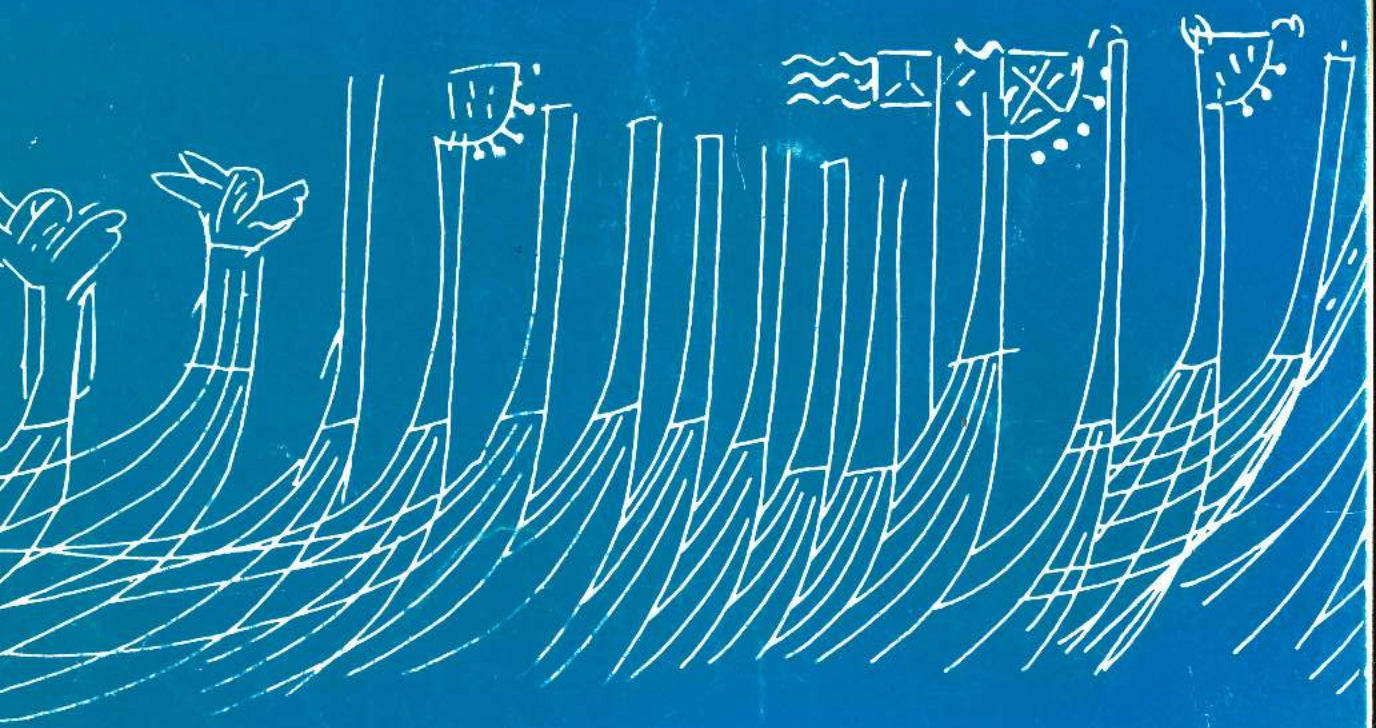
THE BRYGGEN PAPERS

MAIN SERIES · VOL 1



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THE BRYGGEN PAPERS

Main series

The Bryggen Papers

give a scholarly presentation of the archaeological finds from the excavations at Bryggen – The German Wharf – in Bergen.

The Papers consist of two series, *the main series* and *the supplementary series*.

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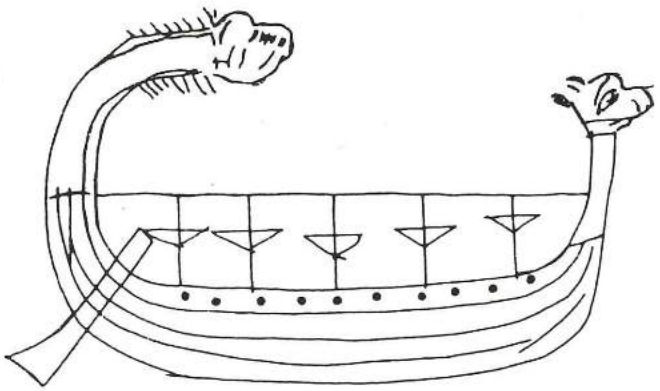
Main series

VOL 1



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FOREWORD

The systematic archaeological excavation of Bryggen in Bergen began in the summer of 1955 after the catastrophic fire on July 4th and continued until the autumn of 1968. Various development plans have later led to three minor excavations, all connected directly with the main site. A preliminary account of the main results up to 1968 has been given in A E Herteig's "Kongers havn og handels sete" (Royal Harbour and Centre of Trade).

The series of publications of which this volume is the first will include all the major studies based on the material from these excavations. At present eight topics are in preparation, five of which are well advanced. Certain groups of material, such as pottery, runic inscriptions and the historical development of the buildings, are so extensive that they will be dealt with in smaller separate publications.

The present volume includes a section on how the field-work was organised, a description of the principles and methods employed in the excavation, a general account of the stratigraphical and chronological relationships and an explanation of the recording system used in the field. The second part of this volume contains a detailed study of the boat and ship material recovered during excavation.

The section dealing with chronology is not complete. However, it provides an adequate account of the dating system which was followed during the excavation of the quays. It is based on the recording and identification of the fires which at various times devastated the area and it is natural to include it in this general presentation of the local stratigraphy and documentation of the site-data. Our site recording system was specially developed with the local requirements in mind, but it can in principle be adapted for any complex urban excavation. Enquiries have been received for a long time concerning the application of this system and it is therefore natural to present it in the first volume.

Future volumes will deal with weaving equipment, the topographical and stratigraphical development of buildings, timber-frame and stave constructions, leather and shoes, combs, household equipement, sheaths and scabbards of leather, and the osteological material. A complete corpus of the runic inscriptions from the Bryggen excavations is under publication in Norwegian as part of the series "Norges innskrifter med yngre runer" (Later runic inscriptions from Norway). A selection together with translations and a historical commentary will be presented in this series. Aslak Liestøl's dissertation on the runic Latin inscriptions is already available in Norwegian. Ingrid Sannes Johnsen's work on letters and ownership marks is ready for publication in the same series.

In addition to the main series of The Bryggen Papers, there is a supplementary series where shorter articles, preliminary results, etc, will be presented. The first volume was published in the autumn of 1984. Volume I of the main series is published with a grant from the Norwegian Research Council for Science and the Humanities. Herteig's work has been translated by Kenneth Young and Clifford Long and the latter has also acted as language advisor for Arne Emil Christensen's English text.

The Editorial Committee responsible for the publication of the series consists of Professor Anders Hagen, Dept of Archaeology, Historical Museum, University of Bergen; Professor Knut Helle, Dept of History, University of Bergen, and Senior Curator Asbjørn E Herteig, Dept of Archaeology, Medieval Collection, Historical Museum, University of Bergen.

Bergen, December 1984

Asbjørn E Herteig
Chief Editor

THE ARCHAEOLOGICAL EXCAVATIONS AT BRYGGEN, "THE GERMAN WHARF", IN BERGEN, 1955–68

Excavation, Stratigraphy, Chronology, Field-documentation

BY ASBJØRN E HERTEIG

CONTENT

1 Background to the excavation

The wharf fire of July 5th, 1955 left in its wake a 70 x 70 metre area of burnt-out property. Of Bryggen's eighteen rows of houses, no less than seven were lost, leaving only a truncated stump of what had been one of the country's most distinctive building complexes. Even before, the area had been but a drastically curtailed remnant of a once colourful and integrated architectural unit which already in the High Middle Ages must have taken in the whole of the east side of Vågen, from Holmen in the north to Vågsbotn in the south.

It was for a long time the generally accepted notion that the town had taken root here in the latter part of the 11th century, progressing rapidly to become an advanced urban community having strong economic links with the outside world, not least with countries south and west of the North Sea. These connections were due in no small part to a continually expanding barter trade in which the yield from fishing, hunting and animal husbandry in the coastal region was exchanged for such foreign products as grain, flour and malt. The Germans early outnumbered all other overseas merchants arriving in Bergen, which became at an early stage the focus for their trading activities in Norway. From the founding of the Hanseatic League in the 14th century until its dissolution in 1630, Bergen was on a footing with Novgorod, Bruges and London as one of the League's key bases abroad. Let us not forget, though, that the German "Kontor" in Bergen pursued its own special course – economically, politically, judicially and culturally. When we refer to Bryggen as the HQ of the Hanse's operations in this country, it is not just a limited local enclave we have in mind – such as The Steelyard in London – but the entire district of a town, 120–130 m wide with a stretch of wharf 450 m in length.

But Bryggen cannot rightly be regarded purely in terms of Norwegian-German interaction. It was the economic focal point in a town which at an early date became the capital of the Norse Dominion – a town, too, bearing all the marks of intercourse with most other countries in Northern Europe. The connections with Norman and Anglo-Saxon regions, in particular, have made an enduring impact on its art, culture and ecclesiastical architecture. It was, in fact, a town which by the end of the 13th century housed a fortified royal palace, an episcopal palace, five religious foundations and more than twenty churches.

As a Hanseatic trading centre, Bryggen was an assembly point for domestic products – from West and North Norway and the tributary islands in the west – intended to a large extent for export, as well as a centre for imported foreign products, partly consumed in the city,

Fig 1 Extent of Bryggen complex up to the 1955 fire. The white line indicates properties destroyed in the fire: (from south to north) Bugården, Engelgården, Søstergården and Gullskogården

partly sent to other parts of West and North Norway and to the tributary islands. It was thus only reasonable to assume that the ground under the fire-devastated area would contain, in addition to remains of earlier building complexes, remnants indicative of the range of stocks and supplies at earlier periods. Excavations dating from the turn of the century had made this plausible (Koren-Wiberg 1908), besides showing that written accounts of catastrophic fires were faithfully reflected in layers of ash and charcoal of varying thickness. But tradition insisted that Bryggen and its distinctive housing pattern rose anew after each of these fires, displaying broadly the same form on the same sites as before.

Nearly all attempts to give a more or less pictorial presentation of the character and evolution of this building complex rested on inferences from written documents of dubious clarity and often mutually inacceptable, so that the Chief Inspector of Historical Monuments, Dr Philos Arne Nygård-Nilssen, had a clear case, considering the town's – and Bryggen's – importance in our earlier history, for deciding that Bryggen should be made the object of archaeological research before rebuilding got under way.

Yet however plainly justified that decision was, and however self-evidently right it now seems, no one at that time had a clear grasp of what such investigations entailed. No adequate medieval archaeological expertise was available. The responsibility was therefore entrusted to a person of the traditional Scandinavian school of archaeology, which at that time meant no experience of medieval, let alone urban archaeology. It is therefore quite apparent from the following account of the way the job was approached, of the methods of excavation and of the way the work was documented, that the excavations at Bryggen were in every respect a pioneering effort.

The general uncertainty that prevailed is well illustrated by the fact that a maximum of six months' field work was initially anticipated. Those six became a hundred and twelve.

Those involved could hardly have believed

that anything much would emerge from operations on such a limited scale, but the Chief Inspector obviously felt that the upshot of this attempt would settle how matters went afterwards. Even so, the restricted scope envisaged was very much in the minds of those leading the investigation and had a considerable impact on the planning of the fieldwork.

The burnt-out area contained only wooden structures, apart from one building with brick facing at the foremost end of Dreggsalmenning to the north and three separate buildings of stone within the main block (fig 1). None of the buildings had cellars: they were built directly on the ground surface – a pattern traditionally held to be typical of the earlier Bryggen – and the whole layout followed what is known as the double tenement design. By this is meant a compact building complex made up of houses

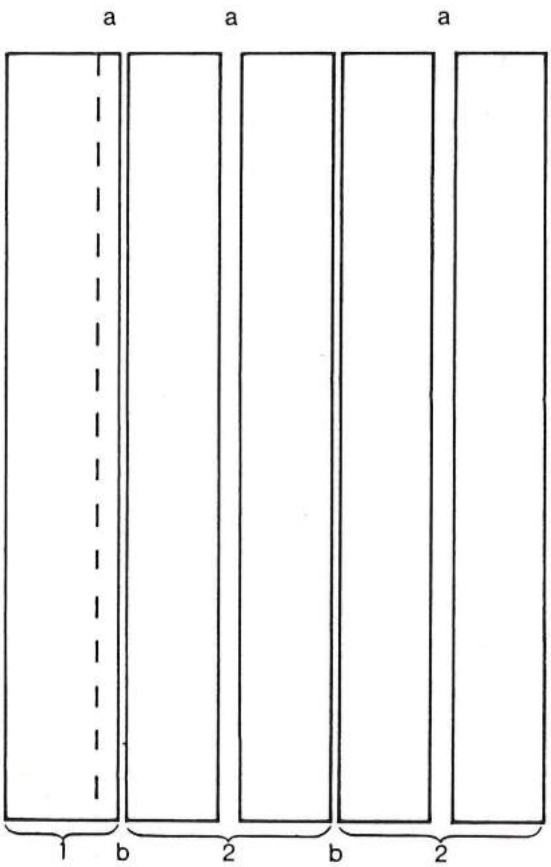

Fig 2 1 – single tenement, 2 – double tenement, a – tenement passage, b – eaves-drip (marking boundary of premises)

lined up one behind the other in parallel rows as much as eighty to ninety metres in length. A pair of rows having a common central alley or passageway was, and still is, called a double tenement (Norw *dobbeltgård*). With a few exceptions characterized by a single row or tenement, the main layout was based on the double tenement pattern (fig 2).

After weather-boarding became general at Bryggen, it also became the practice to cover in the spaces between the individual houses in a row. The building complex thus conveys the impression of long connected rows of houses pointing lengthwise to the sea. For the same reason, the entire complex as seen from the front appears to form a single long continuous roofed facade, though actually the eaves-drips between the rows may vary from three quarters to one-and-a-half metres.

The tenements destroyed by the 1955 fire were, from south to north, Bugården, Engelgården, Søstergården and Gullskogården. They were all essentially double tenements, even if, formally considered, Søstergården was a single tenement with a narrower tenement row or side-annexe (Norw *taske*) tacked on. This seemingly trivial deviation was accentuated by the fact that the main house-row and the side-annexe were placed wall-to-wall, while the tenement passageway ran outside to the south (on the Engelgård side) (fig 3).

Furthermore, Gullskogården displayed the irregularity of having acquired, beyond its northern house-row, yet a third row on the side towards Dreggsalmenningen.

These deviations from the general layout reflected the substantial adjustments to which a variety of factors have contributed down the years. It was nevertheless supposed that a high degree of continuity was to be found, at least as far as the double tenement pattern was concerned, right back to a time around 1300 and even into the preceding century. This was especially the view of the earlier researchers N Nicolaysen and Christian Koren-Wiberg. B Lorentzen on the other hand always maintained that Christian Koren-Wiberg was wrong in this respect and that Bryggen underwent substantial changes after 1476, being turned into higher, broader and fewer rows of houses. Special and sometimes complicated terms of ownership, shared occupation, lack of authority to expropriate, financial and other problems concerning rebuilding after disastrous fires,

and so forth, had all tended to promote conservation of both terms of ownership and pattern of town planning during the medieval period.

Up to the time of the 1955 fire, there was a continuous built-up area stretching from Dreggsalmenningen in the north to Nikolaikirkealmenningen in the south (fig 3). In the Middle Ages, however, the region was traversed by several public thoroughfares (Norw *almenninger*) running from the sea through the built-up area to Stretet (Norw *Øvregaten*), originally the only thoroughfare from north to south (fig 4). Among these, the position of Mariakirkens almenning was supposed to be definitely established as within the fire-devastated area, and, with some reservations, that of Bualmenningen. (Archaeological investigation of Dreggsalmenning in 1979/80 has revealed parts of a comparatively well preserved "street" under its more southerly segment. This follows an alignment passing Mariakirken's West Front, but it has so far been definitely located only at the shoreward end of the thoroughfare some seventy or eighty metres from the church. It is, moreover, far from clear just how far back it can be dated, though its width does in fact conform to the requirements stated in the Town Law regarding the width of thoroughfares, ie 4.5 m. This justifies taking a critical look at the traditional notions about the position of Maria-

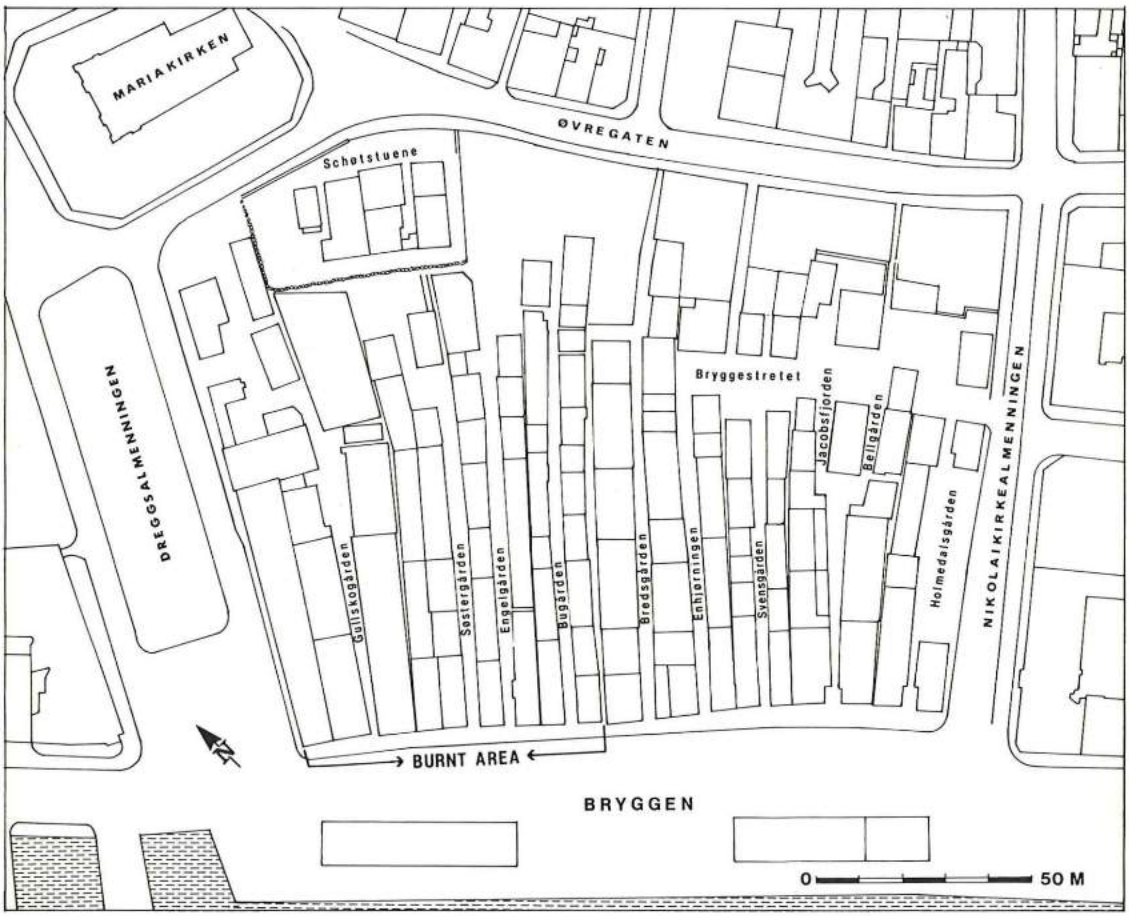

Fig 3 Sketch-plan of the Bryggen complex before the 1955 fire. Of the burnt-out properties, Bugården and Engelgården were regular double tenements with a passageway between the two house-rows. Søstergården's passageway ran up the south side of the tenement (next to Engelgården), and Gullskogården had acquired a third row of houses to the north, with brick facings

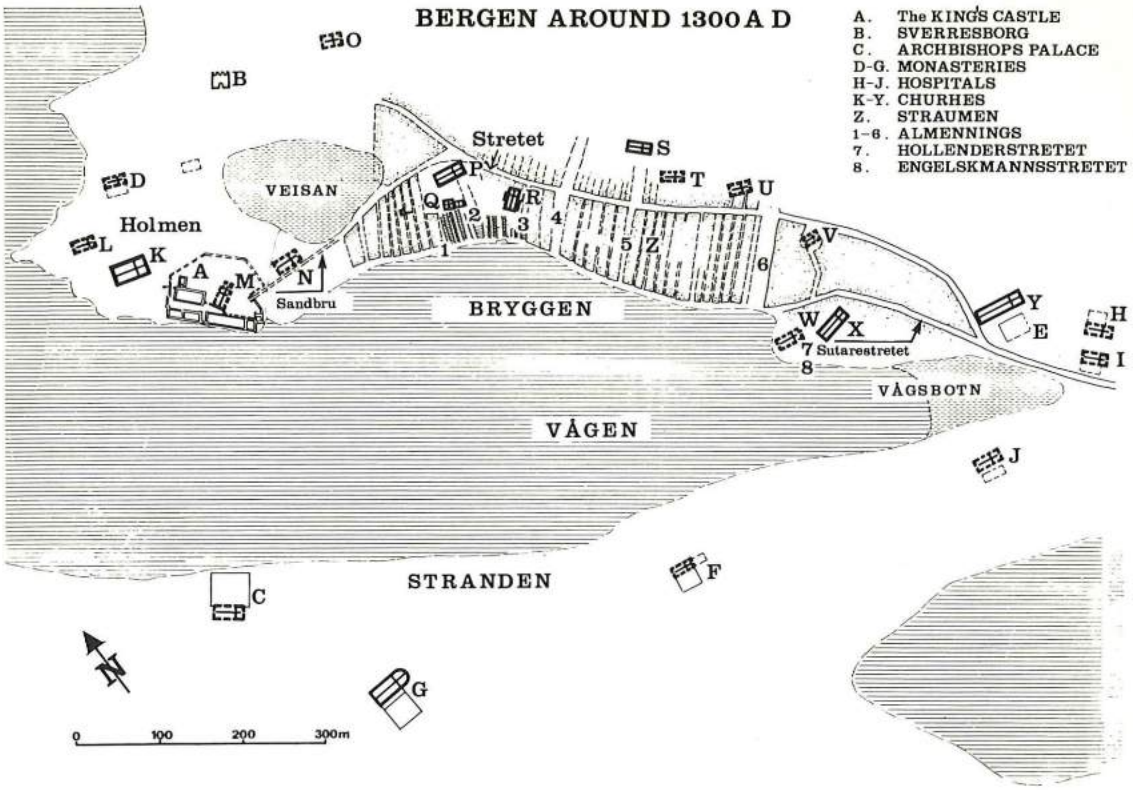

Fig 4 Bergen around AD 1300

kirkealmenning). These thoroughfares, along with a mass of other detail about the built-up area, are mentioned in the Town Law of 1276. Apart from providing certain new requirements, the Town Law has generally been understood as a codification of the way things were arranged during the rebuilding after the fire that had devastated the Bryggen area in 1248.

With the aid of written sources such as sagas, annals, the Town Law and other official documents, many attempts have been made to establish a reasonable "earliest possible date" for certain key characteristics of the local building complex - its plan, its traffic arteries, its structural peculiarities, and so forth. But we must look elsewhere for confirmation of these hypotheses. Nor can the traditional sources give a satisfactory answer when we ask what precedents had helped to form the townscape in the mid-13th century. Here was one important goal for the archaeological investigations planned after the big fire in 1955.

2 Arrangements on site and system of measuring

There was much that favoured the archaeological investigations at the outset. The work was well backed by the authority of the Ancient Monuments Act, and cellarless buildings on moist foundations augured well for the enterprise.

No account will be given here of the numerous problems arising out of such an investigation or of the difficulties inherent in its being the first systematic town excavation in this country. A number of these issues - composition of work force, digging conditions and the motivation for starting work in the rearmost, south-eastern sector of the devastated site (ie the southern house-row at Bugården), are dealt with in the early chapters of "Kongers havn og handels sete" (Herteig 1969) and will not be gone over again here. What will be dealt with here in some detail is the choice of the system of

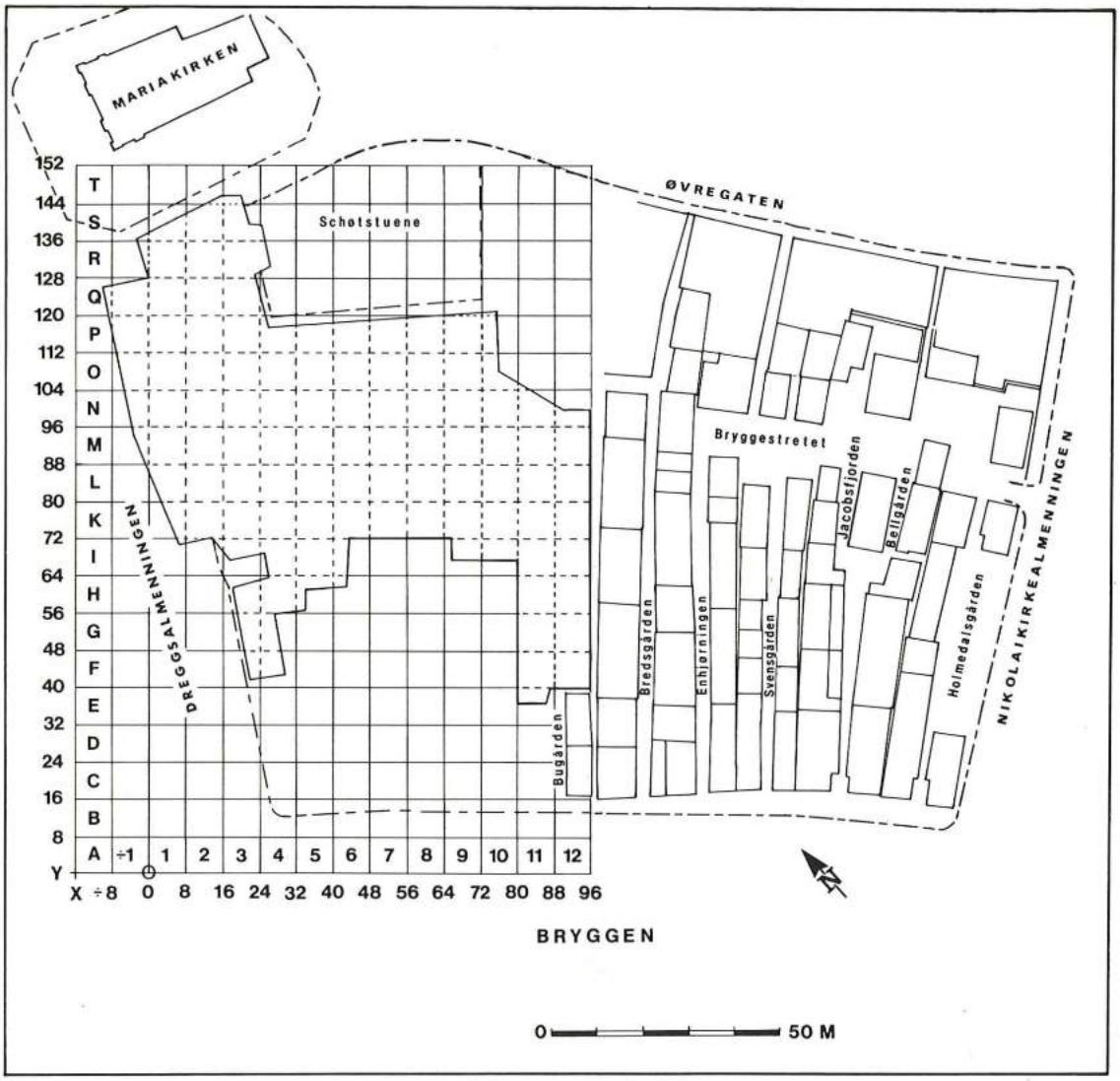

Fig 5 The coordinate system was based on 8 x 8 metre squares with its origin in the street NW of the excavation area. The continuous boundary line round the site includes peripheral research areas excavated in 1971–72, 1974 and 1979

measurement and the use made of it. As a consequence of the planned short-term excavation already mentioned, it was not found feasible to tie in our chosen measuring system with the Norwegian Geodetic Survey, since this would impose coordinates running diagonally across the field of operations. It was therefore decided, as a matter of sheer convenience, to adopt an *ad hoc* system based on local conditions, particularly the existence of more or less evenly spaced house foundations running parallel with each other. A coordinate system was selected with its origin in the street north-west of Bryggen, so that the baselines (x and y axes) ran clear of the actual built-up zone (fig 5). The x-axis was in line with the longitudinal axes of the tenements. This orientation of the coordinate axes of measurement acquired considerable practical significance as it became progressively more essential to extend the excavations northward from their starting point in the rear of Bugården. It meant, for instance, that only positive coordinates were called for. (The only exception is where an extended excavation in

1972, when Bryggens Museum was being erected, involved some crossing of the axes).

As a means of determining excavational and locational units, a traditional grid system was adopted with 8 x 8 m squares. This scale of grid unit was chosen with an eye to the average tenement width. If the grid-divisions along the x-axis were allowed to run lengthwise between the tenement-rows, a square of the grid would take in not just the width of a house but also pretty nearly half of its adjoining passageway and eaves-drip-channel, in short, just about one-half of a double tenement. Under the circumstances, this coverage of a tenement width by one unit of the chosen grid system provided a very promising set of initial conditions.

Unfortunately, the practical advantages this system yielded at the outset were somewhat offset by the fact that, as excavation pushed northward, the line of building tended to diverge more and more from the system of coordinates. Yet although the grid square was frequently abandoned later on as an actual excavation unit, the established grid system continued to be used for purposes of documentation throughout the entire project. It was held on to, so to speak, as a statistical necessity, however devoid of cultural relevance or significance the choice of grid reference points might be.

Choice of a coordinate system on a local and functional basis was primarily due to the all-too-near deadline set for completing the work and the limited scope thereby envisaged. At bottom, however, it is lack of educated insight that must take the blame, since subsequent experience as a whole has made it clear that even in the case of very restricted excavational assignments it is most general practice to establish links with the national grid (NGS). This is of particular importance where extensive excavations have either already taken place or are expected to follow.

Individualistic systems of measurement will always make it unnecessarily difficult to interrelate finds from mutually independent excavations.

3 Excavation methods

Once the mass of charred timber and loose fragments of buildings had been removed, floor and passage timbers lay exposed in a more or less fire-damaged condition (fig 6). The fire had not taken hold to the same extent everywhere,

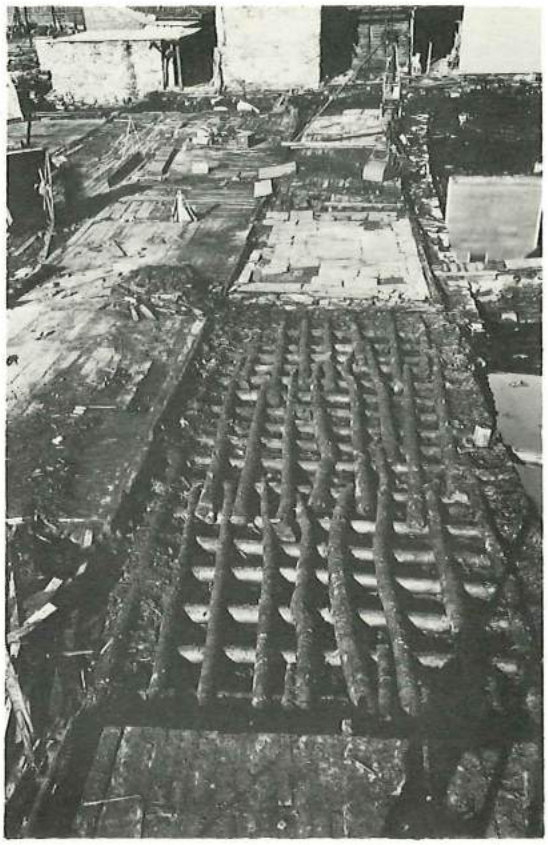

Fig 6 Situation following 1955 fire. Large parts of the wooden floors in the lower storey were intact. In most cases and especially at deeper levels, the fire caused extensive damage deep down into the foundations

and whereas the woodwork was in some places charred and scorched right down into the foundations, there were other places where it was found intact.

Generally speaking, it was no real problem to detect the lay-out of the tenements and the passageways, or even, for that matter, to separate the individual houses which made up each row. This encounter with what remained of completely burnt-out timber constructions was quite encouraging, as it pointed to the likelihood of finding comparably well-preserved remains from earlier fires on the same site – a likelihood which was in turn decisive for the choice of excavation procedure.

At the start of the investigation, the remnants of burnt-out buildings were documented by

drawings, photographs and reports. Even though conditions were apt to vary from house to house, well-preserved remains were everywhere so copiously in evidence in the underlaying layers that the obvious thing to do from the point of view of excavation technique was to take as a starting point the apparently continuous structures whether they were actual remains of buildings or various subsurface soil levels – in short, to opt for purely stratigraphic excavation methods. Initially, this came to the same thing as being guided by the building layers that came to light. They would mostly be succeeded, as digging continued, by masses of detritus in continuous layers of appreciable depth, often with intrusions of sand, stone chippings, clay, nutshells, charcoal, charred timber, etc etc. It was initially both natural and necessary, then, to resort to an excavation method based on following the lead given by structures immediately in evidence: geologically and culturally determined strata, purely architectural patterns, etc. And though a gradual change in conditions was encountered as the work progressed, this stratigraphic mode of excavation was on the whole adhered to throughout the entire duration of the project. Procedure was modified where masses or layers of rubble and debris were more than about 15 cm in thickness, as was most often the case in the deeper layers under the lowest-lying foundations, where one might find largely homogeneous make-up to a depth of several metres. Where this was the case, work was carried out in arbitrary layers averaging 15 cm in thickness until some clearly identifiable structure again showed up and made structured excavation expedient.

One of the advantages of adopting a stratigraphic method was that, given an appropriate work-scheme, it facilitated the establishment of coherent chronological guidelines in the field, possibly even a clear-cut chronological sequence, subject to limitations normally imposed by the scale of the excavation and the need for standing baulks. When digging in predetermined layers, however, one cannot normally expect to get such a general perspective in the field. And since in all excavations it is essential to arrive at as comprehensive an interpretation as possible of the situation in the field, the choice of excavation method is of quite decisive importance. If it is decided to excavate in horizontal layers of predetermined thickness, it will normally only be in retrospect – through the technical and statistical processing of the field-data – that one can arrive at a synoptic view – something effortlessly attained in the field by stratigraphic methods. Nor is it a matter of indifference which way results are obtained: it is especially valuable when the field situation can be used to supply counter arguments to *a priori* interpretations.

With a stratigraphic excavation procedure it becomes possible to engage in an on-the-spot interpretation, and the value of possible grounds for dissent is not overlooked, as it tends to be if retrospective interpretation is relied on. It is indeed entirely possible that by the application of various interpretative models in an on-the-spot attempt to interpret a complex situation, one may discover objections one had failed to grasp or become aware of *a priori*. This sort of self-corrective will normally be screened out from the interpretative process associated with excavating in predetermined or arbitrary layers.

And once objections are played down, the way lies much more open for drawing seemingly consistent, but not necessarily soundly based, conclusions.

Excavation in arbitrary horizontal layers, then, is best resorted to as an auxiliary device in urban excavations, and preferably with the limited objective of establishing connections between structures of relatively wide diversity. Where structures do emerge, it should then be made subordinate to them.

In this sort of excavation, it is customary to stick to a digging depth worked out in advance, and to record by ordinary documentary methods whatever may have turned up in the exposed surfaces (cf pp 41–42). We have given the designation "level" to such an exposed surface, regardless of whether it has been brought to light by this method or by stratigraphic excavation. When excavating in predetermined layers, the levels succeed each other at regular intervals, and, at any rate in principle, without attention being paid to the way structures are interrelated. The establishment of such structural sequences will be part of the subsequent scientific processing.

