved to be human hair (for species identification, see below, 'Human head hair'), which was unusually clean and undamaged for an archaeological specimen. This was also interpreted as modern. All other specimens were stained and showed the varying degrees of deterioration to be expected of organic material buried for several centuries.

Associated plant material

Unprocessed plant material was often present. In the case of Nanook KdDq-9: H-153 it appeared to include seed husks, but most other samples resembled moss, with branching stems and short, close leaves.

Feathers

Some short twists of fibre from Nanook, KdDq-9: H105, H108, H-113 H-150, H-152, H-155, 7047b, 7102, 7117 and 9041, looked to the naked eye as if they might be fragments of yarn, but

in fact proved to be individual feathers. When teased out at x40 magnification they revealed fine transparent arching filaments, which branched in a fan-like manner; and at x400-x640 magnification, each filament displayed a smooth profile interrupted by small lateral barbs. Feathers can be classified and sometimes even identified to species by microscopy (Dove & Koch 2011), but this was not deemed relevant to the study of the cordage. The Nanook specimens have been interpreted as wet feathers that have become fortuitously twisted.

Baleen

A sample from Nanook, KdDq-9: H-97, included fibres which were dark brown, stiff and approximately 100 mm long. They were in the region of 150 microns wide and each had a smooth profile and a tapering tip. When viewed at x100 to x400 magnification, the dark fibres proved to have a pale, almost transparent, material adhering to the surface of the fibre. There was also a central channel in each fibre and in cross-section this proved to be hollow and centrally placed. Most cross-sections were circular, although in some cases they appeared to have been compressed into more angular shapes. The cross-section of the tip revealed only the thick dark ring of the fibre and the central channel, but lower down the shank all sections showed very clear concentric rings.

This material has been identified as baleen, or 'whalebone'. Baleen derives from the horny (i.e. keratinous) plates which grow from the roof of the mouth of Baleen Whales (Mystococeti) – a group which includes Right Whales, Pacific Grey Whales and Rorquals. A sample of whole baleen plate in the author's collection (supplied by Sonia O'Connor) had all the features described above and the pale material on the surface of the H-97 fibres proved to be the remains of the matrix which once held the fibres together in a flat plate.

A further piece of the same material had already been identified as baleen at another laboratory (KdDq-9: H-93, which was wrapped with fur cordage, see below, 'Uses of cordage'). A single fibre in association with a fragment of bear pelt from Nanook KdDq-9: H-82, had similar, but poorly preserved, features and has been tentatively interpreted as a decayed length of baleen.

Animal sinew

Animal sinew presents to the naked eye as thin flat strips of dark brown material (ASLab reference collection). When viewed at x400 magnification, the strips prove to contain fine parallel filaments which often have a regular wavy-line structure and the edges of the fibres sometimes have small pointed indentations along the edge.

Sinew was identified in ten cords and braids from Brooman Point and Nanook, and, more tentatively, in the stitching of a fragment of skin clothing from Nanook (see below, 'Skin garments'). Long strands of sinew were also recovered from a fat ball at Brooman Point.

Arctic hare

Rabbit or hare fur was identified from the following features (Fig.8-9). The fine fibres, 12-15 microns wide, had a chevron scale-pattern, uniserial ladder medulla and cross-sections which were angular tending towards circular. The chevrons of the scale pattern were steep-sided and single or double, shading to a waved mosaic pattern with near margins towards the base of the fibre. The coarse fibres ('guard hairs') had a narrow stalk with a uniserial medulla, which flared to a wide flat blade or 'shield'. The shield area had a multi-serial medulla, waved mosaic and chevron scale-pattern, and an irregular, dumbbell-shaped, cross-section. It is difficult to distinguish the coats of rabbit from hare by microscopy, but Dr Greaves thought that the specimens he examined were most like hare. The absence of pigmentation in all samples therefore suggests the Arctic hare, *Lepus arcticus* (Fig.10).

In the remains of pelts, the staple lengths were often 40-55 mm long, though some were shorter. This compares with our modern specimen of *Lepus arcticus* pelt obtained by Dr Sutherland from the Hunters and Trappers Organisation in Kimmirut, which proved to be 40 mm long, with guard hairs protruding to a length of 50 mm.

Arctic hare was the most common fibre to be identified in the cordage, representing 58% of the whole collection and 67% of the Baffin Island group, although it was absent from the samples taken from the only site in Labrador, Avayalik Island. It was identified less frequently in animal pelts and other raw fibre samples, but at 16% it was still the most common fibre in that group.

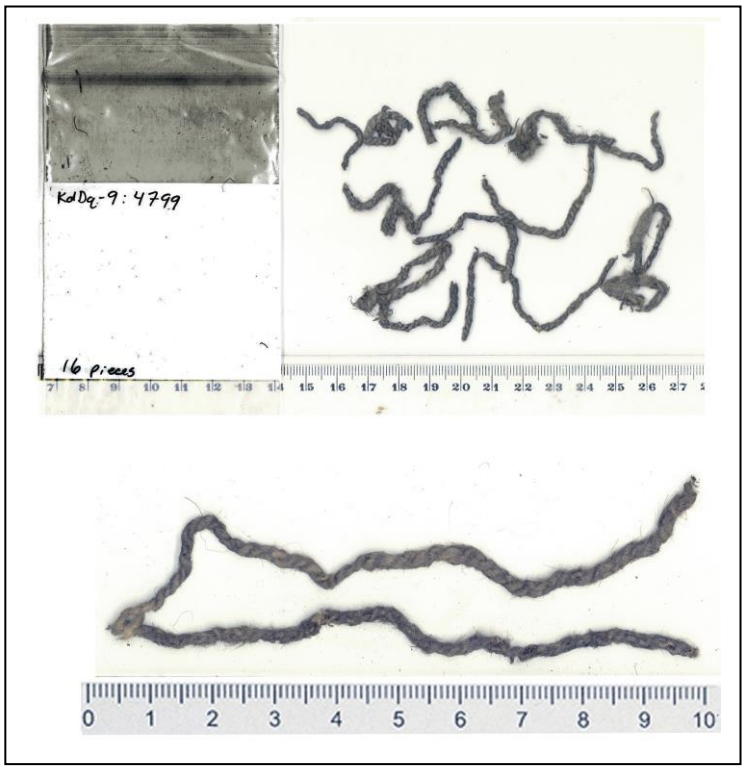

Fig.8. Cords KdDq-9: 4799 as received (above); and a close-up of the two cords from which the fibre samples in Fig.9 were extracted (below). Scales in mm/cm. Photo: ASLab.

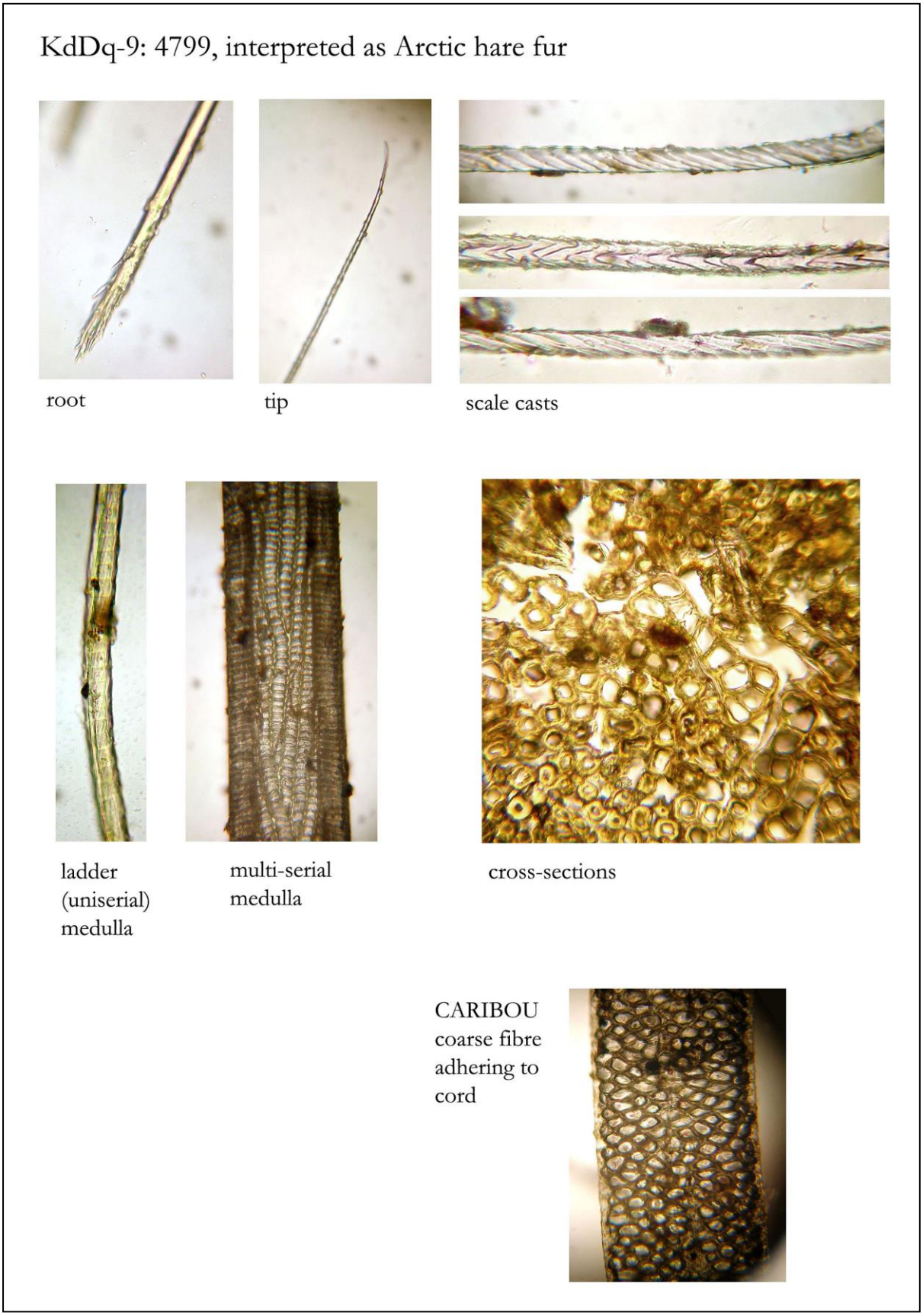

Fig.9. Fibres extracted from cords of KdDq-9: 4799. Note especially the chevron scale pattern on fine fibres, the multi-serial medulla and the dumbbell shaped cross-section of coarse fibres. Images captured at x200 with camera zoom. Photos: ASLab.

The Arctic hare inhabits the tundra regions of northern Canada, the Canadian Arctic islands and Greenland

Fig.10. Arctic hare, Nunavut c.2010. Photo: Steve Sayles, CC BY-SA 2.0.

Yarns made of Arctic hare fur have also appeared in two textiles from the Norse farmstead at Gården under Sandet, in the Western Settlement, Greenland. One fragment was a tabby-weave textile woven entirely from fur, which was plied Z2S in one system and S2Z in the other (KNK 1950 x3058: Walton Rogers 1998, 67-8; Østergård 2004, 66, 243). The other was a dark brown twill (wool/goat) with two stripes of white S-spun fur (KNK 1950x776: Østergård 1998, 62; Walton Rogers 1998, 67; Østergård 2004, 71; Walton Rogers 2004, 82-3). Rabbit/hare fur has on rare occasions appeared in European textiles (Rast-Eicher 2016, 150-2), but the plied yarns of the tabby-weave textile from Greenland more closely resemble the fine cordage from Baffin Island and the S-spun yarns in the twill could have been unravelled from an S2Z cord.

Arctic fox

Fox fibres were identified from the following features (Fig.11). They included numerous fine fibres, 6-20 microns diameter, with very prominent scale margins. Medullae could be ladder-like or they could be less well defined, with uneven medulla walls. The scale pattern was diamond-petal on some and mosaic with smooth distant margins on others. The coarser fibres were 30-65 microns diameter, their medullae were continuous, and the scale pattern was diamond-petal at the base, changing to irregular mosaic with smooth near margins. Cross-sections were often angular in the fine fibres and round and oval in the coarse ones. These features identify the source as fox. Pigmentation was mostly absent, although some coarse fibres had a slightly tawny cast and showed sparse pigmentation close to the medulla. On this basis, they have been interpreted as Arctic fox, also known as the polar fox, *Alopex lagopus* .

