

Square sails of wool

by Erik Anderson

(continued from Vol. II No. 1)

The Viking Period and the Middle Ages until c. 1500

The ship-finds of Oseberg and Gokstad included large lumps of a uniform woollen fabric, clearly red in colour and interlaid with pieces of rope the thickness of a finger. In the material from Oseberg there were also preserved a number of toggles¹⁵. These textile fragments were at first taken to be tent canvas. Today we can state that they can only be sails or tents, i.e. related types of material. The fabrics have been difficult to analyse as they were almost "cemented" together. For the present we can only say that the material is a closely beaten 2/2 diagonal twill with a count of 13-14 z-spun threads per centimetre in the warp and 8-9 z-spun threads per centimetre in the weft. The fulling is estimated to be quite heavy, making the weave less close originally. The quality of the yarn is uncertain¹⁶. On photographs the fragments from the Oseberg find show some preserved weave pattern. The impression of a much fulling material (core fulling) does not agree with a z-spin in both warp and weft, it might rather be a result of the final treatment of the fabric (tanning, horse-fat, wax or the like), whether for use as sail or tent, in combination with the long stay in the mound.

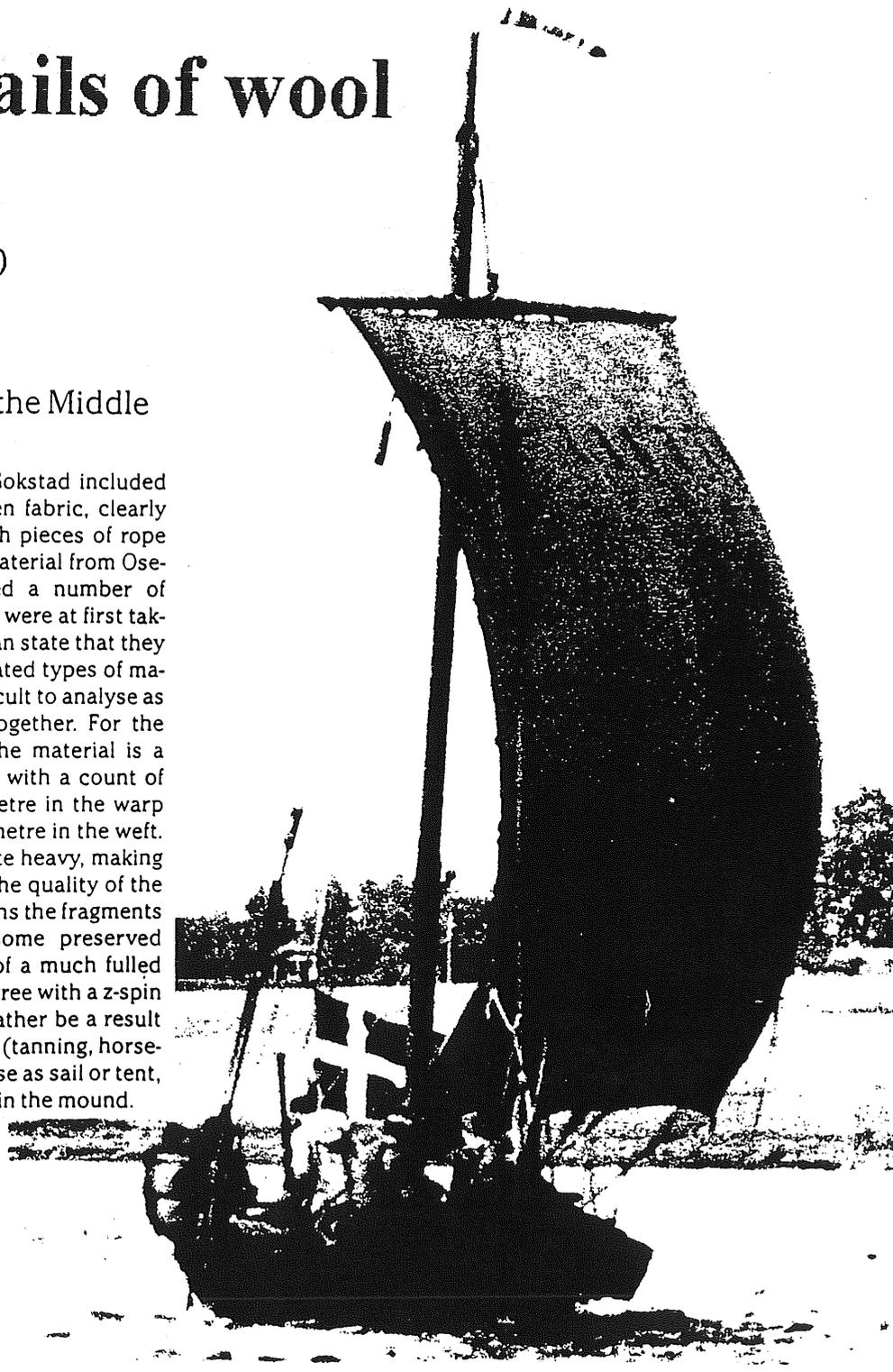


Fig. 18. Roar Ege with a woollen sail in 2/1 twill. Photo: The Viking Ship Museum.