By using a stratigraphic excavation method on the other hand, it becomes possible to establish connections between structures in the field. But coherent structures, whether indicative of remains of buildings, different soil

layers, ground-levelling deposits, fire levels, debris from fires etc may show significant variations in relative size. Where, however, the vertical distance between a clearly identified structure and the next one below it is, for example, more than 15 cm, it will be sought by digging in a succession of regular spits. Each stage of the dig begins and ends at a "level", and each level brings into play the entire set of documentary routines. It will be evident from the facts here adduced that a level in a stratigraphic research procedure may on the one hand reflect an authentic situation bearing on cultural history – to the extent to which the state of preservation and the conditions of pressure permit it, it may actually give an acceptable picture of an actual state of affairs at some earlier epoch – or may, on the other hand, be no more than an intermediate stratum determined by the demands of excavation technique, in which case it amounts to a tactical modification of the excavation method.

In practice, the predetermined layers could not always be made of equal thickness, since even in this type of excavation it proved necessary to make allowances for certain trends present in archaeological layers. Since excavations to a considerable extent were conducted in a filled-in harbour-basin where depth and consequent compression increased steadily as distance from the original shoreline increased, the strata would assume a fan-shaped structure spreading outwards. Consequently, in the case where the main structure had been determined by digging in arbitrary layers, the thickness of the layers were to some degree adapted to that main structure, ie with an adaptive increase in excavation depth from east to west within each individual unit or grid-square.

In instances where there were continuous remains of building to an appreciable depth and no "stratigraphic intrusions", it was normal to dig deep enough for four courses of wall-beams – two lengthways and two across – to be included in the plan of each separate level. It was neither proper nor expedient to take in more on one and the same drawing. As such conditions frequently obtained, the excavations have produced a sequence of documented levels which, taken by themselves, do not necessarily represent a distinct historical situation or phase or a distinct stage in building, but only intervening stages or intervals required by the technique of excavation.

There are other cases however, where an excavated surface may contain remains from several stages of building. Distinguishing these would normally present no problem, but considerable loss of time would often have resulted had every such unit been treated as a distinct level, having its own claim to individual documentation routines. In consequence, even cultural-historical situations of forbidding complexity were often given package treatment and interpretation. It was all part of an emergency timetable developed with due regard to heavy financial and political pressures in the locality, though also partly a result of the limited supply of properly trained assistants in the field. The definitive "physical" sorting out of the distinct unitary levels will in such cases have to await the subsequent scientific processing of the finds.

The procedures here indicated are the outcome of adaptions in stratigraphic method; they are, incidentally, just one instance of the need for flexibility in any major archaeological undertaking.

The main excavation tool was the *grafse* – a kind of hoe with a large crescent-shaped blade, not too sharp-ended, which is attached to the shaft at a slightly acute angle. This tool is ideal for archaeological excavations, being serviceable both for "heavy" digging and for trimming and smoothing off. Those engaged in the coarser operations drag the *grafse* towards them with one of the pointed ends downwards in a way dependent on the depth they aim at reaching, while for trimming off, the blade is drawn flat across the surface at a more oblique angle. It is worth remarking, too, that when drawing the *grafse*, over the under-lying surfaces, one pays careful heed to any structures one might come across. The same can hardly be said for working with a spade.

Besides the *grafse*, other more commonplace archaeological implements were applied to traditional tasks. Excavated material was sometimes removed by means of wheelbarrows and conveyor belts, but this work was mainly carried out with a crane, this being not only more efficient than other transport devices, but incomparably gentler – no small consideration in a field situation where moisture added to the difficulties of every transaction on the site.

As the Bryggen excavations continued each year from the beginning of March till mid-December, operations came under the influence

of the most varied weather conditions, ranging from stifling heat to frost and snow. The former necessitated intermittent irrigation of the site to guard against drying out, while the latter called for an assortment of technical remedies. Any snow over and above what the day's thaw would clear could be shifted with steam. Frost was a bigger problem: it meant either coming to a full stop, or thawing out masses of frozen earth. During protacted cold spells, deep frost was kept at bay by pumping in warm air under a continuous layer of insulated matting. But while heat, frost and snow were sporadic intrusions, rain was a persistent obstacle throughout the excavation period. Fortunately, however, a gently sloping terrain and an excavation procedure that exploited the areas already completed in order to catch the seepage, backed by comparatively handy pumping equipment, served as a rule to ensure speedy drying-out of the site, though it must be admitted that during the lengthier spells of continuous rain, excavation could only be carried on under cover – to which end, portable plastic shelters were brought in.

The weather must surely have occasioned the loss of some possible observations and maybe led to some erroneous record owing to the subsidence of particular objects into a secondary stratum, though the nature and statistical significance of such errors is hardly measureable. But it is only right, in this context, to make the point.

4 Sections: their types and use

At the start of the excavations, there was nothing for an expert to go on concerning the depth and presumable content of the culturally relevant strata – nothing, that is to say, regarding the kind of building remnants to be expected. What has been mentioned above about general historical notions, and more particularly about the archaeological researches conducted around the turn of century under C Koren-Wiberg's direction, seemed to suggest that strata of appreciable cultural significance might be encountered, and that the main features of earlier building patterns might well

Fig 7 Detail of permanent baulk, towards the Engelgården tenement

Fig 8 Permanent baulks across the Bugården tenement

emerge, at any rate some way down through the strata (op cit pp 150–171).

A factor complicating internal relationships within the horizontal sequence of strata was the slight general seaward tilt (c 1:16) of the terrain and the way in which this had been compensated for so that the houses stood on a series of terraces. In a situation where physical remnants of buildings failed to come to light, there were obviously likely to be problems with level stratum – by stratum excavation. These considerations, together with the general *terra incognita* conditions, made it advisable to adopt a tightly organised and – at least initially – rigorously adhered-to baulk system, of which an outline account follows.

Distinctions were drawn among the following types of sections:

a Permanent baulks
b Baulks subsequently removed during excavation
c Profile measurements between fixed points, but without setting up a baulk
d *Ad hoc* strategems depending on a systematic introduction of ancillary baulks and sections

Re a The outer limits of the excavation site constituted permanent baulks (fig 7). In addition, baulks were established at the outset (during the Bugården excavation) across the tenements, following grid divisions along the y-axis (fig 8). These would usually be left in position until the relevant squares of the grid had been worked to bottom level, thus serving as permanent baulks.

Re b As excavation progressed, profile measurements were invariably taken along all grid divisions, but the baulks were now subsequently demolished more frequently, ie they were preserved intact until a new decisively identified and relatively extensive structure had come to light (fig 9). Fire-layers would often constitute structures that could give the signal for removing a baulk. Should the

Fig 9 Section of the C-type, removed during excavation, between the Engelgården and the Søstergården tenements

fire layers be relatively close together – separated by c 10–15 cm – it was always a good policy to retain at least two of them before demolishing the baulk, depending on the length of the section in question.

Re c Independent of the standard sections, baulks were set up or section measurements taken as the need arose, and such a need did arise with mounting frequency as the alignment of the buildings deviated from the grid, since it was always preferable to take sectional measurements as far as possible at right angles to the main axes of the buildings. In any case, it was equally essential that sectional measurements unrelated to the fixed sections should themselves be taken between fixed points, since the correlation of subsequent measurements would otherwise be made more complicated. Such secondary profile measurements were as a rule carried out by dealing with each new level in turn, without setting up a baulk.

Re d In addition to those noted above, baulks were set up for various purposes as a necessary part of special excavation procedures, as for instance where stratification or structures broke off for no very evident reason (fig 10).

With the exception of two sections in Bugården, all longitudinal sections were drawn from the north, all cross-sections from the west.

The standing baulks varied greatly in width, from 10–15 cm in the case of secondarily established local sections and up to as much as 120 cm at the base of the eight-metres-high major permanent baulks at the grid divisions. The commonest width was between 30 and 50 cm.

Those profile measurements that were carried out without the use of standing sections

Fig 10 Ancillary baulks in the Gullskoen tenement

were normally directed to the recording of main structures in the line of section. They are thus apt to be less rich in detail than drawings of standing sections, though this in no way diminishes their value. Indeed, such measurements are well worth the time spent on them, and the overall picture on site becomes clearer as a result. But the section types we have mentioned are by no means mutually exclusive; they rather supplement one another, though it must be added that physical sections are bound to take precedence (fig 11). These are not just a secondary checking device, but a base of reference to be continually consulted on site, so that there is uninterrupted interplay between observations in the horizontal and vertical planes. Once one loses track of a structure, it will often be a hopeless task to rediscover it by continued level-to-level working. What will in many cases get results is the setting up of small local sections radially converging on the problem centre (cp Herteig 1969, 24–39).

5 Chronology

On pp 28–33 of *Kongers havn og handels sete* (Herteig 1969), an account will be found of the dating system on which the excavations were based. In contrast to most urban sites in other countries, the situation at Bryggen was unique in that the occupation layers were more or less intact beneath the burnt-out upper crust. The reason for this was that here, as elsewhere in Norway, timber has been continuously used as the main building material right from the founding of the town, whereas in other parts of Europe, building in stone became usual from the 13th century onwards. Moreover, the wooden buildings either rested on light foundations of stone or else directly on timber foundation-rafts (Norw *bolverk*). In the few instances where cellars are mentioned, these are invariably solid stone constructions built above the ground.

In view of the favourable conditions for

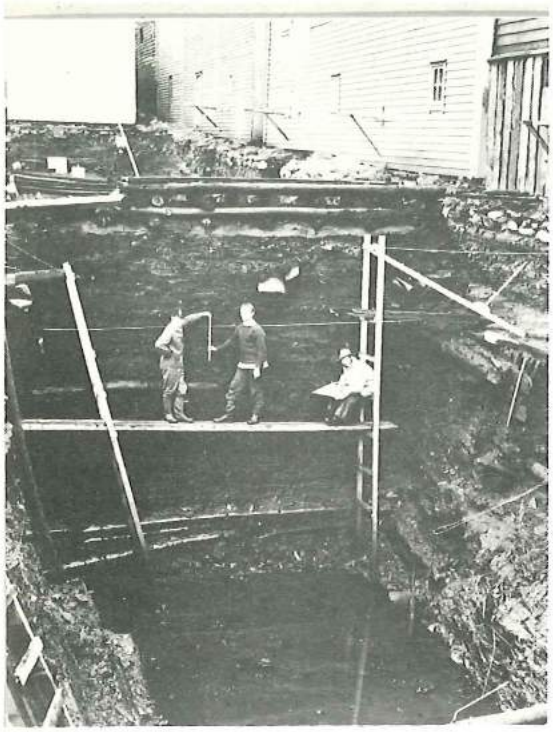

Fig 11 Documenting sections

preservation, the uncovering of cultural and geological structures became an end in itself. These included continuous buildings or parts of these, sections of street, deposits of various kinds either laid deliberately or else merely accumulated, remains from fires, and so on. Special mention should be made of the sometimes extensive and connected structures found within the tenements, whereas the overlapping of constructions between one tenement and the next only occurred in exceptional cases. The extensive layers of burnt material were often of greater help than other layers, as they provided a direct physical link between features. For this reason the "fire-layers" became the key strata in recording the relative, as well as the absolute, chronology.

When excavations began in the autumn of 1955, only limited use could be made of the traditionally datable material. There were virtually no coins, runic inscriptions relating to historical personages first began to appear only after several years of excavation and pottery was of little help because neither English nor Continental wares were dated sufficiently closely or reliably. By the time the excavation came to an end in 1968, the results of a number of foreign studies were available, but even then, dating was not detailed enough to distinguish between the different fire levels. The only thing that might have helped to establish clear stages in the development process was dendrochronology. A large number of samples were in fact collected but a systematic study of the material called for greater efforts and resources than had been allowed for. The crucial contribution to reliable dating which such evidence could have provided while the excavation was in progress had thus to be foregone. Subsequently the processing of dendrochronological material ground to a halt owing to difficulties beyond our control, but this important work is now happily being resumed.

There now follows an account of the successive fires mentioned in the written sources concerning this area, together with the system of absolute chronology based on them which was used during the excavations. It has subsequently become evident that several minor local fires have also occurred in this area; this will be returned to later. This resumé of the fires affecting the area of Bryggen where excavations have taken place is based on Knut Helle's assessment of the sources (Helle 1975, 1979, 1982).

Most of the fires in Bergen are directly or indirectly reported in more than one written source and with the exception of the two earliest ones, the sources are contemporary or even in some cases eye-witness accounts.

The first town fire to which the sources refer happened during the winter after St Sunniva's remains were moved to Bergen from the monastery of Selja to the north. The fire is supposed to have died down when her shrine was carried towards the flames (Sturlunga Saga 1, 133; Biskupa Sögur 1, 418). Since Bishop Paul of Bergen is known to have had the Sunniva relics moved to the town and placed in a reliquary in Christ Church on September 7th, 1170, it is reasonable to date the fire in question to the winter of 1170/71. In contrast to this date which is also given in Gudmund Arason's Saga, the date of 1172 is given in several Icelandic Annals, though the reasons for preferring this date are not known (Islandske Annaler 117, 253, 323, 475; Flat III, 517). Knut Helle points to the generally reliable chronology in Gudmund's Saga and maintains that the saga dating is to be preferred – all the more so since it links

the fire with the reliably dated translation of the Sunniva relics (Helle 1975, 55; 1979, 1 (xerox); 1982, 124). The fire was labelled Fire VII in our chronological scheme.

It is understandable that the fire of 1170/71 is mentioned in the written sources in view of the great significance the Church plainly attached to the attendant circumstances. The possible lack of such special events may be one of the reasons why the same sources are silent about earlier fires. Some time around or before the middle of the 12th century a fire has destroyed the whole waterfront within the excavated area and, in the rear of the excavation, in front of and surrounding St Lawrence's Church (Lavranskirken) and the guildhall (Maria Gildeskåle) traces of burning have been detected that would seem to bear witness of a local fire of an even earlier date (fig 4). For the present, it is difficult to be more specific, since it is only in this confined area that contact has been established with terrain that would have been inhabitable from the beginning. The area in question is c 700 sq m and mostly disturbed by graves. The rest of the excavation covers the artificially "reclaimed" land of the harbour area.

In the annals of the Flateybok (III, 520–21) it is reported that "Brendr bær i Biorgyn" ("the town of Bergen burned") in 1194. Apart from a brief note in some of the Icelandic Annals (121, 181 and 254) this fire does not seem to be referred to in other sources, a fact which is all the more remarkable as this was the year of King Sverre's coronation. Not least for that reason, one would expect a town fire in 1194 to go on record. It is not unlikely that the primary sources have been misinterpreted, that this fire should really be dated to the year 1198 as is commonly accepted by the historians (cf Helle 1979, 3). As far as our dating system was concerned, there was no special *a priori* reason to reject this interpretation. The "extra" fire was not therefore included in our chronological system but the possibility has to be held open during the post-excavation analysis of the structural remains.

The fire in 1198 gets relatively detailed coverage in the written sources, for the good reason that it was apparently caused by Bishop Nikolas who organised the burning of the town in the evening of the feast of St Lawrence, August 10th that year during his "total war" against King Sverre. Everything below The Street (stretet) went up in flames "from the Church of the Holy Cross right out to Sandbru" (Sverre's Saga, 157–158) (fig 4). The circumstances attending this fire are described in detail in Sverre's Saga, which was written down soon afterwards and is therefore to be regarded as reliable concerning its extent. In our chronological system it was labelled Fire VI.

The best documented and most discussed of Bergen's conflagrations in the High Middle Ages is the one that originated in the Straumen tenement in the central part of Bryggen on the night between June 10th and 11th, 1248 (fig 4). The entire town south of Sandbru was reduced to ashes, except for some houses in Vågsbotn (Håkon Håkonssons saga, Ch 260). This fire is also commented on by Matthew of Paris who actually witnessed the results of the catastrophe (Chronica Majora, 35). He came to Bergen just after the fire and describes how the entire town was burned down save for four religious houses, the royal palace and the Church of the Apostles (Apostelkirken), all of which lay on the outskirts of the built-up area. Most surviving manuscripts give the date of the fire as June 11th (a fortnight before Midsummer Day) but several historical accounts assign it to July 4th. According to Helle (1979, 6–11), this erroneous dating is clearly traceable to the nineteenth century historian P A Munch, who arrived at this date for reasons unknown. In our system it was known as Fire V.

During the excavations, a fire of 1332 was included in our field chronology system on the basis of a study by B Lorentzen (1952, 91–92) and labelled Fire IV, but the primary sources contain no direct or precise information about where *beiarbruni i Biorgyn* (the town fire in Bergen) actually raged (Islandske Annaler 398). Lorentzen has suggested that a reference to construction work in the Skjeggen tenement in the years 1334–36 may be connected with rebuilding following the 1332 fire (Lorentzen 1952, 91) (fig 12). As other clues to the site of the fire are lacking, it is vital for us to establish the exact location of the Skjeggen tenement. Helle's comments are interesting in this connection (op cit 1979, 15). His starting point is Lorentzen's hypothesis that Skjeggen was situated between Bætagard/Lagmannsgården to the north and Skieldan/Schulten to the south (Lorentzen 1952, 111–12, 265). "Exactly where in the northern area we are to place the three tenements mentioned is another question," says Helle.

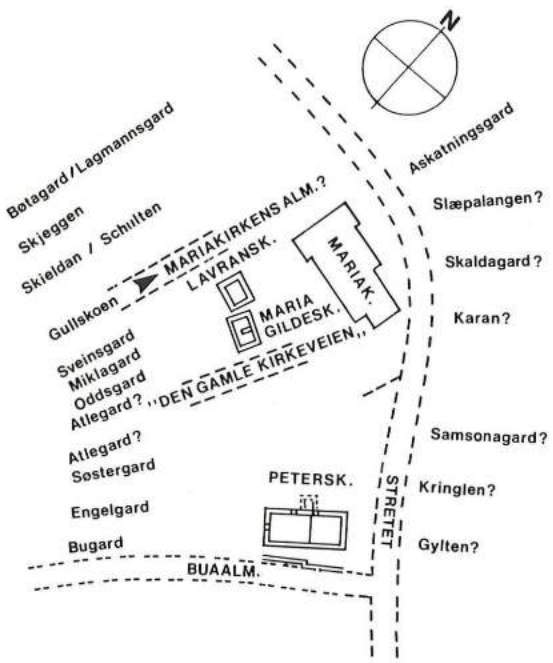

Fig 12 Lay-out of tenements in the northern part of Bryggen (as suggested by Helle, 1983)

A ruined stone cellar under Slottsgaten 3 which was demolished when the new Noregs Sildesalslag building was erected in the 1950's has been identified by Lorentzen as one of the fireproof cellars built at Skjeggen after 1332 (1952, 91–92). But he offers no proof for this assumption which must therefore remain rather tentative. After a comparative scrutiny of all the source material concerning the northerly tenements, Helle has suggested that it is at least as justifiable to locate Lagmannsgården-Skjeggen-Skieldan/Schulten further to the south, immediately north of the medieval Gullskoen, which in turn lies north of Sveinsgården and Miklagard (cf Helle 1982, 230–246). "It is then presumably the southern house-row of (the northerly) Sveinsgården that has been reconstructed as the more northerly of the two rows within Bryggens Museum. If this is so, then Skjeggen must be under the present street of Dreggsalmenning" (Helle 1979, 15, 34, 36–37). If we use the sizes of the contemporary buildings in the adjacent parts of Bryggen as a comparison, then according to Helle's theory Skjeggen should be 50–52 m north of Søstergården in the High Medieval period, while Lorentzen would place it another 60–70 m further north (fig 12). The northern boundary of Søstergården at that time has been clearly established by excavation. When, moreover, the sources speak of "the town" and "a large part of the trading centre in Bergen" having burned (Islandske Annaler 348), then the part of the excavations nearest to the town centre ought at least to have been affected by the conflagration. Lorentzen maintains that "at any rate section A was razed by the fire of 1332" (1952, 91, and fig on p 123). This is the section which coincides with the complex of buildings north of Søstergården. At that time, the passage which has previously been called *Mariakirkens almenning* was no wider than an ordinary tenement passageway and would scarcely have functioned as a fire-break for the tenements to the south. Helle also suggests that the Fatten tenement further south on the Wharf was destroyed by the fire in 1332 (Helle 1982, 184, 277). For the time being, therefore, there is ample reason to maintain that this fire affected the whole area of the excavations. The written sources diverge a little about its date, but as four of the five Icelandic Annals which mention the fire give its date as 1332, this ought to be correct (Helle 1979, 14).

On April 22nd, 1393 the band of pirates known as the *Vitalienbrüder* sacked Bergen and set fire to large parts of the town. According to some sources twenty-one houses belonging to English merchants were destroyed (Dipl Norv XIX, 666) but the dating varies somewhat. It has also often been suggested that there were two attacks by the *Vitalienbrüder*, one in 1392–93 and the other in 1395. Helle draws attention to G Storm's convincing exposition in which he concludes that "one single raid is involved, with subsequent tradition getting the date wrong" (Storm, Hist Tidsskr 3 IV, 428–446, cited in Helle 1979, 18).

It is generally supposed that the fire was centred on Vågsbotn (fig 4), where according to a late 16th century reference the English merchants had their property (Bergen Fundas, 81). Helle also draws attention to Absalon Pedersen's comment "that Hollenderstretet, the present Hollendergate, was earlier known as the Englishmen's street (Hist-Topogr Skr, 31) (fig 4). Consequently it has been usual to locate the English property in Hollenderstrete in the Vågsbotn area of the town, the most recent reference

being Lorentzen, Gård og grunn, 92–83, 184–185. But in fact we know neither the exact location nor the extent of their property" (Helle, 1979, 19). As a result the written sources have not provided much help in locating this fire. Referring to documents from 1395 which mention German offices in Bredsgården and Einarsgården (the present Enhjørning tenement), Lorentzen argues that these properties must have escaped the fire. Helle maintains, however, that Lorentzen's hypothesis is hardly a "convincing interpretation of the documents" (op cit 20).

In our original examination of the written sources, we kept to the traditional interpretation of this fire with its location in Vågsbotn and it was therefore excluded from our chronological scheme. It was only at a relatively late stage that we realised that it might affect the area of the excavations and that we had in fact probably uncovered traces of it. In the southern half of the excavated area three successive building phases were recorded between the fires of 1332 and 1413. The second of these phases was terminated by a hitherto "unknown" fire which should theoretically have belonged to the latter half of the 14th century. This fits extremely well with the historical events of April 22nd, 1393. Since we had no reason to expect this fire within the area of the excavations, it had not been included in the field chronology scheme. When fire traces began to appear below Fire III, they were naturally thought to derive from Fire IV (1332). The real fire IV was subsequently uncovered a metre lower down and the intermediate fire has therefore been labelled Fire IIIb. A detailed account concerning this fire level is to be published in a later volume of The Bryggen Papers: The Topographical and Chronological Development of the Bryggen Area.

Traces of the fire have so far been found in a limited area within the western part of Bugården and within the whole excavated area of the adjacent Engelgården tenement (fig 3). In Bugården the fire must, however, have had a much greater effect than the recorded traces suggest, because Bugården was totally rebuilt after the fire. In the Søstergården tenement north of Engelgården clear evidence of the fire was not recorded but the pattern of rebuilding follows that of Bugården and Engelgården. Within this larger part of the excavated area which has so far been stratigraphically analysed, the fire has clearly had extensive implications for the development of the area.

The written sources are again in disagreement about the date of the next fire, which is usually taken to be 1413, although there can be no doubt that they are all referring to the same fire. Both in Gerens Chronik (Bruns 349) and in the entry in Lübecks Niederstadtbuch (Hans UB, no. 1137) it is recorded under the year 1414, whereas the Icelandic Lögmannsannal has it under 1413. Helle (1979, 21–22) seems to have good reasons for dating the fire to October 29th, 1413 "tveim notom fyrer alla heilagra messo" (two nights before the Feast of All Souls). It is further recorded in Lögmannsannal that: "Kom fyst i Enskra manna garð elldurinn, þaðan i garpa strætit, brann ðat upp allt oc VII kirkiur med oc postola kirkia". (The fire started in the English tenement, then spread to the German street, where it burnt everything, including seven churches, even Apostles Church) (Islandske Annaler 291). As the English tenement was presumably in Vågsbotn, most of the built-up area below the street must have been destroyed, from the Church of the Holy Cross in the south to the Church of the Apostles in the north, both churches included (fig 4). It was known as Fire III in our field chronology scheme.

The sacking of Bergen in 1393 was not the only raid by the *Vitalienbrüder*. Further ravages followed in 1428, 1429 and 1432. The dating of the first two raids is documented by North German chroniclers, while the third is mentioned more summarily in two letters from the mayor and council of Danzig (Helle 1979, 29). Bergen was sacked on each occasion but only in connection with the raid on April 1st, 1429 is there talk of fire. Helle maintains that "we may be reasonably certain that in 1429 the *Vitalienbrüder* burned down both the king's and the bishop's residences on Holmen (the promontory) in Bergen" (op cit 25). All the chroniclers are agreed on this but they have different versions of the extent of the fire. "We may presume", continues Helle "that a greater or lesser part of the town inland from Holmen was also damaged by the fire though how much is uncertain" (op cit 25) (fig 4).

During the period under discussion here, ie 1428–1432, the German merchants had left Bryggen because of the war between the Hanseatic League and King Eirik of Pomerania. It is hard to say whether, or to what extent, this fact

may have affected the *Vitalienbrüder's* attitude to Hanseatic property. From expressions such as "several houses belonging to the citizens and merchants burnt" (Die Chroniken der deutschen Städte 28, 315), "almost the whole town" and "most of the town" burnt (loc cit, version KD and KH, 315, no. 2), we may well assume that at least the more northerly buildings of Bryggen were also destroyed. Moreover it should be borne in mind that any fire in the wooden town would not be easy to limit to the property or properties one intended to destroy. We cannot, therefore, ignore the possibility that the 1429 fire also affected buildings within the area of the excavations, although it has not been included among the fires on which our internal absolute chronology is based.

Two local fires are recorded along the eastern side of Vågen shortly after the middle of the fifteenth century, one localised to the Straumen tenement in 1454, the other devastating the Franciscan friary (Greyfriars) in Vågsbotn in 1464 (Gerens Chronik entry for 1454 and DN VII, no. 463, Hans UB IX no. 133). These do not affect our area, however.

The next large and well-documented town fire ravaged Bergen around midnight on September 9th, 1476. Although there are no clear reports concerning its limits, it must be assumed that most of what stood both above and below Øvregaten caught fire "from the Church of the Apostles to Sutarestretet and Skredderstretet, as well as the Church of the Holy Cross." (Gerens Chronik for 1476). The 1476 fire is consequently regarded as one of the more definite within our area (fig 4) and was labelled Fire II in our chronology system.

On the night between Monday 11th and Tuesday 12th February 1527, the northern part of Bryggen was ravaged by a fire which, remarkably enough, was confined to quite a small sector. According to a narrative published by Bruns (Die Lübecker Bergenfahrer, 394), it encompassed "der Goldscho unde de klene Swenegarden unde de Stwengarden unde de Bremergarden unde de Schege, unde van dysse 5 garde bleff nycht eyn stock bestande... "(Gullskoen, Lesser Svensgård, Svensgård, Bremergård and Skjeggen, and of these five tenements not a stick was left standing...). We read further that "De sellen van der Brugr deden grot arbeyt en deme fur, at se den Sustergarden, seyden myt lacken unde myt wetten..." (The Bryggen apprentices worked so hard that they managed to save Søstergården with sailcloth and water...). They managed therefore to check the fire's progress at Søstergården, which means that the 1527 fire encompassed only the northernmost part of the excavations (fig 4).

Bryggen, we are told, was now spared further disasters for 175 years, until May 1702, when most of the town went up in flames, with the exception of New Church (Nykirken) on the Strand side and St Mary's (Mariakirken) on the east side of Vågen. This long period was not entirely free from fires, however: in the rear section of Bugården two local fires have been recorded of which there is no mention in the available written sources. The earlier of the two, which is referred to as Fire Level b, has been dated to the first part of the sixteenth century, possibly the 1530's. The later fire, Fire Level a, has been dated to the period between 1702 and 1955.

Thanks to the rigorous safety precautions which were taken most of the time, another 253 years elapsed before a new fire devastated one half of what was still left. On July 5th, 1955 Bugården, Engelgården, Søstergården and Gullskoen were reduced to ashes. In the meantime, however, around the turn of the century, the southern part of Bryggen between Vetrlidsalmenning and Nikolaikirkealmenningen had fallen victim to a programme of demolition and redevelopment.

The fires which formed the basis of our absolute chronology have thus been dated as follows: 1702, 1527 (in part), 1476, 1413, 1332, 1248, 1198 and 1170/71. In addition come two local fires a and b in Bugården South and the more extensive fire IIIb in 1393, which so far has been documented in the western part of Bugården and Engelgården. Moreover, there is at least one unrecorded fire from before 1248 in addition to fire VII in 1170/71 and fire VI in 1198. How to place it in relation to the two recorded fires has been a difficult task, since we had no means for absolute dating.

If we follow the historical sequence, the first fire encountered during excavation would be dated to 1198, the next one to 1170/71 and the extra fire will automatically come somewhere before 1170 (= Alternative I). However, the fact cannot be ignored that this hitherto unrecorded fire may have happened some time between 1170/71 and 1198 (= Alternative II) or between 1198 and 1248 (= Alternative III) (fig 13). We must at the outset accept all three

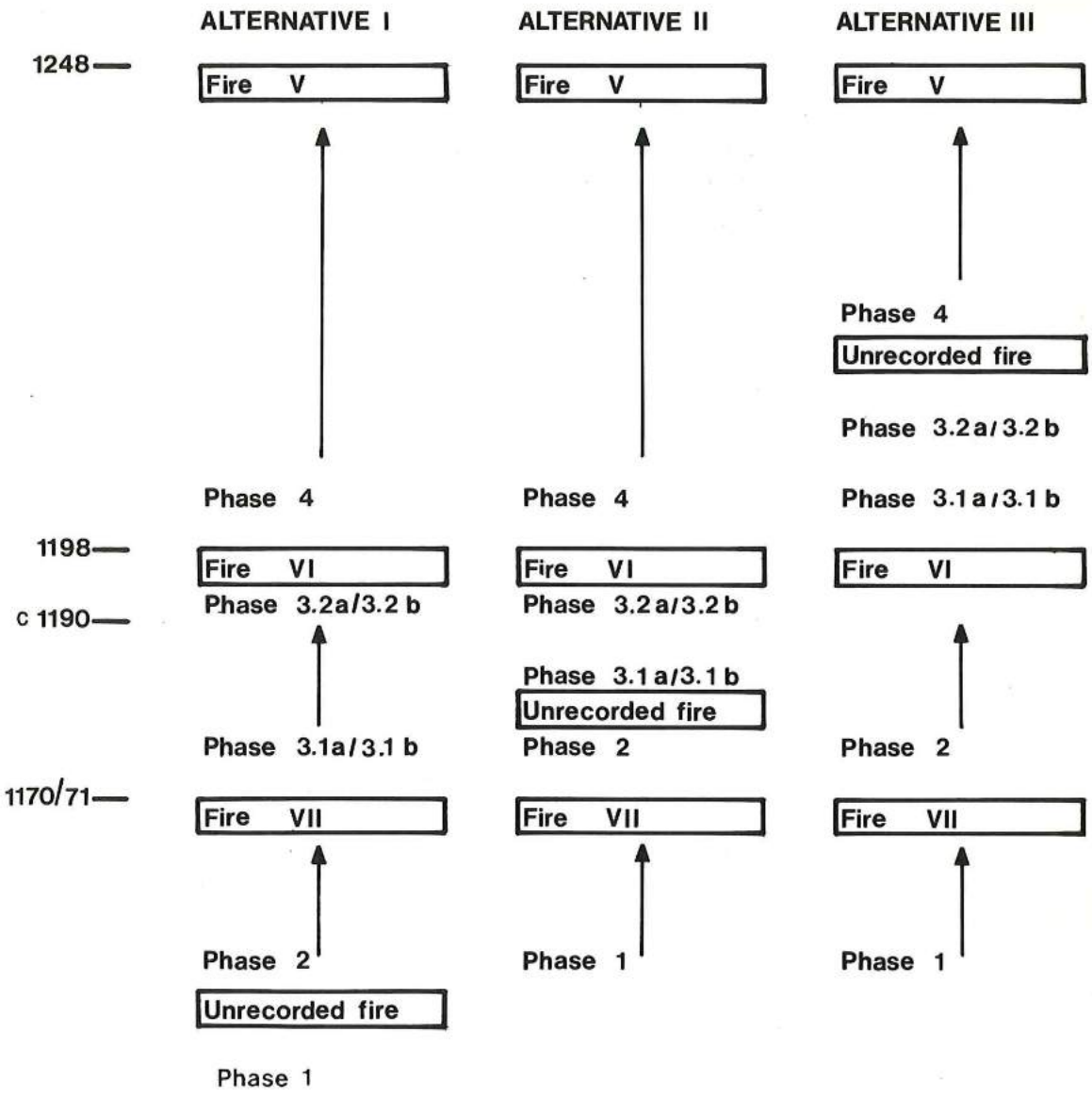

Fig 13 Alternative interpretation of the fire sequence before 1248

possibilities and analyse the consequences on the basis of the archaeological material compared with the historical sources.

One would expect that any trends in the town's topographical and economic development which might be indicated in the written sources would be reflected in the total archaeological material from the town's waterfront. Referring to the main features in the economic development of London from Roman times onwards, Brian Hobley suggests that "waterfront development is an economic indicator not only for the town itself, but in many cases for the hinterland also." (Hobley 1981, 1). If this is so for London, then it should surely also apply to Bergen, where the possibilities for expansion were much more limited. In our analysis of the material which would hopefully lead to the most likely alternative for the dating of the unrecorded fire, it is first necessary to get an

idea of the various building activities along the waterfront between the three fires prior to 1248 and see which principles were followed when extending out into the harbour basin.

Phase 1 The waterfront of the hitherto earliest definitely documented structures falls within the rear portions of a 25–30 m wide shore-zone. This is designated Phase 1. It is terminated by a fire (figs 13–14).

Phase 2 The so-called beach-phase is the expansion in front of this shore-zone and is associated with structures reaching to the front of the actual beach and with wharves raised on piles in front of them. This phase is also terminated by a fire.

Phase 3.1a is represented by an unburnt building phase in which there is an extensive "land-reclamation" and the waterfront is moved a further 12–18 m out into the deeper waters of the harbour-basin. The buildings are fronted with wharves on piles.

Phase 3.1b The waterfront is straightened up after a considerable settlement of the foundations.

Phase 3.2a After further "land-reclamation" the waterfront is pushed forward a further 2.8–13 m, in some places with separate wharves, in other places without them.

Phase 3.2b As in Phase 3.1b, the waterfront is straightened up after settlement of the foundations. The structures are destroyed by fire.

Phase 4 marks more or less a *status quo* in the development of the waterfront; in some places the earlier building-line is retained, in other places there is a slight extension of 2.5–5 m. The structures are destroyed by a fire, which has been correlated with the fire in 1248 (Fire Level V).

Even though Phase 2 takes in the greater part of the 25–30 m wide shore-zone, thus providing an enormous area of beach-won land, no special technical demands are made in the construction of the foundations of the buildings and wharves. Only in the subsequent phases were special requirements imposed for the stability of the new type of foundations which were from then on combined with an extensive and intentional dumping of refuse in the immediate harbour-basin.