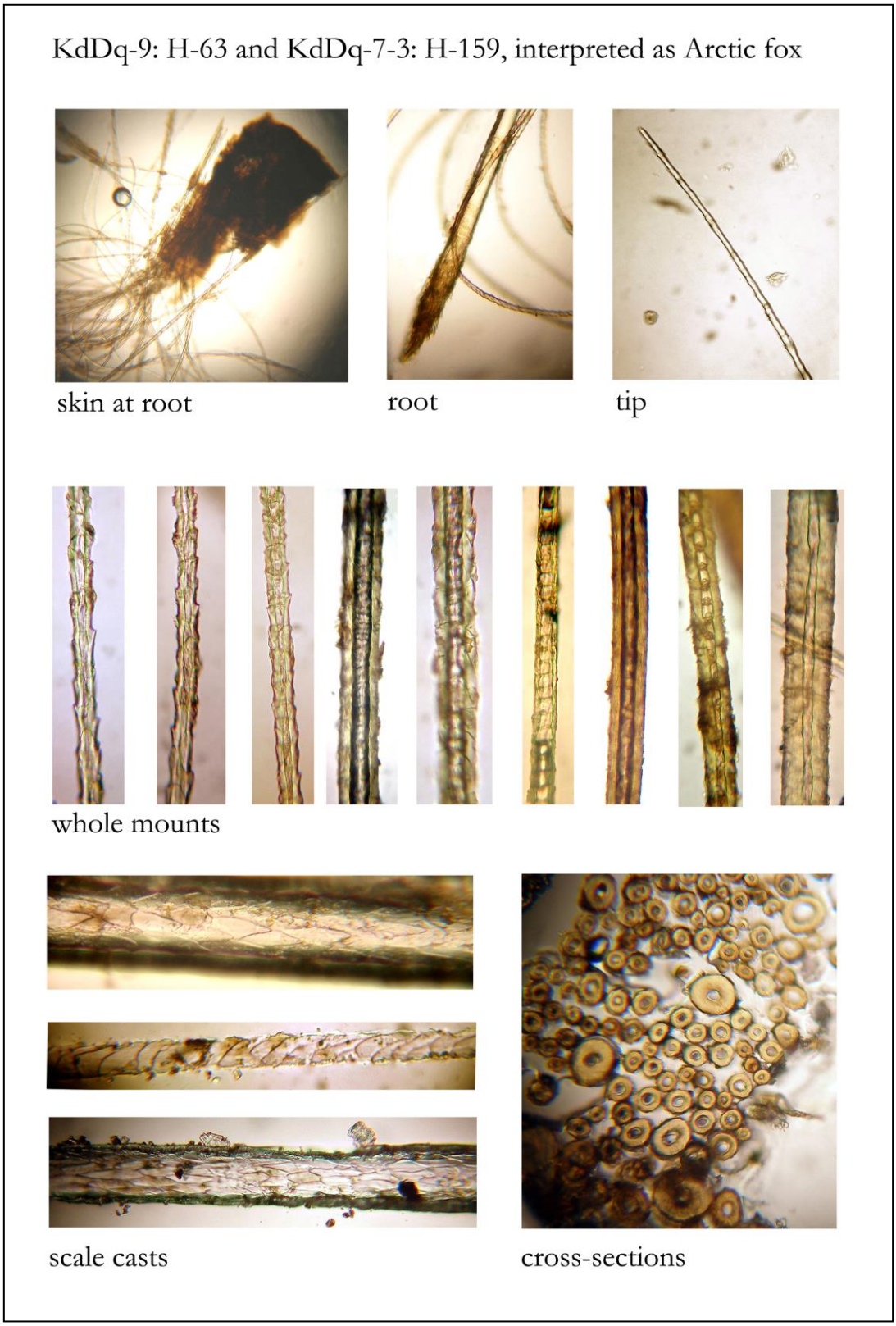

Fig.11. Fibres extracted from skin garment KdDq-7-3: H-159, with scale casts from pelt fragment KdDq-9: H-63. Note the prominent scale margins, variety of medulla types and diamond-petal scale pattern. Images captured at x200 with camera zoom. ASLab.

Fig.12. Fragments of skin garment KdDq-7-3: H-159 (left) and pelt KdDq-9: H-63 (right). Scale in mm. ASLab.

The surviving remains of animal pelts had staple lengths mostly around 25-40 mm, with some shorter examples, only 12-25 mm long (Fig.12). This was substantially shorter than the 60-80 mm length of our modern specimen, derived from the Hunters and Trappers Organisation. The short staple length may indicate a young animal, or that the fibres have come from some part of the animal's body which has shorter fur.

Fox fibres were present in 11%-12% of both the cordage and the animal pelts, though on Avayalik Island they represented at least 13 out of the 17 examples of cordage. They were also identified in a skin garment and a matted layer of fibre, possibly an insulation layer from clothing (see below, 'Remains of garments'). This last had a grey-blue cast, but tests for dye using solvent extraction followed by absorption spectrophotometry (Taylor 1983; Walton 1988) gave no indication of an applied colorant. Vivianite has been suggested as the source, but the vivianite identified on objects from organic-rich urban excavations in Britain is a much more vivid shade of blue. The white fur of the Arctic fox in winter usually turns grey or brown in the summer, when it no longer needs to be camouflaged against the snow, but there is also a variant known as the 'blue fox' which retains its colour all year round. The blue variant may be the one recorded by the 6th-century author Jordanes as 'sapphire-like' in his description of northern furs brought to Rome (Jordanes *Getica* Chapter III, para 21, Mierow (trans) 1915; Rast-Eicher 2016, 159). It is possible, therefore, that this particular fur was naturally a bluish shade of grey rather than white.

Fig.13. Arctic fox, left in winter coat with some tawny fibres; right with darker hairs. Photos: left, Algkalv, CC BY 3.0; right, Rama, CC BY-SA 2.0-fr.

The Arctic fox (Fig.13) has a circumpolar distribution in the tundra regions of North America, Europe and Asia and, according to one of the Icelandic sagas, the fox was already abundant in Helluland when the Norse reached it ('Fjölði var þar melrakka', *Eiríks saga rauða*, Chapter 8, Sephton 1880).

Wolf

A well preserved sample from Nanook, KdDq-9: H-137, consisted of two tufts 35 mm long. They came from a double-coated animal with a fine undercoat, 12-30 microns diameter, and longer coarser fibres, 55-75 microns diameter, protruding through the undercoat. The fine and some of the medium-coarse fibres had ladder medullae, but most of the coarse fibres had wide continuous medullae. The scale pattern was predominantly diamond and diamond-petal, changing to coarse pectinate towards the base. The tips of all fibres had an irregular waved mosaic scale pattern with smooth near margins. Cross-sections were circular to oval, but irregularly shaped where the medulla was wide and the fibre wall thin. There was some pigmentation in the coarser fibres, but it was mostly sparse or absent. Except for the sparse pigmentation, this is typical of the wolf, *Canis lupus*. Only one other sample, KdDq-9: H-53, has been identified as wolf and that only tentatively. This had slightly longer staples, 40-50 mm long, with similar features to those seen in H-137, but was less well preserved.

The grey wolf is found in most of Canada and Greenland, but there is a subspecies, the Baffin Island tundra wolf, *Canis lupus manningi*, which is native to Baffin Island and unusually small, with pale fur (Fig.14).

Fig.14. The Baffin Island tundra wolf.

Dog

Amongst the fox-fur cordage from Avayalik Island was a single example that was different from the others, #7 (find 3614). The fibres were long, 50-60 mm (at least), wavy and relatively coarse, 20-80 microns diameter. Ladder medullae were present on the finer fibres and continuous ones on the coarser ones. Pigmentation was light and to the naked eye the fibres were a pale golden fawn. The scale pattern on the fine fibres was diamond petal alternating with waved rippled; on some coarse fibres there was a clear change from regular mosaic with smooth margins, through diamond petal, to irregular waved with rippled-crenate margins. Cross-sections were round-to-oval in both fine and coarse, with narrow circular medullae. This was identified as hair from the domestic dog, *Canis lupus familiaris* (Fig.15), from its diameter range, ratio of medulla to cortex and scale pattern.

A sample of raw fibre from Nunguvik, PgHb-1: 11465-B, was also given a preliminary identification as dog at an early stage in our study, before our full analytical procedure had been established. A third sample of animal pelt from Nanook, KdDq-9: H-144 (find 9933), showed fibre types found in both wolf and dog, but the absence of a pectinate scale pattern made dog a little more likely. This, too, had light pigmentation.

Fig.15. Dogs near Kimmirut, Baffin Island. Photo: M Hopson, The Chinook Project, www.chinookproject.ca.

Another example of fibre from a canid species (dog, wolf, etc) had already been recorded in a later Thule Inuit site (Walton Rogers 2004, 83). This was a pale fawn fibre blended with white sheep's wool in a textile woven in 2/1 twill. The site was on Ruin Island, Inglefield Land, in the Thule district of northern Greenland, and the textile was radiocarbon dated to around AD 1260. The rarity of this finding was noted at the time and it was concluded that it was 'one of those oddities that occur at the boundaries between cultures' (Walton Rogers 2004, 83).

Mink

One cord from Nanook KdDq-9: 747ii and possibly two of the cords from Tanfield, KdDq-7-1: 2814, were identified as made from the fur of mink. This was interpreted from the site location as the American mink, *Neovison vison* (Fig.16), which has its natural habitat in sub-Arctic Canada and the USA, rather than the European mink *Mustela lutreola.* The diagnostic features were fine fibres, 10-15 microns diameter, with occasional coarser ones around 100 microns; ladder-like medullae and latticed medullae in coarsest fibres; chevron or mosaic scale patterns with smooth margins which were closer towards the fibre tips; and areas where waved mosaic changed to lanceolate. The scale pattern in the Tanfield material was less well preserved than in the Nanook cord, which meant that the results were less certain. No examples of mink were recorded among the fragments of animal pelt.

Fig.16. American mink, Maine. Photo: Needsmoreritalin (Chuck Homler). CC BY-SA 3.0.

Otter

Otter fur was identified from the following characteristics. The staple length was 10-25 mm long. The coat was made up of fine, 7-20 microns diameter, medium, around 40 microns diameter, and coarse fibres, over 75 microns diameter. The fine fibres had ladder medullae and a steep lanceolate scale pattern with relatively prominent and distant margins. The coarser fibres had a distinctive coarse pectinate scale pattern with prominent margins, and could be found with or without medullae. Pigmentation was diffuse. This is based on comparison with our sample of the Eurasian otter, *Lutra lutra*, although one of the American species, such as *Lontra canadensis* (the North American river otter)(Fig.17) is more likely in the region of Baffin Island.

Three animal pelts were identified as otter fur, KdDq-9: H64, H-69 and H-70, and two more were probably so, KdDq-9: H-75 and H-112. More tentatively, otter fur was identified in three examples of cordage, KdDq-9: 2002-T-16, 5927a and 9216ai.

Fig.17. Otter, Lontra canadensis *travelling by ice. Photo: Rocky Mountain National Park, public domain.*

Muskrat

Fig.18. Muskrat. Photo: Sergey Uryadnikov, courtesy of Shutterstock

The fur of muskrat, *Ondatra zibathicus*, was identified from fine fibres, 10-15 microns and coarser ones around 50 microns diameter, from the presence of ladder medullae with elongated cells and from chevron or mosaic scale patterns with prominent margins. Pigmentation was mostly even and streaky. Muskrat was identified in cords from Nanook KdDq-9: 7048i and 7061, and more tentatively in a felted pad of fur from Nanook KdDq-9: 7090i. It may also have been present in cords KdDq-9: 7058i and 7079i and combined with hare fur in cord KdDq-9: 7094. *Ondatra zibathicus* (Fig.18) is found in sub-Arctic Canada and USA, but not at the present time in Baffin Island.

Rat

Fibres from the genus *Rattus*, rat, were identified with confidence only in remains of pelts. The diagnostic features were fine fibres with ladder-like medullae where each cell had a knucklebone shape; coarse fibres with fine lattice medullae; and diamond-petal scale pattern with protruding margins, changing to waved mosaic with smooth near margins towards the fibre tip. Staple lengths were up to 30 mm, or even 35 mm, long There were four examples with these features from Nanook, KdDq-9: 4794, H-59, H-60 and H-67, and one from Tanfield, KdDq-7-1**:** 2813. Since most species of *Rattus* are not native to North America, it seems likely that these four represent an introduction into Baffin Island.

Bear and polar bear

Fig.19. Polar bear. Photo: Alan Wilson, CC BY-SA 3.0

As mentioned, bear coat fibres can be particularly difficult to identify, due to a series of characteristics shared with unrelated species. In the early stages of this research, we were mainly relying on data gathered from the brown bear, but identification of some of the Canadian samples was much improved once a sample taken from polar bear had been acquired. The following description is based on examination of 11 samples taken from different parts of pelts of two polar bears, *Ursus maritimus*, one adult, one juvenile, provided by the Nunavut Department of Environment.