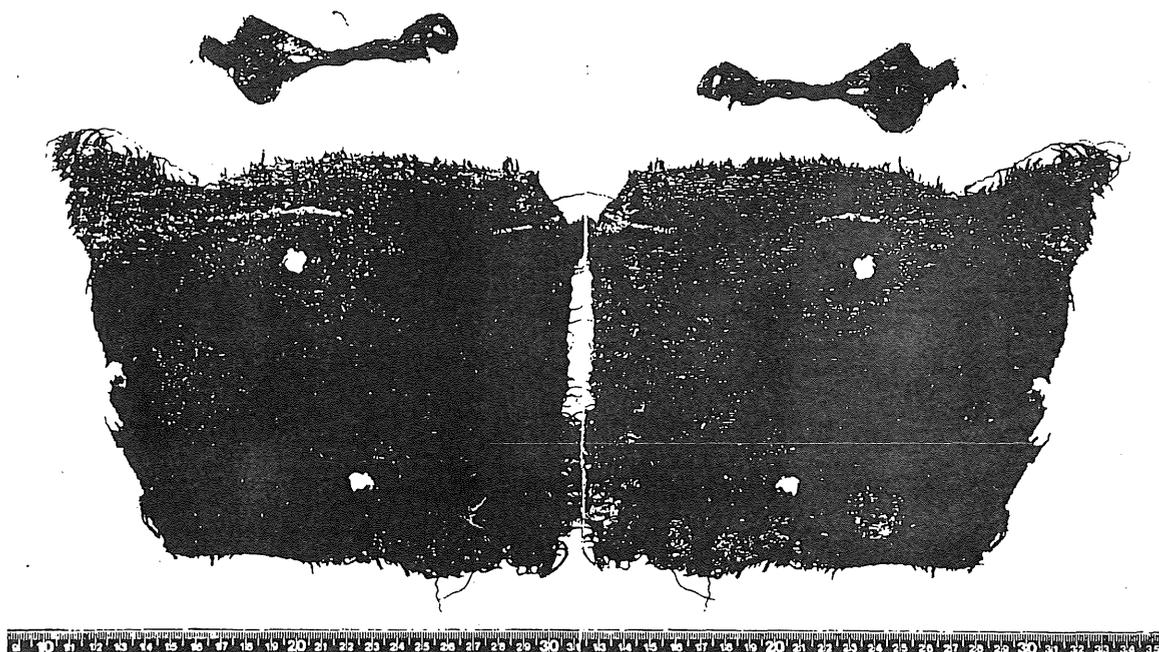


Fig. 10. The two sides of the fragment of a 2/1 twill fabric from the Lynæs ship. Photo: Niels Erik Jehrbo, The National Museum of Denmark.

The size of the sail for the Oseberg ship must have been about 95-107 m² and that for the Gokstad ship about 125 m². The tent- or sail-material that was found in the ships was approximately of the same weight per square metre as the sail from Nordmøre. Naturally we have not been able to compare the two groups of fabrics by bending and stretching and accordingly we cannot be sure of their strength. If the Oseberg material is the tight beat in weave we think it is, then the weight is right. As the 2/2 twill is probably more elastic than the 2/1 twill we cannot be certain if this is also a valid assumption for the larger sail of the Gokstad ship⁴⁷.

A 2/1 twill identical to a Norwegian 19th-century wool sail from Nordmøre was found between a repair and a plank join on the 12th-century Lynæs ship excavated in 1975. Type of wool, quality of fibres, the spin in the yarn and the count of threads in the weave are all alike. There are 12 z-spun threads per cm in the warp and 7 s-spun threads per cm in the weft, compared to the Nordmøre sail with its warp of 12 z-spun and weft of 9 s-spun threads per cm⁴⁸. We cannot be quite certain as to whether the Lynæs material was from an old sail, but we do know that it was like

the material used in large sails. Combining this with the dating of Skuldelev 3 to the latter half of the 11th century and a weight of 700-750 g/m² made us choose the 2/1 twill in a Lynæs-Nordmøre quality for our first wool sail for the Skuldelev 3 replica *RoarEge*⁴⁹.

From the very first attempt with a wool sail our interest in the 2/1 twill for sail material has increased. This is due to the special quality of this weave but also to the find of a number of woollen materials in the roof-constructions of medieval Norwegian coastal churches that were part of the *leding*-system⁵⁰. The textile fragments, dated to c. 1280-1400, had been used (as *skarsi*) to seal up the joins in the plank-built roofs which can be found underneath later shingle-roofing. Cut-off pieces had furthermore been left on top of the battlements even where the original roof had been removed. The 2/1 twill which we are especially interested in was found in quite large amounts in Trondenes church near Harstad. It had a thread count of 8 (z-spin) in the warp and 5-6 (s-spin) in the weft. The warp is hard and smooth and made of long fibres. The weft is looser and wool seems to predominate. The weight of the material is 950-1000 g/m², suitable for sails of from 50-60 m² to

about 130 m², which would be exposed to a lot of wear. The seemingly non-fulled material looks like the coarse material for sails of flax or hemp found on the royal ship *Vasa*⁵¹. The type is akin to the Lynæs/Nordmøre material but much coarser. Whether the Trondenes material stems from a sail will probably never be ascertained by the traditional methods of textile analysis (see below) but it is clearly a type of woollen material which we know could be used for sails. Only practical testing can tell us more and the two sails which are being made by Amy Lightfoot at Kvenvær on Hitra are based on the Trondenes material.

Woollen sail-material called *vadmel* is as noted earlier mentioned several times in the written sources without it being possible to determine the exact quality, for instance *sails white as the snow of vadmål from Nordland*⁶². The *King's Mirror (Kongespejlet)* does suggest in the section on the merchant that a material (*vadmel*) for sails had to be of a special kind. It says: *Whenever you set out to sea you must bring on your ship two or three hundred alen of vadmel suitable for repairing the sails if necessary*⁵³.

Sails made of tabby (*einskefta*) are not mentioned in the written sources before 1500, but later information from for instance Iceland and Sweden on non-fulled wool sails of tabby are so close in time to the Middle Ages that we may assume this to be an old and original type of material for sails. The same weave in flax or hemp was probably also more common in some of the Nordic areas than shown in the material finds. As in later periods, there may also have been sails made of nettle-material.

We have more textile finds than the ones mentioned here which might stem from sails, but in order to analyse these new methods will have to be devised.

Special woollen fabrics from countries outside of the Nordic area have most likely been in use at times during the Viking Period and the Middle Ages. Furthermore, there is the question of import and export or exchange of woollen material among the Nordic countries themselves.

Comparison of the older and newer fabrics seen in relation to the wool-sail experiments

Up to about 1850 there was one rather uniform racial group of short-tail sheep in Northern Europe. They can still be found in Northern Russia

(Romanov sheep), Finland, Sweden (Gotland sheep), Scotland, the North Atlantic islands of Shetland, the Faroes and Iceland, and a few in Northern Germany. These sheep races are on the decline but continue to hold their own on the most meagre of pastures⁵⁴.

In the Viking period and the Middle Ages and up to our time all home-spun woollen material was made of wool from these sheep. In the Swedish region from c. 1500 it is difficult to judge to what degree the sheep of the different regions avoided crossbreeding with other races.

A characteristic of the short-tail sheep is their coat of a fine, soft wool underneath and above this a layer of long, coarse and lustrous hair. The quality of the hair may vary considerably from one animal to another. In this respect there is quite a difference between sheep from Iceland and the Faroes and those from Norway and Sweden, and from one local area to the other. The climate, grazing etc. play a part in this today, as they must have done in the period with which we are concerned. This means that it will be difficult to determine the exact mix of wool and long or short hair in warp and weft of the preserved pieces of sail material. To be able to do this we should need greater knowledge of the specially selected local sheep that yielded the wool, the sorting of the wool and hair etc.

On one point the information from the Faroe Islands and Iceland is quite specific, the warp of tabby weave is made of hair. In Iceland this seems to be the case for the weft also, but what kind of hair is not clear, and neither is the question of whether the thread for warp and weft had the same hard spin. From the Åland islands we hear that the thread for a wool sail must be very thin and especially hard spun. It is also an open question whether the fibre quality was alike in warp and weft. For *vadmel* on the other hand we are given the information that it is only the thread (of the best wool) in the warp that must be spun hard. The same information is given in Norway⁵⁵.