The *average* amount of expansion in the various phases of Bugården, Engelgården and Søstergården (fig 14) is as follows:

Phase 2	extension over the beach	c 20 m
Phase 3.1a	extension into the bay	c 14 m
Phase 3.1b	foundations straightened	
Phase 3.2a	further extension	c 6.5 m
Phase 3.2b	foundations straightened	
Phase 4	further extension	c 3.9 m

In comparison, the extension of Bugården in the next two phases, 5.1 and 5.2, was 13 m and 12 m respectively, ie a total of 25 m during the second half of the 13th century (fig 14). This enormous extension of the waterfront is difficult to explain in relation to the decreasing tendency noted in the phases 1–4. The great expansion in phase 2, the so-called beach phase, must not be overestimated. It is true that it represents an enormous gain in land-area, but it was essentially on dry land and presented no technical problems with foundations for the buildings or quays. As previously mentioned it was not until the following phases that special demands were necessary to ensure the stability of the new types of foundations which had to be employed as the structures progressed into deeper and deeper water. It is possible that one of the reasons for the decrease in the rate of expansion out into the harbour basin was due to the ever-increasing problems with the foundations. In other words, it was preferable to find new ways of fulfilling the local expansion re-

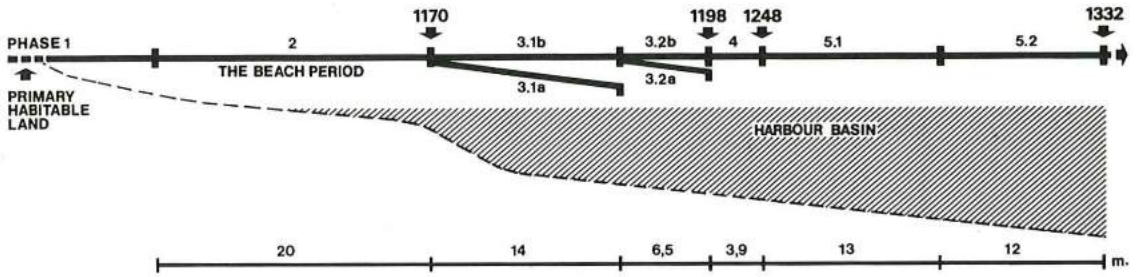

Fig 14 Schematic long-section illustrating the varying rate of development into the bay

quirements. This could only have been in a southerly direction on the whole, as it was hardly possible to find a satisfactory solution by extending up the mountainside to the east. Indeed, it is uncertain, if not extremely doubtful, whether the possibilities of expansion southwards could have been a contributory factor in the apparent deceleration in the development of the northern part of Bryggen. The individual landowner or merchant who had his property here would hardly have found it worthwhile to establish part of his business in other parts of the town. His requirements for more space must in the first instance have been solved either by building out into the water or by building upwards – even perhaps both. This is the pattern which we meet in the written sources at a later date.

From the archaeological material it is clear that there were two-storey buildings at Bryggen in the latter part of the 12th century, and from the written sources they can be further pushed back at least half a century: above Øvregaten two-storey dwellings can be documented as early as the mid-twelfth century. Furthermore in the rear of the excavated area a post was uncovered, which has belonged to a two-storey stave-building from the latter half of the 12th century.

On the other hand it appears that the warehouses along the waterfront from before the so-called beach phase and up to the middle of the 12th century must on the whole have been single-storey sheds. The development to two or even more storeys within the waterfront area – the actual Bryggen area – could therefore have happened around 1200 or after. This could plausibly be the explanation for the apparent reduction in the need for more ground space and consequently for the deceleration in the rate in reclaiming new land from the harbour basin during the latter part of the 12th and the early part of the 13th centuries.

The written sources provide little concrete information about local growth and expansion, but it is generally agreed that development increased rapidly after the foundation of the town. The sources indirectly reflect a high level of activity generally, and in particular much new building. The king, the church, the monastic orders and the local aristocracy were all especially active from the later part of the 12th century, with a peak in the middle of the 13th century, when the royal buildings on the Holmen were erected. The documentary evidence also leads us to understand that this activity led to an increase in private ventures.

When this activity is so clearly represented in the archaeological material after Phase 4 (after 1248), it may well be reflecting the otherwise well documented increase in the foreign connections and the consolidation of the king's power and of the state's, and that the possibilities for expansion by building upwards were now exhausted.

Alternative I

If the historically documented sequence of fires is followed slavishly the unrecorded fire will automatically be placed before the earliest recorded fire, Fire VII in 1170/71, and it will be the fire which terminated Phase 1. Phase 2 will be terminated by Fire VII in 1170/71 and Fire VI in 1198 will correspond to the fire which terminated Phase 3.2b. This means that the period containing by far the greatest activity – Phases 3.1 and 3.2, consisting of two ordinary rebuilding phases with a total expansion of 20.5 m, plus the necessary filling-in of the bay – comes between the fires of 1170/71 and 1198. Each phase must have been long enough for the

foundations of the wharves to have settled so much that they had to be straightened up (phases 3.1b and 3.2b). Such building activity within this short period must almost be described as explosive when compared with the following 50 years. It may therefore possibly be reflecting a real stagnation in the subsequent period, but it is difficult to find real grounds for suggesting such a model. From the written sources, the second half of the 12th century is a breakthrough for Bergen as a centre for overseas trade. Even though the expansion could have slowed down during the intervening period, there is nevertheless still half a century with scarcely any trace of development in the waterfront area. An ever increasing frequency of English pottery throughout the first part of the century shows that there was quite a lively trade-connection with England and it is therefore difficult to explain the archaeological data from the first 50 years of the 13th century simply as a period of consolidation. Moreover, there is nothing to indicate that shipping before c 1200 needed greater depth of water than in the following 50 years. The height of the quays remained the same. Since the written sources therefore do not give any special indication of stagnation or regression, Alternative I can still be defended if the need for increased ground space is compensated by an increase in the height of the buildings during the first half of the thirteenth century. Both the archaeological material and the written sources would suggest that this is a reasonable and acceptable solution. Alternative I must therefore be regarded as a possibility until absolute dating or further relative data become available.

Alternative II

If the fire which terminated Phase 1 corresponds to the 1170/71 fire (Fire VII) and the hitherto unknown fire is placed at the end of Phase 2, with the 1198 fire coming at the end of Phase 3.2b, then the period 1170/71–1198 will have to include not only the two previously mentioned building Phases 3.1 and 3.2 with their subsequent adjustments, but also the earlier expansion in Phase 2 out over the beach. This interpretation implies a concentration of activity which is almost absurd given the short time available. On p 23 the possibility of the fire in 1194 was held open. If the unrecorded fire is dated to that year, it means that the beach-phase, Phase 2, must be placed between 1170/71 and 1194 and Phases 3.1 and 3.2 with their subsequent adjustments will come between 1194 and 1198. This interpretation is unrealistic and must be rejected.

Alternative III

The third possibility is that the unrecorded fire happened between 1198 and 1248. According to this interpretation, Phase 1 will be terminated by the 1170/71 fire (Fire VII) and the fire at the end of the beach-phase, Phase 2, will correspond to Fire VI in 1198. The period with the greatest building activity will thus fall within the period 1198–1248, with Phases 3.1 and 3.2 in the first part, terminated by the unrecorded fire, and Phase 4 occupying the latter part, being terminated by the 1248 fire. Since the Phases 3.1a and 3.1b and 3.2a and 3.2b necessarily must have taken some time, it is unreasonable to place the unrecorded fire earlier than, say, 1220. It is, however, difficult to explain why an extensive local fire at this time should be omitted from the ever richer written records. The later the fire, the more inexplicable is the omission. In principle, however, this period of 50 years should offer abundant time for all the phases, 3.1, 3.2 and 4.

Of the three possible interpretations, I and II have in common the fact that the slowing down in the rate of expansion is placed in the first part of the thirteenth century (cf fig 14). In Alternative I and to an even greater extent in Alternative II the most significant period of activity is concentrated to the 1170's and 1180's, with a minimal expansion in the following 50 years. In Alternative III the decrease in activity is spread more evenly and even though Phase 4 covers here a significantly shorter period of time than in Alternatives I and II, the deceleration in the rate of expansion is just as difficult to explain. Lacking any better argument, Phase 4 might be explained as a period of consolidation before the really great development begins after the 1248 fire. In any case, this theory does not appear to give any support to the idea of a firmly based and regular acceleration in development such as the written sources and the archaeological finds seem to indicate. Those factors which might have been able to explain this situation have not as yet been isolated.

Among our finds there is not much which can contribute to the establishing of an absolute chronology within this early period. The substantial and richly differentiated pottery has not yet been analysed: any contribution it can make will have to come later. Among the coins there are few which are earlier than 1248 and of these the majority were found in the area of the graveyard, whose stratigraphy has not yet been synchronised with the rest of the excavated area. Among the runic material there are two or three inscriptions which can help with the chronology. They will be discussed further in the section on the absolute dating of the phases, but are mentioned here in view of the light they can throw on the chronological problems concerning the extra fire layers.

Inscription 31390 was found in the middle of the excavated area slightly above Fire Level IV (1332). There is fairly good reason to believe that this inscription which includes the name *Gunnar Kvit* had been deposited during the building phase following the fire of 1332. Furthermore, there is good reason to associate the name in the inscription with *Gunnar Kvit* who is known to have been the royal treasurer (Norw *fehirde*) in Bergen from 1340 to 1343. This inscription is therefore regarded as our best absolute chronological contribution in correlating Fire Level IV with the historically recorded fire of 1332.

The inscription 32875 has a reference to the sister of *Olav Hettusvein*, one of the rebels supporting *Olav Ugjæva*. The latter is said to have died in exile in Denmark, probably in 1173. However, the period during which this inscription could have been written is so long that it cannot contribute essentially to the absolute dating of the phases we are particularly interested in.

The third inscription of this type (30428) includes the name *Torkjel the moneyer* (Norw *mintari*). He is not a known historical figure but the inscription for other reasons can be attributed chronological significance. It was found in the waterfront area in foundations belonging to Phase 4, from after the fire which preceded Fire Level V (1248). According to our hypothesis, the inscription, together with the refuse from the layer in which it was found, ought to have been discarded during the preceding period, Phase 3.2. This assumption needs some further comment. In the waterfront area the medieval building phases were preceded by the filling-in with enormous masses of refuse partly in order to gain new land, partly to raise the ground level. We have the impression that the town was more or less completely "cleaned" during each main building period. The make-up for a particular building phase ought therefore to contain the refuse which had accumulated during the preceding phase.

With reference to some epigraphic elements in the inscription, the numismatist Kolbjørn Skaare (1984) associates it with the Bergen coin issues in the later part of King Sverre Sigurdsson's reign. A dotted letter ᛒ for the sound *p* and l for ᛏ for the sound *d* speak for an early date, probably the late twelfth century (op cit). This early dating of the Torkjel inscription found in the make-up layers for Phase 4 (which was terminated by Fire V in 1248) fits well with our hypothesis concerning the dumping processes: the inscription had become incorporated in the rubbish from Phase 3.2 which was subsequently used as the make-up for Phase 4 after the fire. According to Alternatives I and II, the fire which terminated Phase 3.2 (ie 3.2b) corresponds to Fire VI in 1198, with Phase 4 taking up the whole period 1198–1248, whereas in Alternative III, Phase 3.2 (ie 3.2a) does not begin until well after the 1198 fire and is terminated by the hitherto unrecorded fire at some point within the period 1198–1248. If reasonable allowance is made for the length of time and the degree of preservation for the phases, the building of Phase 3.2a according to Alternatives I and II would be placed in the latter part of the 1180's or according to Alternative III to the years around 1215–1220. The late twelfth century date of the Torkjel inscription therefore speaks against Alternative III. Alternative II has been rejected for other reasons (cf p 30) and we are thus left with Alternative I as the most reasonable interpretation.

Another strong argument for an early dating of Phase 3.2a is an inscription (42011) which was clearly made at the request of King Sverre Sigurdsson's eldest son, *Sigurd Lavard*. This find has previously been described by the author (1969, 32) on the basis of Aslak Liestøl's interpretation (Liestøl 1964, 54–56). It is of minor significance that it can no longer be dated quite so exactly. We know that Sigurd Lavard died in 1200 at about the age of 25, which means that the inscription must date from the 1190's "when he was considered sufficiently adult to be entrusted with important

assignments such as this text bear witness to" (Herteig 1969). It was found about 20 cm below the floor of a building burnt in the fire preceding the 1248 one. The find circumstances indicate that the runic inscription was contemporary with that building. If therefore the fire which destroyed it was that of 1198 the runic inscription might belong to the 1190's or the late 1180's.

However, as Sigurd did not die until the year 1200, there is the possibility that the inscription was not made until after the 1198 fire. The building from Phase 3.2a, below whose floor it was found, must then have been destroyed in the next fire, ie some time between 1198 and 1248, which would correspond to our Alternative III interpretation. If this is the case, then the inscription cannot be contemporary with the building, because according to Alternative III Phase 3.2a cannot possibly be earlier than 1215–1220 and is most likely later. This makes Alternative III unlikely.

Taken together, the runic inscriptions therefore seem to strengthen the arguments for an early dating of Phase 3.2a – to before 1198, or in other words our Alternative I. But any decisive chronological argument will have to wait until the scientific analysis of specially selected samples is completed. The best assistance would have been provided by a dendrochronological analysis and by the radiocarbon dating of suitable material, but in the 1950's and 60's there was practically no possibility of getting a ^{14}C analysis of medieval material. Furthermore, the analysis of our relatively large collection of dendrochronological samples has been held up by factors beyond our control. New methods of calibration for radiocarbon dates and a grant from the Norwegian Research Council for Science and the Humanities to fund a research student in dendrochronology suggest that these areas will now be opened up and provide new possibilities for dating.

An analysis of some dendrochronological samples has provided a tentative floating chronology. The samples which have been used are not very representative, with growth periods averaging around 50 years. Nevertheless some clear trends seem to be emerging which, when considered in the light of the other information already described, could be decisive in determining which interpretation is chosen.

Some 90 samples from Phase 3.2 (destroyed in the fire previous to Fire V in 1248) indicate a common felling date at the end of the 1180's. This would imply that Phase 3.2 began around 1190 and in any case before 1198 and so would have burnt in the 1198 fire. Consequently the preceding unburnt Phases 3.1a and 3.1b would have to be placed between Fire VII in 1170/71 and c 1190. From this it can be deduced that provided these provisional dendrochronological analyses can be confirmed, the extra fire will have to be placed in the period prior to 1170/71, possibly around or before the middle of the twelfth century (fig 13). This corresponds to our Alternative I and fits well with both the Torkjel and the Sigurd Lavard inscriptions. If the latter inscription was lost or discarded at the same time as the construction of Phase 3.2a around 1190, Sigurd Lavard would have been about 15 years old when he undertook an important assignment, that of obtaining weapons for his father King Sverre Sigurdsson. At that age even more important assignments would not be regarded as unusual.

On the basis of trends in the archaeological material and provisionally supported by the dendrochronological results, we would maintain that we have good reasons for building further on Alternative I. According to the points discussed above, the sequence of the total and partial fires affecting the excavated area of Bryggen may be given as follows:

Fire Level	Date
0	Corresponds to the fire in 1955
a	A minor fire between 1702 and 1955. Recorded during excavation
I	Corresponds to the historically recorded fire in 1702
b	A minor fire around 1530–1540. Recorded during excavation
Ib	Historically recorded local fire in 1527, north of Søstergården
II	Historically recorded fire in 1476
III	Historically recorded fire in 1413
IIIb	Historically recorded fire in 1393. Found in Bugården and Engelgården and partly also in Søstergården
IV	Historically recorded fire in 1332

V Historically recorded fire in 1248

VI Historically recorded fire in 1198

VII Historically recorded fire during the winter 1170/71

VIII Previously unknown fire provisionally dated to the mid 12th century or earlier

With the exception of the dendrochronologically dated fire VIII the chronological sequence outlined above is based mainly on a study of the stratigraphy and will therefore within certain excavated areas have to be confirmed or modified by the evidence of the finds material. Over the greater part of the excavations, between 48x and 88x, ie in Søstergården, Engelgården and Bugården, the fire of 1702, for example, could be clearly identified immediately beneath the foundations of the burnt buildings. In Gullskogården to the north, however, traces of the 1702 fire, and to some extent of the local 1527 fire as well as that of 1476, had been previously removed by building activity. At various places here, a number of chronological problems can be expected. Here, for example, the numerous pottery finds from half a hundred regions in North West Europe should, when analysed, help to elucidate both stratigraphical and chronological problems.

In many instances where the deposits are so thick that they indicate more than just a levelling up of the site, there can sometimes be some doubt as to whether they represent one single filling-in operation or are a succession of deposits over a period of time. The forthcoming pottery analysis will be able to provide valuable assistance in this connection, as the pottery consists mostly of a multitude of small fragments. A statistical analysis of the find-frequencies, as well as the vertical distribution of fragments of similar wares, may be able to confirm whether these thick deposits represent a single operation or several stratigraphic and/or chronological entities. Comparative distribution studies may also help to corroborate horizontal continuities. Already in one of the earliest years of the excavations, it was clear even without scientific analysis that fragments of one and the same soapstone vessel had turned up at entirely different places in Bugården. The base and parts of the sides were lying relatively deep down in the quay's foundations, whereas the rest of the vessel was found a good deal higher up in a latrine further back in the same tenement. These fragments could confirm the fact that a phase of expansion outwards into the harbour basin was contemporary with development on the landward side. An analysis of the finds will therefore contribute still further to the confirmation or modification of the many phases of development within the area of the excavations.

6 Field-documentation and interpretation

The principles followed in field-documentation remained the same throughout the excavation period, but as time went on, routines were evolved that were more effective and appropriate than those first employed. Only the main lines of this development will be described in the present context.

From start to finish, every single level exposed was duly photographed, drawn, levelled, commented on and interpreted. Photographically, all these levels, along with a host of details, have been documented in black and white – mostly 4 ins x 5 ins, though some were 6x6 cm. The illustrations have been sequentially numbered and to a substantial extent recorded in handbooks with classified and detailed descriptions. Furthermore, the same data have been entered in the folders containing the negatives, these folders, like the negatives themselves, being numbered. The description of shots taken in the field was subsequently transferred to *Selecto*, a semiautomatic "peek-a-boo" system which in our version has a capacity of 5000 numbers per card (figs 15–16). Selecto is what is known as an inverted file system. The point of this in the present instance is that it is not a file of serialised illustration-numbers, but of the characteristics or distinctive features noted in the case of each separate illustration. There are, accordingly, cards for building, door, wall, floor, hearth, foundation, street, well, privy, drainage, fire-level and so on. The "hearth" card, for example, is perforated with the numbers of all photographs that have hearths on them; on the "building" card all the photographs which show buildings, and so on. If negative 3280 encompasses the motifs "building", "hearth" and "door", the position for no. 3280 will receive a perforation on all three cards. Should someone later require an illustration or illustrations that include these three motifs, negative no. 3280 will accordingly cover all these features. And given that the cards

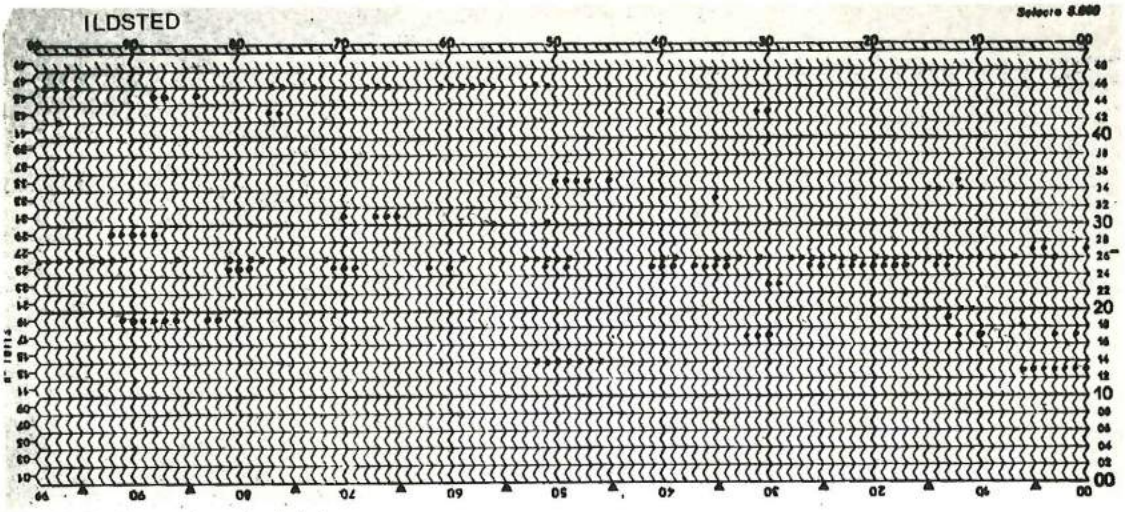

Fig 15 Perforated card of Selecto type

are placed one over the other in front of a light source, the position for 3280 will transmit the light, while all the remaining individual feature positions on the cards will block it. Should it be desirable to limit the search either in time or in scope, cards bearing the relevant features may be selected, as for instance "fire of 1248", "square K11 or K12" etc. In this way, a series of questions can be addressed to the picture material, a simple choice of cards leading directly to the relevant illustrations or negatives. All one needs do is make sure the illustrations are correctly interpreted, so that each single illustration yields the widest possible range of motifs.

On the basis of more subjectively grouped criteria – for example, choice of motifs with a view to giving lectures or meeting special illustrative requirements – a considerable proportion of the motifs has been further documented with colour diapositives, either 24x36 mm or 6x6 cm.

After being photographed, the exposed levels have been planned square by square on a scale of 1:20, special details being usually drawn on separate supplementary plans at a scale of 1:10 or 1:1.

As mentioned earlier, the grid-square remained at all times the unit of documentation, even where the portion exposed encompassed a greater or smaller area. Millimetre-paper in standard A2 format was used for planning and the accompanying illustration (fig 17) will show how the sheet was laid out. On especially rainy days, it became necessary to plan on plastic film, subsequently copying the result on to ordinary mm paper. Regular mm paper shrinks to varying extents regardless of whether it has been exposed to abnormal moisture or not. Where the budget permits, permanent use of plastic film instead of traditional mm paper is strongly to be recommended, at least in complicated excavations. More expensive it certainly is, but vastly to be preferred from a purely technical point of view.

The procedure in levelling was this: all points to be measured were first marked off and sequentially numbered directly on the plan and entered in a levelling book. The number was written on the plan at the point at which the measurement was to be taken, this being done

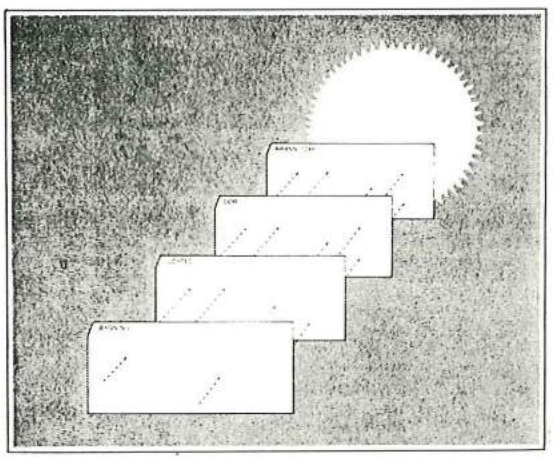

Fig 16 Principle underlying use of Selecto

according to a system designed to facilitate subsequent commentary. Since all constructions and structures, along with selected individual features, were among the points to be levelled, it goes without saying that the levelling location-numbers served at the same time as identity marks. The numbers were therefore sequentially ordered so as to afford as logical and practical a description as possible of each and every construction and feature. By virtue of the subsequent commentary, this renders the whole business of identification appreciably more straightforward – one solid reason for choosing precisely this procedure.

Example: A beam is normally defined by referring to its endpoint levellings, but a broken beam would in addition be levelled wherever the breaks occur, and a description of the beam would include the numbered points of all these levels. If the numbers (ie the points at which it is to be levelled) are consecutive (eg 10-11-12-13), then the beam can be identified by the numbers 10 and 13, otherwise (eg in the 10-12-13-11 case) all the points must be given.

The efficiency of this system shows up even more clearly where the boundary of a structure is indicated by, say, eight consecutive numbers rather than by an arbitrary and discontinuous row of figures. In the former case, the boundary can be given by just the first and last numbers; in the latter, not only must each separate number be given, but to make matters worse, a search for the numbers is often necessary to ensure that the boundary has been correctly specified.

An objection which has been raised is that the numbering of the points which are levelled has in itself nothing to do with the actual plan-drawing, that it is instead the measurement values or reduced levels which are of interest and it is these that should be given on the plan. This is, of course, quite true. In our situation, however, the chosen method constituted so marked an increase in efficiency in the field that

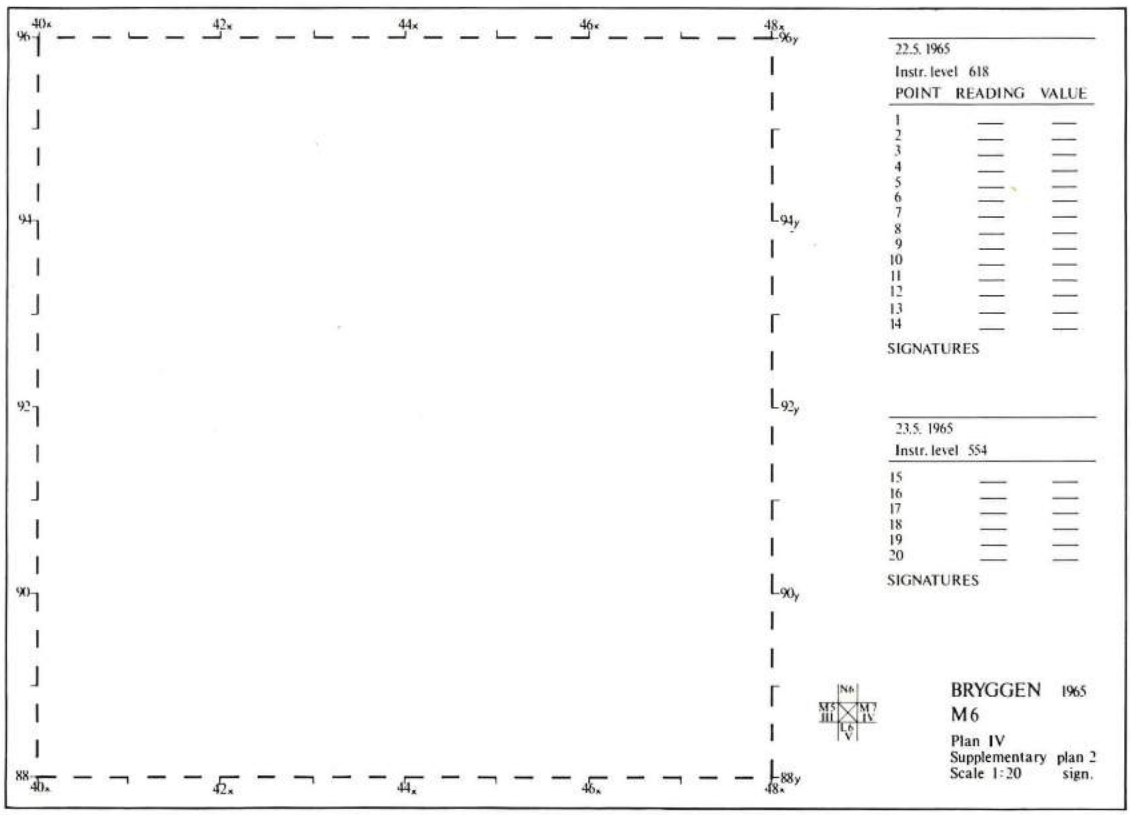

Fig 17 Layout for plan-drawing. Example from grid-square M6, plan IV with cross-reference to associated plans given in adjacent squares. I = height of levelling instrument

no real alternative existed. Even today, when inexpensive pocket-calculators can be used to convert levels in the field, our method has clearly much to recommend it, since the reduced levels can in no way be used for identification or location purposes. The more complicated the field situation, the greater the saving of time both for commentary and interpretation that our system offers, and thus the greater the amount of money it saves; for it is in this direction one must look for gains from increased efficiency where major operations in the field are concerned. Nor is the applicability of measureable values, eg when used for drawings, to any great extent reduced, since the layout of the plan allows for the converted levels to be included in a table on the right-hand side. Where required, moreover, the figures can be transferred to the drawing, but that is mere clerical routine which can be assigned as the occasion demands to a less skilled work force without causing delays in the field. The situation is comparable with extensive use of baulks as compared with pure area-excavation. There's no having it both ways, and a choice simply has to be made. In our case, it seems to me that when all is considered, it is both technically and economically more advantageous to write on the plan the numerical order in which the points are levelled, than to give the reduced levels.

Local sections were drawn wherever it seemed appropriate to supplement the standing or fixed sections and to assist in the final commentary of the plans, which consisted of two main components:

A A short verbal recapitulation of what the drawing actually depicted, of what, in other words, had initially been placed in a common context and recorded

B Interpretation, within the framework provided by the sum total of excavations so far completed, of the situation being depicted

It has often been asked why one should start with a verbal recapitulation of the visually documented situation instead of proceeding directly to an interpretation. In theory, such a question may seem to have every justification, but in practice a direct interpretation will often turn out to be inadequate, particularly in the case of complicated urban excavations, since however good a field plan might be, it is in most cases – like commentaries and interpretations – not entirely innocent of ambiguities. The same goes, of course, for photographs and their interpretation. Thus an introductory pinpointing of what has been noted will serve as a rule to give one's statements a sharper formulation and to disengage one's conclusion from what is inessential. When in course of time the mental image has faded, it is not the conclusion arrived at which gives surety for how things really were, but the verbally formulated premises in conjunction with the on-the-spot drawing. And the interpreting process itself should invariably be part of the day's work. The greater the complexity, the greater the need for a running interpretation and this has to include any alternative interpretations that may suggest themselves. For in the very nature of the case, if counterindications in the field are of such weight that no single acceptable interpretation can be found, even the best documentation will be an oversimplification of the field situation. So that where interpretation comes afterwards, counterindications will carry less weight than they would with on-the-spot interpreting. It may even turn out that interpretative endeavours in the field will lead to the actual discovery of neglected details that now are really seen for the first time or acquire a new meaning. For all these reasons, the less of the interpretative process that is left until after the excavation, the better. That later stage is the time for checking and consolidating the overall views and the broad syntheses. And this, as we said before, is one of the great advantages of the stratigraphic method – the way it provides for on-the-spot interpretation.

6.1 Localisation data

In 1955 it could hardly be said that Norwegian archaeology – and least of all Norwegian urban archaeology – had any field traditions to build upon. Where urban archaeology was concerned, it had been the exception rather than the rule for documentation in the shape of day-to-day reports on observations in the field to take place at all, while any finds were to a great extent carted off with the rubble containing them. So when it came to localising finds at Bryggen, the only thing to do was to start from scratch – in short, with elementary listing of finds. This would comprise, in addition to a brief catchword identification of object or

group of objects, descriptions of the find-spot worded more or less subjectively.

At first glance, one does tend to assume that the most exhaustive description of the find-spot must also be the best, that the more details supplied and the more numerous the points of reference, right, left and centre – the more securely the find has been topographically pinpointed. But experience soon taught us that this holds good only of small numbers of finds such as can be taken in at a glance. The more copious the finds, and the more detailed and individually worded the descriptions, the harder it was to correlate the localisations. Once material was present in sufficient quantity, one's synoptic view of it was imperilled. And it was not long before we were up against just this problem at Bryggen, so that we were forced by the facts to find a more systematic localisation procedure. And this, in turn, led to use of the computer.

Our starting point was the traditional one: a network of grid-squares with associated coordinates and levels. The grid-square was the fixed unit for localisation but grid-square references, like determination of coordinates, are devoid of cultural significance so long as the find location has not in some other way been placed in a culturally significant relationship. Such a localisation acquires cultural content only when it has been related to documented geological or archaeological phenomena, eg, to a stratum or a construction of archaeological importance – the latter could be a building, a part of a building, a well, a pit, a road, a ploughed field or something comparable. It is, after all, one of the archaeologist's most important aims to bring finds into relation with each other, with purely stratigraphical data and with what we may call standard artifacts. In this connection, fixing of coordinates and the indication of levels are merely stepping-stones on the way to the real objective. On the other hand, a verbal account of the find location and its cultural relevance may be quite futile in the absence of systematisation.

It is on the whole preferable to go from the general to the particular, but it can often be difficult to decide in a field situation just what is general or particular. It is usually easy enough to establish that a find has been made in or just outside a building, a well etc, but not always nearly so easy to assign it to the appropriate stratigraphic and chronological category.

With such an investigation as that at Bryggen where numerous remnants of houses and other constructions were in evidence throughout, it was only natural to base the localising of the finds on direct correlation with whatever constructions the particular find was most nearly in line with, without such plotting of position implying any interpretative commitment regarding the connection between construction and find. A detour, so to speak, via the coordinate system was resorted to only where it was either impossible or impractical to relate to a construction, as for instance with "pure" make-up layers or other strata devoid of relevant constructions, and with special finds or find-groups like loom-weights, net-sinkers, runic inscriptions, etc. Where the thick layers of make-up were excavated in arbitrary levels, the strata were defined by levelling and fixing the coordinates, together with level-number, grid-square and plan references.

On the basis of the principles applied – principles developed from referring to archaeological constructions in the horizontal and vertical planes and to the local stratigraphy – a special localisation sheet for field use was developed. After four successive preliminary versions had been tried, each leading to certain improvements, joint efforts by Mr Kolbjørn Heggstad (then Senior Research Assistant, Institute for Computer Language Design) and Mr Michael Gillow (then Chief Consultant at NAVF's Computer Centre for Humanistic Research) resulted in a form on which all relevant field data could be systematically coded directly in the field (cf p 44). Duly filled in, this sheet has subsequently served as a punch-card basis for transferring recorded data to the computer. No account will be given here of the various evolutionary stages leading up to the final version, since all data collected during the interim period have in due course been transferred to the form in its final version and punched in.

To provide a basis for recording the data, a register was compiled of relevant possible reference points in both horizontal and vertical planes and of the way in which finds might be related to these (figs 18–19).

The register also contains a list of the soil layers anticipated on the Bryggen site, references to logbooks, drawings, photographs and so on, as well as a list of distances in cm, all in coded form. By means of this alphanumeric code – built up basically on mnemonics – our

Material Groups

01 Bone (Horn, Animal Remains)
02 Glass
03 Ceramics (Clay, Stoneware, Porcelain)
04 Leather
05 Metal
06 Stone (Unspecified)
07 Textile
08 Wood
09 Plant Remains (except Textiles), Ropes, Amber
10 Soil Samples, Mortar, Chalk
11 Bone + Metal
12 Metal + Wood
13 Metal + Leather
14 Wood + Textiles
19 Divers

Distances

01= 0- 5cm
02= 6-10cm
03=11-15cm
04=16-20cm
05=21-25cm
06=26-30cm
07=31-35cm
08=36-40cm
09=41-45cm
10=46-50cm
11= 51- 60cm
12= 61- 70cm
13= 71- 80cm
14= 81- 90cm
15= 91-100cm
16=101-125cm
17=126-150cm
18=151-175cm
19=176-200cm
20=201-225cm
21=226-250cm

H = Horizontal Plan, Locality

10-Building 11-Fireplace 12-E.wall 13-W.wall 14-S.wall 15-N.wall 16-Doorway
20-Foundation 21-Bulwark under House 22-Bulwark in Quay 23-Stone Foundation
30-Street 31-Public Alley (Almenning) 32-Passageway 24-Post
40-Drain 41-Alley (Veit) 42-Ditch 33-Footbridge 25-Posthole
50-Well 51-Barrel 52-Pit 43-Evesdrip
60-Cesspit
70-Grave
80-Other Locality 81-Level 82-Well-Lining
90-.....

Relationship

A= Around
B= Behind
C= Eastern Part
D= By
E= Western Part
F= In Front of
G= Outside
H= Inside
I= In
K= On Level with
L= In the Middle
M= Between
N= North of
O= Over
P= On
Q= Northern Part
R= Southern Part
S= South of
T= East of
U= Under
V= West of
X= Northeast Part
Y= Southeast Part
Z= Southwest Part
Æ= Northwest Part

Fire Level

1 =1702
1b=1527
2 =1476
3 =1413
3b=1393
4 =1332
5 =1248
6 =1198
7 =1170
8 =
9 =

V = Vertical Plan, Construction Level

10-Log Course
20-Floor
30-Deck 31-Street Deck 32-Passage Deck 33-Footbridge Deck
40-Quay Deck
50-Drain Cover
60-Drain Bottom
70-Flagstones
80-Stone Layer
90-Other Level
00-.....

References to Column 60

0= No reference, information complete
1= Check Serial Card Index
2= Check Register of Catalogued Material - from 1 to 4244
3= Check Plans
4= Check Sections
5= Check Photographs
6= Check Diary
7= Check Several mentioned Sources.
General uncertainty with localization

References to Column 61

1= Ref. concerning H-field
2= Ref. " V- "
3= Ref. " L- "
4= Ref. concerning F-field
5= Ref. " Totality
6= Machine excavation - winter 1971

N.B. All numbers under 10 must be prefixed with zero: 01, 02 etc.
Field u/d = uncertain dating: To be filled out with 0 when all is certain; in the opposite case, filled out with 1.