The samples of modern polar bear fur revealed a double coat, made up of a short layer of fine wavy fibres, approximately 25 mm long and 17-50 microns diameter; and, protruding beyond the undercoat, coarse straight fibres, 60-80 mm long (occasionally longer), and 70-85 microns diameter (Rast-Eicher 2016, 176, reports some up to 100 microns diameter). The length of the outer coat and the ratio of fine fibres to coarse varied from sample to sample, but the same fibre types were present in all samples. Medullae were present in the outer coat fibres and in up to 50% of the undercoat, and they were all narrow. They were defined as continuous, although some had a segmented appearance and others were almost ladder-like. The cross-sections were consistently oval, tending towards elliptical, with the thin medulla centrally placed. Pigmentation was absent. The scale pattern in the coarse fibres was irregular mosaic, rippled with near-to-close margins at the base, becoming waved with rippled near margins mid-shank; and the very coarsest fibres hade rippled-crenate margins. In the fine fibres the scale pattern was irregular to regular mosaic with smooth near margins which were sometimes slightly waved. These features are comparable with Appleyard's records for 'Bear, genus *Ursus*' (Appleyard 1978, 2-3, 36-7), although the very regular mosaic pattern he noted at the root of the fine fibres was not present in our polar bear specimen and he recorded narrow interrupted medullae rather than narrow continuous ones. Although the species of bear was not given, the pigmentation in Appleyard's descriptions indicates something other than polar bear.

The same, or similar, features were recorded in several samples from Nanook. One sample, KdDq-9: H-24, seemed especially like the modern specimens of fur from *Ursus maritimus*: this was a fragment of pelt with a staple length of 50 mm. Loose clumps of fibres with comparable features were recorded in KdDq-9: H-117, H-118, H-119, H-122 and H-136. Two fragments of pelt, KdDq-9: H-23 and H-52 came from animals with shorter coats, 20-40 mm long, which had the characteristics of bear, not necessarily polar, and other examples of pelts attributed to the *Ursus* genus were KdDq-9: H-72, H-82a, H-86, H-88, H-123b, H-124b and H-133.

Samples extracted from the two skin garment fragments from site KdDq-7-3, H-157 (8052i) and H-160 (8052iv), appeared to include both bear and deer/caribou fibres. From observation of the whole item, they have been tentatively interpreted as a polar bear skin with deer/ caribou fibres adhering to the surface.

Individual long whiskery fibres, up to 50 mm long, on their own in KdDq-9: H-139 and H-143, and mixed in with other fibres in KdDq-9: H-153, were also thought to be bear hair. It is difficult to identify species when only one fibre is present (and H-143 was poorly preserved), but their coarse nature, 100-200 microns diameter, narrow medullae and waved mosaic scale pattern with smooth margins, would suggest bear. Pigment was present in H-139, indicating that this was not polar bear, but it was difficult to record presence/absence of pigment in the remainder.

Other samples which might be bear, or horse or cattle, will be discussed below.

The polar bear, *U maritimus* (Fig.19), is found in Arctic regions, including the Canadian Archipelago. The range of brown bear, *U arctos*, includes much of Canada and part of Nunavut, but not Baffin Island. The American black bear, *U americanus*, can be found in Newfoundland and Labrador, but not as far north as Baffin Island.

Seal

Seal coat fibres were identified from the following features. The staples were short, often glossy, and included protruding fibres, only 10-15 mm long, and an even shorter undercoat. The undercoat fibres were 7-40 microns in diameter and had an irregular waved mosaic scale pattern with smooth margins. The protruding fibres had a wide shield area, 100-250 microns across, with an elliptical cross-section, rare medullae, and a scale pattern that ranged from petal to a variant of the irregular waved mosaic pattern that resembles a human fingerprint (Appleyard 1978, 106, fig.74c). Pigmentation was light and arranged in globular granules close to the core.

Fig.20. Pups of the harp seal (above) and the ringed seal (below). Photo: above Matthieu Godbout CC BY-SA 3.0; below, Shawn Dahle, NOAA, Polar Ecosystems Program, public domain.

Most of these features are regarded as typical of seal, family Pinnipedia, except that seal is reported to have lanceolate scale pattern in the fine fibres (Appleyard 1978, 24-5, 105). This lanceolate pattern was observed in only one sample, from Cape Ray CdBt-1, Newfoundland, where it had been blended with Arctic hare in cordage. During the later stages of the investigation, however, it was discovered that young seals (Fig.20) have an irregular waved mosaic, rather than lanceolate, scale pattern in their undercoat. It therefore seems likely that all the samples identified as only 'seal-like' in the early reports were in fact from seal pups.

Seal was identified in the remains of animal pelts from Nanook, KdDq-9: H-123a, H-124a, H-128 and H-132, and as raw fibre in Nanook KdDq-9: H-156 (find 7175vi). A skin garment from Baffin Island site KdDq-7-3: H-158 (find 8052ii) was thought to be from young seal. Seal fur was also sometimes a contaminant on the surface of cordage, but the Cape Ray example was a unique

piece, where the seal fur appeared to have been deliberately integrated with the raw material of the cord before spinning.

Seals are marine mammals with a preference for colder waters such as those around Baffin Island. The harp seal, *Pagophilus (Phoca) groenlandicus*, is found in the North Atlantic ocean and the ringed seal, *Phoca hispida*, and harbour seal, *Phoca vitulina*, more widely in oceans of the northern hemisphere. We do not yet have enough reference material to distinguish between the furs of the different species.

Caribou and/or deer

Deer, *Cervus* sp, and caribou, *Rangifer tarandus* (European name reindeer), share a number of fibre types and can be difficult to distinguish (Appleyard 1978, 8-9, 54). Both have a very fine, crimpy undercoat, which has an irregular waved mosaic scale pattern, with smooth margins which stand proud of the fibre; and distinctive short coarse fibres, 100-200 microns wide, which have an irregular petal scale pattern, flat cross-sections and wide latticed medullae. The remains of animal pelts from KdDq-9: H-87, H-89, H-91 were perhaps most like deer, while 7067b was more like our reference material for caribou. As far as we are aware, there are no species of *Cervus* native to the Canadian north-east, but caribou (Fig.21) prefers the habitat of Arctic and sub-Arctic tundra and has a circumpolar distribution which includes Baffin Island.

Fig.21. Caribou in Nunavut. Photo: Nansen Weber © Weber Arctic.

The coarse outer coat fibres were often detected adhering to other materials, such as cordage KdDq-9: 4799 (Fig.9) and skin garments, KdDq-7-3, H-157 (8052a) and H-160 (8052d).This accords with Else Østergård's finding of numerous 'reindeer' fibres on textiles recovered from the Norse settlements in Greenland (Østergård 2004, 120). As she pointed out, this testified to 'close contacts if not with caribou, then at least with its hide'.

Horse

Two samples, KdDq-9: H-103 and H-104, consisted of coarse fibres, 35-40 mm long, 75-150 microns diameter. Fibre tips were present but the proximal end was broken or cut, so that the full length is unknown. No surviving scale pattern could be located, but there were other features that suggested horse. The tips were sometimes 'flagged' (frayed). Medullae were narrow and fragmented, or sometimes wide and continuous. The cross-sections were mostly oval, tending towards circular, with concentric circular medullae. These resembled horse hair, although horse and bear can be difficult to distinguish. Sample KdDq-9: H-111 shared some features with H-103-4, but the absence of flagged ends and traces of a scale pattern which included some scalloped areas and close rippled margins made bear more likely than horse. A single coarse pale fibre, KdDq-9: H-78, however, lacked the scalloped scale pattern and its flagged ends and streaky pigmentation made horse mane hair seemed the most likely identification. Some short tufts of coarse fibres, KdDq-9: 7101iii, were poorly preserved with only a few areas of preserved scale pattern, though their regular diameter and near, smooth margins and relatively narrow medullae made horse mane hair a possibility.

The horse became extinct in the Americas over seven thousand years ago and was only reintroduced on the arrival of Europeans. The lack of certainty around these identifications must, therefore, be stressed.

Human head hair

Sample KdDq-9: H-114 was a single long, wavy fibre, 62 microns diameter, 175 mm in length, and mid-light brown with a grey area at the root. The scale pattern was irregular waved mosaic with smooth near margins at the root end of the fibre, changing to waved with close rippled-crenate margins further along the shaft. Pigmentation was streaky. These features are typical of human hair, although it was not possible to obtain a confirmatory cross-section without damaging the fibre. The clean, undamaged nature of the fibre suggested a modern contaminant.

Two samples, KdDq-9: H-80 and H-81, were both single fibres, 45 mm and 60 mm long respectively. They were coarse, 161 microns (H-80) and 127 microns (H-81) in diameter, with a rounded angular cross-section. Medullae were absent and they had a waved scale pattern with close crenate margins. H-81 was less well preserved than H-80, but both have been identified as human hair. Pigmentation was present, but it was difficult to judge the density: the hair may have been brown.

One specimen from Nanook, KdDq-9: 7089iii, was a short tuft of coarse animal fibre, 40 mm long. Dr Greaves commented as follows: 'Despite the levels of degradation present, the very close smooth margins, wide medullae and general dimensions of these fibres appear most like

those of human hair. Some of the fibres have rounded ends, possibly suggesting that they have been used in an application causing gentle wear, e.g. a fine brush'. Pigmentation was moderate, suggesting a mid-brown hair colour. This represents an interesting example of hair seemingly being used for a tool of some sort.

Cattle and goat unlikely

There remain a few tentative identifications of cattle and goat, which would, if correct, indicate a source outside the Canadian Arctic Archipelago. However, in every case, these results were obtained either from poorly preserved specimens, or from single fibres plucked from the outer surface of cordage or skins. As such, their presence must be recorded, although their species identification cannot be regarded with confidence. They include possible cattle fibres from Nanook, KdDq-9: H-92 and H-94, where bear is a credible alternative; and fibres resembling goat from KdDq-9: H-125, possibly also bear. It is unfortunate that two loose fibres with a wide latticed medulla adhering to a hare-fur cord from Nunguvik, PgHb-1: 14765, were identified by Walton Rogers as goat fibre, in a preliminary note at the start of the project, and published as such by Dr Sutherland. After 2000, the development of a collection of verified modern specimens of Arctic animal coats at ASLab, and consultation with Dr Greaves at Microtex, led to the conclusion that caribou was a likely alternative.

The absence of muskox

Fig.22. Caution: muskox. Road sign at Kangerlussuaq, Greenland. Photo: Algkalv, CC BY 3.0.

According to some of the literature on Dorset culture finds, the raw material of some of the cords has been identified as muskox wool (sources summarised in Sutherland 2009, 286) and this identification has reportedly been confirmed by microscopy of cords from Avayalik Island (Fitzhugh *et al* 2006, 156-161). Since no fibres resembling the wool from muskox, *Ovibos moschatus*, have been identified in the 314 samples that we have examined for the Helluland study, including those from Avayalik, a review of the diagnostic features that we have been using has been inserted here.

The two specimens of muskox wool in our reference collection (one provided by the National Museum of Denmark and the other collected by a colleague in Greenland) have fine, medium and coarse fibres. The fine ones are 6-25 microns diameter, with circular-to-oval cross-sections and a scale pattern which is irregular waved mosaic with smooth distant margins; and the waves are often deeper than in other species. The medium ones are similar, but with diameters of 32-50

microns, relatively frequent narrow continuous medullae and cross-sections which are oval or flattened oval. The coarse fibres are up to 100 microns wide, with cross-sections which are flattened with irregularly shaped outlines; their scale pattern is still irregular waved mosaic with smooth margins although the scale margins are closer than in finer fibres; medullae are wide and continuous. The underwool is often non-pigmented and pigmentation is unevenly distributed in the coarser fibres. In our opinion, muskox fibre on preliminary examination might be confused with wool from some of the primitive breeds of sheep, or with the coat of goat, but it seems unlikely that it would be confused with the hare and fox fur fibres observed in the cordage described here.

It can also be confirmed that muskox has not been identified in any of the Greenland material that our two laboratories, ASLab and Microtex, have examined (*contra* Sinding *et al* 2015, 298, who appear to attribute multiple identifications of muskox to 'P W Rogers'). A single specimen of animal pelt from GUS, x479, was determined as 'muskox, probable' by H M Appleyard (Appleyard in Walton Rogers 1998), but two further examples taken from cords with the same find number provided in 2006 were considered to be more like goat (see Appendix 1 & 3).