There is no doubt that the non-fulled tabby sails from the Swedish-Finnish region, given the differences in the sheep's coats mentioned earlier, are very similar to those of the Faroe Islands and Iceland.

The first wool sail (2/1 twill) made for the Skuldelev 3 replica *Roar Ege* had a mix of hair and wool in both warp and weft with more wool in the weft. The material was about half-fulled. We did not make the desired weight of 750 g/m² but only

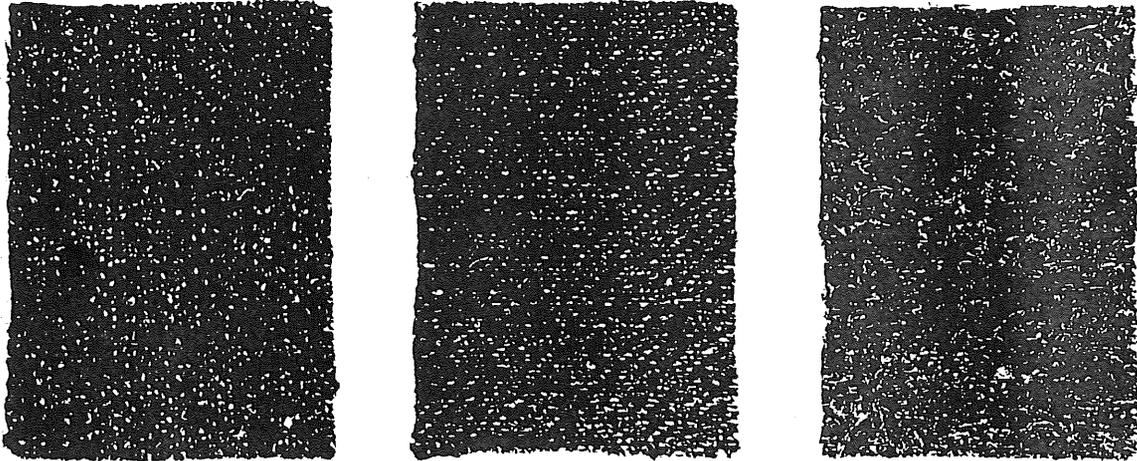


Fig. 11. Samples of *Roar Ege's* wool sail. The one to the right has been rubbed with melted sheep's tallow mixed with train oil and tar. Experiments in treating the Faroese tabby wool sail in the same manner are so promising that *Roar Ege's* sail will be part of further experiments. Photo: Werner Karrasch, The Viking Ship Museum.

500 g/m². For a sail of c. 46 m² like *Roar Ege's* this weight gave a material which was too elastic in heavy wind, and not tight enough. The material would have suited a sail of 20 m². No doubt we can improve this 2/1 twill and get a more useful product. But we did not match the Nordmøre/Lynæs quality of material, at which we were aiming.

The conclusion at this stage is that the warp must be made of hair and the weft of combed wool with a looser spin than that of the warp. The material must be lightly or quarter-fulled. One must take into account when making a thread count that all the preserved material has been exposed to some kind of treatment after weaving. It is characteristic for the sail fabrics that the weave was hard beaten in as opposed to *vadmel*, which nearer our time was a looser weave in order to felt better during the fulling. The threads of warp and weft were made from the short and fine wool.

The present picture of the wool sail-material is as follows:

1. *Binding*. In the Viking period and up into the 11th century a 2/2 diagonal twill and plain 1/1 tabby are the dominant weaves in material for sails. These bindings were used right up to the 19th century. In the Faroe Islands and Iceland the tabby seems to have been the usual binding far back in time. In Iceland this specialization could be connected with the fact that this binding, besides providing a strong and durable product, needs less wool than the 2/2 twill, and also that the type of

wool used for tabby was not a suitable material for the large Icelandic export-production of woollen fabrics in the Middle Ages to the 16th century.

In the 11th century the 2/1 twill emerges. From what we know up to now, it was very suitable material for woollen sails. We cannot be certain on the other hand as to its distribution. It can be found in Norway but is not used in Iceland and the Faroes, and in the Swedish and Swedish-Finnish region the 2/2 twill and 1/1 tabby seem to be the traditional bindings.

2. *Direction of spin in warp and weft*. 1/1 tabby has z/z spin, 2/1 twill has z/s spin and the 2/2 twill is seen with both z/z and z/s spin.

3. *Tightness of spin. Type of fibre and treatment*. Tabby. A. Tight spin of thread from hair in warp, and looser spun and fuller thread for the weft of mixed short hair and wool. B. Tight spin in the warp, predominantly of hair. Tightly spun weft? Hair? Both A and B fabrics are lightly treated and not really fulled.

Twill 2/1. A. Tight spin in the warp, predominantly of hair. Looser and fuller weft, predominantly of wool, possibly with some short hair mixed in. Lightly to quarter fulled. B. Possibly a tightly spun warp combined with a tight or looser thread for the weft. Both threads of mixed fibres. Quarter to half fulled?

Twill 2/2. A. Tightly spun thread in the warp, predominantly of hair. Looser and fuller weft. Large content of wool. Light to quarter fulled depending