Stratigraphic layer - L

010 MOSS
011 with twigs
012 with chips/shavings
013 with charcoal
014 with peat/turf
015

020 TWIGS
021 with moss
022 with chips/shavings
023

030 NUTS
031 with charcoal
032

040 DECOMPOSED LIMESTONE
041 with clay
042 with soot
043 with charcoal

050 GRAVEL
051 with sand
052 with soot
053 with charcoal
054 with pebbles
055

060 SAND
061 with gravel
062 with soot
063 with charcoal
064

070 CLAY
071 with sand
072 with decomposed limestone
073 with soot
074 with charcoal
075 with shells
076 with humus
077

080 MUD
081 with clay
082 with sand
083

090 SILT
091

100 SOOT
101

110 ASH
111
112

120 CHARCOAL

130 PEAT/TURF
131 with moss
132 with twigs
133
134

140 EXCREMENT
141
142

150 FAT SUBSTANCE
151
152

160 HUMUS
161 with sand
162
163

170 GENERAL FILL LAYERS
171 with twigs
172 with chips/shavings
173 with charcoal wastes
174
175

180 STEATITE/SOAPSTONE WASTE

190

200 UNSTRATIFIED MATERIAL

COLORS

10 black 11 grey/black
20 grey 21 light 22 dark
30 yellow 31 light 32 dark
40 green 41 light 42 dark
50 brown 51 light 52 dark 53 red
60 blue
70 violet
80 pink
90 red
00 no stated color

Fig 18-19 Field code

localisation sheet can be filled in section by section. One heading on this sheet provides for the name of the excavation site, and there is a space for the signatures of those responsible for filling it in and for checking it.

On the principle of assembling all objects or units from the same locality in the field, the form is divided into two main parts, an upper register for recording their location, and an identification section below, where all the individual data are separately gathered, – level-readings and coordinates included. Each accession number recorded for a given locality has a box assigned to it in the identification section. This collective localising procedure cannot, of course, prevent the duplication of sheets with the same localisation while the work is in progress, due to renewed excavation after an interval in a locality already dealt with. An entirely fresh form will, in fact, be employed for each day that work continues in the same locality. Considering the numerous finds normally made within the various localities during a modern urban excavation, the advantages of using collective recording-sheets are obvious, even where the computer is not being used. In the case of computer-based sorting, the finds can be assembled or grouped as need dictates, regardless of the way they have been recorded.

6.2 The location section

The location part of the sheet begins by referring to grid-square, part of square (P/Sq), plan (PL) and supplementary plan (S Pl). The grid-square has been retained as a location unit mainly for statistical reasons, despite its having been gradually dropped as a unit of excavation. It is accordingly an obligatory reference unit in much the same way as the plan is. Next come three sections for references in the horizontal plane (H-section) and two sections for references in the vertical plane (V-section), together with sections for stratigraphy or layer (L) and dating.

Localising part:

Square	P/Sq	Plan	S Pl	Horisontal (H) 1			Horisontal (H) 2			Horisontal (H) 3			Vertical (V) 1			Vertical (V) 2			Stratigr. layer (L)			Dating			Ref.	
				Locality	No.	Dist.	Locality	No.	Dist.	Locality	No.	Dist.	Constr.	No.	Dist.	Constr.	No.	Dist.	Layer	Col.	Dist.	F	Dist.	%	60	61

6.2.1 References in the horizontal plane

All references serving to localise an object in the horizontal plane are entered in the H-spaces.

Each of the H-sections is divided up into "Locality", "No." and "Distance". Of the three boxes under "Locality", the first is reserved for a relationship which will be indicated by one of the coded prepositions, the other two for the relevant construction or locality.

Example:

As "V" is the code for "west of" and "10" the corresponding code in the horizontal plane for "building", "V10" in the first H-space will mean "west of building". "West of building 18", for example, will be indicated by "V10-018".

The first thing recorded in the H-section is the relationship of the find to the construction (locality), which in this connection is considered only in the horizontal plane, irrespective of height or depth. The relation is given as "in", "outside", "inside", or, preferably "east of", "west of", etc or, where the inside/outside relation is of special importance, by a combination. Should a situation crop up where one requires a combination of such directional designations as "north of south wall", "inside building" and also, perhaps, "in front of" or "south of" hearth each single relation-entry will have to be repeated on the form (cf example 2 p 44).

Example:

If a find is made 28 cm outside (south of) well no. 4, the following sequence will be entered in the H1-section: "S50-004-06", the relation "outside" being in this case implicit. "50" stands for "well", "004" stands for "no. 4" and "06" is the code for 26–30 cm.

The use of "between" is often inexact. If an object is discovered in between two or more constructions, horizontal and vertical relationships can equally well be given to all the constructions concerned. Such a procedure is, how-

ever, both superfluous and ineffective, since everything is normally taken care of by relating the object to one of the relevant constructions. Where our work is concerned, the consequences of this have not been ignored: the seemingly obvious notion of "between" has been rejected so as not to complicate the system. For this reason it is recommended that "between" be replaced by a directional designation such as "south of" or "east of", followed by an entry showing the level-reading relative to the selected construction. Should the boundary of a construction be unclear, a choice must be made and the uncertainty is then indicated by entering the appropriate symbol in column 60, referring where necessary to plan, logbook, photo-archive etc, and perhaps also to column 61, which tells which section is involved. In conclusion, it must be noted that "construction" represents a concept which is entirely independent of the physical components involed. Thus "10" in the H-section represents "building" irrespective of what the building is made of. Nor have reference-points in the H-plane, at least in the first instance, any chronological implications. These find relative expression in the "V" and "L" sections, and are recorded absolutely in the dating section "F" (for fire-level). It should be noted that foundations are not assigned separate numbers, but are numbered according to the building they belong to. However, where an isolated foundation is recorded and given a number, it implies the existence of a distinct and independent building.

6.2.2 References in the vertical plane

The delimitation or localisation of an object in the vertical plane may partly be entered in the V-sections but where special stratification is involved, it goes in the stratigraphy section "L". References based on fire-layers go in the dating section, "F". The V-sections are divided up on much the same lines as the H-sections, though here "construction" or "locality" are replaced by "construction layer", a locality or construction normally being thought of as confined to the topographical surface level or horizontal plane. The first of this section's three boxes is reserved for an indication of the relationship, the next two for the construction level. The "No." entry indicates the relevant course of wall-logs or some equivalent in a three-dimensional construction. The vertical relation is usually expressed by the prepositions "in", "on a level with", "above" or "beneath", the last two being supplemented with an indication of distance.

First example:

"-found on a level with log-course 5". Since "K" is the code for "on a level with", the V1 entry becomes "K10-05", where "10" stands for the no. of the log-course.

It is here assumed that the construction of which the wall-log forms a part has already been defined under "locality" in the H-plane.

Second example:

"-found 12 cm above stone layer". The V1 entry becomes "080-blank-03", where 0 stands for "over" or "above", "80" stands for "other locality" and "03" is the code for 11–15 cm.

Once the H and V-sections are filled in, the object will in most cases be adequately localised. The construction which is the centrepiece in this frame of reference is assumed to have been related via logbook entries and sections to strata of geological and/or cultural-historical significance. Even so, it is important that the composition or consistency of the layer in which the find is made should also be recorded. This is of absolutely fundamental importance where the strata being excavated contain no evident "constructions", as one is then totally dependent on stratum references to supplement one's grid-square reference, individual coordinates and level readings.

In the account given of our excavation methods, it was noted that when thick layers of make-up were devoid of internal stratigraphy or constructions, they were excavated by arbitrary levels until the presence of a new, clearly definable structure was confirmed. Such arbitrary layers will be related primarily to the level from which they originate, and whether this is fixed in terms of stratigraphy or of excavation technique, it will be defined by its height and coordinates and by the way it relates to grid-square, plan and fire-level. The arbitrary layers succeeding a given level are defined by the same coordinates as that level, though these are supplemented by noting the consistency or composition of the layer and by giving the levels at

all corner-points. A running description is also entered in a layer-book. In this case, it is only the number of the arbitrary layer with reference to grid-square, plan, stratigraphic layer and relation to fire-sequence that is entered on the location sheet.

Note that where documentation is concerned, a layer that is fixed in terms of excavation technique will have been defined as "locality" and therefore entered in the H-section. The make-up or consistency of the layer, on the other hand, will normally be recorded in the L-section.

First example:

"-found in light-green, layer containing moss and twigs on a level marked by the following coordinates in grid-square R8: 12–14x/80y and 12–14x/88y. Drawn on plan VI, supplement 2, c 140 cm beneath fire IV."

Top of layer	Bottom of layer
1 = 130	1 = 115
2 = 138	2 = 122
3 = 138	3 = 120
4 = 130	4 = 115

The layer number is recorded as no. 32. The actual recording of it takes the northwest corner of the level as the starting-point.

Example of how the location form is filled in:

	P.		S.	Horisontal (H) 1			Horisontal (H) 2			Horisontal (H) 3			Vertical (V) 1			Vertical (V) 2			Stratigr. layer (L)			Dating			Ref.	
Square	sq	Plan	Pl	Locality	No.	Dist.	Locality	No.	Dist.	Locality	No.	Dist.	Constr.	No.	Dist.	Constr.	No.	Dist.	Layer	Col.	Dist.	F	Dist.	%	60	61
R 0 8		0 6	2	3 8	1 0	3 2													3 0	1 1	4 1	μ	0 4	1 8		

The L-section provides for the specification of the type of layer (first box for preposition, next three for layer-description), followed by the colour of the layer and distance (if any).

The L-section is really to be regarded as a differentiation of the vertical-plane references. In the case of Bryggen, a further step has been taken by giving a separate reference to the fire-level. As earlier noted, this is our only absolutely dated reference, and it is divided into three compartments, the first of which labelled "F" (fire-level). If the relation is in doubt, a "1" goes into the final box in this section to indicate uncertainty "UD" (Uncertain dating). If the relationship is not in doubt, this box is left empty.

Example:

"-found 4 cm beneath Fire Level II (1476)". Entry reads: "U2–01-blank".

Columns nos 60 and 61 – the last two in the location section – as noted earlier are for cross-references. Column 60 refers one to data recorded in photo-archives and logbooks, on plans and sections, etc, while column 61 shows which sections are referred to.

Date	Mat.	Accession no.	No. of units	Co-ordinates X	Co-ordinates Y	Level ÷	Level cm	Obj. no.	No. of units	Ref. to parent – find Accession no.	Ref. to parent – find Obj. no.	Ref.	Verbal identification – Comments

6.3 Identification section

The identification section of the form, as noted above, encompasses all such data as are relevant to a somewhat broad identification of the particular finds or groups of homogeneous finds found within the same locality. The first section is for the date of recording, after which come sections for the type of material, accession no., number of units, coordinates and level-readings, and finally, on the far right, a "Remarks" space for a brief verbal identification. Such particulars as fall under these headings are continuously recorded item by item as the finds turn up. Finds from one and the same locality are arranged by the type of material and thereafter sorted into individual objects or groups of homogeneous, but loosely specified, objects, eg leather, earthenware, stoneware, etc or rim fragments, handles, etc. The heading "Accession no." can thus cover everything from an isolated object or fragment to as many as forty or fifty fragments possibly from several different objects, but all belonging to one particular material group within one and the same

locality. The definitive assignment to objects has to wait for the systematic processing of the various material or subject groupings.

The lower part of the sheet is divided into two sections by a thick vertical line: the section to the left is for the initial systematic information, while the section immediately to the right is for gathering together assorted fragments of one and the same object regardless of the locality in which they were found.

Entries under "Remarks" are normally verbal identifications (usually no more than a "catchword") of the object, fragment, or group of finds indicated by the accession number. But also entered here are measurements and items of supplementary information which may be necessary, as well as any data not provided for by the code.

By way of introduction, it was pointed out that a start was made with a traditional accessions register, and that this form of primary documentation was carried on up to and including accession number 44367. In the period that followed, continual efforts were made to improve and simplify the localisation process. In all, four different types of forms were tried before one emerged which was found satisfactory. After terminating the original register with its verbal location-data, the material was recorded on the following types of forms:

Type 1 from 44368 to 48775
Type 2 from 49921 to 52828
Type 3 from 52829 to 53392
Type 4 from 53393 to 78340
Type 5 from 48776 to 49920
Type 5 from 78341 to 87649

Traditional cataloguing also found a place in the primary processing of finds for the first year or two, but this soon turned out to be more than the limited technical and financial resources really permitted. If the cataloguing were to continue, then either specialists in numerous fields would have to be brought in, or the resulting documentation would be of limited scientific worth. And in any case, those who were to undertake the final systematic processing of the various kinds of material and the groups of objects would themselves have to make a decision on all the relevant material. From purely professional considerations, therefore, it was found expedient to discontinue the cataloguing work after 4244 numbers, and to focus documentation solely on "accessions". Here it was found advisable from the outset to use differentiated object-descriptions. Where pottery was concerned, distinctions continued to be drawn between sherds from rim, belly, bottom, handle, etc, and between glazed and unglazed within the more important types of ware. But from sheer shortage of people with special qualifications, we finished up by recording just sherd, unless, by way of exception, an intact object turned up. Since the number of ceramic fragments to be dealt with ran into tens of thousands, the limited usefulness of a broad classification was not enough to justify the considerable extra effort it called for. As already mentioned, when the time came for a definitive and systematic processing of the pottery finds, it would be necessary to take a synoptic survey of the material in toto, in order to set about grouping and classifying it.

The customary objections to such a simplified recording-system carry little weight when one is confronted by an accumulation of finds on the scale met with at Bryggen. And copious as this may be, it is but a fractional and fragmented remnant of the original inventory. Should any one object or fragment come adrift through some deficiency in the basis of identification, hundreds more will in most cases be on hand to fill the gap. What is more, our highly simplified recording has naturally been conducted with the flexibility and caution that must be displayed in dealing with special finds or combinations of finds as regards both identification and localisation. So it has not been any great problem to lay one's hand on relevant material when faced with multifarious demands.

The recording-system and the location sheets described in the preceding paragraphs have been tailored to suit local conditions at Bryggen. But the underlying principles are of an elementary order and can therefore be adapted to any urban excavation. The references in both horizontal and vertical planes may be added to or reduced in number as occasion demands; all one needs do is insert or omit the localities or reference options as required. When all is said and done, no new types of data have been introduced; one has simply made an attempt to bring some system into the traditional verbalized – but not very readily comparable – descriptions of finds as these are typically given in the field. What is really at issue here can be illustrated by a few examples.

1 Traditional description:

"Accession no. 60105. Runic inscription on wooden peg from grid-square K4, drawn on plan IX. Coordinates: 28.10x74.40y. Height: minus 46 cm OD, found in pit no. 18, in layer of dark grey ash, 21 cm beneath fire V."

Systematised version:

Square	p. sq	Plan	S. Pl	Horisontal (H) 1 Locality	No.	Dist.	Horisontal (H) 2 Locality	No.	Dist.	Horisontal (H) 3 Locality	No.	Dist.	Vertical (V) 1 Constr.	No.	Dist.	Vertical (V) 2 Constr.	No.	Dist.	Stratigr. layer (L) Layer	Col.	Dist.	Dating F	Dist.	%	Ref. 60	61
K	04		09		3512	0118																				

Date	Mat.	Accession no.	No. of units	Co-ordinates X	Y	Level ÷	cm	Obj. no.	No. of units	Ref. to parent – find Accession no.	Obj. no.	Ref.	Verbal identification – Comments
	08	60105	001	028	100	74	40	1	046				Runic Inscription

2 Traditional description:

"Accession no. 48178. Rim of jug, three parts. NW part of P5, drawn on plan XIII, supplementary plan II. Coordinates: 65.80x114y. Height: minus 1.48 OD, found in building 34 at a distance of 152 cm west of east wall, 12 cm in front (south) of fireplace in a layer of dark brown clay, c 4 cm above remains of floor and c 8 cm beneath Fire Level IV. Cf photo."

Systematised version:

Square	p. sq	Plan	S. Pl	Horisontal (H) 1 Locality	No.	Dist.	Horisontal (H) 2 Locality	No.	Dist.	Horisontal (H) 3 Locality	No.	Dist.	Vertical (V) 1 Constr.	No.	Dist.	Vertical (V) 2 Constr.	No.	Dist.	Stratigr. layer (L) Layer	Col.	Dist.	Dating F	Dist.	%	Ref. 60	61
P	06	E	13	2	3	10	03	4		V	12			18		S	11		03	02	0		01				3	07	05	2		2	04	02		6	

Date	Mat.	Accession no.	No. of units	Co-ordinates X	Y	Level ÷	cm	Obj. no.	No. of units	Ref. to parent – find Accession no.	Obj. no.	Ref.	Verbal identification – Comments
	03	48178	003	065	801	14	00						Rim Fragment

3 Traditional description:

"Accession no. 53104. Wooden ladle. Grid-square K12, western part, plan II. Found in silt c 18 cm beneath boards of passageway, southern part, and 22 cm beneath beam-layer 3 in adjoining building 8, destroyed in fire IV."

Square	p. sq	Plan	S. Pl	Horisontal (H) 1 Locality	No.	Dist.	Horisontal (H) 2 Locality	No.	Dist.	Horisontal (H) 3 Locality	No.	Dist.	Vertical (V) 1 Constr.	No.	Dist.	Vertical (V) 2 Constr.	No.	Dist.	Stratigr. layer (L) Layer	Col.	Dist.	Dating F	Dist.	%	Ref. 60	61
K	12	E	02		W	10	008						U	32		04	U	10	03	05	3	08	0		U	04	

Date	Mat.	Accession no.	No. of units	Co-ordinates X	Y	Level ÷	cm	Obj. no.	No. of units	Ref. to parent – find Accession no.	Obj. no.	Ref.	Verbal identification – Comments
	08	63104											Ladle

Were the work based on a traditional verbalised field documentation as illustrated in these three examples, the items of information would have to be arranged or classified with a view to facilitating an overall view. Even so, an adequate synoptic view would not be obtainable, given the hundreds of thousands of possible combinations yielded by our copious material. Nor will the recorded particulars be to any extent mutually comparable.

The systematisation planned as a basis for computer-processing is transferred directly to the scene of operations. Not only does this represent a crucial saving of time when compared with traditional routines, but it also satisfies the commensurability requirement. To this we may add that anyone who feels put off by a codified listing can always get hold of a verbalised version.

In giving an account of the broad classification carried on during field operations, we have noted that an accession number normally comprises several homogeneous units belonging to the same type of material, eg 48103: four parts of a shoe; 48104: one shoesole; 48105: 34 rim fragments of blackware and one miniature jug; etc.

As will be clear from this, an accession number can encompass both an isolated object and several diverse parts of an object which nevertheless belong together. Finally, it can include parts of several separate – but basically similar – objects, as in our example "34 rim fragments of blackware" where one accession number comprises fragments from several different vessels, though for reasons indicated earlier no decision will be taken regarding the grouping and ordering of these until the scienti-

fic processing of the material gets under way. One of the preliminary procedures at that stage will be to acquire a synoptic view of the assembled material by deciding among other things how many objects are represented in a given group of finds ("objects" are thought of here, not as more or less intact individual objects, but as the maximum number of objects that seem to be represented). In that connection, each single object must also be identified. In the above example, the "miniature jug" is an object in its own right, whereas the "shoe-parts" and "rim fragments" must obviously be bits of several. Each object sorted out is identified not only by means of its verbal definition but also:

a) relatively to the others, by being assigned its own object number,
b) absolutely, ie in relation to the total corpus of finds, by bringing its individual object-number into relation with its accession number.

The object number is entered in the first compartment to the right of the thick vertical line on the registration form. If two or more fragments with different accession numbers constitute an object, an object number is given to the largest or most significant fragment; from considerations of statistical relevance, the other fragments are then subsumed under the first and lose their former identity. If, however, the second (third, etc) fragment – the subsidiary find – is not found in the same locality as the more significant one – parent-find – the identification of such a composite object becomes more complicated. A medium-sized jug may be recovered in some twenty or thirty fragments, found scattered around in the field. Yet even if individual fragments lose their former identity by having their accession numbers subsumed under the identification number of the parent-find, it is important for other purposes to preserve the details of such a composite topographical background, seeing that one and the same object – the parent-find – can document the contemporaneity of unconnected localities. In order not to let this information disappear through the subsumption of the subsidiary find, a reference system has been devised which unites parent and subsidiary find in such a way that the primary localising relationships are preserved. A subsidiary find receives the parent-find's identification, viz its accession and object number, and this serves at the same time to indicate that it has lost its statistical value as an object in its own right: the parent-find alone statistically represents the composite object, and the original identification (accession number) of the subsidiary find is preserved merely as a referential option. The systematic treatment will result in a considerable number of regroupings within the identifying part of our registration form, but thanks to our special recording system and our computer-based frame of reference, constant updating of the necessary overall picture becomes possible. As regards the relationship between parent and subsidiary finds, attention is here directed to the main principles involved in combinations and references; this kind of problem is, however confined on the whole to ceramic objects, the find-group which more than any other is most likely to appear in fragmented form and scattered among the levels. But for that very reason it is of crucial importance not to lose track of information through the gathering of multiple fragments from different localities into a new unit – an object. The details of this procedure will therefore be left until the treatment of this find-group has been completed. What will be given here is a brief review of the special lessons to be drawn from the use of our systematic localising procedure in the field. The following observations have been made:

1 Even at the field stage, efficiency could be appreciably stepped up by relieving the director of the localising work by delegating it to assistants. The form ensured continuity and uniformity in the references.
2 Whereas records of finds had hitherto been commensurable only to a very minor extent, full control has now been gained over a large body of information extending to an incredibly large number of possibilities for localisation and combination.
3 Most of those using the form have sensed a certain restriction of choice compared with the accustomed practice, which provided endless opportunities for long, subjective descriptions (cf restriction of the use of the preposition "between"). But this loss is, in the first place, compensated for by greater commensurability, while special cases can always be dealt with by supplementary comments.
4 In addition, the form has the advantage of serving as a punchcard basis for computer

treatment. Computer-programmes are available at Bryggen for tape-recording, sorting, listing, proof-reading, etc, but these are continually being added to, so that those interested are well advised to apply to the computer section of the medieval collection at Bryggens Museum for further particulars.

7 Indexes

With a view to clarifying the overall picture, and incidentally facilitating the filling in of our location sheets, separate indexes have been set up to record buildings, hearths, horizontal timber foundations, wells, fire-levels and other layers. These indexes contain cross-references to grid-square, plan, logbook, photo-archive, fire-dating and miscellaneous items of information. The various objects are numbered consecutively in their respective indexes. The photographic material, as noted above, has been recorded on Selecto. The sections have been numbered and they have all been drawn in on the general plan on the excavation area. Typewritten copies of the original logbooks have been made in triplicate. The originals have been placed in the archives unedited and in chronological order, while the copies are arranged according to grid-squares.

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ABBREVIATIONS

DN	Diplomatarium Norvegicum
H Ub	Hansisches Urkundenbuch
KD and KH	refers to different versions of Die Chroniken der deutschen Städte

BOAT FINDS FROM BRYGGEN

ARNE EMIL CHRISTENSEN

CONTENT

FOREWORD

My first experience with the ship and boat fragments found at Bryggen was in 1956. My summer "dig" that year was as an assistant on Bryggen. It was the first full excavation season, with work concentrated on one tenement: Bugården søndre. From the deep foundations built after 1332 came the huge beam 90659. At first, this carefully squared timber with its curious heads at either end caused much speculation, until with the help of Åkerlund's Kalmar publication it was finally explained as a ship's beam (Åkerlund 1951). On later visits to Bryggen, there were generally some new-found timbers to see, some of them undoubtedly from ships, some more uncertain, but no less exciting. Then came the rather dramatic recovery of the beams from the "Big Ship" in 1962 (figs 1-1/1-2). At that time, I was preparing an M.A. paper on ancient Scandinavian shipbulding and was specializing in the history of shipbuilding. Asbjørn Herteig offered me the opportunity to work out a provisional reconstruction drawing of the "Big Ship", to be used in a skeleton reconstruction in the temporary Museum. Later, it was agreed that I should be entrusted with the publication of all ship fragments found during the excavation. I should like to thank Asbjørn Herteig for offering me the job, and for help during the work. My thanks are specially due also to Egill Reimers, who for many years has recorded the larger ship fragments together with the house timbers, thus making my task of documenting the material much easier than it would otherwise have been. My stays in Bergen have always been pleasant and the staff of the excavation and the Museum have helped me in many ways. My thanks to all, especially to those who suffered most from my questions: Arne Larsen, Egill Reimers, Per Solberg, Ingvild Øye Sølvberg, Anne Ågotnes. My work has been aided through grants from the Norwegian Research Council for Science and the Humanities making it possible for me to take leave of absence from my regular work for two months in 1972, all of 1974, three months in 1977 and four months in 1981. In 1980 I had one month's leave for studying parallel material abroad thanks to a travelling grant from Norsk Arkeologisk Selskap. My special thanks are also due to Gunnar Leiro, who prepared most of the line drawings for publication, tracing them from the supplementary plans or from my sketches. The librarian of Universitetets Oldsaksamling (the University Collection of National Antiquities), Diana Stensdal Hjelvik, assisted with the bibliography and list of terms. Clifford Long was kind enough to correct my English and suggested improvements. In the final stages of drafting the manuscript, Knut Helle and Asbjørn Hertig gave valuable comments. Last but not least, warm thanks to my wife Anne Louise Gjesdal Christensen, whose constructive criticism has been of great help.

Oslo, February 1982
A E Christensen

MATERIAL AND METHOD

The boat and ship remains from the Bryggen excavations form a unique group of material, numerous but fragmentary. The dating is more secure than is usually the case with boat finds, but the fragments from each vessel are too small to allow reliable reconstructions of the size of the various vessels or the shape of the hulls.

My aim has been to identify, and as far as possible interpret, ship fragments among the huge number of damaged wooden artefacts found at Bryggen, and see what these fragments can tell about ships and shipbuilding in medieval Norway, or to be more precise, medieval Western Norway.

In the analysis of the fragments, it has proved valuable to include some comments on the use of modern parallel material when this was relevant, and to discuss some of the results obtained by the use of such material.

The finds are either discarded or re-used material. When reusing ships' timbers, the carpenters have selected the few straight or nearly straight beams of a ship for use in foundations, and they have cut the strakes into manageable pieces that could be flattened and used as drain covers, temporary flooring etc. In recent times, parts of boats were often used as panelling or roofing material on sheds, and this may also have been the case with some of the strake fragments from Bryggen which show secondary treenail-holes. As a result, only a small percentage of each vessel is preserved, even in the case of the "Big Ship" where c 50 fragments can be attributed to the same vessel. As a result, no complete vessels can be reconstructed from the fragments. A comparison between the Bryggen material and the ships found in Kalmar Harbour (Åkerlund 1951) will show the limitations of the Bryggen material clearly. Harald Åkerlund could number his wrecks I to XXV. Even though some of his "wrecks" are just a keel or a fragmentary stem, eight wrecks, five or six of them medieval, were sufficiently complete to permit reconstruction of the hull at the drawing-board. However, compared to the finds from Bryggen, the dates of the Kalmer wrecks are in many cases insecure, as they are based on a less defined stratigraphy.

The ship and boat fragments from Bryggen are typical examples of the source material with which archaeologists have to work. What we have are small and scattered fragments of a lost totality. The number and conditions of the fragments vary, of course, but archaelogical sources are never complete. In our case, we cannot reconstruct the shape of the vessels, much less tell about life on board, cargoes carried, the social and economic structures around the ships. On the other hand, the material has the inherit strength which artefacts have as historic sources: their nearness to the people who once made and used them. The background for a written or iconographic source may be unclear and it does not necessarily give a true picture of events. Artefacts were made to be used, they were parts of real life for common people, while a church fresco or a peace treaty on vellum might be very far removed from real life. More than once, as I worked on documenting the fragments, I had the feeling that I was looking over the shoulder of the medieval shipwright at work. We can see how various problems were solved, what materials were used, how details have changed and developed from Iron Age and Viking shipbuilding. We also find a number of technical solutions that have fallen out of use between the middle ages and the 19th century, when we again have ample sources in Western Norway for boatbuilding.

These results, however, are of limited value outside the rather small group of archaeologists working with the history of shipbuilding and the evolution of wood technology. Taking the work one step further, by drawing in comparative sources, we may arrive at greater knowledge and wider understanding of medieval ships and shipbuilding in Northern Europe. This cornerstone of medieval urban life is still very little known.

During excavation, the larger timbers were drawn by the excavation architect or his assistants together with building timbers, and numbered in a special series. The drawings are at a

scale of 1:10 and related to the excavation plans. Each grid-square has a master plan for each layer, numbered with Roman numerals. For each plan there are one or more supplementary plans (Norw *bilag*). For example, "K4, bilag 1 til plan IV" would be the first supplementary drawing to plan IV in grid-square K4 showing perhaps timbers from buildings and ships, and there might be more timbers on the 2nd, 3rd etc supplementary plans.

Timbers from ships and buildings have later been allotted numbers from 90000 in the general find-number series, so the fragment originally numbered 45 in the "building numbers" series has now been renumbered 90045 and so on. Small fragments of boats and ships not connected with buildings and foundations were numbered with other finds in the running inventory. During the first years of the excavation, a more formal catalogue was kept, and the artefacts were renumbered in the cataloguing process. As this proved too time-consuming, the practice was discontinued and the artefacts retained their inventory numbers. Small finds of organic material were stored in deep freeze and given PEG conservation treatement in batches. As I went through the small finds of wood in 1972, most of the material had gone through conservation and was accessible in the storerooms. A few things have been recorded later, after conservation. Some were inaccessible or could not be found. Large pieces were stored with other building timber, some were not easily accessible. Whenever possible, I have inspected the pieces, checked them against the drawings or made my own measured drawings. For the purpose of illustration, some of the supplementary plans have been traced at Bryggen Museum. The originals were drawn by Håkon Christie and Egill Reimers, and traced by various assistants. Other drawings from the plans and most of my own sketches were traced by Gunnar Leiro, while I have finished a few myself.

Since 1968, when the main excavation on Bryggen was terminated, excavations have been conducted at a smaller scale on several sites near the large excavation and these excavations have also yielded boat finds. With few exceptions these finds are not treated here. The exceptions are the finds from the 1979 excavations in Bugården which are from the same boat as fragments found in 1956, and the keel 87888 from Engelgården.

When identifying fragments, the other possibilities were housetimbers, furniture, agricultural implements, sledges and carts, various tools. In most cases the identification has been easy, as the characteristic features of clinker-built vessels could be readily identified. I may, of course, have made mistakes, attributing objects to boats that have nothing to do with them or on the other hand, ignoring ships' timbers where the shape lay outside my experience and the available comparative material. Some of the uncertain pieces are discussed in chapter 13.

I have chosen to arrange the material according to place and function in the ship, with one exception. All timbers from the "Big Ship" are treated together. Smaller groups of fragments that may come from the same vessel, have been given appropriate extra comment in addition to the treatment of the timbers in their respective groups.

I have studied each fragment as thoroughly as time permitted, but I hold no illusion that I have been able to document all the significant details. The time available made quick surveys necessary. What I felt to be of less importance has had less thorough treatment. Some timbers had decayed badly and were better studied from the drawings made at the time of excavation. In most cases, I had the drawings at hand when studying the pieces, and in some cases I have added detail to the drawings. In other cases I have measured and drawn the pieces, while some have only been recorded in the tables. In this selection, my criteria have been to treat more fully those fragments that have special character and can give new information about medieval boatbuilding practice. The dating of the material is based on the results obtained by the correlation team of the Bryggen Project, led by Asbjørn Herteig. The results are not published, but I have been given the information as the results were forthcoming. I have not considered it as part of my task to try to elaborate on this. This means that all dates are based on the stratigraphic chronology of the Bryggen excavations, based mainly on the fires known from literary sources, and identified as fire-levels in the excavation. The fires, numbered by the excavator, are I–1702, II–1476, III–1413, IV–1332, V–1248, VI–1198, VII–1170/71. A fire in 1527 which damaged only Gullskogården was numbered Ib.

Other means of dating have not been used. Radiocarbon dates would give too wide margins

to be of much help, and ships' timbers on the whole are not suitable for dendrochronology, as the sapwood, or most of it, is usually cut away. In addition, master dendrochronology series are not yet available for Western Norway.

The huge task of combining the fire-layers with datable small finds is still in progress, so some of the dates given here may have to be revised in the light of later studies. As far as I can see, the medieval ship fragments found at Bryggen offer no morphological clues that can be used to establish an independent dating sequence, so my dates are based exclusively on the information I have received about the chronology of the fire levels.

In the late Viking period, roughly around AD 1000 there seems to have emerged a small type of cargo vessel or rather, a large boat. Its shape and size changed little over the centuries, and there seem to be few differences in the various parts of Scandinavia. When found as wrecks, such vessels are very difficult to date on morphological grounds and it is equally hard to attribute them to a specific building place, other than to the broad division between those parts which used oak and those where conifer provided the material for boatbuilding.

A number of elements in such a vessel, strakes, beams and ribs, will not give new information at the present stage of knowledge, especially when they are found in a fragmentary state. They can be identified and interpreted as part of clinker vessels, that is all. Further research may give morphological clues for a geographical or chronological attribution. As the material increases, a numerical analysis of scantlings, rib distances etc may also give results. I have not ventured to perform such analyses of the Bryggen material. The time available for the documentation and treatment of the material was limited, and I have chosen to treat more fully those artefacts whose "witness value" is more direct. I have selected for detailed documentation fragments which show characteristic details or previously unknown technical solutions and I have treated more summarily those pieces that are representative of standard clinker-building practices. I have set out the scantlings and other numerical information in tables, with the hope that such information will be of use in the future.

The tables published by Cederlund (1980-1) look promising. However, when they were published, the treatment of the Bryggen material was too far advanced for adopting new techniques. The identification process is naturally restricted by the experiences and knowledge of the person at work. Either one recognises a fragment and knows what the artefact was in its complete state, or one has to make a reasonable guess. Both the knowledge and the guesswork is based on things either previously seen at first hand or recognised from illustrations. My background for the work on the Bryggen fragments is twofold. In the course of the last 25 years, I have studied most of the Scandinavian ship and boat finds from the medieval and earlier periods. All of the Norwegian and a considerable part of the Danish and Swedish material I have seen and handled, some of the Continental and British material I have also seen, while the remainder I know through literature.

From field and museum studies, I have obtained a thorough first-hand knowledge of traditional Norwegian boatbuilding and to a lesser extent that of the neighbouring countries. This background knowledge of "boat anatomy" has made it possible for me to recognise rather small pieces of wood as boat fragments and to interpret their place and function in the boat. Much of the comparative material used in this work will be drawn from sources outside the usual chronological framework of archaeology. In fact, the majority of interpretations rest on my knowledge of more recent boats and boatbuilding practices in Norway, Sweden and Denmark. Other medieval and older ship finds are, of course, utilized as comparative material whenever relevant, but a considerable number of these finds have also been interpreted in the light of more recent material.

As a general rule, going from the well-known to the unknown in the study of old Scandinavian ships, means using 19th century and early 20th century material as a basis for working out models for interpretation and understanding, and then applying the models to the archaeological finds. This is, of course, the case in other branches of archaeology too, eg in the study of tools and of various crafts, but there seems to be a remarkable degree of continuity in Scandinavian boatbuilding, which makes the use of retrospective methods more relevant here than elsewhere. This continuity has been observed and studied by several authors (C Engelhardt 1866, B Færøyvik 1933-1, O Hasslöf 1958, A E Christensen 1975).

The remarkable adherence to tradition seen

Fig 1-1 The keelson and mast cross-beams of the"Big Ship" in situ

Fig 1-2 Many hands were needed to get the windlass from the "Big Ship" out of the excavation field

in recent boatbuilding gives unique possibilities for detailed interpretation of fragmentary archaeological material. The possibilities and limitations of the retrospective method will be discussed more fully later (fig 1-3). For the modern comparative material, I have drawn heavily on the work of B Færøyvik and Kr Kielland for Norway, Olof Hasslöf and Nils Nilsson for Sweden and Christian Nielsen and Ole Crumlin-Pedersen for Denmark. Some of the Norwegian material is based on my own field-work.