The fur-fibre cordage

Structure of fur-fibre cords

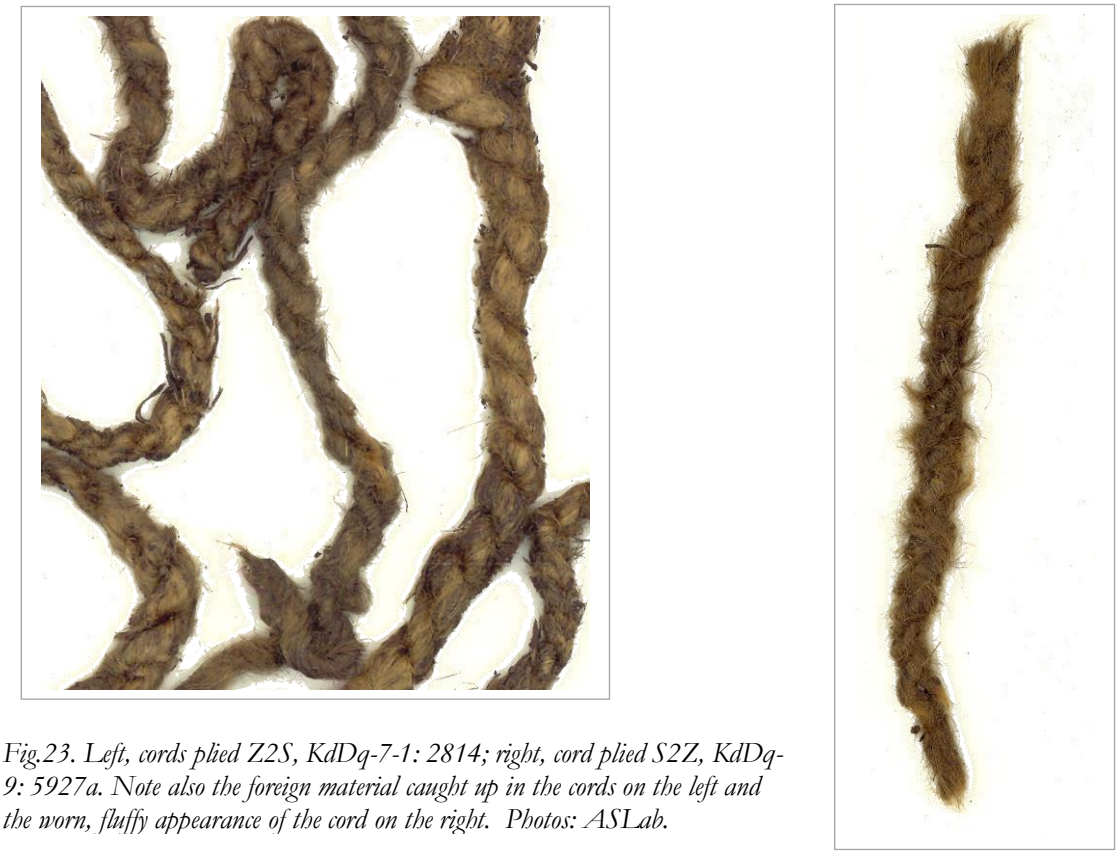

Fig.23. Left, cords plied Z2S, KdDq-7-1: 2814; right, cord plied S2Z, KdDq-9: 5927a. Note also the foreign material caught up in the cords on the left and the worn, fluffy appearance of the cord on the right. Photos: ASLab.

Table 2. The structure of cords and braids made of fur and sinew.

Site name	Site code	plied Z2S	plied S2Z	plied Z2Z	plied I2S	multi-ply*	single Z	single S	3-strand plait	structure not identified	Total number specimens
Tanfield	KdDq-7-1	3	1								4
Tanfield	KdDq-7-3	4									4
Kimmirut	KdDq-7-4	9									9
Nanook	KdDq-9	94	19	1	1		5	3	3	2	128
Tanfield	KdDq-9-3	2									2
Willows Island	KeDe-14	1									1
Nunguvik	PgHb-1	2									2
Brooman Point	QiLd-1	1							1		2
Avayalik I		9				8					17
Cape Ray	CdBt-1	1									1
TOTAL		126	20	1	1	8	5	3	4	2	170*
made of sinew		(5)			(1)				(4)		(10)
made of fur		(121)	(20)	(1)		(8)	(5)	(3)		(2)	(160)

* the two multi-ply cords from Nunguvik which proved to be modern have been excluded from this table.

The construction of the fur-fibre cords is very simple, the majority being two-ply. Most have been twisted Z2S (76%), some S2Z (13%), and one Z2Z (Table 2; Fig.23). They are all of similar diameter, although some of them fluctuate along their length. The full range of diameters is 1.0-4.0 mm, but 2.0-3.0 mm is the most common measurement. The surviving lengths vary, the greatest from Nanook, KdDq-9: 4797, being 360 mm long. A few of the cords have part-unravelled ends and a small number of single Z- and S-spun yarns may well have come from the tail-ends of similar cords. The base yarn is very tightly twisted, and sometimes cockles up into small loops. The ply can also be uneven, the angle of twist varying from 30º-60º from vertical, but on the whole it is more regular and usually around 40º from vertical. At least eight of the two-ply cords have a closed end, which indicates that they have been constructed, not from two yarns, but from a single yarn folded in the middle.

The Avayalik cordage has the same basic structure as the Baffin Island examples, except that in eight instances the two-ply cords have been re-combined by twisting them together in the Z direction, in twos (Z2S2Z), threes (Z2S3Z), fours (Z2S4Z) and sixes (Z2S6Z), to make progressively thicker cords (Table 3).

Table 3. Multi-ply cords from Avayalik Island.

Construction	*Diameter*	*Sample #*
Z2S	2.0-3.0 mm	2, 4, 5, 7, 9, 10, 11, 12, A
Z2S2Z	3.5-4.0 mm	3, 6, 13, B
Z2S3Z	5.0-6.0 mm	1
Z2S4Z	5.5-6.0 mm	8, 14
Z2S6Z	7.0 mm	15

Five of the multi-ply cords have folded ends like the two-ply cords. In examples #6 and #13, a single two-ply cord has been folded in half and the ends twisted together. In #8 and #14, two two-ply cords have been folded, and for #15 three cords have been folded. This procedure cannot have been followed in #1, where an odd number of cords (three) have been combined, and this cordage is also less regularly constructed than the others. There is a knot in one of the Z-spun strands of #8, where fresh yarn has been added in during plying.

Fibre selection

As Table 4 shows, the cordage is dominated by the fur of Arctic hare. Only at Avayalik does fox come to the fore. In some instances there was more than one fur type present in the same cord. In these cases, it could be difficult to distinguish a deliberate blend from a cord with surface

contamination, or from fibres accidentally caught up during spinning. In the cordage from Cape Ray, CdBt-1, however, several samples were extracted for microscopy from different parts of the same cord, and the blend of seal and hare proved to be present in the core yarns of all samples (it is particularly curious to see the short fibres of seal used in this way). Another blend, probably of three different furs, fox, hare and a third unknown, was recorded in one of a cluster of cords from Nanook, KdDq-9: 9216a. One of the fox-fur cords from Avayalik Island, #15, also appeared to have a second fibre spun into the base yarn and the same may have been true of Avayalik #A and #B. In cord KdDq-7-3: 10R20, two separate tufts removed for microscopy proved to be one hare and the other fox.

Since in most cases only one sample was extracted for microscopy, it is possible that some fibre blends have been missed. Nevertheless, there can be no doubt that Arctic hare was the main fibre source for cords of the Baffin Island group.

There did not appear to be any correlation between the fur species and the structure of the cord. The three-strand plaits, however, and the I2S cords were worked only in sinew (Table 5).

Method of manufacture

How the fibres were prepared for spinning and how the spinning was carried out is largely a matter for conjecture, but the following observations can be made. When taking fibre samples from the ends of the cords, it was sometimes possible to remove an intact staple. Staples were recognised by their tapering appearance and the presence of fibre tips at the pointed end. There were occasional root ends present, but mostly they were absent, which suggests that the fibre was sometimes cut, broken or sheared from the pelt. From this evidence, it seems likely that in many cases the fur fibres had been drawn out by hand, and fibre ends spliced together, but not processed by combing or carding in the way that sheep's wool is usually processed for spinning. One find from Baffin Island, site KdDq-9-3, included a plied cord of hare fur in association with loose tufts of the same fur laid against each other, with fibre tips pointing in opposite directions. Fibre roots were again mostly absent and this was interpreted as raw material in the process of being made into cordage. At the same time, the presence of fur blends in the cords suggests that some degree of thought has gone into the fibre preparation.

Table 4. The animal sources identified in the cordage

Site name	Site code	Arctic hare fur	Arctic fox fur	Mink fur	Muskrat fur	Animal sinew	Other	Total number specimens
Tanfield	KdDq-7-1	2?		2?				4
Tanfield	KdDq-7-3	2 + 1?					1 blend hare + fox	4
Kimmirut	KdDq-7-4	7 + 1?					1 not identified	9
Nanook	KdDq-9	87 + 6?	5 + 1?	1	2 + 2?	5 + 3 braids	6 blend + 2 ?rat + 3 ?otter + 5 unknown	128
Tanfield	KdDq-9-3	1 + 1?						2
Willows Island	KeDe-14	1						1
Nunguvik	PgHb-1	2					2 modern	4
Brooman Point	QiLd-1					1 + 1 braid		2
Avayalik Island			13 + 2?				1 dog + 1 blend	17
Cape Ray	CdBt-1						1 blend hare + seal	1
TOTAL		100+11 ?	18 + 3?	1 + 2?	2 + 2?	6 + 4 braids	23	172

Table 5. Structure and animal source in cordage from Nanook, KdDq-9: confident identifications only

Site	Structure	Arctic hare fur	Arctic fox fur	Mink fur	Muskrat fur	Animal sinew	Total number specimens
Nanook	plied Z2S	70	3	1	1	4	79
Nanook	plied S2Z	12	1				13
Nanook	plied Z2Z		1				1
Nanook	plied I2S					1	1
Nanook	single	4			1		5
Nanook	braid					3	3
TOTAL		86	5	1	2	8	102

One distinctive feature of many of the cords was the very tight spinning in the individual yarns, which had caused cockling (over-twisted loops). This is something that is sometimes seen when novices attempt to spin, but in this instance it was almost certainly not an indication of inexperience, but of a competent spinner having to deal with very short, slippery (low-friction) fur fibres. The yarn would fall apart if the spin were not tight. (Antoinette Rast-Eicher has suggested that some form of coating might have aided the process.) It was noticeable that the long fibres in the only example made of dog hair, Avayalik Island #7, were not spun so tightly. Another property of tightly spun yarns is that if they are folded in half while under tension and then allowed to relax, the two halves will automatically twist around each other. It appears to be this feature which has resulted in the closed end on some of the cords described above.

Uses of the fur-fibre cordage

The cordage had clearly been used for tying and binding. Many of the pieces had preserved knots, although matting of the cord from wear meant that the structure of the knots could not always be discerned. A few finds, KdDq-9: 7060, 7066, T-8 and T-29, represent a single cord with a simple overhand knot (sometimes called a thumb knot) towards one end, but most knots appeared to tie two loose ends together. One example, KdDq-9-3: #0, had a 'granny knot' where the ends crossed right-over-left and right-over-left again, while others had been repeatedly re-tied in a seemingly haphazard fashion. In some instances, the cord was tied to form a complete circle. In one group, KdDq-9: 7077, 7078ii and 7089ii, the diameter of the circle was only about 8-10 mm diameter, and in KdDq-9: 7211 it was 40 mm diameter, but if the broken cords represent similar remains, the diameter must have been larger still.

Fig.24. Examples of knotted cords. Left KdDq-9: 8366 (note the overhand knot at one end as well as the joining of two cords; right KdDq-9-3: [no find number]. Scale in mm. ASLab.

Complex knots involving more than one cord were noted in KdDq-9: 747ii, 7048i and 7064, and in KdDq-9: 5000, there was at least one example of a loop of one cord hitched to the middle of another (a rolling hitch) to form a T-shape. Similarly, in KdDq-9: T-6 a single strand of Z-spun yarn had been folded over another cord of Z2S construction and the Z-spun yarns plied together in the S-direction, so that one cord joined another at right angles, without the need for a knot. One length of cord from Nanook, KdDq-9: H-93, had been wrapped spirally around a piece of baleen, perhaps as a means of storing the cord, ready for use.

What manner of goods the cords were meant to tie is unknown, but the frequency with which caribou fibres were recorded on the surface of the cords suggests some connection. They might have been used to tie skin clothing or bind goods wrapped in caribou hide. Alternatively, the loose fibres may simply reflect how people lived and worked in close proximity to their animals.

Cordage from Norse Greenland

In order to investigate the eastern extent of fur-fibre cordage, Dr Sutherland commissioned a study of the cordage from Norse sites in Greenland held at The National Museum of Denmark. Altogether there were 18 samples, including textile yarns and sewing thread, from GUS, five from Herjolfsnæs and one each from sites 991 and Ø34 (Appendix 3). The following is based on the 21 cords and ignores the weaving yarns and sewing thread. As Fig.25 and Table 6 show, the cords were made in a variety of spin, ply and diameter.

Fig.25. A variety of yarns and cords in a single find, GUS 1950 x 1846, Greenland. Scale in mm & cm. Two cords have been identified as sheep's wool. Photo: Irene Skals, National Museum of Denmark.