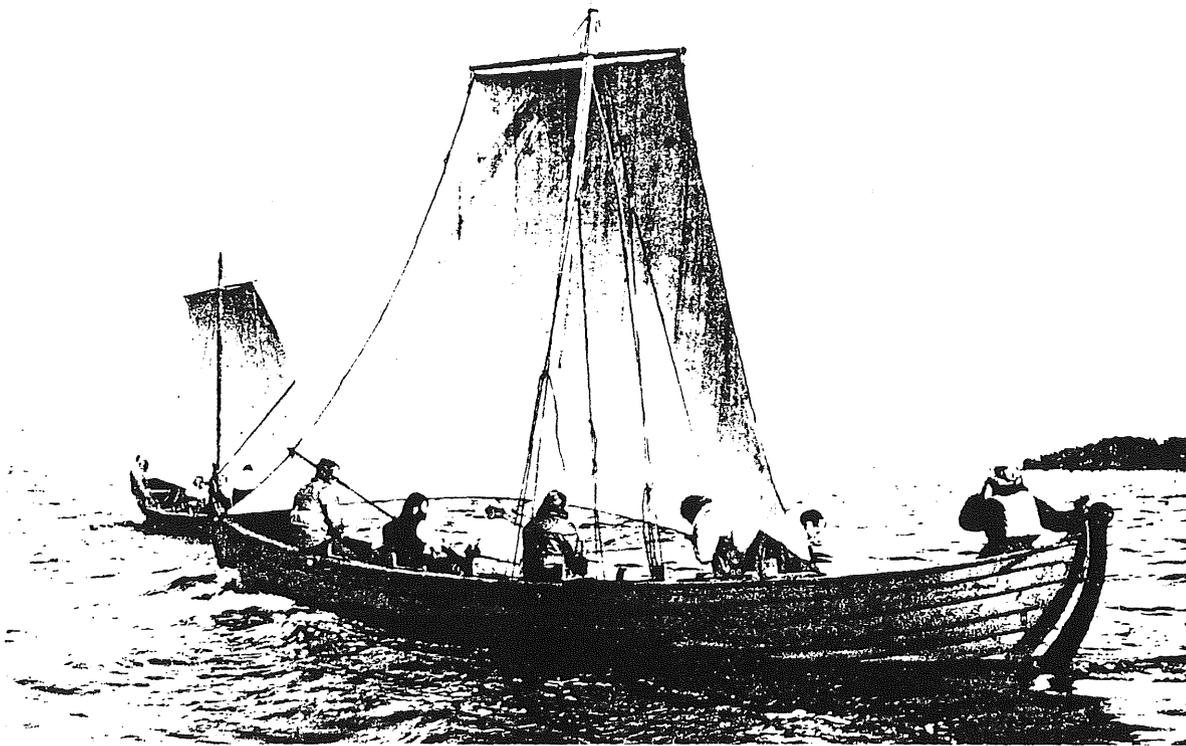


Fig. 13. The two Faroese boats *Ask* and *Embla* belonging to the Viking Ship Museum with square sails of cotton and wool respectively. The wool sail in the foreground (tabby or *einiskjeft*) performed quite as good as the cotton sail. Photo: Werner Karrasch, The Viking Ship Museum.

among other things on the direction of spin in the weft. B. Tight spin in warp. Looser or tight spin in weft. Mixed fibre-content in both threads. Quarter to half fulling? C. Tight spin in warp. Tight spin in weft? Long hairs in warp. Weft thread not determined? Lightly treated fabric.

Of these sail materials we know the lightly treated or half fulling fabrics best. Even the most specially designed of these fabrics (i.e. those from the Faroes and Iceland) have had other uses such as "shirts to wear when on the sea".

In the 10th-century (?) fabrics from Greenland, which are probably not sail fragments, we find a fibre content in warp and weft very similar to the one in the Lynæs, Nordmøre fabric. We must allow for the fact that in addition to the making of material for local boats and *leding*-vessels etc., there would have been a "mass" production of standard fabrics for other purposes to be sold at markets. This is made clear from the Swedish written sources dating from the 16th century and later. A certain variation in the fabrics must also have been seen in the Middle Ages and the Viking

period. Some of these types of fabric could have been imports from other Nordic countries. It is also likely that non-Nordic woollen cloth types were occasionally used for sails though I do not believe that completely fulling *vadmel* or cloth were ever used.

The three different bindings and their matching qualities of threads give, as we see it now, the following types of sail material. Tabby makes a harder and stiffer (less elastic) material than the two twills, but probably also a more durable one. The 2/2 twill binding on the other hand gives a softer fabric more easily folded and workable, which is a great advantage in large sails. The 2/1 twill is in between as to elasticity and softness. It is well suited for all sizes of sails.

The complicated process of wool-treatment, spinning and weaving lies outside the scope of this article but we can pose the interesting question: Which of the above types of sail fabrics that we have tried to come to grips with is identical to the material (*vadmel*) for repairing the sails that is mentioned in *The King's Mirror*?

On the width and length of the sail material and on the technique of the square sail

The types of square sails we are working with at present had two lengths of material sewn together. The width referred to the *alen* measure which was used in the land or region in question. As mentioned earlier, the width of the material on the Åland islands was in recent times about $1\frac{1}{4}$ *alen* or 70-75 cm. In the wider Nordic region the material was made in widths from c. 55 cm (in Norway) to a maximum of 90-100 cm. A narrower material could also have been made. It has not been possible to see any connection between the thickness and the width of the fabrics, but to get a good shape in the sail the fabric should be neither too wide nor too narrow. If it had to be wider than mentioned above a hidden seam was needed. We expect that the width of sail material whatever the type would be within the same standards in the Viking Age and Middle Ages as in later times.

The square sail with its vertical lengths sewn together can be traced far back in literature and in the iconographic sources, and it remained in use right to the end. In more recent material the lengths were also sewn together horizontally⁵⁶.

The medieval sources mention in addition to the one-coloured wool sails (white, grey, reddish-

brown, depending on the colour of the wool and treatment of fabric) striped sails with lengths in different colours. Bands and strengthenings have also been used. On the picture stones from Gotland we find sails with diagonal patterns. There are those who think they represent plaited sails⁵⁷. Some of the details in this very much discussed material do belong to the world of reality, for instance the many sheets underneath the sails, but it is not possible at this time to deduce any certain information on the sail material, the construction of the sail etc. In the very difficult task of getting the right quality of material, we must stay with the sail sewn together of vertical lengths, which we know for certain was widely utilized and which can be followed into more recent times.

In Iceland and the Faroes the woollen fabrics were for a very long period of time woven on a warp-weighted loom. Faroese sources relate that in more recent times it was possible to weave lengths of 9 *alen*⁵⁸. In Iceland on the other hand they could weave unbroken lengths of 21 *alen* (c. 55 cm wide) as early as the Middle Ages on the same type of loom⁵⁹. This might have been in competition with the horizontal loom which was introduced to Scandinavia in the 11th century, and on which it was possible to weave long unbroken lengths. If and where and to what extent the horizontal loom was used for weaving sail material in the Viking Age and Middle Ages it is not possible