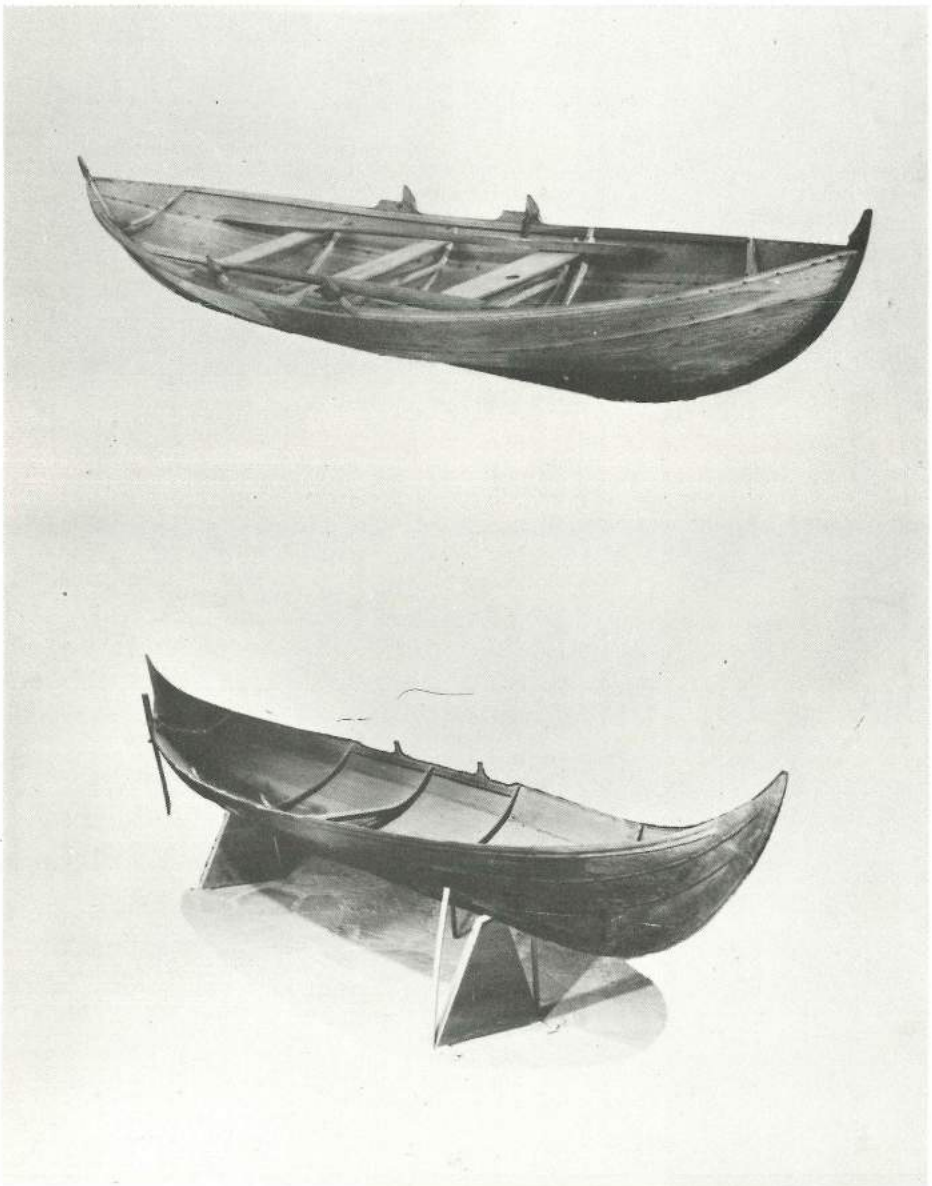


Fig 1-3 A modern Oselver and the four-oared boat found with the Gokstad ship. The continuity in building tradition is immediately evident

THE FINDS

The boat and ship fragments from Bryggen total 542 units in the find-series. The actual number of artefacts is smaller, as several fragments from one object each have their own number. Most of the pieces show secondary damage, either intentional, as they have been adapted to secondary use in foundations etc or as a result of the vessel being broken up, or accidental, by decay in the ground or fire.

If we simplify the grouping of the material somewhat more than I have done in the full treatment of the fragments, the most numerous group are the fragments of the framing system and backbone, with 155 pieces.This is closly followed by strake fragments, 154. In size, the frame and strake fragments vary from small slivers that could just be identified to the 7 meter long crossbeams from the "Big Ship".

Rowing, sailing and steering equipment numbers 110 pieces, with rowlocks and parrels as the most numerous sub-groups. Of other loose equipment, floorboards and bailers number 44, strangely enough, no thwarts were found.

About 20 miscellaneous timbers make up the number of full-size pieces. To this must be added a group of 30 models of boats and boat parts, some of them of considerable interest. A list of the finds is given in table form as appendix 1 (p 260ff).

The analysis of the material has been arranged as follows: As much information as possible has been set out in tables. Following the tables, pieces of special interest are discussed in notes related to the tables. The most important pieces are illustrated at the end of each chapter. Due to the character of the material, it has been impossible to give the tables the same lay-out, and the arrangement of the verbal analysis also varies somewhat from chapter to chapter. A more consequent structuring of the analysis would of course have been possible, but I have found that this would not fit the character of the material.

Fig 2-1 Headbeams from Søstergården, secondarily used as foundations, a typical situation for the larger ship's timbers found at Bryggen

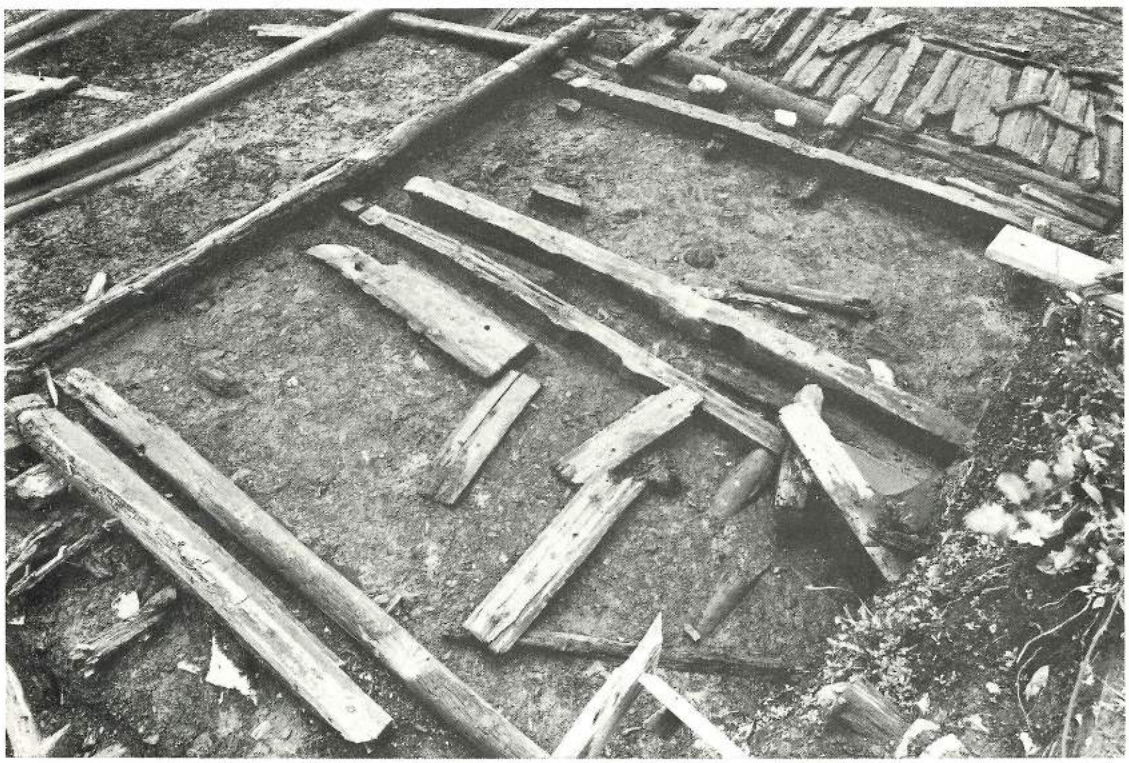


Fig 2-2 The large headbeam 90789 saw secondary use as a sill in a building

KEELS AND STEMS

Only two keels have been found at Bryggen, 87888 and 90474. 87888 was found during the 1979 excavation in Engelgården. This piece was available for study at the conservation laboratory in March 1981, while 90474 has not been available during my stays in Bergen. My description is based on the field drawing (N6, bilag 1 til plan III). 90474 is a fragment of the keel of a comparatively small boat, with a sliver of a garboard strake adhering. The fragment lacks a piece along one edge and is broken at the ends. It is 116 cm long and the original width across the best preserved part must have been c 14.5 cm. The keel is 6.5 cm deep, and the upper side is slightly concave. The keel has the T-shape common to small boats from the Viking Age right up to the present in Western Norway. The faying surface between keel and garboard slopes at c 66 degrees from the vertical, indicating that the fragment comes from the middle of the boat. The dimensions indicate a small boat, four to six-oared. The strake fragment found with the keel is c 220 cm long. It has a scarf, and if this opened aft, as usual, the strake must be part of the port garboard. The rivet spacing is slightly uneven, max 25 cm, min 21 cm. Along the outer-lower edge, the strake is moulded, the moulding being of type 3 (cf chap 15), (fig 3-1).

87888 comes from a larger boat. The assembled length of the fragments is 510 cm. The best preserved fragment shows a width of 24.5 cm, with a depth of only c 11.5 cm. Even where the keel is incomplete, the surfaces of the upper V-shape and the faying surface for the garboard indicate that the cross-section did not change very much (fig 3-1).

On the most intact fragment, the garboard slopes at 60 degrees from the vertical. The keel gets narrower towards one end of the best preserved fragment, but the angles of the cross-section seem to change very little. This shows that the keel must have been considerably longer to accommodate the deadrise of the garboards towards the stems. The upper edges have a moulding of type 3 and slightly unevenly placed rivet-holes. The distance varies from 16 to 20 cm. There are 3 sets of treenail-holes in pairs along the keel at distances of 145 and 80 cm.

The best fragment shows a slight curve, indicating that the keel rose slightly towards both stem and stern. The slack garboard angle shows that we are still a considerable distance from the stem. Even if the change in garboard angle was abrupt, at least 100 to 150 cm is necessary to twist the curve up, so that the garboard fits vertically against the stem. The keel is remarkably wide and shallow. Found isolated it would probably not have been given a medieval date. In fact, the only medieval details are the moulding and the treenail-holes, which are in all probability rib fastenings. It is possible that the keel comes from an old boat, where the vertical part of the keel has been worn down by frequent beachings, like the Skuldelev wrecks 3 & 5. However, no matter how much may have been abraded, the keel is also very wide. The nearest parallels to this shape are keels of Migration and Merovingian date, like the keels of the Kvalsund and Grested-bro vessels and the reconstructed Sutton Hoo keel (Shetelig & Johannessen 1929, Crumlin-Pedersen 1967, Evans 1975).

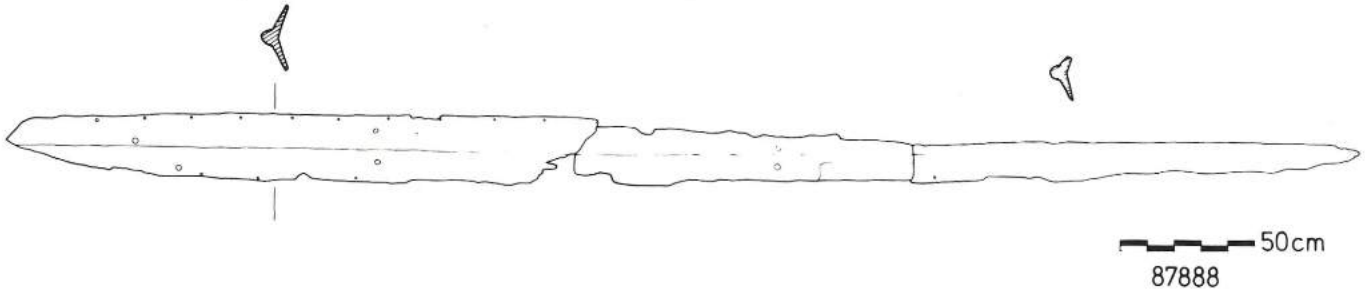
The smaller fragment 90474 is also rather wide. In the 19th century, wide keels were characteristic for boats built in the Sunnfjord district, north of Bergen (Færøyvik 1931). Færøyvik has also pointed out that the grave from Holmedal in Sunnfjord, a boat burial with some wood preserved, also shows an extremely wide keel (Færøyvik loc cit). The grave was originally dated by Shetelig to the Viking Age (Shetelig 1928) but a recent ^{14}C-date indicates that it is considerably earlier (Myhre 1980).

The dating may not be quite reliable, however, as the dated material is oak from the boat. If the sample is from the heartwood of an old oak, quite possible in a boat, the date may be much earlier than the building date of the vessel. However this may be, a single grave find and 19th century parallels are not enough to place our keel fragments in boats built in medieval Sunnfjord, but the possibility should be noted.

Stempieces are as rare in the Bryggen material as keels, again only two have been found. 92389 is part of a stem, or the intermediate piece (Old Norse *lot*), from a fairly large vessel. The piece is 180 cm long, gently curved, and has scarfs at both ends. The stem is about 7 cm thick at the inner edge, tapering to c 4 cm at the outer edge (fig 3-2). At one scarf the stem is 12 cm wide, flaring to about 15 cm in the

middle, then remaining constant. Several examples are known where a stem or *lot* flares from the keel scarf, so this may indicate which side of the stem is uppermost. There are traces of numerous iron nails for fastening strakes, but they give no indication of the width or number of strakes. The stem is not rabbetted. The material is oak. Near the outer edge is a hole, probably for a rope used when towing or beaching the vessel. To give an indication of the size of vessel that the stem came from, it is shown in fig 3-4 with the *lot* from the Tune ship, the stem fragment from the Sjøvollen ship and the stem of largest Gokstad boat. 92389 was found above the fire III.

The other piece, fig 3-3 has lost its number during the conservation process, and has now been renumbered 93397. The material is oak, and the scantlings indicate that it came from a smaller vessel than 92389, a large boat rather than a ship. The stem has remains of iron nails which held the strakes. Like 92389, it has no rabbet, but the fragment is so small that it is impossible to say whether it came from a stem that was smoothly curved, stepped or winged. One end has a scarf, while the other is broken. The inside is ridged. Seen from above, the stem gets slightly narrower from the scarf to the broken end. This may indicate that the scarf is the bottom end where it was scarfed to the keel. As the original field information is unknown, due to the loss of the number, the piece cannot be dated.



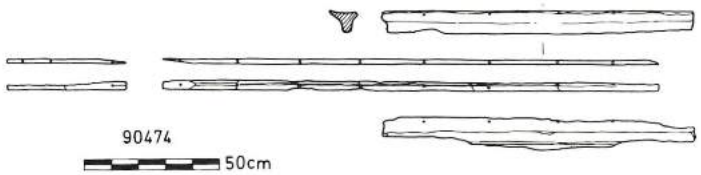


Fig 3-1

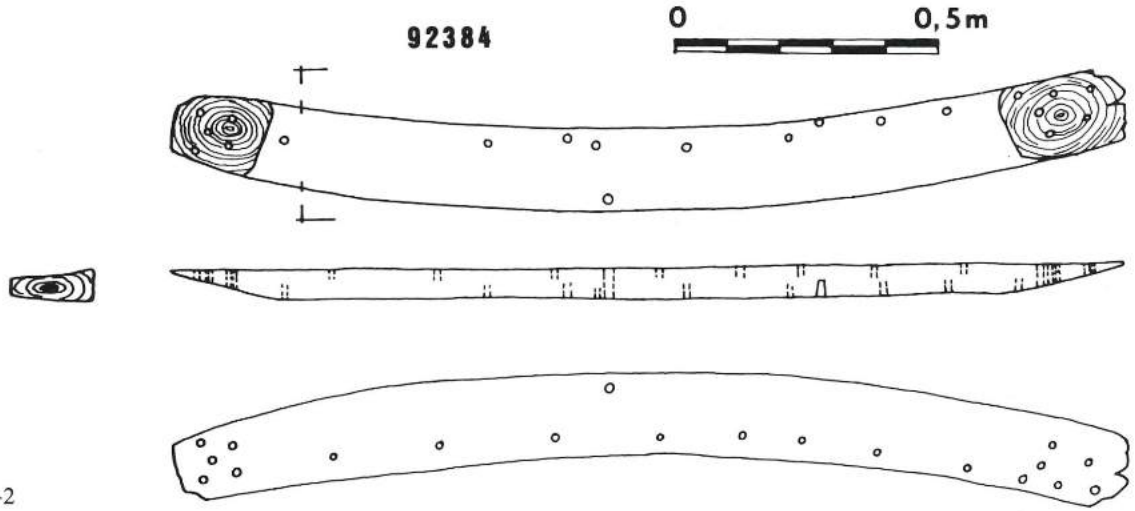


Fig 3-2

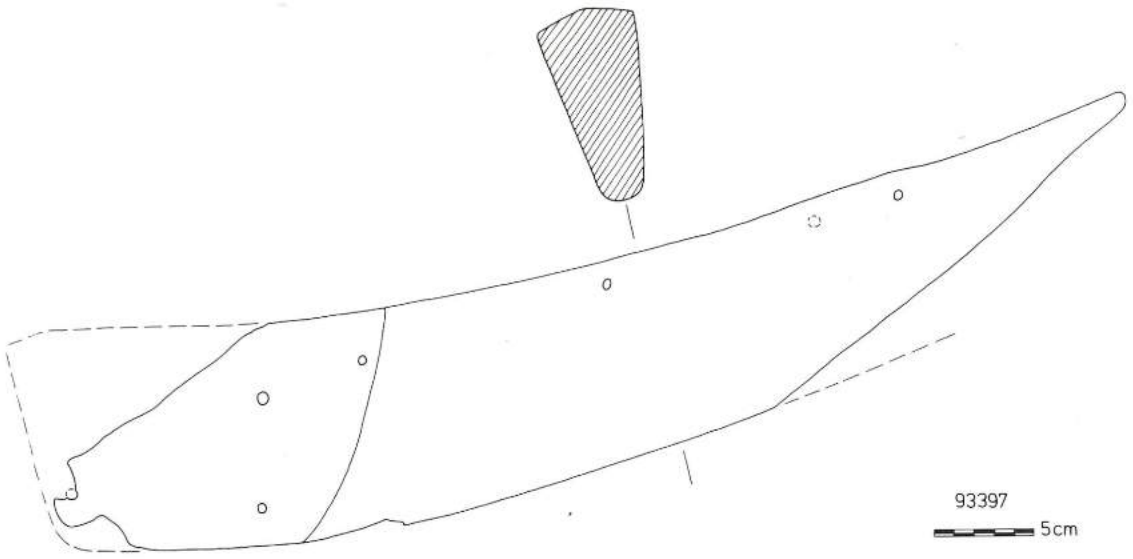


Fig 3-3

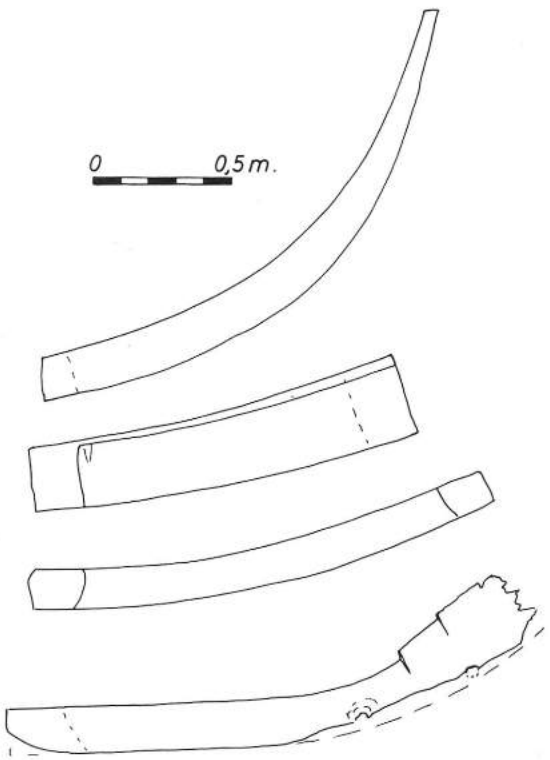


Fig 3-4 Top to bottom, stem from the largest Gokstad boat, "lot" from the Tune ship, Bryggen 92384, stem fragment from the Sjøvollen ship

FRAMING SYSTEM

The following information concerning fragments of framing elements has been tabulated under the following headings (all dimensions are in cm).

Find number.

Length. The present length of the piece, in its complete or fragmentary state.

Sided dimension. This is the size, scantling, of the piece in a direction parallel to the keel. Maximum/minimum values are given when the dimension changes from one end of the piece to the other.

Moulded dimension. This is the scantling of the piece as measured vertically from the keel to the upper side of the rib as it is fitted in the boat, or approximately at right angles across the rib further up in the hull, from the strake inwards. Maximum/minimum values are given.

Number of strakes. The number of strakes that were in contact with the fragment as shown by the faying surfaces where the strakes rested.

Width of strakes as shown by the distance between the notches cut when fitting the rib.

Material. The material has been judged by eye, and the division is a rough one, either oak or pine.

Treenail diameter. Diameter of treenail-holes or intact treenails which originally held strakes and frames together.

Vertical angle. In the case of breasthooks, the actual angle between the arms of the piece. In the case of floortimbers, the actual angle between garboards. For knees and beams, the outward slope of the faying surface for the first strake, from a horizontal line below the piece.

Horizontal angle. The inward slope of faying surfaces towards the stems, measured from a line at right angles to the longitudinal axis of the vessel. Both angles are given in degrees.

The fragments of framing timbers have been subdivided into:

Floortimbers (F) That part of a rib which is fitted above the keel, in the bottom of the vessel.

Futtocks (Fu) That part of a composite rib which continues up the ship's side from the floortimber. In larger vessels, this may be in several parts, generally named futtocks and top timbers. I have grouped these details together.

Breasthooks (Br) The obliquely placed, one-piece rib supporting the stem part of a small boat. In larger vessels there may be several, known as cant frames. On Bryggen, only breasthooks from small boats were found.

Knees (Kn) A naturally grown, angular piece of wood used to connect two other constructional details. In the Bryggen material, most knees are "hanging knees", a few are "lodging knees" (see terminology list).

Beams (Be) Timbers lying at right-angles to the keel, generally above a floortimber or a pair of futtocks.

Headbeams (Hb) That particular variation of beam, which is run through the planking, having a head on the outside.

Fragments that could be seen to be part of the framing system of a vessel but which could not be identified more closely, or unique details.

Additional comment and information on the individual pieces are given in the notes. Groups of connected fragments are further discussed under separate headings. Date Before (BF), in or contemporary with (IF) or after (AF) the fire as numbered.

TABLE 4 - I FRAMES

NUMBER	LENGTH	SIDED	MOULDED	N.STR.	W.STR.	MA.	T.D.	V.∢	H.∢	F.	FU	BR	KN	BE	HB	?	DATE	NOTE
4826													x				BF 5	1
4976	42	4	2-7.5	2	16/8	0	2	101°	90°				x				BF 1	2
5619	35	6.5	5.5	2	16 +	P ?	1.7									x	BF 2	
7771	44	8	3-8			P	2						x					3
8035	27	6	5-5	2	9 +	P ?	1.7				x						AF 3	
8705	23	CA.6	CA.2.5			P ?	1						x				AF 5	
19049	16	4.5	1.5-2.5	1	12 +						x						BF 5	4
19133	41	4-5.2	1.5-3.5	3	22	P	0.8			x							BF 5	5
19733																	BF 5	
28140																	AF 4	
29663	18.5	12	2-3										x				AF 6	6
30341	37	CA. 8	5-9			P ?	2.5									x	AF 4	
31699	24	3	3-4	2	7 +	0 ?	1.3	124/138	72°	x							BF 6	7
33833	28	5-9	4-11		20	P ?							x				IF 6	8
36344	34	CA.6	3-3.5	2	19	P ?	1.2				x						BF 4	9
36365	17	6.5	3.5	2	8 +	0	2.3				x						BF 4	10
36429	52	CA.8	5-7	3	27		1.1									x	BF 4	
37029						P									x		BF 3	11
37690	23	6.5	3.7	2	16 +	P ?	1.2				x						BF 4	
40230	14	4.5	3													x	BF 2	12
42665	20.5	CA. 5	2-3	1	14.5 +	P ?	CA.1									x	?	13
42666	20	CA. 5	0.5-2	2	14 +	P ?	1.5	130			x						?	14
43952	2	2.5 +	4	1		P ?		130		x							BF 5	15
45382				2		P ?										x	AF 6	16
46763	34	6	2-5	1	20 +	P ?	1.5	110				x					BF 6	17
46821	63	3-5	2-8.5	3	25	P	1.1	115/91		x							BF 6	18
52491	35	CA.8	2-4			P	1.8						x				BF 5	
61164				2		0										x	AF 4	19
63473						0 ?							x				BF 5	19
64823																	BF 6	
78280													x				BF 3	
80220												x					BF 5	20
83491	55	6.5-7.5	2.5-3.5	3	17-15	0	1.5	150					x				AF 5	21
90017	150	10	9			P		123	80.5					x				22
90018	190	12-18	7			P		115	69					x			BF 4	23
90019	274	12	10			P		115	70					x			BF 4	24
90026	130	12	10			P		116	81					x			BF 4	25
90119	80	7	6-12	3	19	P	1.5	69/90				x					BF 2	26
90154	65	10	CA. 10	2	24	P	1.8	139					x				AF 4	
90220	45	3.6 +	3-12	2	18 +	P	CA.1	70 ?				x					BF 3	27
90222	186	12	22-30			P	2.5	90	90				x				IF 3	28
90355	70	18	14			P		121	73.5						x		BF 3	29
90356	301	18	14			P		?	76 ?						x		BF 3	29
90357	451	18	13.5			P		107.5	77.5						x		BF 3	30
90359	465	16-22	14			P		107	85						x		BF 3	30
90368	356	18	13			P		125	71					x			BF 4	31
90369	271	12	13			P		127	64					x			BF 4	32
90370						P							x					32
90381	122	11				P ?							x?				AF 5	33
90382																		33
90387	140	18	15			P								x			BF 4	34
90393																x	BF 4	35
90403	370	18.5	14			P ?		108						x			AF 5	36
90438	539	18-25	19.5			P		113.5	83.5						x		AF 4	37
90464																x		
90525	312	15	17			P										x	BF 2	38
90528	66	7	3-8	1	40	P	1.5				x						IF 5	39
90535	70	7	4-8	1	40	P	1.5				x						IF 5	39
90594														x			BF 3(2)	40
595/596																		40

← 90387

Number	Length	Sided	Moulded	N.str.	W.str.	Ma.	T.d.	V.∢	H.∢	F.	Fu	Br	Kv	De	He	?	Date	Note
90648								90	90			x					BF 6	47
90659	782	20	20			P			90						x		AF 4	42
90703	31	4-13	7			P ?		100	90							x	AF 3	43
90743	178	12-19	10-20	3	16	P	2.5	103	68				x				?	44
90773	ca.750	28	20			P		108	64						x		BF 3	45
90788														x			BF 3	46
90789	ca.780	28	18			P		111	77						x		BF 3	45
90791						P				x							AF 4	45
90792										x							AF 4	45
90794										x							AF 4	45
90801																x	AF 4	45
90818																x	AF 4	
90852														x			BF 4	47
90853														x			BF 4	47
90854														x			AF 4	47
90863														x			BF 5	47
90864														x			BF 5	47
90865														x			BF 5	47
90867														x			BF 5	47
90868														x			BF 5	47
90899	85	7	20										x				AF 6	48
90900	95	10	8	5	27-20	P ?	1			x							BF 5	47
90901													x				BF 5	47
90902													x				BF 5	
90903				3		P ?				x							BF 5	49
90907																x	BF 5	
90928																	AF 6	50
90929																	AF 6	48
91034														x			BF 3	
91220										x							AF 4	51
91279	428	20	20	3	25	P	2.5	110	87				x				BF 5	52
91860																x	BF 4	53
91956																x	BF 4	54
91988														x			BF 4	55
92410														x				
92464	140	15	9			P ?		114	73					x			BF 3	56
92993	55	8-14	6-16			P	ca.2		90				x					57
93154															x			58
93213														x			AF 4	59
93327	47	6	2-12	2	22	0 ?	2	90	90				x				AF 5	60
93384														x			?	61
93385														x			?	62
93389																x	?	63
93390										x							?	64

Notes to table 4-1

1 (4826) This piece is too fragmentary to warrant further description.
2 (4976) fig 4-1.
3 (7771 and 92993) are similar in shape and stand out from the rest of the knees. They may be from ships and as there are parallels to the general shape in the Gokstad and Tune ships, they have been included here, but I am not at all certain about the identification. Their function on a ship would be to support the mast partner sideways. The flat part of the knee would be treenailed to the crossbeam and the curved part would support the mast partner. Similar knees are known for supporting the keelson, found in the Gokstad, Tune and Skuldelev ships, but such knees have the longer arm shaped to follow the deadrise of the rib. The ship finds from recent years seem to indicate that the heavy mast partner as we know it from the Norwegian Viking ships was discarded in the Late Viking Age in favour of

one or more crossbeams. We do not yet know if this was the case with both merchantmen, where the mast was probably left standing during the entire sailing season, and with warships, where the mast was shipped and unshipped more frequently. If warships retained the mast partner, we need not worry about our knees; if they did not, the knees are hard to place aboard a ship (fig 4-2).

If we turn to houses, the knees may have had a place in the support of the vertical posts of a stave building. For instance, they may have been placed on a horizontal beam with the curved surface against the vertical post.

4 (19049) Fragment of a futtock near the sheerstrake, with traces of an iron rivet through the rib top.

5 (19133) This piece, even in its fragmentary state, is of great interest in several respects. It is clearly from a small boat, a floor timber broken at top and bottom. The upper side carries mouldings of type 3, worn and rather unprecise. The wood has been analysed, and proved to be pine. The grain is unusually close, so I originally believed it to be juniper. (Analysis of the wood was kindly done by amanuensis Kari Henningsmoen, University of Oslo). (fig 4-5).

The treenail-holes, two complete and two fragmentary ones, have been prebored with an auger and then cut to a rectangular shape with chisel or knife on the inside, where the wedge was to come. This is unique in our material, and rare elsewhere too. In the archaeological material from Norway there are two parallels, neither of them very close. The rib from Yttersø, Hedrum, Vestfold (C 27076) has square lashing holes that seem to be chisel-cut. The strake fragments from Vik, Mardal, Nordland (T 16158) have the lashing-holes in the cleats cut with a gouge. In both cases the cuts are less precise and not so nicely finished as on 19133. Both pieces are undated, but they are definitely much older than the Bryggen piece, probably 1st to 5th century AD. More recently, squared treenails are characteristic of boatbuilding among the Lapps, and their neighbours in present-day Soviet Union. Examples are the two Lappish boats in Tromsø Museum, both late 19th century, the "Skoltebask" at Norsk Sjøfartsmuseum, Oslo, and the "Schnjaka" from Kola in the same museum. The latter vessels were both collected by Bernhard Færøyvik in the 1930's. From Northern Sweden comes a couple of undated bog finds, sewn boats of Lappish character, which also have square treenails (Hammarstedt 1908). It may be rash to attribute our piece to Lappish boatbuilding on the shape of the treenail-holes alone, but I can find no other possibility. It would not be surprising to find fragments of a Lappish boat in Bergen. We know from the material assembled by G Gjessing (1941) that the Lappish boatbuilders did supply boats to the Norwegian fishermen on the treeless outer coast in the 17th century and Gjessing was of the impression that this trade might go back to the Viking Age. The boat in question may have come to Bergen as the tender of a North Norwegian coaster, been left in Bergen for a number of reasons and finally been broken up there. If we look at the surfaces where the strakes rested, they have a pronounced curve athwartships. This is not uncommon in the case of garboards, where the shaping with the axe has been common practice to within living memory in many parts of Scandinavia. In our case it is clear that all strakes were sculptured with the axe, in addition to being bent alongships. It is important to get proof of this practice in so obvious a way as this fragment has given us.

6 (29663) This is probably the horizontal part of a standing beam-knee from a fairly large vessel.

7 (31699) A small floortimber fragment that shows steps on the underside that must indicate either an unusually broad keel, or extremely narrow garboards. The piece has a centrally placed hole for a stanchion, *snelde*, and two treenail-holes. The holes are not on the same line, probably intentionally, in order to avoid splitting the slender rib when drilling. The angles given in the table are for both the 1st and 2nd surface (fig 4-4).

8 (33833) Probably a *bite*-knee, very fragmentary. Date: close to fire VI.

9 (36344) There is a scarf at the lower end, indicating that the fragment is part of a top-timber.

10 (36365) Rib top. Rather coarse workmanship. One treenail, still left in its hole, is unwedged.

11 (37029) Even though little is left, there can be little doubt that this is a fragment of the head of a through-beam. The fragment shows mouldings of type 3 on top and sides (fig 4-5).

12 (40230) Too fragmentary to warrant further description.

13 (42665) Very fragmentary piece, the date is uncertain, but probably between 1198 and 1248.

14 (42666) The proportions of this piece are so slender and delicate that at first sight, one is tempted to take it as a half-size rib from a toy boat for children. However, the treenails are full size, so we must take this as another example of the extremely slender scantlings used in small boats. The small shoulder on the inside of the rib resembles those cut as rests for the thwarts on modern boats, and it probably served the same purpose (fig 4-5).

15 (43952) (fig 4-4).

16 (45382) Very fragmentary, does not warrant further description.

17 (46763) The piece is fragmentary and difficult to interpret, but it is probably a breasthook.

18 (46821) One of the more complete ribs in the Bryggen material, this piece is best explained as coming from near the stem or stern of a small boat, four or six oared. The twist seen in the 2nd and 3rd strakes may be original, showing that the boat had a sharp entrance or run in the first strake, while the 2nd and 3rd strakes were amply rounded-in towards the stem to give good flare in the bows. The garboard faying surface shows that the garboard was axed to shape (fig 4-6).

19 (61164, 63473, 78280) Very fragmentary, and not discussed further.

20 (80220) (fig 4-7). Small breasthook(?) of unusual shape. The small triangular pieces of wood closing the gap between sheerstrakes on modern Færoese boats are the closest parallels I have been able to find.

21 (83491) *Bite*-knee from a fairly small boat. The piece shows a remarkably slack angle, indicating either a very flaring bow section, if the knee was placed near one end, or an unusually V-shaped midships section. The treenails for the strakes are set unusually close to the lower edge of the strakes (fig 4-8).

22 (90017) A beam (*bite*) with one "grown" knee. One side has a deckboard rabbet, showing that the *bite* was originally placed at the forward or aft end of the hold in a small cargo vessel. Dated to the later part of the 13th century (fig 4-9).

23 (90018) Beam with one grown knee and one knee nailed on. The loose knee is joined to the beam with an elegant joint also known from the small Gokstad boats (fig 4-9).

24 (90019) Beam, probably from the same vessel as 90018 (fig 4-9).

25 (90026) The find-spot is in the second building layer after fire V; probable date c 1300. See comment to strakes 90022–90029, which are probably from the same boat.

26 (90119) This piece is probably a breasthook from a small boat, in which case, the first strake is more than usually sharp in its entrance to the stem. Another possibility is that this is a fragment of a sharp floortimber from a somewhat larger vessel with nearly vertical garboards. The date is c 1450 (fig 4-10).

27 (90220) This is clearly a fragment of a breasthook from a small boat, probably four-oared. It is of light and delicate proportions and moulded on the upper face (fig 4-10).

28 (90222) A lodging knee of large size, clearly from a big vessel. Originally it must have supported a crossbeam, probably by the mast to judge from its size. Found in a house burned in fire III, probable date c 1400 or a little earlier (fig 4-11).

29 (90355/356) In all probability, the two fragments come from the same headbeam (fig 4-12).

30 (90357 & 90359) Two through-beams with heads, found near 90355/56 and 90438. They are probably from the same ship. The angles indicate that we have two pairs of beams, one pair supported the mast. The grouping of the beams is based on the fact that they were found close to one another and have identical mouldings (figs 4-12/4-13/4-14/4-15).

31 (90368) The beam has one deckboard rabbet and a hole which is probably for a centrally placed stanchion (fig 4-16).