Of the 21 cord samples, 14 exhibited the typical features of sheep's wool (with one less certain example). They had an irregular mosaic scale pattern, sometimes waved, with smooth near margins; a range of coarse and fine fibres; continuous medullae in some of the coarser fibres and wide latticed medullae in the very coarsest; and cross-sections which were round-to-oval and flatter in the widest fibres. This represents a double-coated fleece (with both fine and coarse fibres) which is typical of the Northern Short-Tail stock, to which the sheep of Iceland and Greenland belonged (Ryder 1981). The range of pigmentation patterns matched those seen in Northern Short-Tails and is also seen in textiles from Greenland (Walton Rogers 2004). To judge from the density of pigment granules and their distribution through the fibres, the fleece colour ran from dark brown or near black, through skimlet (white with black or brown coarse fibres protruding beyond the underwool) and grey (black and white fibres), to white.

Table 6. Structure and animal source in cordage from Norse sites in Greenland. For details, and for single yarns and sewing threads, see Appendix 3.

Site	Structure	sheep	goat	cattle	bear	dog/wolf	Total
GUS	Z2S	2	2	1	?1	1	7
GUS	S2Z	3					3
GUS	S3Z	2					2
GUS	S6Z	2					2
GUS	S?8Z	1					1
GUS	S2Z2S	?1					1
GUS	Z2S4Z	1					1
GUS	?				?1		1
Herjolfsnæs	braid	2					2
Site Ø34	Z2S	1					1
TOTAL		14 + 1?	2	1	?2	1	21

One of the Z2S cords, GUS 1950 x1796, was identified as cattle hair. The fibres were medium and coarse, 50-85 microns diameter, and had light, diffuse pigmentation in most fibres. The scale pattern was irregular waved mosaic with near-to-close margins which were rippled in places. Cross-sections were round, oval and oblong and medullae were frequent, continuous and wide. The light pigmentation and the frequent wide medullae suggested a young beast.

Two samples, GUS 1950x814 (structure unknown) and GUS 1950x1902, a Z2S cord, were thought to be more like bear, although, as noted above, bear shares a number of characteristics, such as rippled scale margins, with cattle. If it is correct to identify them as bear then their pigmentation, especially dense in x814, rules out polar bear. Another sample, Herjolfsnæs D12807(1), was identified as fur from one of the canids, most probably wolf, from the features described above ('Wolf'). It had a mix of densely pigmented and non-pigmented fibres suggesting an originally grey coat. Both x1902 and D12807 have been blended with a second species of unknown identity.

This use of fibres reflects a common feature of cordage in general. While the structure of cords and braids is universal, the raw materials tend to be whatever cheap fibre is immediately to hand. This is a useful characteristic when, for example, attempting to locate the port-of-origin for wrecked ships with surviving cordage (Walton Rogers 2012b). The farmers of Late Norse Greenland will have found their farm animals the most convenient source of fibre, but wild animals were the existing resource for hunting and trapping communities in the region of Baffin

Island. Why the fur of Arctic hare would be so often selected over other wild species cannot be answered at this stage.

The sinew cords and braids

Flat strips of animal sinew were sometimes plied like the fur-fibre cords, or they could be worked into a three-strand plait (Tables 4-5). The surviving lengths of the sinew products were usually less than 100 mm long and they were mostly thinner than the fur-fibre cordage, the full range of diameters being 0.5-3.0 mm. Because sinew occurs as continuous strands, the base element of the cord or plait could be used without twist, but was sometimes given a slight Z-twist. Strands of prepared sinew were found with the cord and braid from Brooman Point, QiLd-1: 575, where they were embedded in a ball of fat, along with remains of feathers.

One further item, KdDq-9: 4440, represented an elliptical piece of skin or hide, c.20 x 5 mm, which had been pierced and threaded through with two lengths of probable sinew (both through the same hole). The sinew strands were c.22 mm long and one was Z-twist, the other S-twist. These were not sampled for high-power microscopy, because that would have meant destroying a substantial part of this small object, but at x10 magnification, the strands appeared comparable with the sinew seen elsewhere.

Animal pelts and raw fibre

The unprocessed (non-spun) fibres could be grouped as (i) fragments identified as skin garments on excavation, (ii) remains of pelts identified in the laboratory and (iii) loose fibres. They proved to contain a much wider range of fibre type than was present in the cordage (Table 7).

Remains of garments

Sub-samples from four items described as 'skin garments' were provided for species identification. These had been found together in the same context at a Baffin Island site, KdDq-7-3: 8052 (= H157-H-160). Since more than one fibre-type proved to be present in the sub-samples, it was sometimes difficult to distinguish the ground pelt from adhering fibres. From the presence of fibre roots, however, it was thought most likely that H-157 and H-160 represented polar bear pelts, H-158 young seal (Fig.26) and H-159 fox, probably Arctic fox. Caribou fibres without intact root ends in H-157 and H-160 probably represent loose fibres adhering to the surface of the garment.

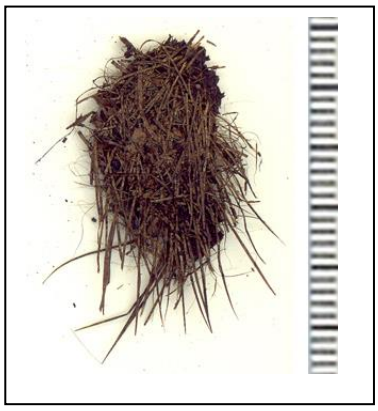

Fig.26. Fragment of sealskin garment, KdDq-7-3: H-158. Scale in mm. Phot;o ASLab.

Table 7. Animal pelts (including fragments of skin garments) and raw fibre arranged by site and animal source.

Site name	Site code	Arctic hare	Arctic fox	Bear & Polar bear	Seal & similar	Caribou / deer	Dog/ wolf	Otter	Musk rat	Horse	Rat	Human	Other	Total number
Tanfield	KdDq-7-1										1			1
Tanfield	KdDq-7-3	1	1	2	1									5
Kimmirut	KdDq-7-4												1 moss, etc	1
Nanook	KdDq-9	22	15 + 2?	15 + 11?	8	7	2 + 1?	3 + 2?	1	5	4	3 + 1?	10 feathers, 2 baleen, 3 moss etc, 1 moss & fur, 14 unknown	132
Willows Island	KeDe-14												1 plant tissue	1
Nunguvik	PgHb-1					1?	1							2
TOTAL		23	16 + 2?	17 + 11?	9	7 + 1?	3 + 1?	3 + 2?	1	5	5	3 + 1?	32	142

No seams or edges were present in the sub-samples from KdDq-7-3, but a fragment of sealskin (seemingly identified before it reached our laboratory) from Nanook, KdDq-9: S-1, did have the remains of a worked edge. A cut edge had been folded inwards (fur-side in) and along the edge there was a row of small oblong puncture marks, each with a groove leading away from the perforation towards the edge of the skin. This is clearly the remains of needlework, which must have either tidied up the raw edge, or been worked as one half of a seam. It cannot have been a hem, since the marks along the edge had no corresponding marks on the layer underneath. The perforations probably mark where the work was prepared with an awl. The sewing medium (thread or sinew) is now absent, but will have been threaded through the holes: the grooves mark the path of the stitching, diagonally over the edge and back to the next perforation.

A flat layer of matted fur (probably from Arctic fox) was thought likely to represent a layer of insulation from clothing, KdDq-9: 4795. Many of the fibres lacked roots and tips, the maximum fibre length being about 20 mm, which indicates that this was not an intact pelt. A high-quality photomicrograph prepared by Louis Laflèche showed clear flexing breaks and fibrils at the broken ends (Analytical Report from Ontario Service Centre, Parks Canada, Lab.no.2003-163). Damage of this type occurs in objects that have seen extensive flexing wear (Cooke & Lomas 1990, 216-8). The investigation of the blue-grey colour of this fur has been described above.

Remains of pelts

When untreated animal pelts are placed in the ground in wet conditions, the skin tends to decay, leaving the fibres relatively intact. The remains of animal pelts have been identified in 81 examples from Baffin Island sites. The full length of the coat was often present, with roots and tips lined up as they would be on the animal, and there was powdery black material, representing the remains of the skin itself, at the root end of the fibres. The main animal sources identified were Arctic hare, Arctic fox and bear (polar or other), with seal, caribou or deer, wolf and otter present in smaller numbers (Table 7; Figs.27-28). Rat fur was also recovered although this could have come from rodents burrowing at the two sites where they were identified, Nanook (KdDq-9) and Tanfield (KdDq-7-1). The pelt fragments, as provided, were relatively small pieces, but they form a useful comparison with the raw materials of the cordage.

There is no evidence to explain the function of the pelts, since no particular wear patterns were observed, although there were sometimes fibres from other animals adhering to the surface of the pelt. The fragments could perhaps represent waste pieces from skinning, or from fragments of clothing. All these furs have appeared in traditional Arctic clothing, sometimes several species together in one garment (King *et al* 2005, 28-9, 32-3, 37-9, 40, 70).

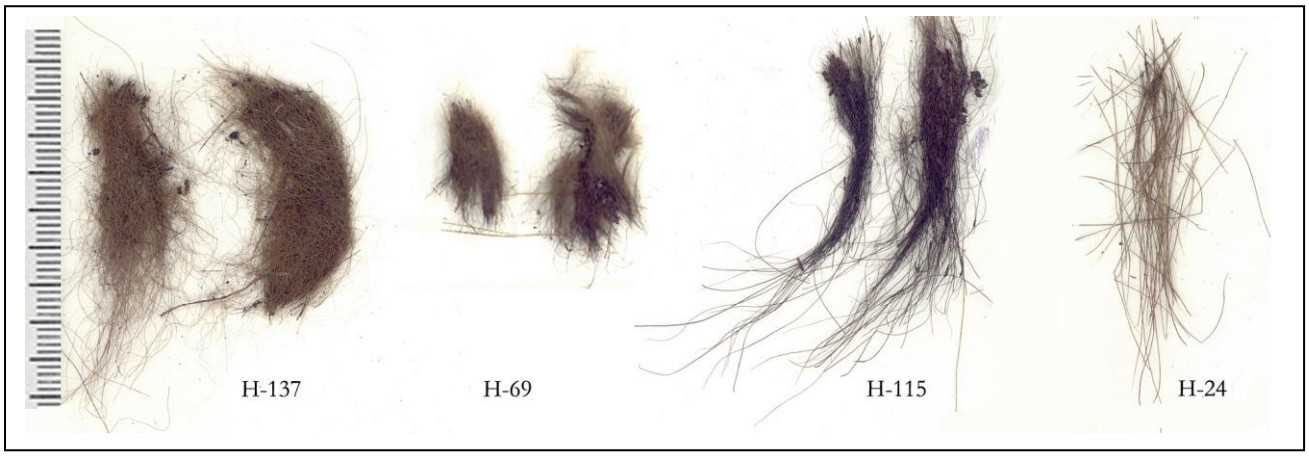

Fig.27. Fragments of pelts and loose fibres from KdDq-9. H-137 identified by microscopy as wolf, H-69 as otter, H-115 as bear and H-24 as polar bear. Scale in mm and cm. ASLab.

Fig.28. Remains of pelt of Arctic hare, KdDq-9: H-100. Scale in mm and cm. Photo: ASLab

Loose fibres

Some clumps of fibre lacked the orderly arrangement that indicated that they had entered the ground as an intact fragment of pelt and some, such as KdDq-9: H-148 and H-149, included more than one species. Most examples of loose fibre came from the same sources as those identified in the pelts, but there were also fibres thought to be from horse (KdDq-9: H-103 & H104), one example of felted remains of muskrat (KdDq-9: 7090i) and some individual strands of human hair (KdDq-9: 7089iii; KdDq-9: H-80 & H-81). Loose fibres adhering to the surfaces of cords and pelts were most commonly caribou.

Comment

In summary, the cordage has proved to be a large and distinctive group with a discrete set of characteristics. Its identifying features are the use of white animal fur for the raw material, a standard diameter of around 2-3 mm, a two-ply construction (recombined into thicker cords at Avayalik Island) and tight spinning of the base yarn. It has not been possible to establish if there

was any environmental factor such as soil conditions that would prevent the survival of the material at other sites, but if the distribution of the finds is taken at face value, the main area of use appears to have been southern Baffin Island. The presence of prepared fibre at site KdDq-9-3 implies that the cords were made locally. The finds from Avayalik Island are similar to those from Baffin, but the number of multi-ply cords and the difference in the raw material may indicate that this was a second place (or time) of production. The function of the Baffin Island cords seems to have been as string for tying and binding.

The animal furs used for the cords were primarily Arctic hare (58%), with Arctic fox in second place (11%-12%) and rare individual examples of mink, muskrat and dog. The evidence for fibre blends, and the frequent occurrence of extraneous fibres, adhering to the surface of cords and pelts, means that there may have been interference in the identification of the ground material in some instances, but the ratios of one species to another should be approximately correct. A much wider range of species was available than was used in the cordage. Arctic hare, Arctic fox, polar bear, seal, wolf, deer/caribou, otter and rat were identified amongst the remains of pelts, and there was a similar range of sources amongst the loose fibres, with the possible addition of horse and dog.