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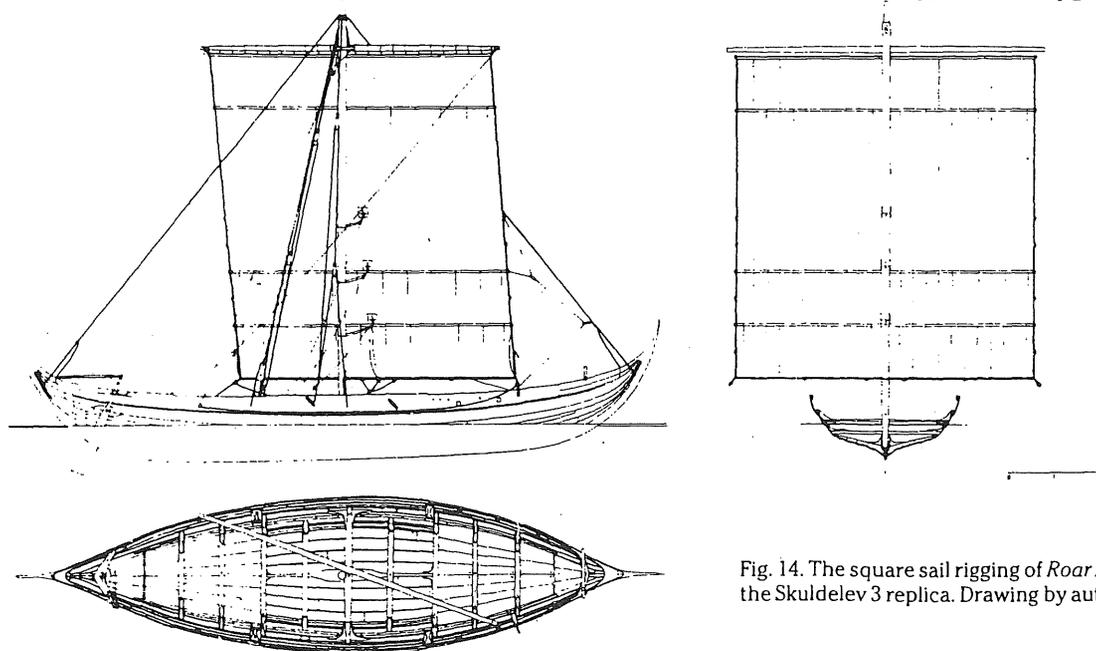


Fig. 14. The square sail rigging of *Roar Ege*, the *Skuldelev 3* replica. Drawing by author.

IN SEARCH OF NORWEGIAN TEXTILES

Laurann and I have felt that we should not limit our registration of old Norwegian textiles in private collections only to coverlets. We also feel that we should be compiling information on Norwegian textiles in small museums. They often have unpublicized and little known collections that include real gems. I am beginning the process today, in fact, by visiting the Hennepin History Museum in Minneapolis.

I would like to enlist the help of all NBC members by asking if they would let me know of any collections in their region of which they are aware. A phone call asking if a museum has any Norwegian textiles will usually elicit enough information to determine whether or not further follow-up might be warranted. If the answer is yes, I would appreciate having the address of the museum and, if possible, the name of the specific person to whom I might write. I would then get in touch with the museum and take it from there, possibly working out some travel routes to make actual visits or at least getting catalogue information on the textiles of interest. (If any NBC members want to do their own follow-up, I would welcome their getting in touch with me.)

Separate classification systems are being kept by Laurann for coverlets, for other Norwegian textiles, and for museum collections; the first two are numerical and the last alphabetical by museum name.

Lila Nelson

DANSKBROGD STUDY GROUP

Twelve NBC members have formed a danskbrogd study group. In December a packet was sent to each participant. Thanks to Betty Johannesen and Lila Nelson for sharing their experience and knowledge about krokbragd and danskbrogd.

By mid- January, all members were asked to submit their plan for study and by the middle of May, we anticipate being able to share the results of our initial efforts. This should include

samples, photographs and/or photocopies. Norma Smayda suggested making additional copy of materials to be donated to Vesterheim as a notebook. This will make the results of the study available to other interested weavers.

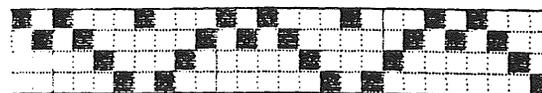
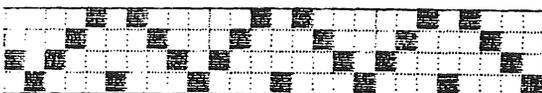
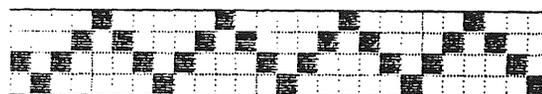
In June, my family is traveling to Norway. I hope to be able to do a little research and photographing of danskbragd pieces at the Kristiansand Historical Museum in West Agder and bring back this information to share with the study group.

I would like to encourage anyone interested in a particular weave structure to start another NBC study group. It doesn't take a lot of effort to coordinate a group and there is much to be gained in shared information and friendship.

Jan Mostrom

FOR THE LOOM

4-shaft krokbragd threadings from the class by Ulla Suul, Vesterheim, Summer 1995



Decorah Conference Update - Survey Results

As of press time, 45 survey were returned. Nearly everyone agreed that we should hold a Norwegian Breakfast Club conference in Decorah. Many people checked only Decorah as the preferred conference site. Minneapolis/St. Paul was selected as the most popular site outside of Iowa. The question of "When should we hold the conference" brought a variety of responses from "Only in the summer" to "Not in the summer" but most picked the months of May through October as the time they were most available. As I had suspected, members have a broad range of interests for both formal and informal presentations. Short research updates and discussions of weaving problems or solutions may be informally presented in the form of short talks, discussion groups, or posters. Members would definitely like to take advantage of Vesterheim's library, collections, and fiber classes before or after the conference.

Total Responses 45

I am interested in: attending 44, presenting 11, planning 10

Where should we hold the conference?

Decorah	42
Minneapolis/St. Paul	25
Seattle	17
Chicago	14
Wisconsin	14
Oregon	12
British Columbia	11
Colorado	8
Ontario	8
Alberta	7
Nova Scotia/Maine	7
California	6
Pennsylvania	5
Georgia	4
Indiana	3
D.C./Maryland*	1
Massachusetts/NH*	1
Saskatchewan*	1

When should we hold the conference?

January	2
February	2
March	5
April	10
May	14
June	17
July	12
August	13
September	12
October	17
November	5
December	1
(No preference*	4)

* indicates a written in choice

What topics...?

Historical/traditional	37
Design motifs/art history	31
Weaving/home production	27
Archaeological textiles	26
Techniques/how to	25
Card and band weaving	24
Contemporary/innovative	22
Museum or private collections	22
Museum/gallery tours	22
Clothing and accessories	21
Short research updates	19
Show & tell	19
Travel and exhibitions	17

Weaving/professional, art	16
Textiles in rites of passage	15
Care and conservation	14
Textile equipment/technology	12
Dyeing	12
Tours of artists' workshops	12
Spinning	10
Fibers/plants/animals	10
Biographies	9
Poster sessions	7
Non-Scandinavian tours/activities	6
Norw. social & agricultural history*	1
Other Scandinavian textiles*	1

The first Norwegian Textile Conference will be held in Decorah in 1997 and will be sponsored by Vesterheim Norwegian-American Museum. I hope to have the exact date of the conference for the next newsletter. If you would still like to return your survey or have additional comments or suggestions, please send them.