32 (90369/370) Beam, as usual with one grown and one loose knee. The knee is numbered separately, but does belong to the beam. Probably from the same vessel as the preceding piece (fig 4-16).

33 (90381/82) Beam in two fragments. This may be a fragmentary ship's crossbeam, but it may equally well be a *bite* from a house.

34 (90387) As can be seen from fig 4-17, this may be part of a crossbeam with deckboard rabbets, secondarily altered for another use. Cf nos 90390/91 & 90395 in chapter 13.

35 (90393) This piece, which may be a fragmentary futtock, seems to be one half of a piece which has been split longitudinally. The other half is 91956 (fig 4-18).

36 (90403) Crossbeam with deckboard rabbets. The oblique end surfaces may be the original faying surfaces against the strakes (fig 4-19).

37 (90438) See note 29-30.
38 (90525) Uncertain rib timber.
39 (90528 & 90535) Breasthooks, in all probability from the same boat, burned in fire V (fig 4-20).
40 (90594/595/596) Crossbeam with one knee nailed on.
41 (90648) I am not sure if this is a breasthook, as both angles are 90 degrees, rare in a vessel. It may equally well be a piece of furniture or a house-knee.
42 (90659) See special section on headbeams for comment. The beam is dated to the middle or second half of the 14th century (fig 4-22).
43 (90703) This is probably a stem-knee, originally placed at sheerstrake level (fig 4-10).
44 (90743) This is the only example in the Bryggen material of a combined *bite*-knee and bollard. Both the bollard part and the horizontal angle suggest a place rather far forward or aft in the ship. Originally, this was taken to be part of the "Big Ship". The find-spot is uncertain, but probably in grid-square O3, which excludes it as a "Big Ship"-fragment. The layer is not recorded, but it might well be part of the same ship as the fragments discussed in note 45. It is too large to be grouped with 90852 ff, also from O3-O4 (fig 4-21).
45 (90773/90789/90791/792/794/801) For comment on this group, see the special section on headbeams and "second big ship" (p 67). (The stringer fragments 90793 and 90797 are probably also from this vessel) (figs 4-22 to 4-25 and 4-35).
46 (90788) The piece was unavailable for study, cf 91034.
47 90852/53/54/63/64/65/67/68/900/901 (figs 4-26 to 4-31). In the grid-squares O3-O4 were found a group of nicely shaped and finished beam fragments, which I originally grouped together as fragments of one vessel. On closer study I believe that they in fact stem from four different vessels of similar size, probably built within the same district, as many details are similar. I have listed the pieces in a separate table, for easier reference and I refer to the vessels as boats A-D. Crossbeam fragment 90825 could not be found as I was working through the material, but I believe it to be the renumbered 93385. The character is very similar to 90853 and the two pieces have identical mouldings. Both pieces, if 93385 is in fact 90852, were found in grid-square O3, in layers from before 1332, and come from boat A. Also in O3 was found a short fragmentary beam-end, shaped for a loose knee, of roughly the same scantlings. It is, however, from a layer dated after 1332, lacks mouldings, and is morticed on the underside for a rib of narrower siding, while the beams from boat A are cut for a rib sided equal with the beam. This beam is the only piece of boat B.

The beams 90864/865 are fragments of the same beam, and I believe that the beam 90863 comes from the same vessel. The pieces were found close together in O3, and they are damaged by the same fire (V–1248). 90865 has a moulding of the same type as that seen on boat A, but clearly different from it. The two beams come from boat C 90867A–B and 90868 are also damaged by the same fire, but they were found in grid-square O4. 90868 was not available for study, but it was found close to the 2 fragments of 90867 and is probably part of the same boat. 90867 has a third moulding of the same type, but again distinct from the other two. These beams are from boat D. In O3 at a level dated to around 1248 was found a fragmentary floortimber or futtock with a moulding identical to 93385. This may well be another piece of boat A.

Characteristic of all timbers are the very elegant lines of the beams, the well-finished surfaces and accurately executed mouldings. 90852 (=93385?) and 90853 have deckboard rabbets on one side and must originally have been part of a small cargo vessel with an open hold amidships and decks fore and aft. They are two separate beams and must be the forward and aft beam from the hold of the same vessel.

If the rib fragment 90900 is also part of the same vessel, it may be a futtock from the open hold, or a floortimber under one of the beams. 90852 has a blind hole on the underside which probably originally held a stanchion.

The two beams from boat C also have stanchion holes. On the complete beam 90863 it is set a little off-centre. The beam fragment from boat B is also rabbetted for deckboards on one side and must come from a similar vessel. 90867 is a piece with several unusual features. The wider part in the middle and the semicircular cut-out shows that it is a mast-beam, and so does the mortice for a flat board-shaped stanchion on the underside. On the upper surface, there are two blind holes symmetrically placed about the middle. I inter-

pret these as stanchion holes, and as proof that the ship originally had another beam above this one. There are other blind holes on the flat vertical surface in the middle part of the beam. According to Egill Reimers' photograph of the beam (fig 4-31) this surface was the underside in the secondary situation and the holes are therefore probably original. A possible explanation is that a piece of wood was originally treenailed on, so that the mast stood in a hole, instead of being supported by the beam on one side only.

TABLE 4-II. BOAT FRAGMENTS FROM SQUARES O3-O4

Number	Square	Plan	Mrk	Date	Moulding	Boat
90852	O3	VIII	209	?	I	A
90853	O3	VIII	195	BF 4	I	A
90854	O3	VIII		AF 4		B
90863	O3	IX	31	BF 5	II	C
90864	O3	IX	81	IF 5		C?
90865	O3	IX	59	IF 5		C?
90867	O4	IX 1. bil	50	IF 5	III	D
90868	O4	IX 1. bil	43	IF 5	?	?
90900	O3	IX	147	c F 5	I	A?
90901	O3	IX	139	c F 5	?	?

48 The two knees 90899 and 90929 are foreign birds in the Bryggen material. They were found together in square O3, in layers above fire VI ie after 1198. Both are damaged at the longer and heavier arm, and both show treenail-holes at the top of the shorter arm, which seems complete on both pieces. I know of no exact parallel to the knees, but there is a resemblance to the huge knees sitting on top of the crossbeams on the Bremen cog (figs 4-32-/33). In the excavations in Tønsberg, a similar knee has been found. In the late 12th century, German merchants did sail to Bergen, so a cog being broken up in Bergen after the 1198 fire is not at all impossible. I must confess that I am not at all sure about the identification of the pieces, but I feel that they should be included in the hope that they may be of comparative interest for future finds.

49 (90903) Short futtock with scarfs at both ends. Maybe a repair piece, to replace a damaged part of a longer futtock (fig 4-38).

50 (90928) Probably a rib. At least one strake notch is fairly certain, but too badly decayed for further identification.

51 (91220) Unusually large sharp floortimber. Originally taken as part of the "Big Ship", but the find-spot makes this very unlikely (fig 4-34).

52 (91279) Crossbeam with grown knee. Mortice may be for an inwale, or it may be secondary (fig 4-36).

53 (91860) Recorded as rib timber in the card-file kept by Reimers, but not further documented. Lost.

54 (91956) Cf 90393. Lost.

55 (91988) Crossbeam with deckboard rabbets.

56 (92464) Crossbeam with one deckboard rabbet and faying surface for a loose knee. Large hole on underside for stanchion. If this was placed centrally, the original length of the beam was c 240 cm (fig 4-37).

57 (92993) See note 3.

58 (93154) Lost headbeam, known from plan only. See special section on headbeams.

59 (93213) Beam with deckboard rabbets.

60 (93327) Small oak knee with vertical and horizontal angles that are approximately 90 degrees. This may be a house-knee, eg a support under a projecting gallery (Norw *svalgang*). However, there are good parallels to the shape in Kalmar I. One possible place for a knee of this shape is below a crossbeam or thwart amidships and sufficiently near the sheerstrake to have nearly

vertical strakes. However, the rule is that the knee stands on the beam and in that case our piece has the notch on one arm cut the "wrong" way. In Kalmar I, the similar pieces stand on the top crossbeam, and the "reverse" notch is intended to fit over a stringer, running inside the top ribs. I would suggest a similar function for our piece (fig 4-38).

61 (93384) The piece is renumbered. Original number and information are lost. A fragmentary crossbeam of sturdy proportions (fig 4-39), is labelled with number tag 35 in the building-timber series. This is probably a case of double numbering, as this should be a log from the "underwater-house". The beam has been given carbolineum treatment and was acçordingly found in the early years of the excavation, but I have been unable to find any notes referring to it. The grooves along the sides probably once held lodging knees. In one groove there are remains of wood, held by one treenail. The grain runs parallel with that of the beam, so this cannot have been a catwalk running from beam to beam along the ship's side. However, there is no corresponding treenail on the other side, so an eventual knee here would have no fastening. It is, of course, possible that the cuts are secondary and that the beam originally had only a standing knee on top. The flat inboard part may also be secondary. The scantlings indicate that the beam came from a vessel of considerable size.

62 (93385) Cf 90852.

63 (93386) Renumbered. Original number and information lost. The piece has an unusual shape and is nicely finished. The shape is best explained if the fragment is taken to be part of a rudder rib, or a corresponding bulkhead-like breasthook like the ones found in the Gokstad and Oseberg ships (figs 4-40 and 4-41).

64 (93390) Renumbered, original number and information lost.

Through-Beams with Heads

The construction of ships with crossbeams protruding through the strakes was first observed on Scandinavian ships by Åkerlund (1951). Åkerlund related his findings on Kalmar wrecks I, II, and IV to numerous iconographic sources and concluded that this had been a common technique among medieval shipwrights. Through-beams have been observed on several new finds of medieval vessels, and they are not lacking in the Bryggen material. The four beams from Søstergården are so similar in workmanship, including the mouldings on the heads, that they must come from the same ship. The beams were reused in foundations built after fire IV. The angles for the strakes clearly indicate that we have two pairs of beams, originally placed vertically above one another, one rather far forward or aft, the other amidships, supporting the mast. One of the mast-beams has some secondary cuts where the mast rested, but the best preserved one is cut to support a mast which had a diameter of c 25 cm at that level (beams 90359 and 90438). The latter beam was placed uppermost (fig 4-12/15). The Kalmar wrecks I and II have the beams placed in sets of 3 and 2 vertically. We lack material to decide whether our vessel had a third beam as part of the set. If we adapt the length-beam ratios of the Kalmar vessels I, II and IV, our vessel would have been bigger than Kalmar I and IV but smaller than Kalmar II. The length-beam ratios of the Swedish wrecks are: Kalmar I 2.5-1, Kalmar II 3.3-1, Kalmar IV 4-1. The largest mast-beam of our vessel has sloping slots for the strakes, so it must have been placed some distance below the sheerstrake, and its maximum length would therefore be less than the maximum beam of the vessel at the mast. Consequently our figures are somewhat too small. Using the Kalmar figures we get possible lengths of c 12 m, c 14.7 m and c 19 m.

The beam fragment 37029 seems to come from a beam of roughly the same scantlings as the ones from Søstergården, thus bearing witness to yet another ship with through-beams repaired or broken up in Bergen. The fragment has a moulding of our type 3 (fig 4-5).

The beam 90659, reused in the foundations at Bugården after fire IV and probably dating to the period 1350/1400 is a huge timber of 782 cm length. The scantlings are 20x20 cm. The planking slots have a vertical slope of c 110 degrees, indicating a maximum beam of well over 8 m for the ship. The horizontal angle is nearly 90 degrees, indicating a place near midships, but no traces can be seen of either wear-marks or a cut-out for the mast. The

material is pine. Again using the Kalmar wrecks for comparison, we arrive at possible lengths of c 18.7 m, 24.7 m and 30 m. There is a small rabbet cut near the middle of the beam. If this is original, it may be a ledge for a catwalk or a beam spanning the hold of the ship. The beam has a number of treenail-holes, some of which are difficult to explain as original fastenings. When the beam was found, it was not treenailed to other structures, so the treenails do not stem from its use in foundations (personal communication from A Herteig 1982). Four of the treenail-holes are nearly symmetrically placed around the central axis of the beam. They are marked x on fig 4-22. They all run vertically through the beam and may be for stanchions to a beam originally placed above or below this one. The beams 90773 and 90789 are of very similar shape and scantlings. Both were cut during excavation and both are rather damaged. The lengths 780 and 750 cm indicate that the beams come from a large ship. The horizontal and vertical planking slots show that the beams were not placed amidships, so the maximum beam of the vessel must have been well over 8 m. The two beams may originally have been a pair, placed vertically above one another, but this is not certain. Both beams have several cuts that may be secondary. The large, square notches are from the secondary use as house-sills. However, the shallow "notches" or rabbets near the ends of 90789 seem to be symmetrically placed and may be original, as housings for longitudinal beams of catwalks spanning the hold (fig 4-22).

On a supplementary plan to plan V, K11, a headbeam head is summarily sketched. This has been numbered 93154, but the object is lost. The situation, K11, pl V, is a long way from the other beams, so this must be from still another vessel. On the plan, one end of the beam is hidden under other timbers, but it can be followed for 6.3 m (fig 4-23b).

The headbeams and headbeam fragments, 9 in number, stem from 5 different vessels. Two of them have been very large ships, with a maximum beam amidships well exceeding 8 m. The Søstergården complex, nos 90355/56/57/59/90438 and the huge beam from Bugården were found in foundations built after fire IV (1332). The two beams 90773 and 90789 were used as foundation sills in a building which burned in fire III. Even if this particular house was not erected just after fire IV, the complete beams were all reused at some time during the 14th century. This is also the case with the fragmentary beam head 37029, which was found in fill below fire III. The lost beam 93154 was found in a layer which can be dated to c 1360/1370.

What age a ship may have been before it was broken up and its timbers reused in foundations is impossible to determine. According to Helset, the North Norwegian coasters, called *jekt* in Norwegian were lightly built clinker vessels and had an average working life of around thirty years. However, a brand-new ship might well be badly damaged in a fire and so broken up for building foundations.

The ships represented by the headbeams can be given a late 13th century date in the case of the Bugården and Søstergården vessels, and probably a little later for the 90773/789 beams. In no cases can the vessels be reconstructed on the evidence of the beams alone.

Close to the two headbeams 90773 and 90789, other ships' timbers were found: one floortimber or *bite*-end, one stringer, 3 futtock fragments and part of a beam with one deckboard rabbet (90791/92/93/94/90797 and 90801). The stringer and the futtocks were used as floor-joists in the house where the headbeams saw secondary use as sills. I had originally grouped the futtocks with the timbers from the "Big Ship", but Asbjørn Herteig is of the opinion that it is very unlikely due to the different dates and find-spots (personal communication 1981). However, the scantlings of the pieces from P3/P4 indicate that they may well come from the same vessel, and this leaves us with another "Big Ship", broken up and re-used in a house which burned in fire III (figs 4-24/25/25b). The headbeams are mortised on the underside for the tops of futtocks and it is possible that the futtocks which have been found did originally fit here. The two longer futtocks have lost most of the horizontal arm which would originally have rested on the crossbeam or floortimber, while the shorter piece shows more of this. The stringer 90793, gives a rib distance of c 47 cm, measuring between the centrelines of the ribs. The beam 90797 does not have the typical shape of crossbeams with one deckboard rabbet used forward and aft of the cargo holds. In my opinion, this is part of a longitudinal beam or stringer which may have doubled as a catwalk along the ship's side and housing for removable deckboards.

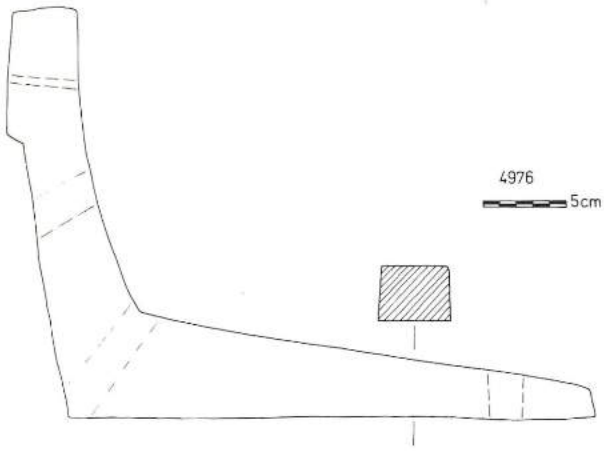


Fig 4-1

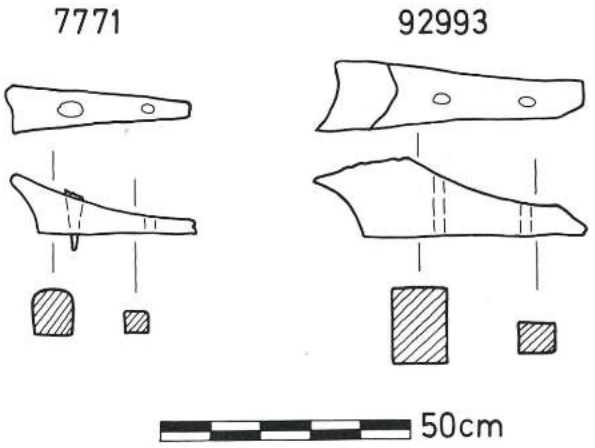


Fig 4-2

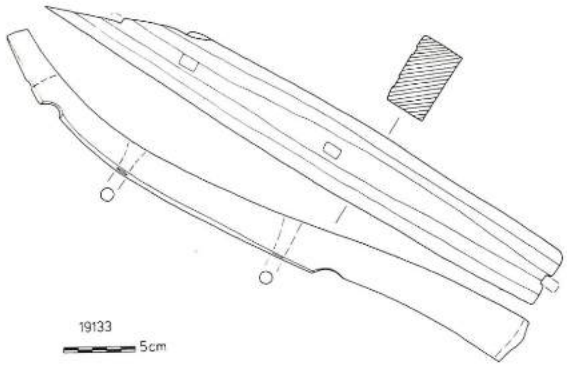


Fig 4-3

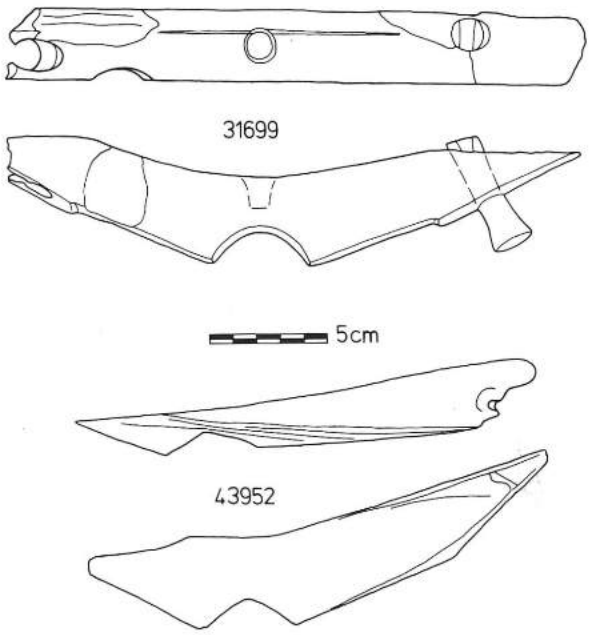
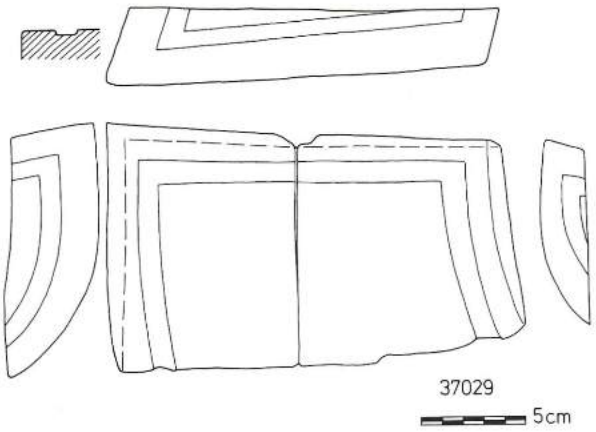