Most of these species could be trapped or hunted in the neighbourhood of the sites in which they were found. Arctic hare, Arctic fox, polar bear, wolf and caribou are all to be found in the islands of the Canadian Arctic Archipelago and seal in the waters around them. Mink, river otter and muskrat, which have the northern limit of their range along the coast of Labrador, were present only in very small numbers. Either these pelts were brought across the Hudson Strait to Baffin, or the animals themselves reached beyond their usual range during fluctuations in climate.

Dog is likely to represent a domesticated animal and the blending of dog hair with wool in a 13th-century textile from a Thule Inuit site at Ruin Island, north-west Greenland, has already been mentioned. The identification of deer, horse and rat, however, require further consideration, since they are potentially European in origin. There are no species of deer other than caribou in the vicinity of Baffin Island, the nearest in North America being the wapiti, *Cervus canadensis*, which had, at its greatest extent, a range that reached only into southernmost Canada (Centre for Agriculture and Bioscience International *Invasive Species Compendium*, www.cabi.org/isc/datasheet/119059). The European red deer, *Cervus elaphus*, is a possible candidate for the source of the three deer-like pelts from Nanook, although the overlap in fibre types with caribou cannot be disregarded. Similarly, coarse horse hair identified among loose fibres from the Nanook excavation would have to have come from a European source, although the correspondence with certain types of coarse bear fibre has been noted. Rat, on the other

hand, is unlikely to have been confused with any of the species within our reference collection and is most likely to represent introduced rodents.

The Helluland Archaeological Project is moving towards biomolecular analysis of this last group of samples, since, if their identification proves to be correct, they would add significantly to our understanding of the interaction between Europeans and the indigenous peoples of the Canadian Arctic. The appearance of identical cordage made of Arctic hare, worked into at least one textile in the Norse western settlement in Greenland, has already indicated some form of contact between the two regions. The director of the project, Patricia Sutherland, continues her research in this arena.

Appendix 1. Statement by Penelope Walton Rogers concerning the identification of animal fibres investigated by Sinding *et al* 2015 (published on-line in 2014)

In 2014, I gave an immediate on-line response to a paper published by Sinding *et al*, in which it was asserted that aDNA analyses contradicted the identification by H M Appleyard of samples from GUS, Greenland. Since then, I have had a chance to make a more thorough review of the contents of the Greenland archive held at The Anglo-Saxon Laboratory. The following represents a summary, which I believe demonstrates that Sinding was working on different material from Appleyard.

From our archive

In 1997, as part of our consultancy with The National Museum of Denmark, our laboratory examined a series of fragments of animal pelts excavated in the Norse farmstead known as GUS (Gården under Sandet, 'Farm beneath the Sand') in the western settlement in Greenland. This was as a supplement to our work on wool quality in the textiles from the same site.

The items sent to us were listed in a fax from Else Østergård dated 5 March 1997, which stated that 'except for one sample, it's all staples' (the exception being x602, a textile). Staples are the intact tufts of fibre into which an animal coat naturally falls. Visual examination at ASLab on receipt of the objects confirmed that several of the staples had intact roots and remains of skin at the proximal end.

The identification of the animal pelt samples was then contracted out to HM (Harry) Appleyard, who was an established expert in the microscopy of animal coat fibres and author of *Guide to the Identification of Animal Fibres* (Appleyard 1978). His identification of the pelt samples were goat (x1651), cattle (x2448), bison (x633), caribou (x497, x846), probable muskox (x479), bear (x1429, x1925, x2519), polar bear (x469), wolf (x431), and possible Arctic fox (x606). His results were then combined with my own on the raw materials of the textiles, in a report to the National Museum of Denmark.

The material was then returned to the Museum and a request sent for photography of animal pelts, x479, x431, x606, x497, x2519 and x633, which asked for the ends with black specks (the remains of skin) to be placed at the top of the image (fax dated 20 November 1997).When page proofs of our report reached us, I found that a photograph of a cord tied to a V-shaped object had been inserted, with the label x633. I raised a query with the Museum, noting that this did not resemble the material we had examined and that it contradicted the subject of the study, which was clearly defined as animal pelts. Nevertheless, it appeared in the final publication (Arneborg and Gulløv 1998) as fig.3.

In 2006, two cords plied Z2S, 3mm diameter, with the same museum accession number, KNK 1950x479, as the sample of pelt identified by Appleyard as probable muskox, were submitted for analysis as part of the Helluland Project. Greaves and I both considered these to be most probably spun from goat fibre (ASLab Report 060814 on behalf of the Helluland Project).

In 2007, a further 24 cords, braids and yarns from four sites in Greenland were examined on behalf of the Helluland Project. These proved to be predominantly made from sheep's wool, with one example of cattle, one of a canid, probably wolf, and two probably bear (see above, 'Cordage from Norse Greenland' and, below, Appendix 3).

In 2014/15, M-H Sinding published an aDNA study purporting to have proved that 'the bison was a horse, and the muskox and bears were goats' in the *Journal of Archaeological Science*. In fact, these were clearly not the samples that Appleyard had studied, as Table 8 shows.

Table 8: samples studied by Appleyard (in Walton Rogers 1998) compared with samples in Sinding et al 2015

Museum code	**Appleyard 1998 description**	**Appleyard 1998 microscopy results**	**Walton Rogers 2006 microscopy**	**Sinding 2015 description**	**Sinding 2015 illustration shows**	**Sinding 2015 aDNA results**
x633	pelt	bison		braided string	cord	horse
x1925	pelt	bear		fur tuft	'uldtrad'*	goat
x2519	pelt	bear		fur tuft	cord	goat
x479	pelt	muskox probable	cords = goat	twisted string	twist of fibres	goat

* The packet was labelled *uldtråd*, 'wool thread', which must indicate spun yarn.

It is impossible to tell at this distance how this mix-up occurred, but it is obvious that cords and fragments of animal pelts have somehow become confused. Either the objects have been swapped in bags, or groups of finds with a single accession number have been divided and re-packaged into different material types without revision of the numbers on the packaging.

Comment

As scientific advances improve our methods of fibre identification, it is inevitable that some corrections to previous identifications by microscopy will occur. I am confident, however, that the Greenland samples do not represent such a case.

It is unfortunate that what suffers in entanglements of this nature is the archaeology. If, however, one sets aside the contentious issues, it is possible to see something useful here. If we agree that Sinding has examined cordage, not pelts, then his results correspond with the previous identifications of Greenland cordage carried out in 2006 and 2007 (Appendix 3). This has shown a heavy reliance on sheep's wool. The primitive breeds of sheep of the North Atlantic islands have fleeces similar to the coats of goat and both can be categorised, along with the cattle hair identified by microscopy and horse (by aDNA), as domestic animals in a Norse context. Microscopy has indicated that a much wider range of animals, many of which were wild species, were the source of pelts (none of which appears to have been tested for aDNA).

In a way, this mirrors the usage observed in the Canadian material, where a narrow range of raw material, primarily hare fur, was used for the cordage, but a much wider range of species appeared in the remains of animal pelts and unprocessed fibres. This seems to reflect a general principle, that different choices were made when selecting fibres for cordage from those choices made when selecting animal pelts for other purposes, such as clothing and furnishings. Accuracy in identification is therefore essential if we are to appreciate how different types of community valued, understood and used their resources.

Penelope Walton Rogers
The Anglo-Saxon Laboratory
30 September 2018

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Appendix 2. Table of results of analysis by microscopy of finds from the islands of eastern Canada, grouped by site.

Region	Site name	Site/area code	Specimen number	ASLab Report	Type find	Struct-ure	Species from microscopy	Notes
Baffin Island	Tanfield	KdDq-7-1	2814i	040323	cordage	S2Z	mink probably	
Baffin Island	Tanfield	KdDq-7-1	2814ii	040323	cordage	Z2S	mink probably	Several lengths; one folded & knotted
Baffin Island	Tanfield	KdDq-7-1	2814iii	040323	cordage	Z2S	Arctic hare possibly	
Baffin Island	Tanfield	KdDq-7-1	2814iv	090330	cordage	Z2S	Arctic hare probably	
Baffin Island	Tanfield	KdDq-7-1	2813	040323	pelt		rat	
Baffin Island	Tanfield	KdDq-7-3	10R20	070910	cordage	Z2S	Arctic hare & Arctic fox blend	
Baffin Island	Tanfield	KdDq-7-3	7760	090330	cordage	Z2S	Arctic hare	
Baffin Island	Tanfield	KdDq-7-3	7761	090330	cordage	Z2S	Arctic hare	
Baffin Island	Tanfield	KdDq-7-3	7762	090330	cordage	Z2S	Arctic hare probably	poorly preserved
Baffin Island	Tanfield	KdDq-7-3	7758 H146	090330	pelt		Arctic hare	
Baffin Island	Tanfield	KdDq-7-3	8052i H-157	090330	skin garment		polar bear	
Baffin Island	Tanfield	KdDq-7-3	8052ii H-158	090330	skin garment		young seal	
Baffin Island	Tanfield	KdDq-7-3	8052iii H-159	090330	skin garment		fox	
Baffin Island	Tanfield	KdDq-7-3	8052iv H160	090330	skin garment		polar bear, deer/caribou adhering	

Baffin Island	Kimmirut	KdDq-7-4	#1	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#2	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#3	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#4	040323	cordage	Z2S	Arctic hare	folded end
Baffin Island	Kimmirut	KdDq-7-4	#5	040323	cordage	Z2S	Arctic hare possibly	poorly preserved
Baffin Island	Kimmirut	KdDq-7-4	#6	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#7a	040323	cordage	Z2S	??	poorly preserved, not hare/rabbit; loosely plied
Baffin Island	Kimmirut	KdDq-7-4	#7b	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#8	040323	cordage	Z2S	Arctic hare	
Baffin Island	Kimmirut	KdDq-7-4	#9	040323	organic material			green moss in brown organic matrix
Baffin Island	Nanook	KdDq-9	4384	010330	fibres	loose	Arctic hare	for cordage see REP 000427.
Baffin Island	Nanook	KdDq-9	4440g	010330	fibres		plant tossue	in packet with cord
Baffin Island	Nanook	KdDq-9	2002-T-17b	030327	fibres		caribou	associated with cord
Baffin Island	Nanook	KdDq-9	2002-T-24b	030327	fibre		caribou	associated with cord
Baffin Island	Nanook	KdDq-9	2002-T-31b	030327	fibres		caribou	associated with cord
Baffin Island	Nanook	KdDq-9	4384	000427	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	4440a	000427	cordage	3-strand plait	animal sinew	2.8 mm wide
Baffin Island	Nanook	KdDq-9	4440b	000427	cordage	Z2S	animal sinew	1.3-1.8 mm wide
Baffin Island	Nanook	KdDq-9	4440c	000427	cordage	Z2S	animal sinew	1.5-2.0 mm

Baffin Island	Nanook	KdDq-9	4440d	000427	cordage	Z2S	animal sinew	1.0-1.5 mm
Baffin Island	Nanook	KdDq-9	4268	010322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	4272	010322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	4310	010322	cordage	Z2S	Arctic hare	some over-spinning
Baffin Island	Nanook	KdDq-9	4438	010322	cordage	Z2S	Arctic hare possibly	poorly preserved; loose fibres adhering from ?fox and ?seal
Baffin Island	Nanook	KdDq-9	4708	010322	cordage	Z2S	Arctic hare probably	
Baffin Island	Nanook	KdDq-9	4797	010322	cordage	Z2S	Arctic hare	large cluster of cords
Baffin Island	Nanook	KdDq-9	5000	010322	cordage	Z2S	Arctic hare	includes knots (one a rolling hitch)
Baffin Island	Nanook	KdDq-9	5001	010322	cordage	Z2S	Arctic hare	loose fibres possibly fox
Baffin Island	Nanook	KdDq-9	4394	010322	cordage	3-strand plait	animal sinew	2.5-3.0 mm thick
Baffin Island	Nanook	KdDq-9	4440e	010330	cordage	Z2S	Arctic hare	two cords knotted together
Baffin Island	Nanook	KdDq-9	3 OL15-5L15-a	010627	cordage	S2Z	Arctic hare	ply reverse of usual; 2.5 mm wide as rest
Baffin Island	Nanook	KdDq-9	2002-T-2	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-3	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-4	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-6	030327	cordage	Z2S	Arctic hare	one cord 285 mm long; two cords attached to each other by partial splicing.
Baffin Island	Nanook	KdDq-9	2002-T-7	030327	cordage	Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-8	030327	cordage	Z2S	Arctic hare	folded & knotted with overhand knot