Laurann Figg, Curator of Textiles, Vesterheim Museum,
502 W. Water St., Decorah, IA 52101 (319)382-9681 Fax (319)382-8828

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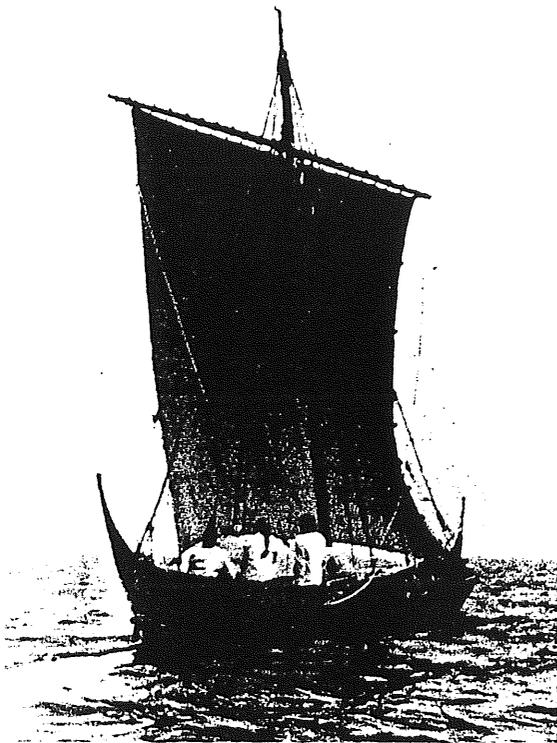


Photo: Werner Karrasch, The Viking Ship Museum.

to determine. The different potential of the warp-weighted loom has long been forgotten and can only be rediscovered by extensive testing. Moreover, it is not at all certain that the weaving of "long" lengths on the warp-weighted loom was developed in competition with the horizontal loom. It could have been an earlier development, following a demand for long unbroken lengths of material for large square sails. Depending on the period of time and locality we have to take into account that lengths of material for larger square sails could have been made up of several pieces.

It is impossible here to go into the many complex questions pertaining to the square sail which for the past 25 years has been studied in connection with ship finds and square rigged boats⁶⁰. We shall just touch on the principal issues in relation to the quality of the sail material.

Depending on the size of the fabric etc., a square sail is made up of a number of fabric lengths sewn together either with a round or a flat seam (the latter is hardly ever used on traditional sails). The edges have a hem (2-5 cm) reinforced by a leech rope in dimensions according to type of

material, size of sail and the material of the rope itself. A distinction is drawn between rope of hemp and rope of animal hair, for example horsehair (*simereb*, *liksima*). The four sides of the sail are called top, bottom and side leeches. In the bottom corners the bolt ropes make long loops where the sheets are fastened. Along the side and bottom leeches there are a number of straps. At the bottom they are meant for the sheets and in the sides for fastening the *boline* or *boline-pole* which is used to support the sail when sailing against the wind. The top leech is fastened to the yard with straps which can be tightened or loosened as required. In rows across the front of the sail there may be rows (reefs) of straps with 5-6 cm wide strengthenings (*sejsinger*) of sail material at the back. The material for the strengthenings follows the weave direction of the sail material itself. There are loops on the side leeches at the end of each row. In the Middle Ages the longships had up to 6 such reef or *rif* in the sail⁶¹.

The interplay between bolt rope and sail material is quite important. The forces of the *boline*, sheets etc. must run in the bolt rope and not in the sail material. This is determined by the amount of material that makes up the bolt rope, especially in the side leech. When sailing against the wind the sail must deepen (stand out) in the middle of the front half (and not just bulge at the middle). In increasing winds it is important that the sail can be flattened by the sheets and the *boline*. The elasticity of the sail must run diagonally across and not vertically, but as already mentioned not be too elastic. When tacking with a square sail the two side leeches are in front in turns, and as the demands on the front and aft leech are different (and most important in the front leech) one aims at the best compromise when sewing the sail.

It is obvious, that to meet the above mentioned qualifications the bolt rope must be made of materials with an elasticity that matches that of the sail material. Sails made of hemp and later of cotton had bolt ropes of hemp. Wool sails had ropes of horsehair (*liksima*). It is possible that other types of hair rope were used, for instance rope of sheep's hair, and to some extent rope of pig's bristles (*grisebust*), but our best knowledge is of horsehair ropes⁶².

The experiences we have obtained so far with woollen sail material tell us that it is supreme when it comes to standing straight without folds. This fact combined with the use of ropes of horsehair and the great skill in sewing the woollen mate-

rial has not made for an easy conversion to sail materials of hemp, flax or cotton. Bolt ropes of horsehair for sails made of flax or nettles were used in the old days in Nordland. We know from an inventory from Troms of a sail where the side leeches were still made of wool⁶³. When people of the Åland islands for various reasons including a shortage of wool changed over to sails made of flax, they added all the woollen material their resources would sustain. The linen material was obviously not as good and soon became leaky (*ud-blæst*)⁶⁴. It is an open question, however, whether this is the full explanation behind the continuous attempts to acquire woollen material for at least some of the sail. Another reason could be, as suggested by the North Norwegian inventory mentioned earlier, that an optimal and constant interaction between the bolt rope in the side leeches and the form of the sail were difficult to obtain with a linen sail, which soon changed its character⁶⁵. A "bigboat" from Brandö, which was in use until 1863-69, had 3-4 lengths of woollen material in a sail made up of 7 lengths in all.

Supplementary methods of analysis

As already stated, we have to expect that the particular types of weave used in our own country for wool sails in the Viking Age and Middle Ages and later were either specially made for the sails in question or were similar good standard fabrics, which also had other uses such as clothing, tents and the like.

This, of course, poses a problem, when we have to analyse the present textile finds as well as all future finds. We shall find ourselves in possession of a larger or smaller textile find whose quality and type of weave is identical to fabrics, that we know were used for sails, but we lack the details which determine that it is sail material. The question is then if we can clarify this by some method of analysis. Normally material for sails will have been subject to continuous treatment preventing the wool fibres from drying out and splitting, a phenomenon that can be observed in material for clothing as a result of washing etc. The problem remains though as the sail material will often have had more than one life and been reused as tarpaulins, caulking, sealing up of roofs etc. (*skarsi*), where it has been treated with tar, preserving the inner structure of the material but obscuring the treatment it received as a sail with

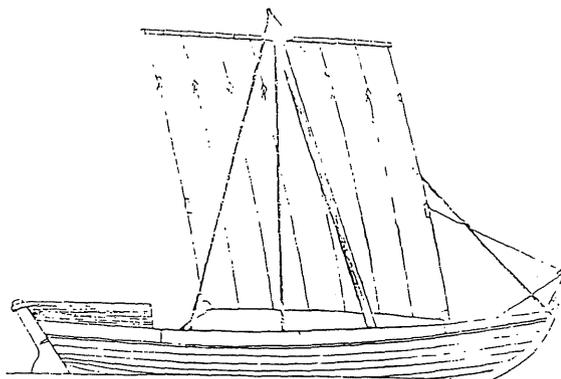


Fig. 15. Drawing of the Brandö "bigboat" by Emil Åkerberg. The square sail was made of 7 lengths of material. 3-4 were non-fulled wool tabby, the rest of linen. After Budkalven 1924.

horse's fat, tallow and the like. Re-use for clothing, where the original characteristics of the material are obscured, must also have been widespread.