Fig 4-4



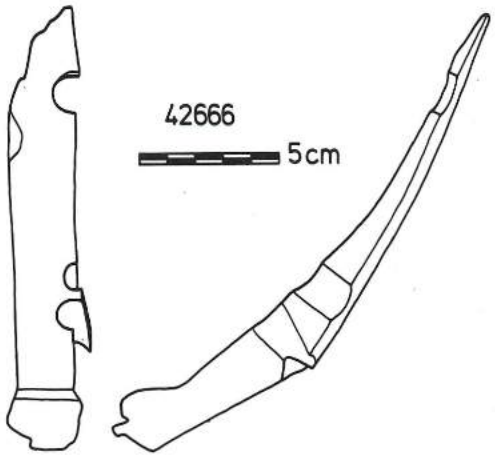


Fig 4-5

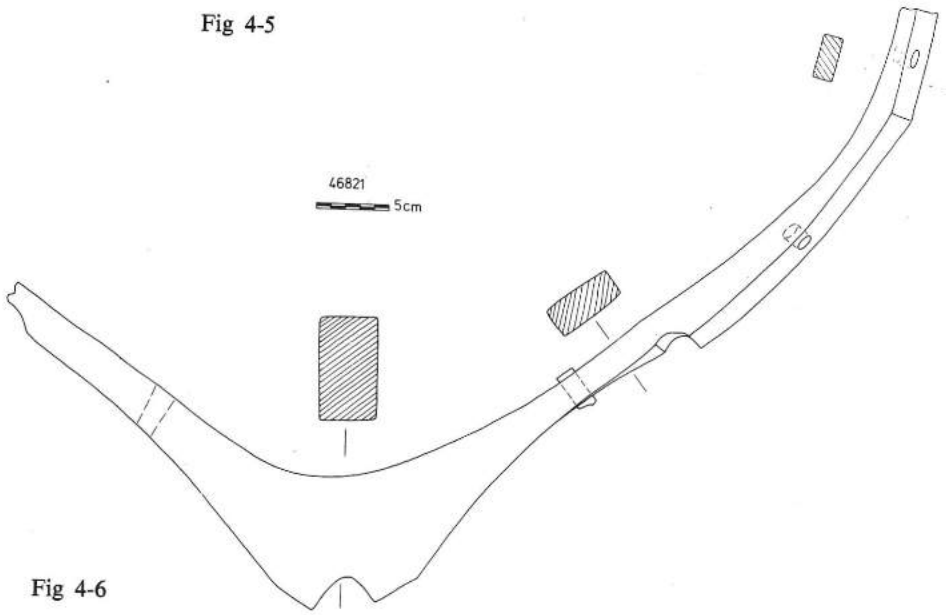


Fig 4-6

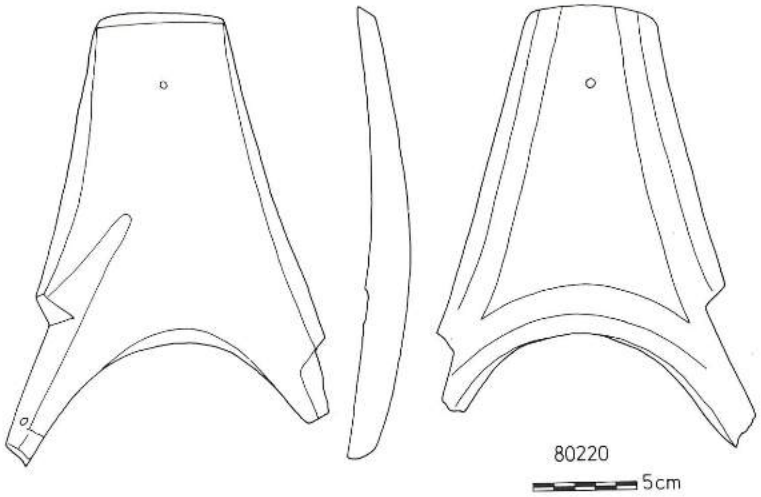


Fig 4-7

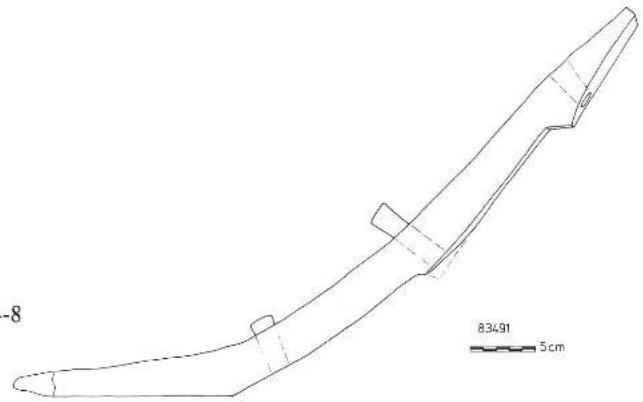


Fig 4-8

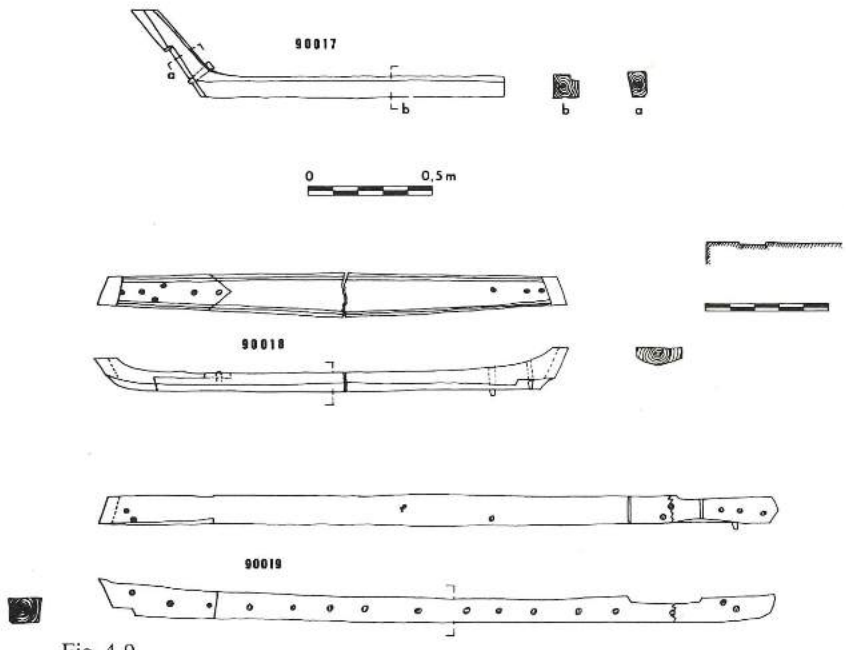


Fig 4-9

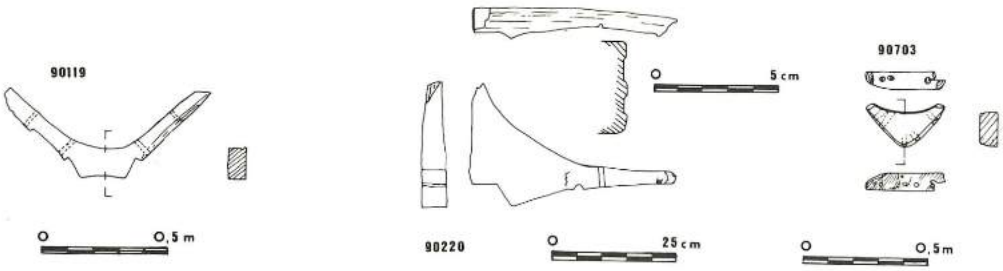


Fig 4-10

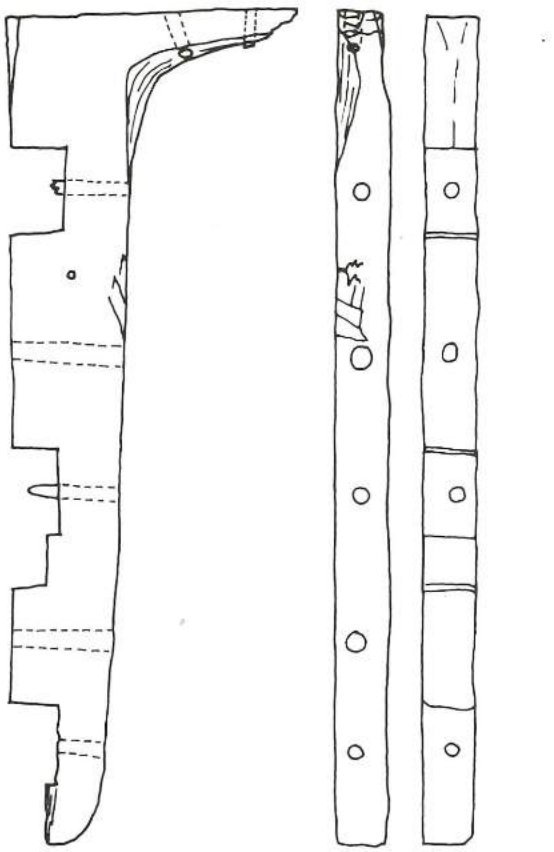


Fig 4-11 90222 0,5 m

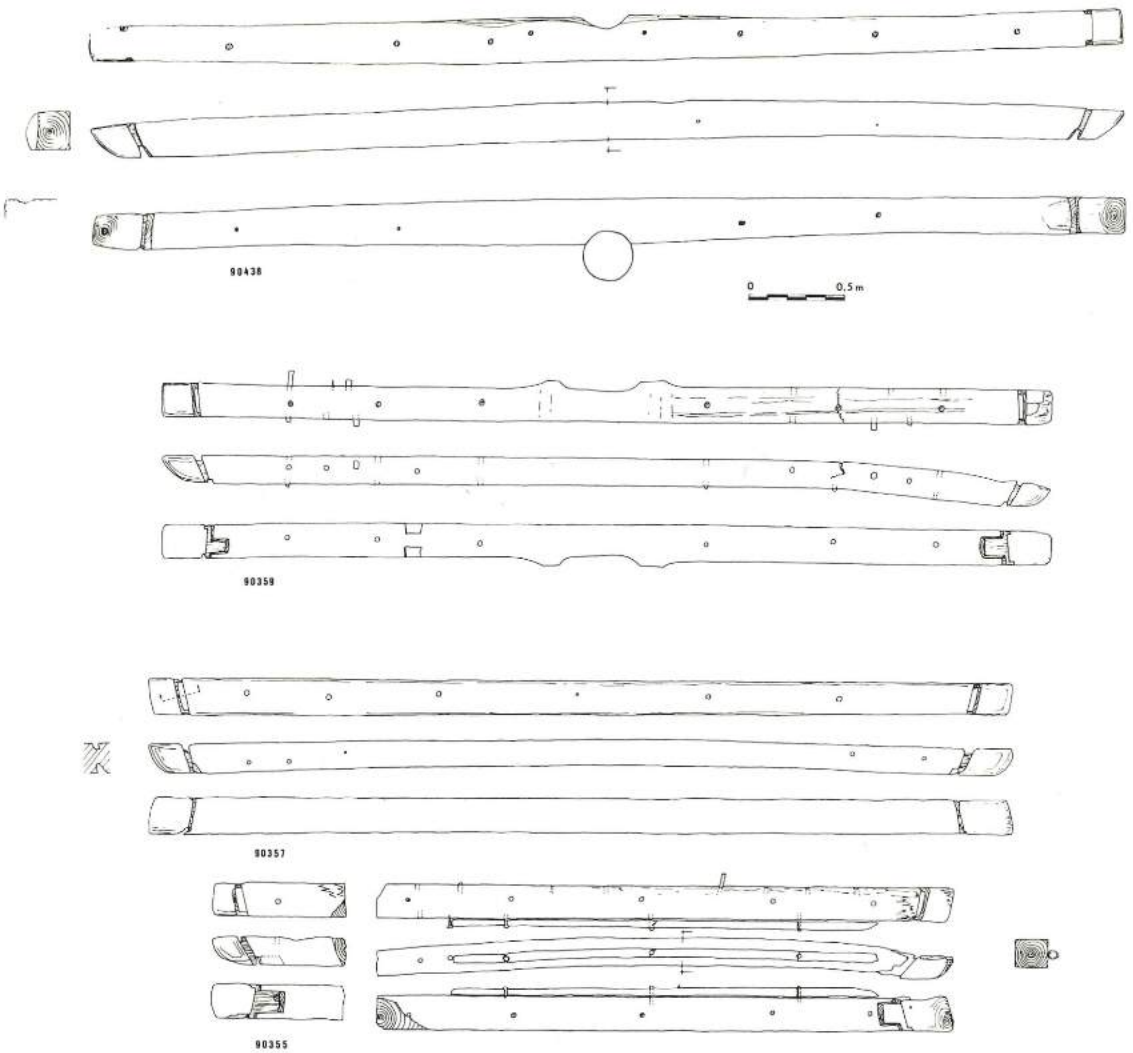


Fig 4-12

Fig 4-13 Detail of headbeam 90395 showing rib mortise on the underside

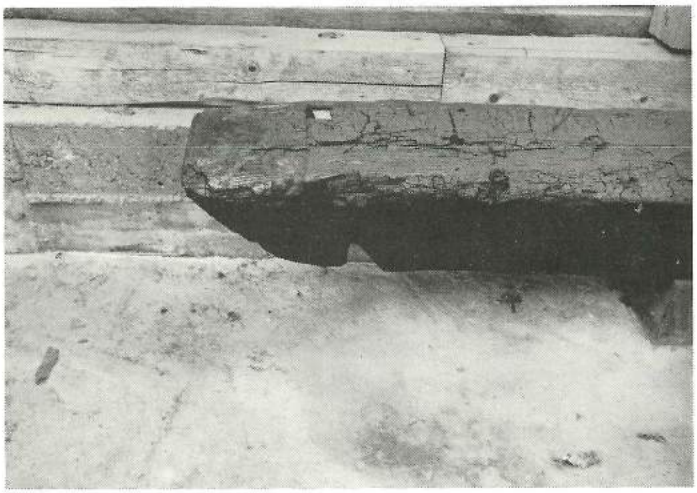


Fig 4-14 Detail of 90438

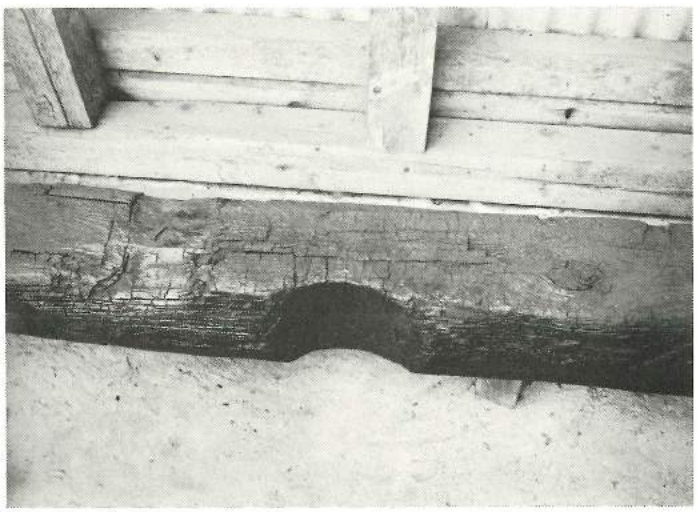


Fig 4-15 Detail of 90438 showing cutout for mast

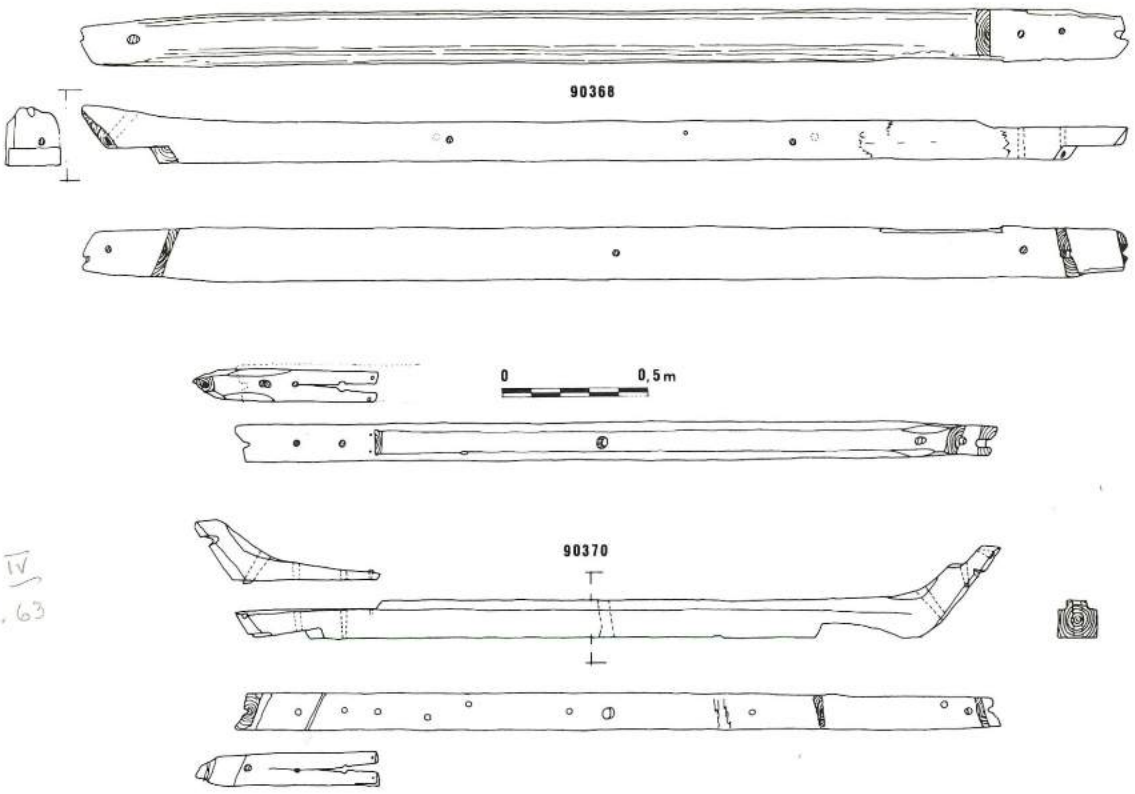


Fig 4-16

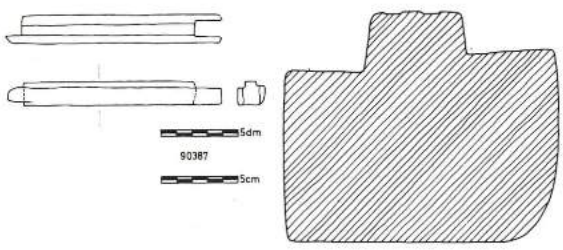


Fig 4-17

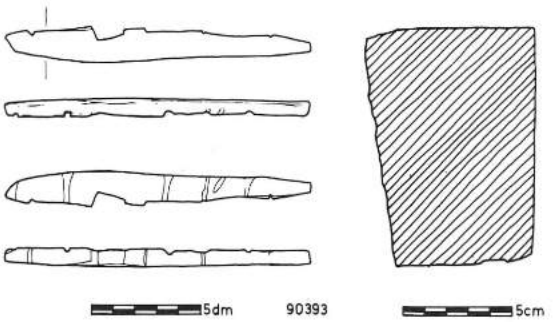


Fig 4-18

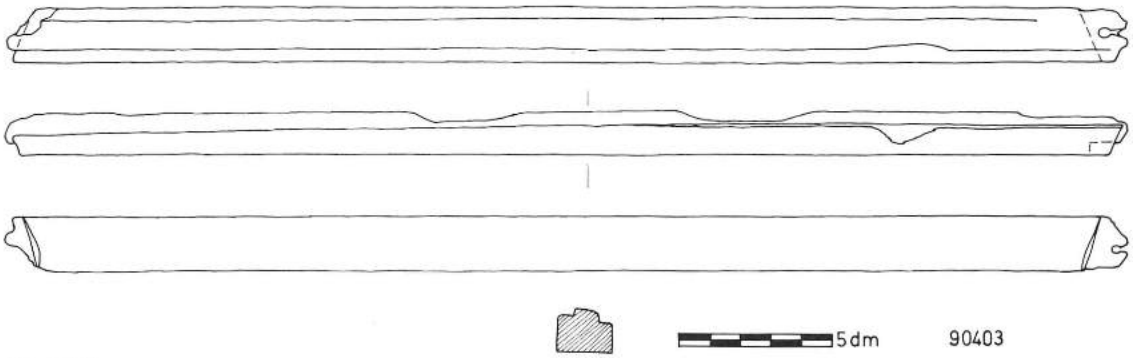


Fig 4-19

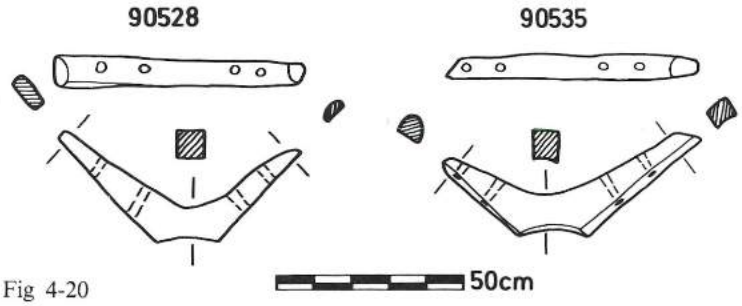


Fig 4-20

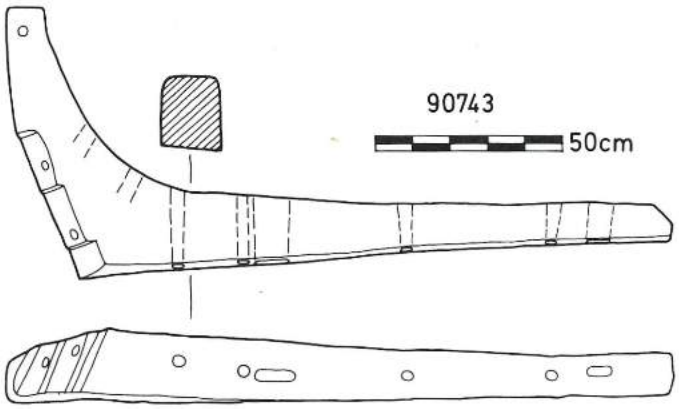


Fig 4-21

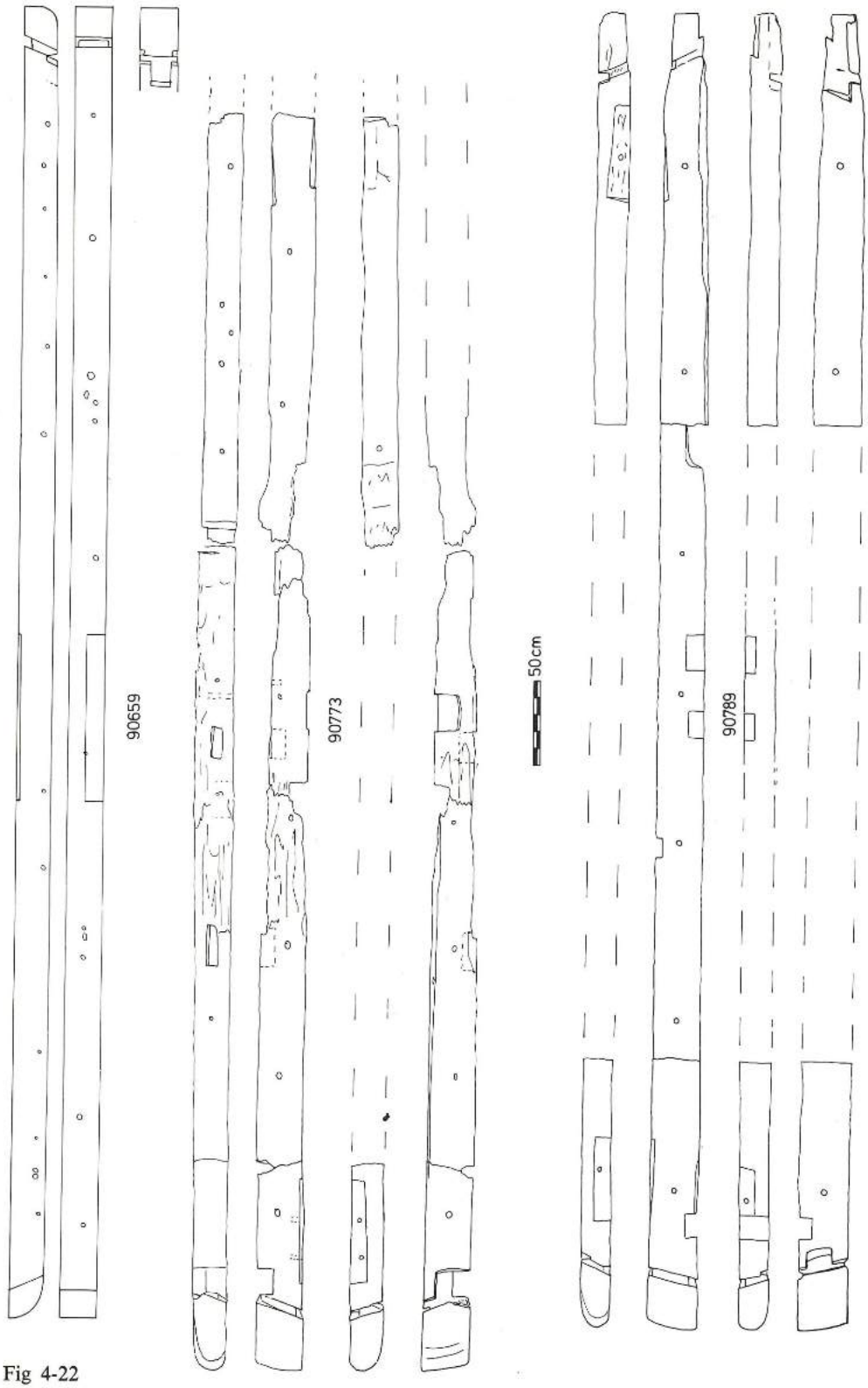


Fig 4-22

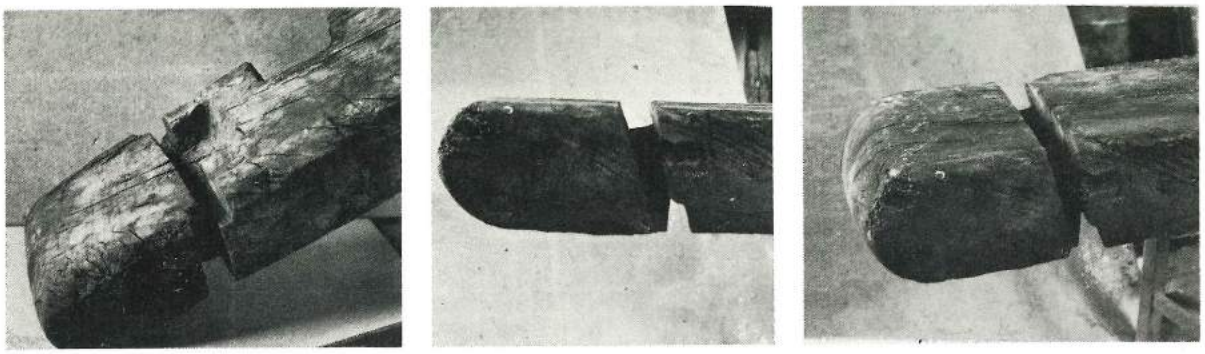


Fig 4-23

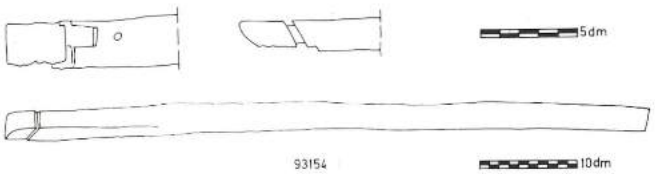


Fig 4-23b Lost headbeam 93154, traced from excavation plan and plan supplement

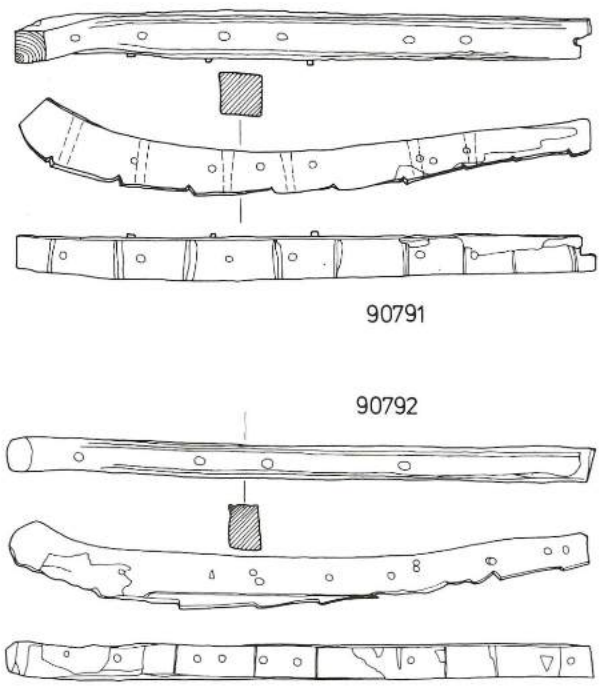


Fig 4-24

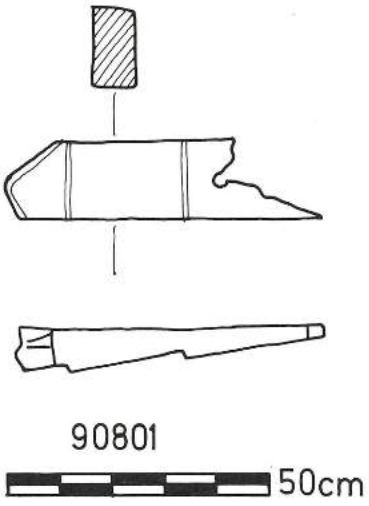


Fig 4-25

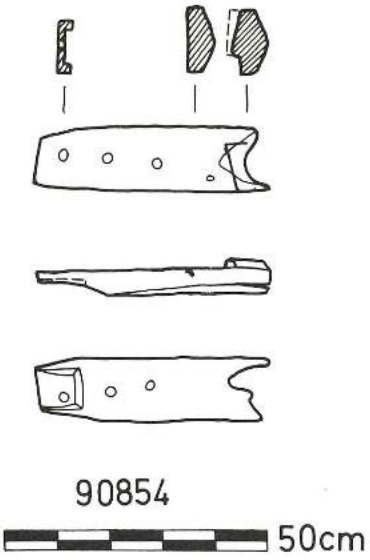


Fig 4-27

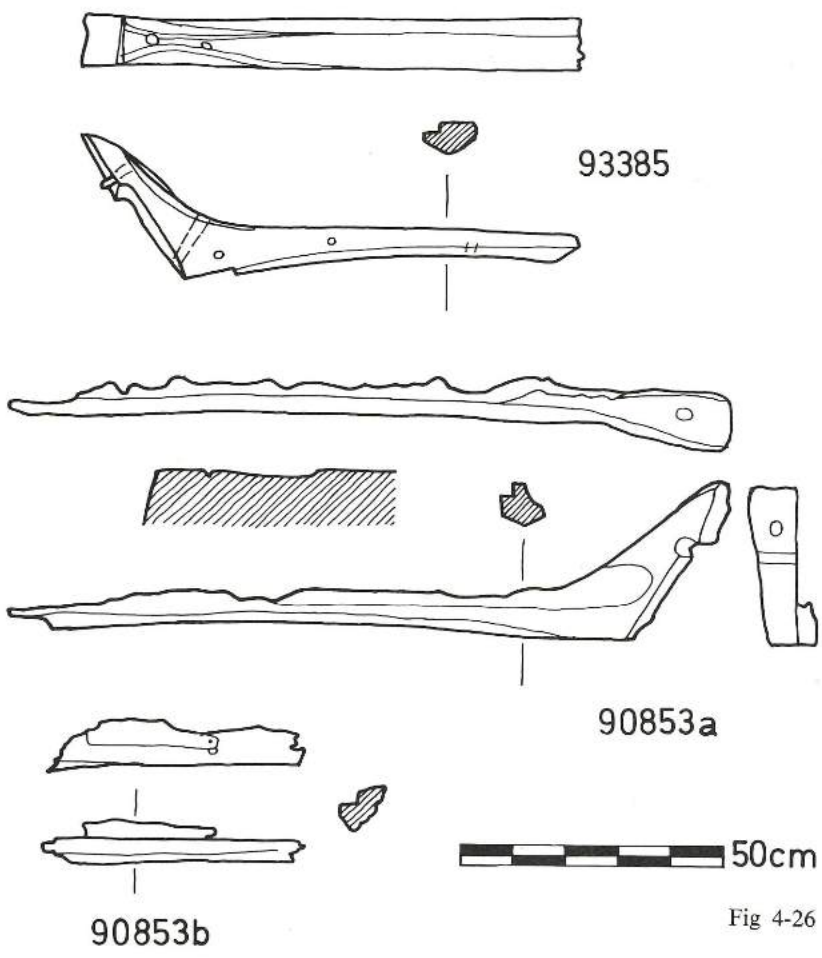
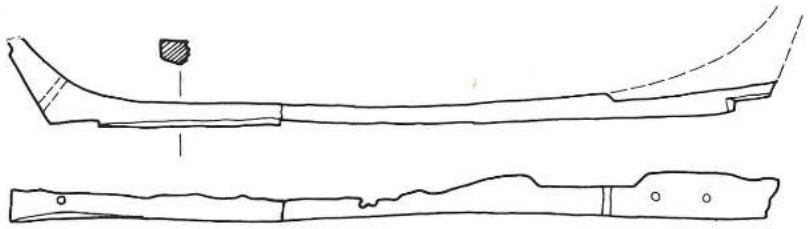


Fig 4-26



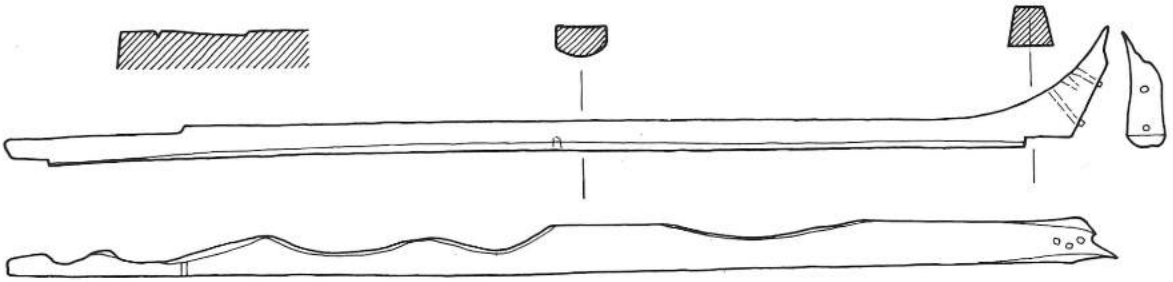


Fig 4-28

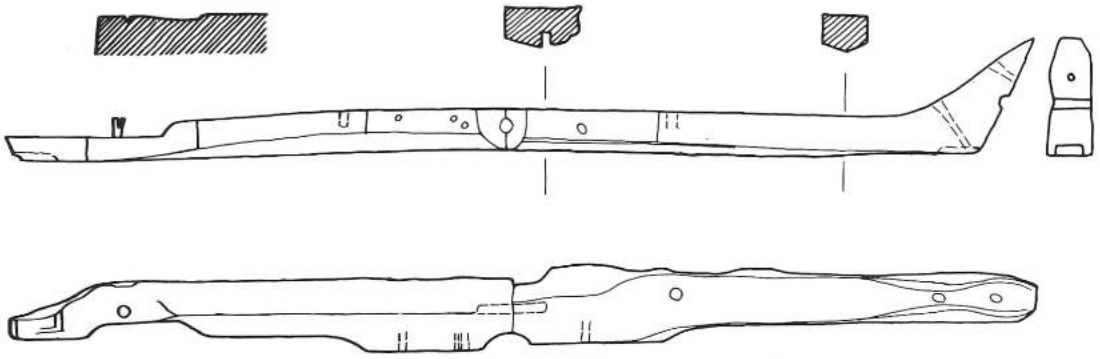


Fig 4-29

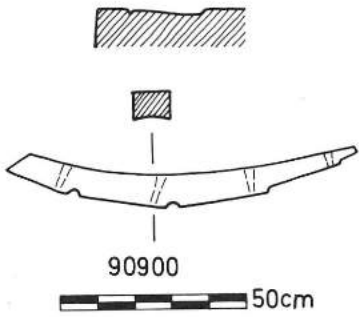


Fig 4-30

Fig 4-31 Even in its damaged state, the elegant lines of 90853 are easily seen

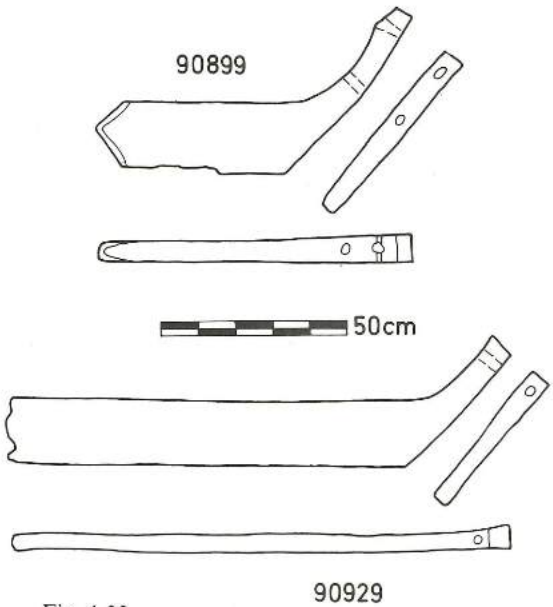


Fig 4-32

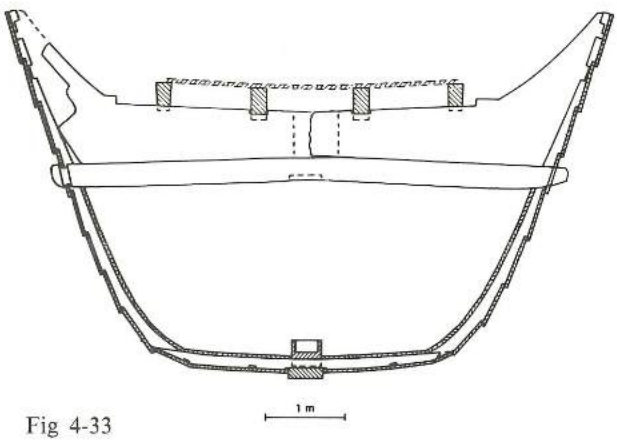


Fig 4-33

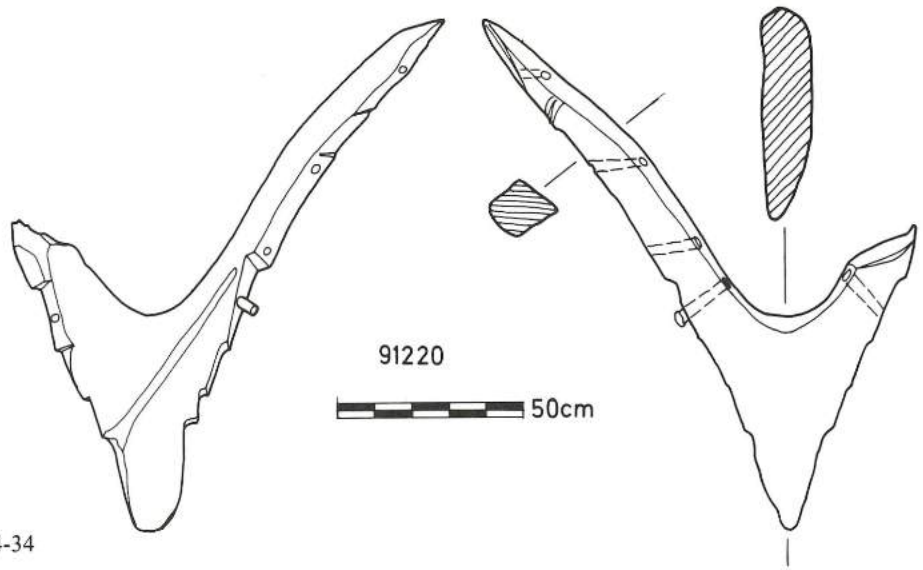


Fig 4-34

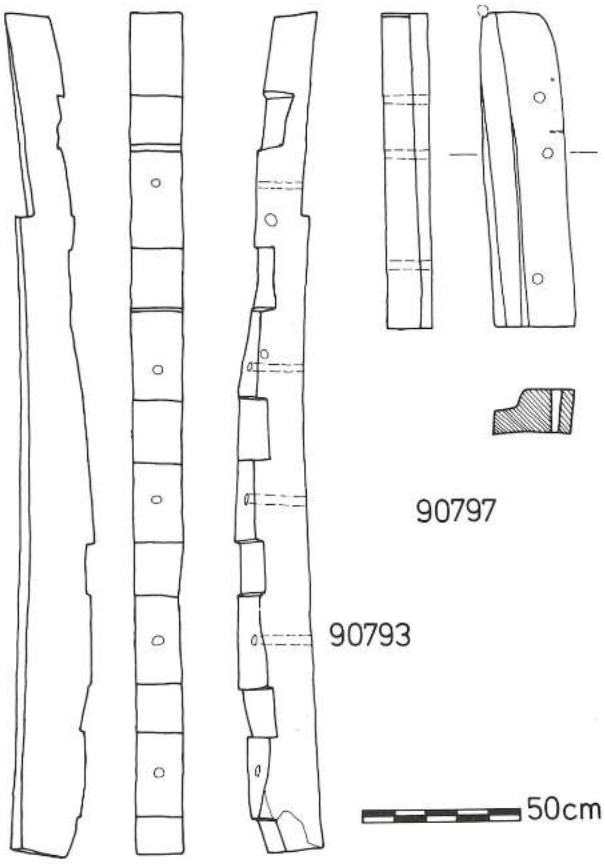


Fig 4-35

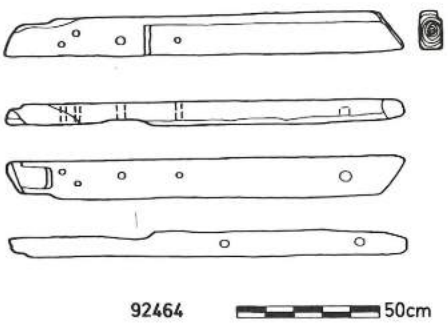


Fig 4-37

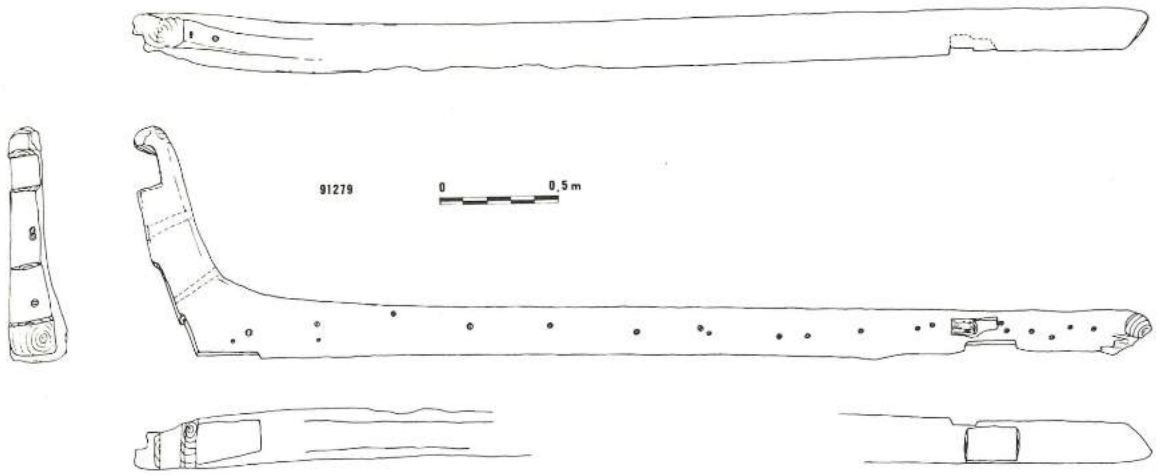


Fig 4-36

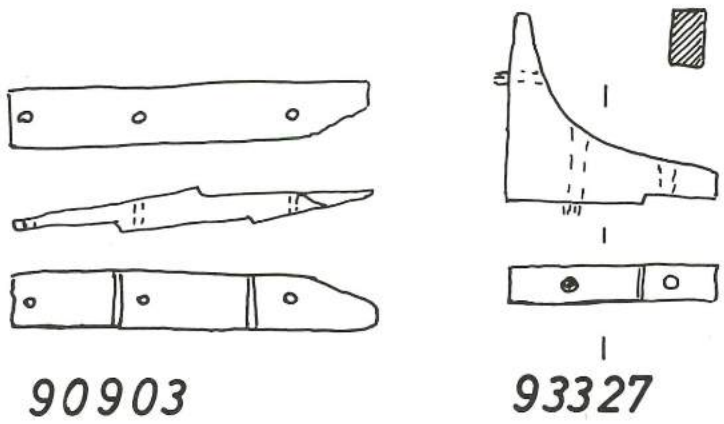


Fig 4-38

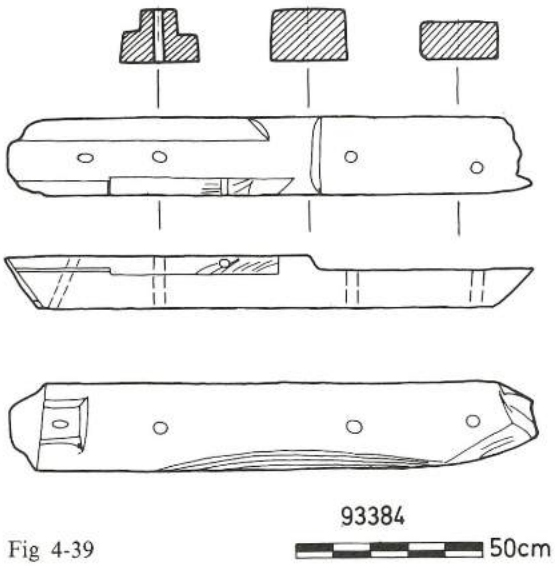


Fig 4-39

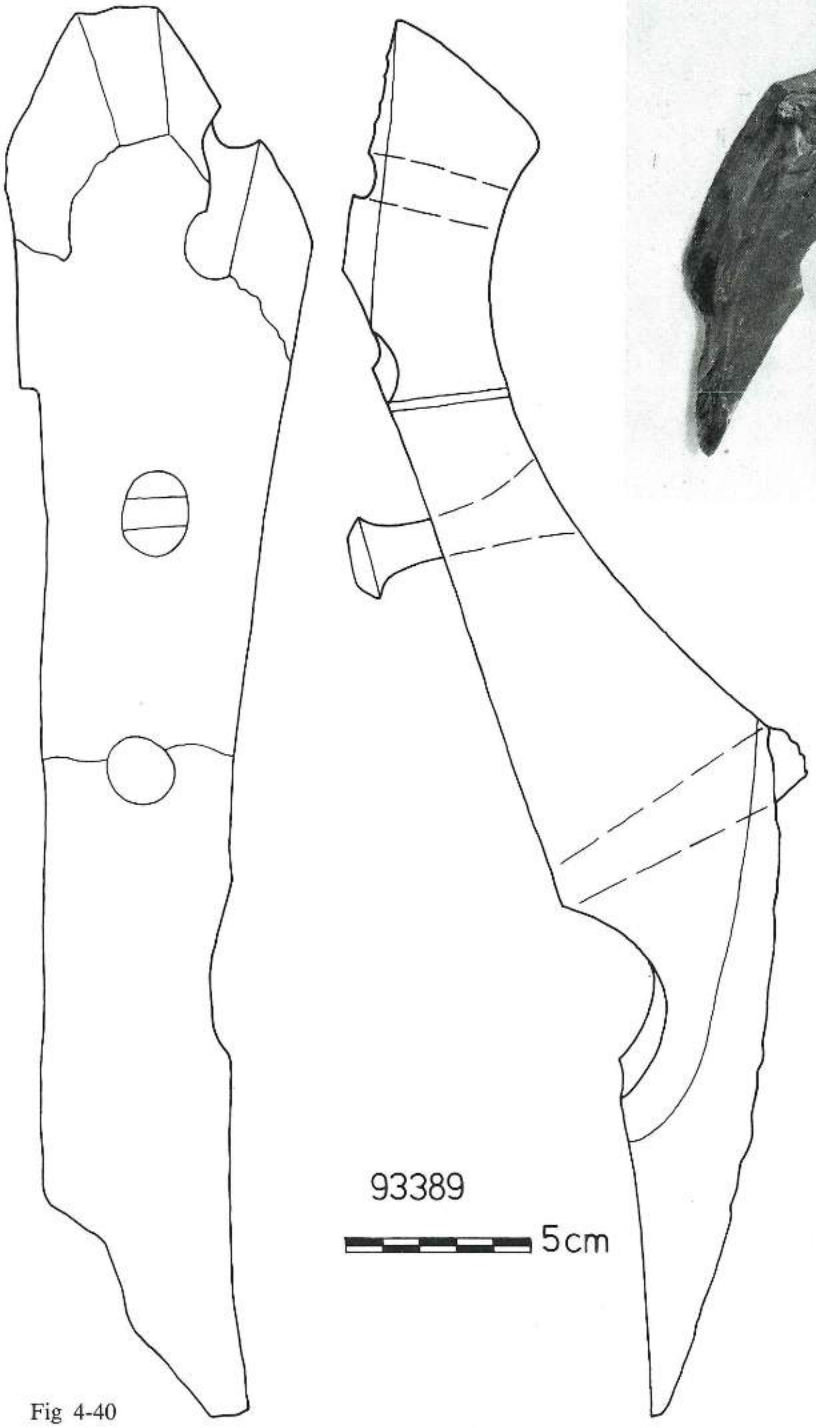


Fig 4-40

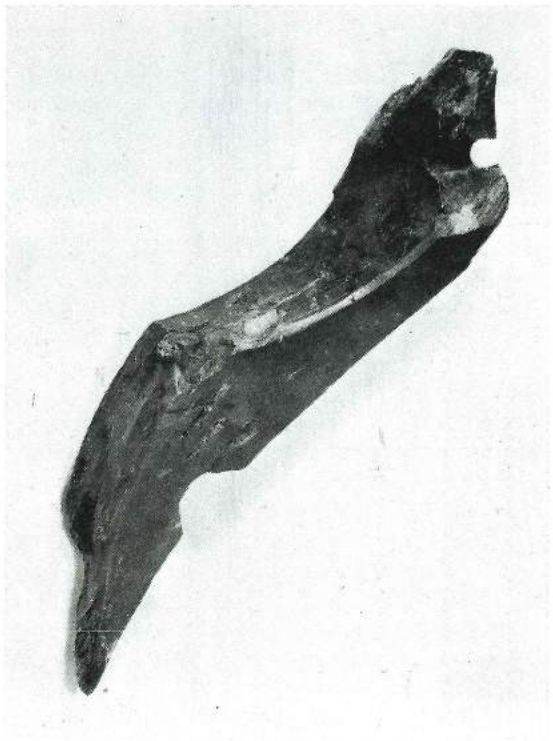


Fig 4-41

MAST STEPS AND KEELSONS

The system used for stepping the mast of the "Big Ship" (chapter 14) was not uncommon. The long keelson, notched to fit over the ribs, is known as early as the Late Viking age (Skuldelev 5), but the low-set crossbeams of which a pair form the mast-step seems to be a medieval invention (Olsen and Crumlin-Pedersen 1958). In the Bryggen material, there is one additional "mast crossbeam" (90405/06). This has a length of 250 cm.

The mast step is 16 cm wide athwartships at the top, tapering to 12 cm at the bottom. Alongships, the step is only 6 cm long at the top and 3 cm at the bottom, indicating that the other beam of the pair held the greater part of the step. There is no trace of an upright to support beams higher up in the ship. Both the latter details indicate that this beam was the one behind the mast (apart from the Elling Aa ship, all vessels with this type of mast step known so far have 2 beams forming the mast step together).

On the underside of the beam there is a rather roughly cut notch for the keelson and faying surfaces for 4 strakes on each side, 3 being treenailed to the beam. The treenails are placed near the lower edge of the strake and wedged in the usual manner on top of the beam. The width of the strakes can be estimated as c 31 cm, excluding one overlap (fig 5-1).