Baffin Island	Nanook	KdDq-9	2002-T-9	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-10	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-11	030327	cordage	S2Z	Arctic fox	
Baffin Island	Nanook	KdDq-9	2002-T-12	030327	cordage	Z	Arctic hare possibly	single strand with an overhand knot at one end.
Baffin Island	Nanook	KdDq-9	2002-T-13	030327	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-14	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-15	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-16	030327	cordage	Z2S	otter possibly	
Baffin Island	Nanook	KdDq-9	2002-T-17a	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-18	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-19	030327	cordage	S2Z	Arctic hare possibly	unevenly made and possibly more than one fibre present.
Baffin Island	Nanook	KdDq-9	2002-T-20	030327	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-21	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-22	030327	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-23	030327	cordage	Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-24a	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-25	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-26	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-27	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-28	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-29	030327	cordage	Z2S	Arctic hare	

Baffin Island	Nanook	KdDq-9	2002-T-30	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-31a	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-32a	030327	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-747i	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-747ii	040322	cordage	Z2S	mink	knotted
Baffin Island	Nanook	KdDq-9	2003-7045	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7046	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7047i	040322	cordage	Z2S	Arctic hare + ?	2nd fibre present, not ident.
Baffin Island	Nanook	KdDq-9	2003-7048i	040322	cordage	Z2S	muskrat	knotted with loop and five ends emerging from knot
Baffin Island	Nanook	KdDq-9	2003-7048ii	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7049	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7050	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7051	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7052	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7053	040322	cordage	S2Z	Arctic hare + caribou	
Baffin Island	Nanook	KdDq-9	2003-7054	040322	cordage	?	Arctic hare + ?caribou + feather	
Baffin Island	Nanook	KdDq-9	2003-7055	040322	cordage	Z2S	Arctic hare	knotted
Baffin Island	Nanook	KdDq-9	2003-7056	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7057	040322	cordage	S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7058i	040322	cordage	Z2S	muskrat possibly	
Baffin Island	Nanook	KdDq-9	2003-7058ii	040322	cordage	Z2S	Arctic fox	

Baffin Island	Nanook	KdDq-9	2003-7059	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7060	040322	cordage	Z2S	animal sinew	knot at one end
Baffin Island	Nanook	KdDq-9	2003-7061	040322	cordage	S	muskrat	
Baffin Island	Nanook	KdDq-9	2003-7062	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7063	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7064	040322	cordage	Z2S	??	poorly preserved, but not hare/rabbit
Baffin Island	Nanook	KdDq-9	2003-7066	040322	cordage	Z2S	Arctic hare	knot at one end
Baffin Island	Nanook	KdDq-9	2003-7067a	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7068	040322	cordage	Z2S	??	poorly preserved, but not hare/rabbit
Baffin Island	Nanook	KdDq-9	2003-7069	040322	cordage	Z2S	Arctic hare possibly	poorly preserved
Baffin Island	Nanook	KdDq-9	2003-7070	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7071	040322	cordage	Z2S	Arctic hare possibly	poorly preserved
Baffin Island	Nanook	KdDq-9	2003-7072	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7073	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7074	040322	cordage	S2Z	Arctic hare	irregular
Baffin Island	Nanook	KdDq-9	2003-7075	040322	cordage	Z2S	Arctic hare	loose ply
Baffin Island	Nanook	KdDq-9	2003-7076	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7077	040322	cordage	Z2S	Arctic hare	knotted to form a loop 10 mm diam.
Baffin Island	Nanook	KdDq-9	2003-7078i	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7078ii	040322	cordage	Z2S	Arctic hare	one piece knotted to form a loop 8 mm diameter, second piece threaded through loop
Baffin Island	Nanook	KdDq-9	2003-7079i	040322	cordage	Z	muskrat possibly	

Baffin Island	Nanook	KdDq-9	2003-7079ii	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7080	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7081	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7082i	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7082ii	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7083	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7084	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7085	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7087i	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7087ii	040322	cordage	Z2S	??	poorly preserved, not hare/rabbit
Baffin Island	Nanook	KdDq-9	2003-7088	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7089i	040322	cordage	Z2S	??	poorly preserved, not hare/rabbit
Baffin Island	Nanook	KdDq-9	2003-7089ii	040322	cordage	Z2S	Arctic hare	knotted to form loop 10 mm diameter
Baffin Island	Nanook	KdDq-9	2003-7090ii	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7091	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7092	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7093	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7094	040322	cordage	Z2S	Arctic hare + muskrat possibly	
Baffin Island	Nanook	KdDq-9	2003-7095	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7096	040322	cordage	Z	Arctic hare	single
Baffin Island	Nanook	KdDq-9	2003-7097	040322	cordage	S2Z	??	poorly preserved, not hare/rabbit
Baffin Island	Nanook	KdDq-9	2003-7098	040322	cordage	S2Z	Arctic hare	

Baffin Island	Nanook	KdDq-9	2003-7099	040322	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7100	040322	cordage	3-strand plait	animal sinew	
Baffin Island	Nanook	KdDq-9	2003-7101i	040322	cordage	S2Z	Arctic hare	
Baffin Island	Nanook	KdDq-9	7173	050322	cordage	Z2Z	Arctic fox	loosely plied
Baffin Island	Nanook	KdDq-9	7211	050322	cordage	Z2S	Arctic hare + Arctic fox possibly	
Baffin Island	Nanook	KdDq-9	7230	050322	cordage	??	Arctic hare	
Baffin Island	Nanook	KdDq-9	H-93		cordage		Arctic hare	no report; pencil record only
Baffin Island	Nanook	KdDq-9	5927a	060909	cordage	S2Z	otter possibly	
Baffin Island	Nanook	KdDq-9	8224	060909	cordage	S-spun yarn end	Arctic fox probably	
Baffin Island	Nanook	KdDq-9	8366	060909	cordage	Z2S	Arctic hare	knotted
Baffin Island	Nanook	KdDq-9	9216ai	060909	cordage	Z2S	otter possibly	
Baffin Island	Nanook	KdDq-9	9216aii	060909	cordage	Z2S	blend	
Baffin Island	Nanook	KdDq-9	9042	070130	cordage	Z2S	Arctic fox	
Baffin Island	Nanook	KdDq-9	9043	070130	cordage	Z2S	Arctic fox	
Baffin Island	Nanook	KdDq-9	9044	070130	cordage	S2Z	rat possibly	
Baffin Island	Nanook	KdDq-9	9045	070130	cordage	S2Z	rat possibly	
Baffin Island	Nanook	KdDq-9	9079a	070130	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	9157b	070130	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	4799	090330	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	#2	180208	cordage	Z2S	Arctic hare	

Baffin Island	Nanook	KdDq-9	#8	180208	cordage	Z2S	Arctic hare	
Baffin Island	Nanook	KdDq-9	2002-T-1	030327	cordage	I2S	animal sinew	0.5-1.0 mm wide
Baffin Island	Nanook	KdDq-9	2003-7090i	040322	felted fibre		muskrat	
Baffin Island	Nanook	KdDq-9	H-78	050322	fibre		horse mane hair possibly	
Baffin Island	Nanook	KdDq-9	H-82b	060914	fibre		baleen	
Baffin Island	Nanook	KdDq-9	H-101	060909	fibre			poorly preserved coarse single fibre
Baffin Island	Nanook	KdDq-9	9827	090330	fibre tuft		Arctic fox	
Baffin Island	Nanook	KdDq-9	2003-7065	040322	fibre twist		??	twist of fibres, poorly preserved
Baffin Island	Nanook	KdDq-9	H-105	070130	fibre twist		feathers	
Baffin Island	Nanook	KdDq-9	H-108	070130	fibre twist		feathers	
Baffin Island	Nanook	KdDq-9	H-113	080320	fibre twist		feathers	
Baffin Island	Nanook	KdDq-9	H-150 = 7290iv	090330	fibre twists		feathers	
Baffin Island	Nanook	KdDq-9	H-152 = 7172iii	090330	fibre twists		feathers	
Baffin Island	Nanook	KdDq-9	H-155 = 7172ii	090330	fibre twists		feathers	
Baffin Island	Nanook	KdDq-9	7102	050322	fibres		feathers	

Baffin Island	Nanook	KdDq-9	7117	050322	fibres		feathers	
Baffin Island	Nanook	KdDq-9	H-80	050617	fibres		human hair	
Baffin Island	Nanook	KdDq-9	H-81	050617	fibres		human hair	poorly preserved
Baffin Island	Nanook	KdDq-9	H-97	060912	fibres		baleen	
Baffin Island	Nanook	KdDq-9	H-111	070130	fibres		horse or bear	see report for difficulty of distinguishing
Baffin Island	Nanook	KdDq-9	2003-7089iii	040322	loose tuft		human hair	
Baffin Island	Nanook	KdDq-9	2003-7101ii	040322	loose tuft		Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7101iii	040322	loose tuft		horse mane hair possibly	
Baffin Island	Nanook	KdDq-9	4794	010322	pelt		rat	fibre tufts 35 mm long
Baffin Island	Nanook	KdDq-9	2002-T-32b	030327	pelt		Arctic fox possibly	plant roots present
Baffin Island	Nanook	KdDq-9	S1	040225	pelt			sealskin already identified. PWR provided comment on needlework
Baffin Island	Nanook	KdDq-9	H-52	050617	pelt		bear	poor condition
Baffin Island	Nanook	KdDq-9	H-53	050617	pelt		wolf probably	
Baffin Island	Nanook	KdDq-9	H-54	050617	pelt			poorly preserved
Baffin Island	Nanook	KdDq-9	H-55	050617	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-56	050617	pelt		bear possibly	poor condition
Baffin Island	Nanook	KdDq-9	H-57	050617	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-58	050617	pelt		bear possibly	possibly fine bear fur

Baffin Island	Nanook	KdDq-9	H-59	050322	pelt		rat	
Baffin Island	Nanook	KdDq-9	H-60	050322	pelt		rat	
Baffin Island	Nanook	KdDq-9	H-61	050617	pelt		???	
Baffin Island	Nanook	KdDq-9	H-62	050322	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-63	050617	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-64	050617	pelt		otter	
Baffin Island	Nanook	KdDq-9	H-65	050617	pelt		bear possibly	poorly preserved
Baffin Island	Nanook	KdDq-9	H-66	050617	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-67	050617	pelt		rat + some Arctic hare	
Baffin Island	Nanook	KdDq-9	H-69	050322	pelt		otter	
Baffin Island	Nanook	KdDq-9	H-70	050322	pelt		otter	
Baffin Island	Nanook	KdDq-9	H-71	050322	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-72	050617	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-73	050322	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-74	050617	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-75	050322	pelt		otter probaby	
Baffin Island	Nanook	KdDq-9	H-76	050322	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-77	050617	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-79	050322	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-23	050617	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-24	050617	pelt		Polar bear	
Baffin Island	Nanook	KdDq-9	H-82a	060328	pelt		bear	updated in REP 060914

Baffin Island	Nanook	KdDq-9	H-83	060328	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-84	060328	pelt		???	updated in REP 060914
Baffin Island	Nanook	KdDq-9	H-85	060328	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-86	060328	pelt		bear	updated REP 060914
Baffin Island	Nanook	KdDq-9	H-87	060328	pelt		deer	
Baffin Island	Nanook	KdDq-9	H-88	060328	pelt		bear	updated REP 060914
Baffin Island	Nanook	KdDq-9	H-89	060328	pelt		deer	
Baffin Island	Nanook	KdDq-9	H-90	060328	pelt		???	updated REP 060914
Baffin Island	Nanook	KdDq-9	H-91	060328	pelt		deer	
Baffin Island	Nanook	KdDq-9	H-92	060328	pelt		bear/cattle	updated REP 060914
Baffin Island	Nanook	KdDq-9	H-94	060328	pelt		bear/cattle	updated REP 060914; poorly preserved
Baffin Island	Nanook	KdDq-9	H-95	060328	pelt			
Baffin Island	Nanook	KdDq-9	H-96	060328	pelt		Arctic hare + rat possibly	
Baffin Island	Nanook	KdDq-9	H-98	060909	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-99	060909	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-100	060909	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-102	060909	pelt		water mammal probably	resembles seal but not identical, cf H-95
Baffin Island	Nanook	KdDq-9	H-106	070130	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-107	070130	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-109	070130	pelt		??	
Baffin Island	Nanook	KdDq-9	H-110	070130	pelt		Arctic fox	