The present methods of textile analysis have not been able to solve this problem, so they must obviously be supplemented by other techniques. And I think that the only chance of obtaining a useful result is by long-term analysis of the effect of wear and tear on the threads of warp and weft. The fact that wool fibres have special properties; that not only a tabby weave but probably more often a 2/1 or 2/2 twill was used complicate the issue considerably. On top of this we have to add the fulling process etc. With certain reservations it should be possible, however, if one starts with sail material of flax, hemp, cotton and some of the artificial fabrics. When they are new and unused we find a strongly waved, thread in the warp and a straight or almost straight thread in the weft in these fabrics. When the material has been used and strained for a long time the thread in the weft will be waved while the warp thread becomes straighter. This applies to hand-made as well as factory-made fabrics. This problem was also discussed by Sam Svensson in his analysis of the sails found in *Vasa's* sail-room.

All the sail material we examined was woven in such a way that the weft was straight from side to side while the warp was wavy, over, under, over, under the weft. This is in complete accordance with all machine-made sail cloth today, cotton as well as hemp. When the sails are used for sailing the wavy warp will stretch and become straighter making every length of material longer. At the same time the

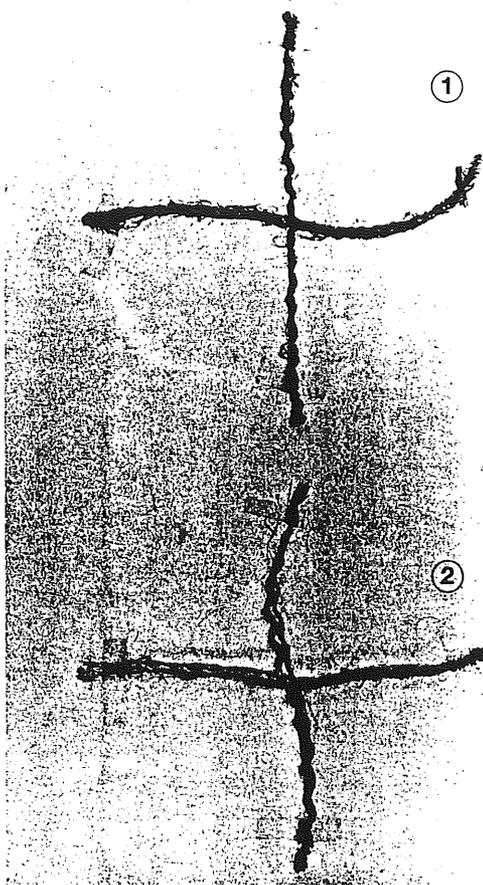


Fig. 16. 1. Warp and weft for an unused linen fabric. 2. Warp and weft for the Viking Ship Museum's wool sail (1/1) before it was taken into use. Photo: Werner Karrasch, The Viking Ship Museum.

weft, which was straight from the beginning, will now wave over and under the warp making the sail cloth less wide. Used sail cloth then will always be longer and narrower than corresponding new material. This is the case today and must also have been so at the time of Wasa. The distinctly straight weft and wavy warp of the examined sail cloth is thus proof that the sails were new. As Wasa was a new ship it is rather obvious that she had not been given old sails from another ship. We do think, however, that this might sometimes have happened. When a ship was equipped for an expedition, one could take equipment not otherwise available from another ship that was perhaps laid up or under repair. This applied mostly to canons, gun carriages and boats, but also blocks, rigging and sails.⁶⁶

At the present time we have two wool sails at our disposal, which we can analyse before as well

as after long time use. One is our new Faroe sail in tabby. The other the 2/1 twill sail for the Skuldelev 3 replica *Roar Ege* that has been in use continually for a couple of seasons (unused reserve material is available for comparison). Furthermore we have the two 2/1 twill sails that were made in Kvenvær on Hitra, Norway.

For the Faroe tabby sail we can start by noting that the threads in warp and weft appear to be like those of a new linen- or hemp material, there still is a slight wavy structure in the weft. What will happen in use remains to be seen. Threads for analysis from the wool sail for *Roar Ege* are about to be taken out. The sail has been on exhibition abroad. It will not be possible to make a realistic comparison, before this has been done, to the threads of wool sails or remains of such from Norway.

At the same time it is important to examine the threads of warp and weft in similar types of fabrics used for clothing etc.

Sail cloth of flax, hemp and possibly nettles may have found some use in local areas. A thread analysis of these materials should not be too complicated.

To this complex of problems one must add the fact that the forces affecting the threads in the warp and weft are not equally strong on all parts of the sail.



Fig. 17. *Embla* test-sailing the woollen sail. The material is *einskjeft* (tabby). Photo: Werner Karrasch, The Viking Ship Museum.

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Notes

1. Larsen, Svend 1975:74.
2. Steigen 1985, unpublished report: on finds of that time and preserved wool sails see Andersen et al. 1989:21-29.
3. Lightfoot 1991.
4. Falk 1912:57-58; Fritznér 1896:836, 838; Kulturhistorisk Leksikon for nordisk middelalder Bd. XIV:column 409-16.
5. *Ibid.* column 409-10.
6. *Ibid.* column 412-13 og 415-16; Kjellberg 1943:86.
7. Kulturhistorisk Leksikon for nordisk middelalder Bd. XIV: column 409-12; Hoffmann 1964:194-205.
8. Guðjónsson 1985:116-129; Hoffmann 1964:200-212; Kulturhistorisk Leksikon for nordisk middelalder Bd. XIV: column 411, 605.
9. Batzer & Dokkedal 1982, 1991.
10. Kulturhistorisk Leksikon for nordisk middelalder Bd. XVIII: column 536.
11. Kristjánsson 1982:204.
12. Anna Grostøls Samlinger 1947, nr. 1368; Vævebog for Hjemmene 1937:37-39.
13. Sande 1953:20-21.
14. Hoffmann 1964:361.
15. Dahl 1987:314-315; Svabo 1959:80 stk 287ff
16. Batzer & Dokkedal 1991; Rathje 1976; Strømberg, Geir, Hald & Hoffmann 1974.
17. Kulturhistorisk Leksikon for nordisk middelalder Bd. IX: column 604-5 (Kypert); *ibid.* Bd XVIII: column 536 (Toskaft); Stromberg, Geier, Hald & Hoffmann 1974.
18. Banck 1992:151-157; Bender 1980, 1991:59-78 og 1992, this is a large book on textile finds in which spin direction in warp and weft, thread count etc. are discussed; Deutgen 1991:112-117; Hundt 1984; Hägg 1984, 1991; Hiorth 1908; Ingstad 1992; Pritchard 1992:93-103; Schjolberg 1992:151-157. Jon Bojer Godal has communicated that s/z-spin in recent time (18th century) in Gudbrandsdalen/Norway was the spin found in the woollen tabby called *barkan*, which was used for waterproof clothing.
19. Højrup 1972:198.
20. Andersen m.fl. 1989:21-29.
21. Sande 1953:20-21.
22. On the square sail, wind flows and the balance of sail and hull etc. see Andersen & Andersen 1989:127-135, 127-153; Eldjarn & Godal 1988-1990 Bd. 4:40-71.
23. *Ibid.* Bd. 3:188.
24. Information 1993 from Åge H. Klem, textile engineer. Formerly at the textile factory A/S Klem og Krüger.
25. Same as 24.
26. Thowsen 1966:18-19 excerpts from Skifteprotokol nr. 1 for Helgeland 1687-1694; Skifteprotokol nr. 1 for Senja og Troms 1706-1712:126b. ff; also Færøvik 1929:176 og Eldjarn & Godal 1988-90 Bd. 4:46-47.
27. Kulturhistorisk Leksikon for nordisk middelalder Bd. XIV: column 413; Gardberg 1924:103.
28. Kulturhistorisk Leksikon for nordisk middelalder Bd. XIV: column 413.
29. *Ibid.* column 415; Kjellberg 1943:86.
30. Högnäs & Öljans 1985:61-64.
31. Dahl 1987:197.
32. *Ibid.* s. 197; Törnroos 1968:91.
33. Dahl 1987:197; Högnäs & Öljans 1985:61-64.
34. Törnroos 1968:92.
35. Dahl 1987:314-15.
36. Kjellberg 1943:38-78; Kulturhistorisk Leksikon for nordisk middelalder Bd. XIX: column 500-01.
37. *Ibid.* p. 360-37x; Dahl 1987:314.
38. Svabo 1959:stk. 1017.
39. Vardín - Føroyskt Tíðarrit 1934:88-91 concerning commandant J.C. Morrath and bailiff J.F. Hammershaimb's approach to Otto M. Rantzau 22 September 1759.
40. *Ibid.* s. 88f.
41. Kristjánsson 1982:204.
42. Andersen m.fl. 1989:16-18.
43. Tekstil håndbok. Oslo 1964 and Sunniva Sønning; Håndspinning, material og arbeidsmåter. Den norske husflidsforening. Oslo 1965.
44. Vebæk 1993:52-56.
45. Andersen m.fl. 1989:13-16; Ingstad 1992:222f and 1982:87f; Nicolaysen 1882:37f. and Planche I & IV.
46. Andersen m.fl. 1989:13-16; Ingstad 19xx:196-198, 209f., 222f.
47. Andersen & Andersen 1989: 242-259, a total analysis by Bent & Erik Andersen and Jon Godal. Later sailings in the Gokstad replica and the Oseberg replica confirm the limits to the size of the sails for these two ships.
48. Andersen m.fl. 1989:28.
49. *Ibid.* s. 29-37; Aune 1985 unpubl.
50. Godal 1994:271-278; plus a number of unpublished reports on the analysis of textiles from Medieval coastal churches from Lofoten to Sognefjorden performed by Erik Andersen and Jon Bojer Godal 1990-92.
51. Jespersen 1992; Svensson 1965:43-48.
52. *Fugrskinna*:102; also Falk 1912:57f. In recent time white wool was considered to be the strongest, see for instance Anna Grostøls Samlinger 1947: nr. 1203.
53. *Konungs-Skuggsjá*: stk 13; *Kongsspegelen* 1963: §13.
54. Lone 1991; Lightfoot 1991.
55. Dahl 1987:314; also Anna Grostøls Samlinger, spinne or spinning and væv or vev.
56. Direks 1863; see under *Søndfjordbaade*, a drawing of the Sunnfjordbåd shows a sail with horizontal lengths. Direks also writes that it was especially at the "sea-edge" i.e. at the outer side of the archipelago that this type of sail was found; Færøvik 1989:108, the use of sails with the lengths of material horizontally sewn together seems to be a speciality of Sunnfjord. Here such a sail is preserved.
57. Falk 1912; Nylén 1978:104-113 og 1987; Andersen & Andersen 1989:54-60, 90, 101, 114-16, 224, 227, 270, 334-336.
58. Andersen 1895:247.
59. Hoffmann 1964:195-199.
60. Andersen 1989; Eldjarn & Godal 1988-1990.
61. Falk 1912:62.
62. *Ibid.* s. 59; Eldjarn & Godal 1988-1990 Bd 2:268-274.
63. Skifteprotokol nr 1. for Senja og Troms 1706-1712:fol. 126b ff.; Eldjarn & Godal 1988-1990 Bd. 2:268-274 og Bd. 4:46f.
64. Törnroos 1968:92; Gardberg 1924:103-105.
65. Andersen m.fl. 1989:28.
66. Svensson 1965:46ff.

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Edi Thorstensson - My husband and I just returned from a wonderful year in Tromso, where we were involved in translating Norwegian and Sami literature from Norwegian to English, and where I was a member of the Kvaloysetta Husflidslag.

I have taken classes in spinning, weaving, felting, and other textile arts in Sweden, Norway, and the United States. I am especially interested in techniques and materials traditionally used in Scandinavia and in the social history of which they are part. Things made for everyday use, the technology developed to make them work, the ways in which they were or are used, and the esthetic elements in their design interest me very much.

I have a Glimakra loom. I've never used more than 8 of its 10 harnesses. With the optimism of youth, I once bought all the gear to convert the loom for damask weaving. But I have never fulfilled my dream.

There is always something to look forward to learning and doing.

Syvilla Tweed Bolson - I am an avid student of Norwegian textiles and weaving techniques. Presently, I have been working on six shaft danskbrogd. I have a mail order business, TWEEDS and FLEECE, which operates out of my home.. My main feature is the Raunagarn in several weights and Roros-Tweed tapestry yarn which I import. Inquiries are welcome at any time (answering machine).

Barbara Schweger - Barb has been a "hobby" weaver and spinner for 25 years and raised Lincoln sheep for 13. Her primary interest, though, is researching and writing about textile and clothing history in northern countries. From October 25-December 6, 1995 she was in Norway learning more about how women's work, especially in agricultural communities, is portrayed in museum exhibits. It is no surprise that she is finding that textile production is prime!

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