Baffin Island	Nanook	KdDq-9	H-112	070130	pelt		otter probaby	
Baffin Island	Nanook	KdDq-9	H-115	080320	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-120	080320	pelt		polar bear possibly	
Baffin Island	Nanook	KdDq-9	H-121	080320	pelt		fox probably	
Baffin Island	Nanook	KdDq-9	H-122	080320	pelt		polar bear	
Baffin Island	Nanook	KdDq-9	H-123a	080320	pelt		young seal	
Baffin Island	Nanook	KdDq-9	H-123b	080320	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-124a	080320	pelt		seal-like	
Baffin Island	Nanook	KdDq-9	H-124b	080320	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-125	080320	pelt		??	poorly preserved
Baffin Island	Nanook	KdDq-9	H-126	080320	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-127	080320	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-128	080320	pelt		young seal	
Baffin Island	Nanook	KdDq-9	H-129	080320	pelt		??	poorly preserved
Baffin Island	Nanook	KdDq-9	H-130	080320	pelt		??	poorly preserved
Baffin Island	Nanook	KdDq-9	H-132	080320	pelt		seal-like	
Baffin Island	Nanook	KdDq-9	H-133	080320	pelt		bear	
Baffin Island	Nanook	KdDq-9	H-134	080320	pelt		bear possibly	
Baffin Island	Nanook	KdDq-9	H-136	080320	pelt		polar bear	
Baffin Island	Nanook	KdDq-9	H-137	080320	pelt		wolf	
Baffin Island	Nanook	KdDq-9	H-140 = 9831	090330	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-141 =	090330	pelt		Arctic fox	

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Baffin Island	Nanook	KdDq-9	H-142 = 10023	090330	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-144 = 9933	090330	pelt		dog or wolf	
Baffin Island	Nanook	KdDq-9	H-147 = 9929	090330	pelt		Arctic fox	
Baffin Island	Nanook	KdDq-9	H-154 = 7172i	090330	pelt		Arctic hare	
Baffin Island	Nanook	KdDq-9	2003-7067b	040322	pelt probably		caribou	
Baffin Island	Nanook	KdDq-9	2003-7086	040322	pelt probably		??	semi-carbonised fur fibres
Baffin Island	Nanook	KdDq-9	2002-T-5	030327	raw fibre		moss, fur, sinew & fungal hyphae	
Baffin Island	Nanook	KdDq-9	4795	010322	raw fibre	matted fibres	Arctic fox	matted fibres, incomplete length; 2nd report ASLab 040224
Baffin Island	Nanook	KdDq-9	3 OL15-5L15-b	010627	raw fibre	tufts	Arctic hare	fibre tufts arranged tip-to-end
Baffin Island	Nanook	KdDq-9	H-103	070130	raw fibre		horse probably	
Baffin Island	Nanook	KdDq-9	H-104	070130	raw fibre		horse probably	
Baffin Island	Nanook	KdDq-9	H-116	070130	raw fibre		bear with some ?human hair	
Baffin Island	Nanook	KdDq-9	H-117	080320	raw fibre		polar bear	

Baffin Island	Nanook	KdDq-9	H-118	080320	raw fibre		polar bear	
Baffin Island	Nanook	KdDq-9	H-119	080320	raw fibre		polar bear	
Baffin Island	Nanook	KdDq-9	H-131	080320	raw fibre		Arctic fox possibly	
Baffin Island	Nanook	KdDq-9	H-135	080320	raw fibre		Arctic hare + Arctic fox possibly	
Baffin Island	Nanook	KdDq-9	H-143 = 9928	090330	raw fibre		bear possibly	poorly preserved
Baffin Island	Nanook	KdDq-9	H-145 = 9832	090330	raw fibre		Arctic hare	
Baffin Island	Nanook	KdDq-9	H-148 = 7179	090330	raw fibre		mixed, some Arctic fox	
Baffin Island	Nanook	KdDq-9	H-149 = 7276	090330	raw fibre		mixed, some Arctic fox	
Baffin Island	Nanook	KdDq-9	H-151 = 7459	090330	raw fibre		???	poorly preserved
Baffin Island	Nanook	KdDq-9	H-153 = 7110iv	090330	raw fibre		plant remains, including seed husks	one short animal fibre resembled bear
Baffin Island	Nanook	KdDq-9	H-156 = 7175vi	090330	raw fibre		young seal	
Baffin Island	Nanook	KdDq-9	H-114	080320	single fibre		human hair or bear	possibly modern
Baffin Island	Nanook	KdDq-9	H-138	080320	single fibre		??	poorly preserved
Baffin Island	Nanook	KdDq-9	4440f	010330	skin	Z & S	animal sinew probably	elliptical piece of skin/hide pierced by

					stitched sinew			?sinew
Baffin Island	Nanook	KdDq-9	2003-7047b	040322	tuft of fibres		feathers	
Baffin Island	Nanook	KdDq-9	9041	070130	twisted fibre		feather	
Baffin Island	Nanook	KdDq-9	H-68	050617	twisted tuft		mixed fibres	
Baffin Island	Nanook	KdDq-9	H-139 = 9816	090330	two fibres		bear possibly	
Baffin Island	Tanfield	KdDq-9-3	??	090330	cordage	Z2S	Arctic hare	knot = granny knot
Baffin Island	Tanfield	KdDq-9-3	4789	090330	cordage	Z2S	Arctic hare probably	
Baffin Island	Willows Is, Nunavut	KeDe-14	4879b	010330	fibres		plant tissue	associated with cord
Baffin Island	Willows Island	KeDe-14	4879	000427	cordage	Z2S	Arctic hare	
Baffin Island	Nunguvik	PgHb-1	14765	000721	associated fibres	loose	goat re-assessed as caribou	
Baffin Island	Nunguvik	PgHb-1	14765	990716	cordage	Z2S	Arctic hare	Some other animal fibres adhering & plant tissue, probably moss
Baffin Island	Nunguvik	PgHb-1	8424	990914	cordage	Z2S	Arctic hare	some moss present

Baffin Island	Nunguvik	PgHb-1	18025	none	cordage	Z6S3Z	polyester	contaminant
Baffin Island	Nunguvik	PgHb-1	18027	none	cordage	Z6S3Z	polyester	contaminant
Baffin Island	Nunguvik	PgHb-1	11465-B		raw fibre		?dog	No report on file but record dated 2 November 2001.
Bathurst Island	Brooman Point	QiLd-1	575	010626	cordage	Z2S	animal sinew	embedded in seal fat with feathers
Bathurst Island	Brooman Point	QiLd-1	575	010626	cordage	3-strand plait	animal sinew	embedded in seal fat with feathers
Labrador	Avayalik I	218 ON/6E	#2 cat 3608	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	579 ON/8E	#6 cat 3613	010417	cordage	Z2S2Z	Arctic fox	3.5-4.0 mm thick; folded end
Labrador	Avayalik I	618 ON/8E	#7 cat 3614	010417	cordage	Z2S	dog	
Labrador	Avayalik I	695 ON/8E	#11 cat 3615	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	55 ON/10E	#12 cat 3621	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	231 2N/8E	#13 cat 3618	010417	cordage	Z2S2Z	Arctic fox	3.5-4.0 mm thick
Labrador	Avayalik I	247 2N/8E	#14 cat 3626	010417	cordage	Z2S4Z	Arctic fox	5.5-6.0 mm thick; folded end

Labrador	Avayalik I	132 ON/6E	#15 cat 3606	010417	cordage	Z2S6Z	Arctic fox possibly, or Arctic fox + another fibre	7.0 mm thick; folded end
Labrador	Avayalik I	698ON/8E	#1 cat 3616	010417	cordage	Z2S3Z	Arctic fox	5.0-6.0 mm thick.
Labrador	Avayalik I	231 2N/8E	#3 cat 3619	010417	cordage	Z2S2Z	Arctic fox	3.5-4.0 mm thick
Labrador	Avayalik I	??	#4 cat 3609	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	231 2N/8E	#5 cat 3619	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	134 2N/6E	#8 cat 3611	010417	cordage	Z2S4Z	Arctic fox	5.5-6.0 mm thick; folded end
Labrador	Avayalik I	157 ON/6E	#9 cat 3607	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	??	#10 ct3 610	010417	cordage	Z2S	Arctic fox	
Labrador	Avayalik I	JaDb 578 ON/8E	cat 3612 #A	130124	cordage	Z2S	Arctic fox probably + 2nd species	
Labrador	Avayalik I	JaDb 1989-91 PIT A	wood bag' #B	130124	cordage	Z2S2Z	Arctic fox probably + 2nd species	4.0 mm thick.
Newfound-land	Cape Ray	CdBt-1		000722	cordage	Z2S	Arctic hare+seal blend	updated in ASLab REP 010321 where seal identified.

Appendix 3. Table of cordage, threads and yarns from Norse sites in Greenland.

Site	Object code	Construction	Identification from microscopy	Notes
GUS	1950x608	S2Z	sheep	dark brown pigmentation
GUS	1950x698	Z2S & individual Z yarns	sheep	1 cord & variable pigmentation along length
GUS	1950x791	S3Z	sheep	non-pigmented, originally white
GUS	1950x814	unknown	?bear	dense pigmentation
GUS	1950x819	Z2S	sheep	black & white fibres = overall grey
GUS	1950x1014	S6Z	sheep	black & white fibres = overall grey
GUS	1950x1063	S2Z & Z2S4Z	sheep	non-pigmented, originally white
GUS	1950x1109	S	sheep	dark brown pigmentation
GUS	1950x1426	sewing yarn, Z2S	sheep probably	poorly preserved
GUS	1950x1611	S2Z2S	sheep probably	poorly preserved, mostly pigmented
GUS	1950x1796	Z2S	cattle	probably adult
GUS	1950x1846a	fine Z	sheep	non-pigmented, originally white
GUS	1950x1846b	S2Z	sheep	brown pigmentation
GUS	1950x1902	Z2S	?bear + ?	brown pigmentation; second species present
GUS	1950x2119	S6Z	sheep	poorly preserved, some pigmented
GUS	1950x2506	S	sheep	white underwool black hairs
GUS	1950x3457a	multistrand:S8Z?	sheep	white underwool brown hairs
GUS	1950x3457b	S3Z	sheep	pigmented & non-pigmented
GUS	1950x479	Z2S	goat	
Site 991	x448	braided edge	sheep	non-pigmented, originally white
Site Ø34	x640	Z2S	sheep	non-pigmented, originally white, stained red
Herjoflsnæs	D10584	braid made from Z2S yarns	sheep	poorly preserved
Herjoflsnæs	D10622	S-spun	sheep	non-pigmented, originally white
Herjoflsnæs	D10624	flat plait made from S2Z	sheep	non-pigmented, originally white, stained red
Herjoflsnæs	D12411(2)	S-spun	sheep	non-pigmented, originally white
Herjoflsnæs	D12807(1)	unknown	canid possibly wolf	black & white fibres = overall grey; possibly second species present.

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Fig.1. A bundle of cords from site KdDq-9, find 4799. ASLab, Penelope Walton Rogers.
Fig.2. Sites which have yielded cordage (red) and other sites mentioned in the text (black). ASLab.
Fig.3. Scale patterns in the cuticle mentioned in the text. Adapted from Appleyard 1978.
Fig.4. Fibre cross-sections mentioned in the text. Adapted from Appleyard 1978
Fig.5. Medulla types mentioned in the text. Adapted from Appleyard 1978.
Fig.6. Pigmentation (inherent colour) appears as granules in the fibre, which can be seen in whole mount and cross-section. Adapted from Appleyard 1978.
Fig.7. The spin direction of single yarns and the ply of cords. ASLab.
Fig.8. Cords KdDq-9: 4799 as received (above); and a close-up of the two cords from which the fibre samples in Fig.9 were extracted (below). Photo: ASLab, Penelope Walton Rogers.
Fig.9. Fibres extracted from cords of KdDq-9: 4799. Note especially the chevron scale pattern on fine fibres, the multi-serial medulla and the dumbbell shaped cross-section of coarse fibres. Images captured at x200 with camera zoom. Photo: ASLab, Penelope Walton Rogers.
Fig.10. Arctic hare, Nunavut c.2010. Photo: Steve Sayles, CC BY-SA 2.0.
Fig.11. Fibres extracted from skin garment KdDq-7-3: H-159, with scale casts from pelt fragment KdDq-9: H-63. Note the prominent scale margins, variety of medulla types and diamond-petal scale pattern. Images captured at x200 with camera zoom. Photo: ASLab, Penelope Walton Rogers.
Fig.12. Fragments of skin garment KdDq-7-3: H-159 (left) and pelt KdDq-9: H-63 (right). Photo: ASLab, Penelope Walton Rogers.
Fig.13. Arctic fox, left in winter coat with some tawny fibres; right with darker hairs. Photos: left, Algkalv, CC BY 3.0; right, Rama, CC BY-SA 2.0-fr.
Fig.14. The Baffin Island tundra wolf. Despite an extensive on-line search, it has not been possible to establish the identity of the original copyright-holder, although the image is believed to be in the public domain.
Fig.15. Dogs near Kimmirut, Baffin Island. Photo: M Hopson, The Chinook Project, www.chinookproject.ca.
Fig.16. American mink, Maine. Photo: Needsmoreritalin (aka Chuck Homler), CC BY-SA 3.0.
Fig.17. Otter, Lontra Canadensis, travelling by ice. Photo: Rocky Mountain National Park, public domain.
Fig.18. Muskrat. Photo: *Sergey Uryadnikov, courtesy of Shutterstock.*
Fig.19. Polar bear. Photo: Alan Wilson, www.naturespicsonline.com, CC BY-SA 3.0.

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