81442 (figs 5-2 and 5-3) is, as far as I know, unparalleled in the material from medieval Scandinavia. In my opinion, there can be no doubt that this is a "keelson/mast step" from a large boat or small coastal freighter. Made of oak, the piece is 52 cm long, shaped at both ends to fit over two ribs, placed 31.5 cm apart. There is one treenail-hole at one end. The remains of a corresponding hole at the other end is placed near the edge, probably indicating that there were originally two treenails here. This end is somewhat damaged, but the shape of the piece is clear. The mast step is placed closer to one rib than the other, the distance from mast step to the ribs being 10.5 and 21 cm. The step itself is slightly irregular, c 6.5x7 cm, 3.5 cm deep. In the bottom, traces of auger-holes tell us that the shipwright bored a number of holes to assist in removing the wood, probably finishing the job with a chisel. A limber-hole is bored obliquely through the keelson from the bottom of the mast step. It is reasonable to suppose that the mast was supported by a crossbeam or thwart above the nearest rib. Examples are known of masts standing in front of the support, but in the majority of known cases the mast stands behind the support. This, I suggest, is most likely in this case. A rib distance of about 40 cm centre to centre (or in this case, treenail to treenail), seems to indicate a rather sturdily built vessel, probably a small coaster. For comparison, the mast 90301, probably intended for a vessel c 8-11 m long, has a square heel measuring 10x10 cm.

The remainder of the known mast steps are of Viking Age date and all have a vertical branch left standing to support a mast partner or crossbeam.

50131 is a rib fragment with a mast step. The dimensions of the mast step and the scantlings of the rib would indicate that it came from a boat in the 8–10 oared size, using 19th century boats for comparison. The step is widest athwartships, 12.5x9 cm, tapering to 6.3x5.9 cm at the bottom. The depth is 5 cm. One surface of the rib, probably the forward one, shows damage by fire and the piece is broken at both ends. The underside has notches for the feathers of a c 12 cm wide keel and faying surfaces for the first strakes, which were at least 25 cm wide. The treenails for the strakes are placed in the middle of the strake. The upper surface has traces of a moulding and there is a limber-hole in the bottom of the mast step (figs 5-4 and 5-5). A smaller, similar piece was renumbered 93396 after the loss of the original number and its find-situation and date cannot therefore be established. The original sided dimension is uncertain, as the piece is split along the grain. The underside is notched, probably for the feathers of a broad keel (17 cm wide across). The faying surfaces for the garboards show that they were hollowed and at least 15 cm wide. The step is now 7.5 cm long and 8.5 cm wide, tapering c 1 cm from top to bottom. The sided dimension was originally greater. There is no limber-hole (figs 5-6 and 5-7).

As a rule, medieval and other sailing vessels in Scandinavia have the mast stepped in a carling or keelson parallel to the keel, while several of the Continental boat finds have the mast stepped in an extra sturdy rib (Ellmers 1972, figs 46, 66, 75 and 76). I know of two

medieval parallels from Norway, the Sørenga ship from Oslo (Christensen 1973) and an unpublished mast rib from the 1976 excavations in Tønsberg. The Sørenga ship was probably discarded in the harbour about 1400.

Kalmar VIII, a small boat from the early 17th century according to Åkerlund, has a mast rib and they are also known from 19th century boats in various parts of Norway. This particular shape of rib has parallels in the 19th century boats from around Mandal/Kristiansand in South Norway and the boats from Sunnmøre on the west coast.

The shape of the smaller Bryggen specimen and the fact that the treenails are wedged on the upper face indicate that this piece was not connected to futtocks. The other pieces are proper ribs, while this must be classed as a very short floortimber, which probably stood beside another rib.

In the districts around Bergen, boats in the 19th century often had the mast stepped on a floorboard. A block of wood nailed to the floorboard supported the foot of the mast on 3 sides, while a rib and crossbeam or thwart supported the front of the mast. A clamp originally fastened to another structural detail by two treenails, may be a mast step of this kind (14065). The identification is tentative, as other functions can be imagined. The piece may for instance have been fastened to the wall of a house as a support for a beam (fig 5-8).

Some timbers, originally not properly understood during the excavation and tentatively classified as house-timbers (horizontal beams notched on the underside for the uprights of an arcade) can be demonstrated to be fragmentary keelsons or bilge-stringers, on the evidence of the keelson from the "Big Ship" and parallels in the Sjøvollen ship.

90125 is clearly part of a keelson, with corresponding notches for ribs and low-set crossbeams on top and underneath. Rib distances, centre to centre, vary from 52 to 65 cm. Sided dimension of ribs and beams is c 12 cm. 90337, also a keelson fragment, comes from a vessel which must have lacked the low-lying beams, as the notches are missing on the upper side. The rib distance as shown by the notches on the underside is c 65 cm centre to centre, and the ribs are sided c 12 cm.

The fragment tapers vertically at one end. The explanation for this is probably that the shipwright wished to keep the upper edge of the keelson roughly horizontal and compensated for the increase of moulded height in the floortimbers towards the ends of the ship by cutting away on the underside of the keelson. As is usually the case in Scandinavian vessels, the keelsons have not been nailed to the floortimbers. On the other hand, 90020 and 90136 have a treenail in each rib recess, and the cross-section of 90136 would make it a very lop-sided keelson. Whether these timbers should be called side-keelsons, bilge-stringers or inwales is a matter of taste. A parallel was found in the Sjøvollen ship, on which a knee was fastened by treenails. It is quite probable that our "side-keelsons" were actually connected to crossbeams by lodging knees, or they may even be the long arm of huge lodging knees like nos 90222 and 93225, the latter from the "Big Ship".

The earliest use of lodging knees is seen in Skuldelev 1, where sturdy knees run from the crossbeams in the upper part of the rib system. The knees are notched to fit over the futtocks. The identification of the long straight piece 90020 is somewhat uncertain, as it is rather too straight for a lodging knee, while at the same time, it has treenail fastenings in the rib notches, which is generally not found in keelsons.

The following information on keelsons and bilge-stringers has been tabulated as follows:
Find number.
Length. As measured on the piece, or taken from plans or plan supplements.
Maximum moulded dimension. (Mm) Height of piece as seen from the side.
Maximum sided dimension. (Sm) Thickness of piece as seen from above.
Rib distance. (Rd) Distance between rib notches, measured centre to centre. Maximum/minimum distances are given centre to centre. Maximum/minimum distances are given when the distances are unequal.
Date before (BF) or *after* (AF) fire as numbered.

TABLE 5-I KEELSONS AND BILGE STRINGERS

Number	Length	Mm	Sm	Rd	Date	Notes
90020	404	19	11	62–65	AF 4	1
90125	325?	25	8	52–65	AF 4	2
90136	190	15	12	35–45	AF 4	3
90337	285?	30	12	70	BF 3?	4

Notes to Table 5-I

1 Treenails in the rib notches

2 Precise date c 1350. The keelson has notches on the upper side for low-set crossbeams

3 Treenails in the rib notches, oblique cross-section

4 Moulded dimension tapers towards one end. Only a fragment drawn in detail and kept, otherwise the piece is known only from the plan

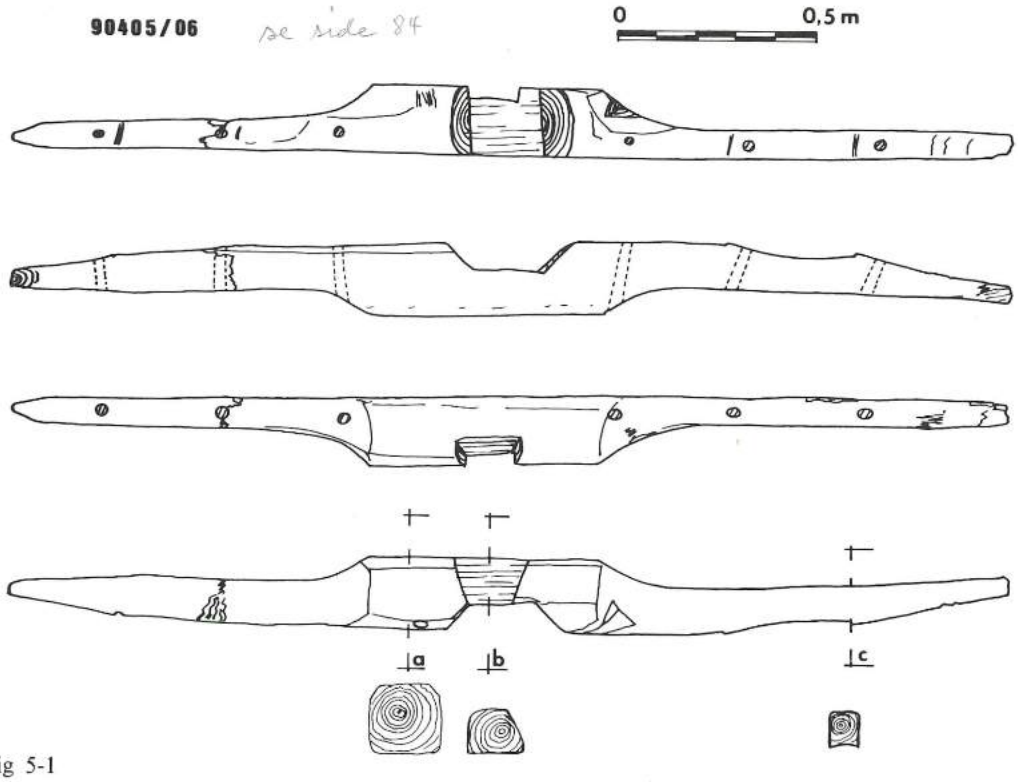


Fig 5-1

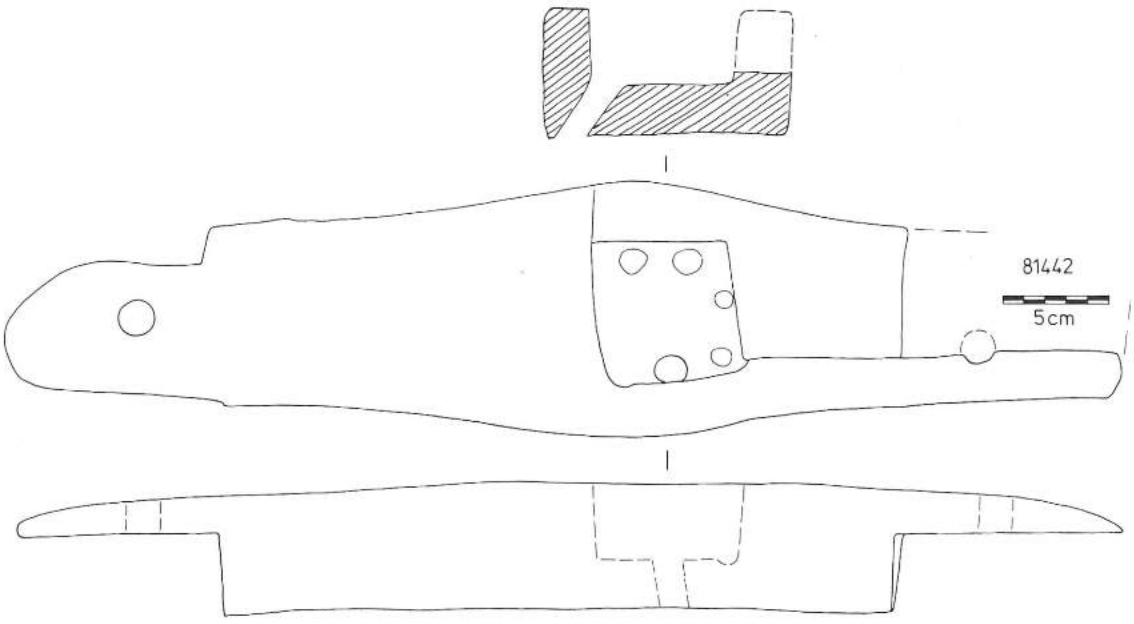


Fig 5-2

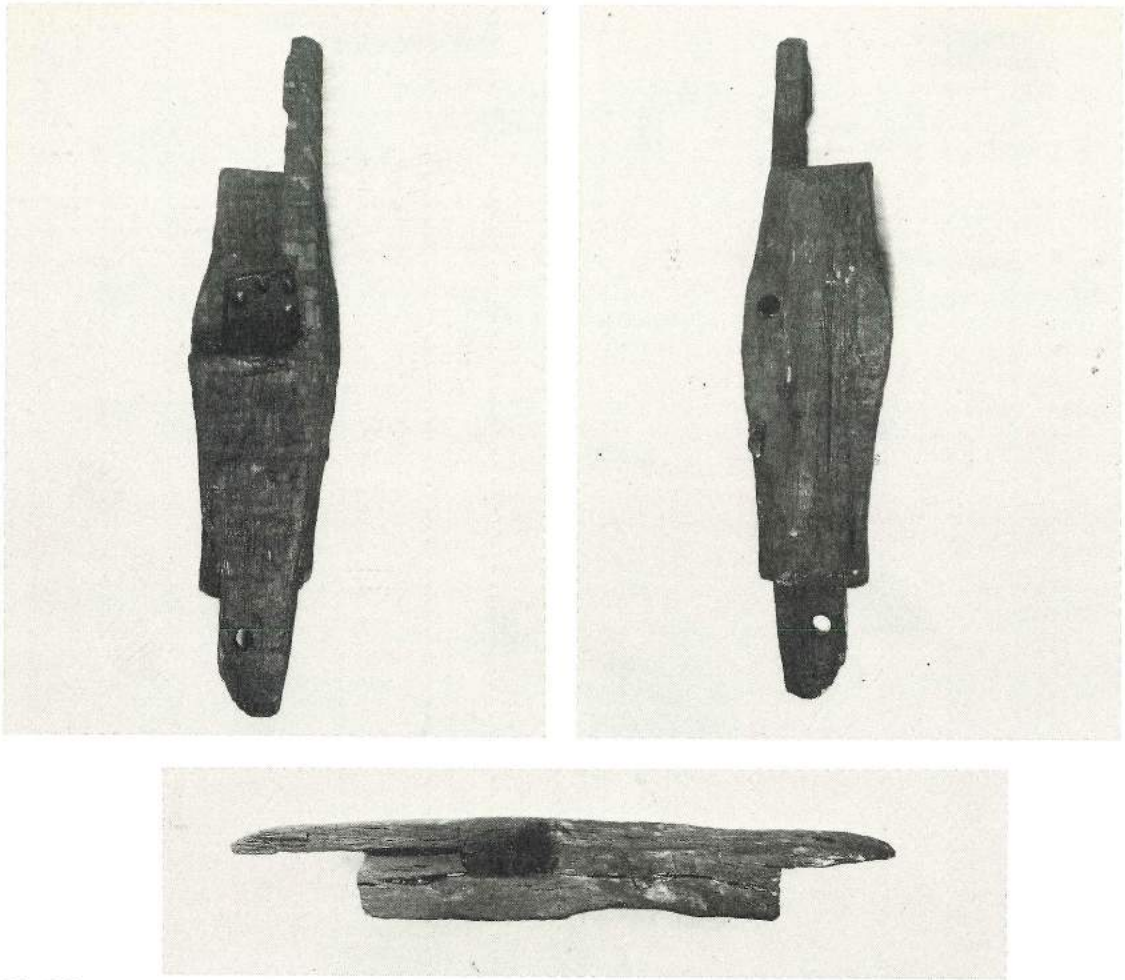


Fig 5-3

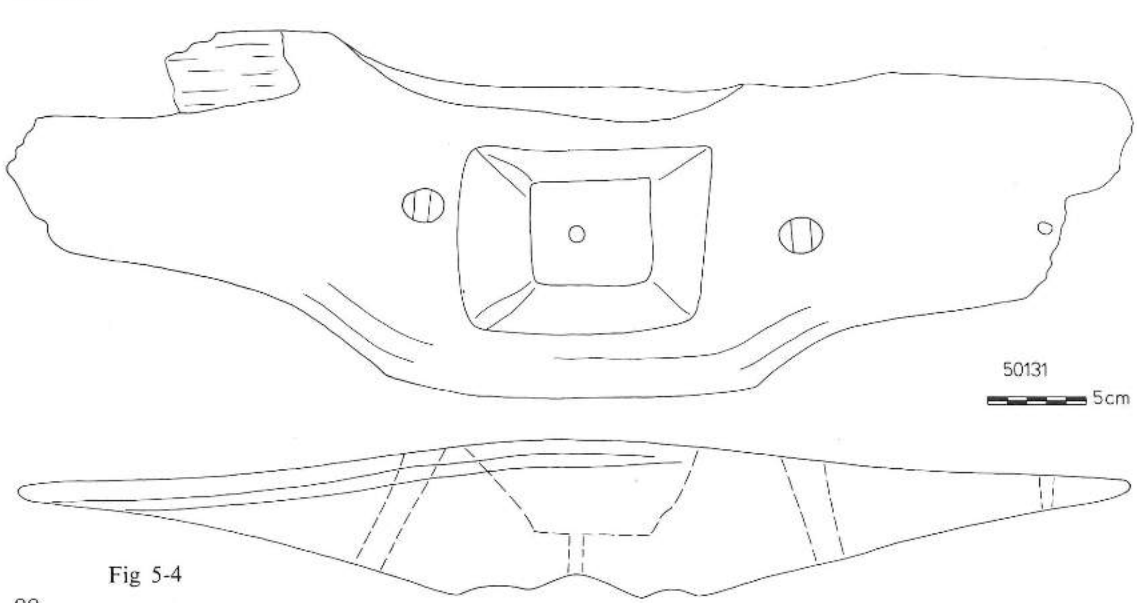


Fig 5-4

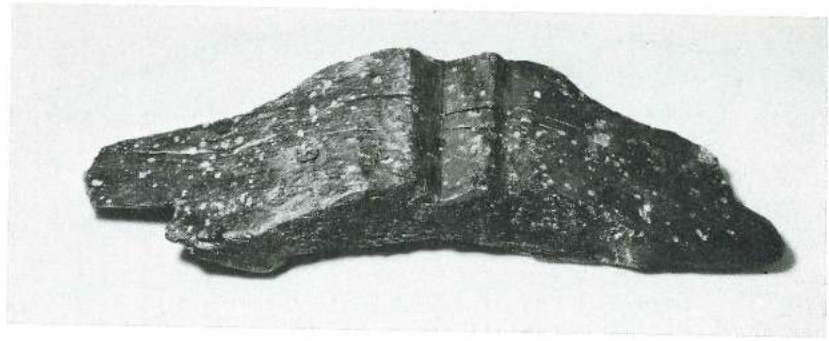


Fig 5-5

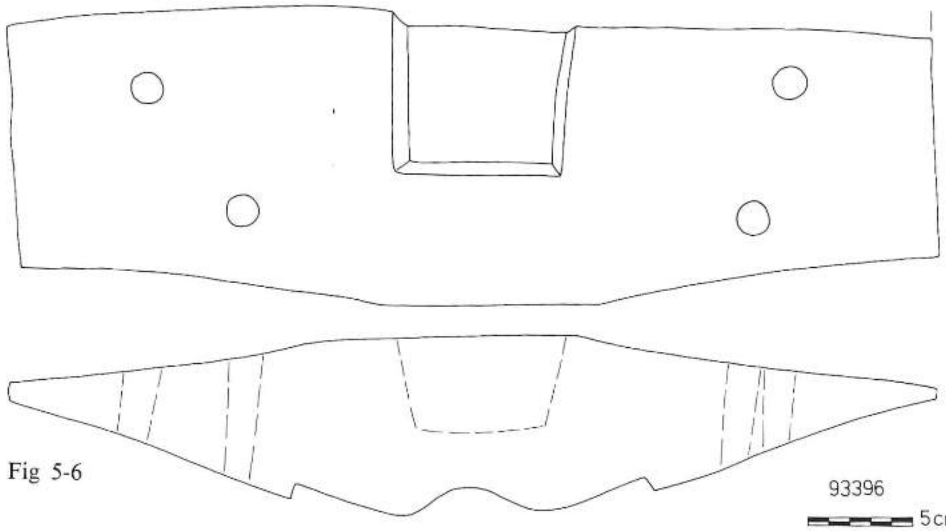


Fig 5-6

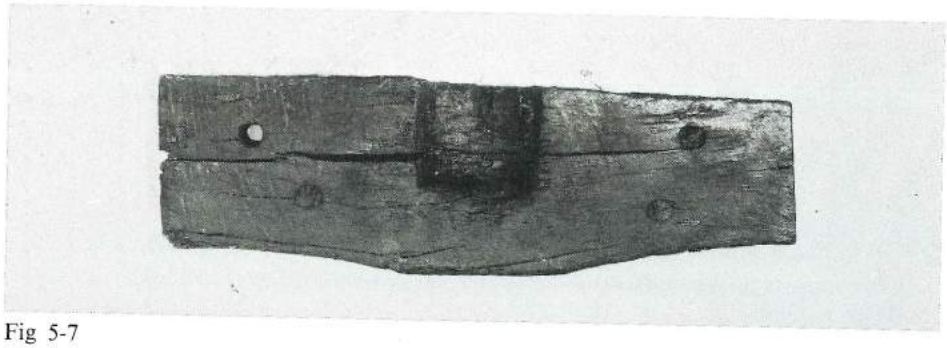


Fig 5-7

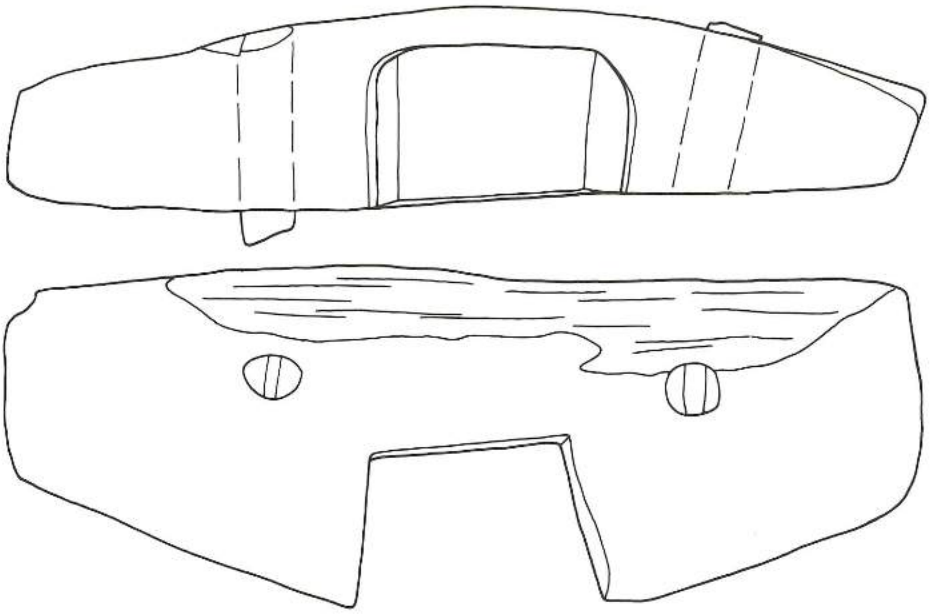
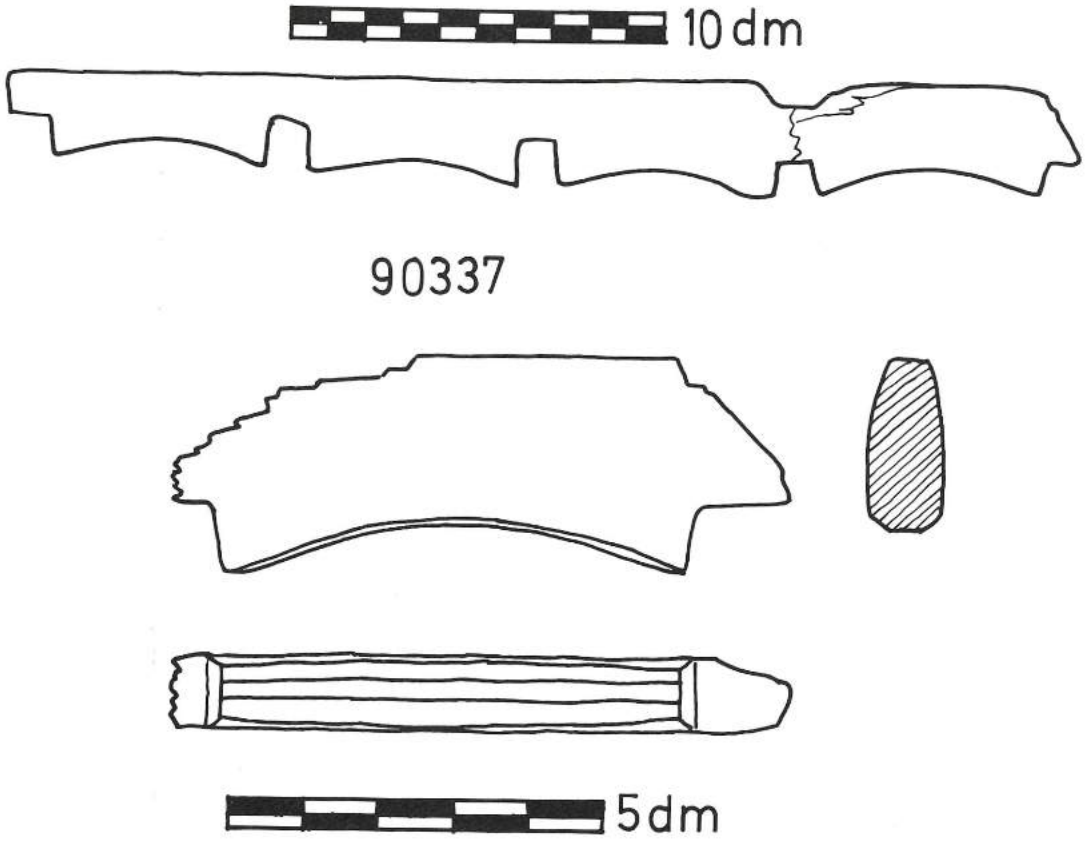


Fig 5-8

Fig 5-8b Mast support on floorboard. 12-oared boat from Nordfjord at Norsk Sjøfartsmuseum, Bygdøy, Oslo



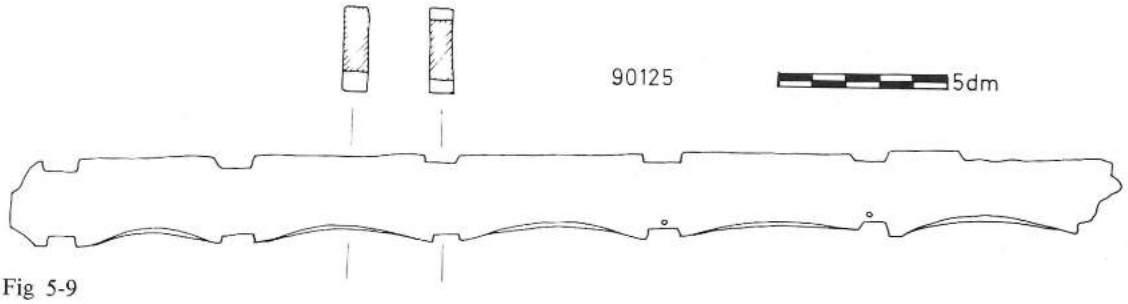


Fig 5-9

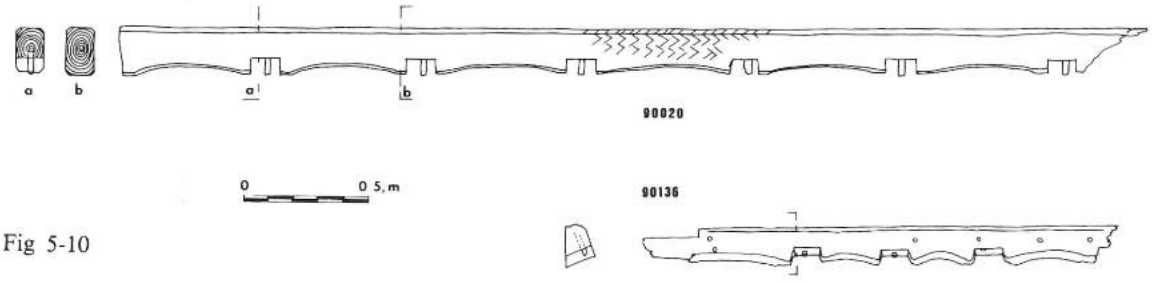


Fig 5-10

STRAKES

Among the strakes and strake fragments found at Bryggen, the majority do not give much information, apart from the fact that they come from clinker-built vessels. They show standard clinker building practice, and their value lies mainly in the fact that they show how standardized some parts of vessels could be. I have tabulated the information I think may be significant in table 6-I. The main dimensions are mainly there for the identification of the fragments, as few of the strakes are complete. Accordingly, the lengths give little information except minimum lengths between scarves. The width of the strakes as given is the maximum surviving width. When two measurements are given in the thickness bracket, they are min-max measurements, at edge and middle, or edge and thickest surviving part. Rivet and treenail distances are also min-max. The treenails were not always placed on the centre-line of the rib, so the treenail distances are only approximate rib distances, centre to centre.

Material has been identified by eye, without proper botanical examination. In a few cases, larger pieces of ships' sides have been re-used, the best example being shown on fig 6-11. Even in this case, far too little has survived to give proper indications of size or hull shape. Many of the strake fragments had detoriated between excavation and 1974, when I worked through the body of the material and in several cases my assessment is mainly based on the drawings made at the time of discovery. As a result of this, some information is lacking in the table for several numbers.

A few strakes merit closer description, due to special features. Some of them have been given unusual cross-sections by the shipwright, others are unusual in dimensions or other detail. Additional information and verbal descriptions are arranged in numerical order, following the note numbers from the tables.

The following information on strakes has been tabulated as follows:
Find number.
Length of fragment.
Width of fragment. In some cases, a + indicates that original width was greater.
Thickness. For strakes where the thickness changes from the middle to the edges maximum-minimum values are given.
Rivet distance (Rd) Distances are centre to centre measurements from actual rivets or holes left by disintegrated rivets. Maximum-minimum values are given where the distance varies.
Treenail distance. (Td) Distances are centre to centre between the treenails which originally held the ribs, or the holes left by them. Where rib distances vary, maximum-minimum values are given.
Scarf length. (Scl) When scarfs occur on the strake fragments, the length is given from the start of the scarf cut to the end of the feather edge.
Material. (M) The material has been judged by eye, and sorted roughly into pine and oak.
Date before (BF) or *after* (AF) fire as numbered.

TABLE 6-Ia STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
27250	21		c 3				P	BF 3	1
30166							P	AF 6	2
31475								BF 4	
33062	22.5	8	1.5	6.5			O?	BF 6	3
37787	20.7	2.9	1.5			7	P?	BF 3	
40048								AF 3	4
43433	7	11	1.6				P	BF 6	5
49846							P	BF 2	6
52670							P	AF 5	7
53960	53	12.5	2	22.5			P	BF 4	8
54401	29	c 10	1.3			7+	P	BF 4	9
55107							P	BF 6	10
56159	45	16	2.5			7	P	BF 6	11
64497	21	7.5	3-1.5				P	BF 6?	12
70643	34.5	6	2			7.5	P	BF 3	
72062								AF 4	13
72063								AF 4	14
72064								AF 4	15
73218		14	10	2.5			P	BF 3	16
84207	37	12.5	0.9-2.8	19.5			P	BF 6	
87658	223	20	2.2				P		17
87661	60	8	2.2				P		17
87663	183	20	1.5-2.4	17/20	68		P		17
90022	56	14		18			P	BF 4	18
90023	53	8					P	BF 4	18
90024	93	20		c 20			P	BF 4	18
90025	71	11					P	BF 4	18
90027	250	18+	c 2	18/20	80/84		P	BF 4	18
90028	215	22	c 2	60/75			P	BF 4	18
90029	211	23	15/19	81			P	BF 4	18

TABLE 6-Ib STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
90043	164	24	c 3		48	8	P	BF 4	18
90044	290	27+	c 3	8/10	70/80		P	BF 4	18
90045	120	11	2.5				P	BF 4	18
90046	120	11	2.5				P	BF 4	18
90147	106			c 25			O	AF 4	18
90150	c 120						O	AF 4	18
90151	c 250			20/30	65		O	AF 4	19
90152							O	AF 4	19
90208	480+	c 30	c 1.6	c 30	10		P	AF 6	20
90217	164	21	c 3	19/22	47		P	BF 4	21
90218	167	20	c 3	21/24	46/47		P	BF 4	22
90219	377	31	2/4	18/26	c 76		P	BF 4	21
90273	380	36	3.5	20/40	86	14	P	AF 4	23
90286	172	25	3	18	40/45		P?	BF 4	
90306	178	22	3	12/20	66	12	P?	BF 4	24
90326								AF 2	25
90360	180	20	3.5	16/18	75/80	12	P?	BF 4	26
90361	239	24	2/6	44?	76		P	AF 4	27
90372	320	24	1/7.5	19	62/65	18	P	BF 4	28
90373	248	25	1/3.6	20			P	BF 4	28
90377	208	32	c 2.5				O	AF 4	29
90378	173	18	c 2				O	AF 4	29
90379	119	22.5	3	30/66	14		P	BF 4	
90396	72	10	3.5				P?	BF 4	30
90397	78	26	3.5	36	14		P?	BF 4	30
90401	99	15	4				P?	BF 4	
90402	116	12						BF 4	
90404	210	29	1.5/3.5	52/56	12		P	AF 5	31
90418	135	22	c 4	57	20			AF 5	32
90430									32

TABLE 6-Ic STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
90460	141	24	2/5.4	55/58	10		P	AF 4	33
90484	60	18	2	19.5	38		O	BF 4	
90498	92	20	3	20/25	63		P	BF 2	34
90499	128	31	3	20	70		P	BF 2	34
90500	139	14	4	18/20	44		P	BF 2	34
90513	240	31	6	63/64			O	BF 2	35
90521	280	27	2.5	20/22	52/62		P?	BF 2	36
90522	83	25	3.5	17/20			P?	BF 2	37
90523	75	31	3.5	17/20			P?	BF 2	37
90586	238	32	3	15/28	65		P?	BF 3	38
90587	100	32/20	3.5	15/18			P?	BF 3	38
90588	74	19	4	16/18	52	15	O	BF 3	39
90591	572	20	3	24/30	60/70		P	BF 3	
90593	143	15	4	13/21	47		P	BF 3	
90598	285	27	2.5	19/24	103/106	10/13	P	BF 3	40
90631									
90716	115	9	1/2	24/26				AF 4	41
90768	59	28						BF 2	
90784	70	19	1.3	13/16			O	AF 3	42
90787								BF 3	
90795								AF 4	
90796								AF 4	
90800								AF 4	43
90803	74	25	2/4.5	20	50		P	AF 4	44
90804	150	30	2/4.5	17	25/46		P	AF 4	44
90805								AF 4	44
90806								AF 4	44
90814	180	22	2/2.5	34/57			P	BF 3	
90821								BF 3	45
90822								BF 3	45

TABLE 6-1d STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
90842	195	25	3.5/5.5					BF 3	46
90843	145	23						BF 3	46
90844								BF 3	46
90847								BF 4	47
90851								BF 3	48
90884	42	26	5					BF 3	46
90887								BF 5	49
90910								BF 5	50
90984								BF 5	
91024a	82	13	31.5					BF 6	
91102	126	33	1.5	10/20				BF 2	
91357	170	19	1.5/5	37/49	11		P	AF 4	
91358								AF 4	51
91428								AF 4	52
91431								?	53
91433								BF 4	54
91434								BF 4	54
91436								BF 5	54
91437								BF 5	54
91438	97	11	1.5				P	BF 5	55
91439	65	11.5	1/2	20.5			P	BF 5	
91440	94	15						BF 5	56
91441	56	12						BF 5	56
91442								BF 5	56
91449								BF 4	
91459								AF 5	
91488								AF 3	
91513	403	40	40/56					AF 4	57
91514	184	24						AF 4	58
91516								AF 4	

TABLE 6-Ie STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
91521								AF 5	
91629								AF 4	
91630	125	24	1.5/3.5	23	55	10	P	AF 4	
91631								AF 4	
91632								AF 4	
91635								BF 3	
91639								AF 4	
91640								AF 4	
91642	35	32	2/3	17.5			P	AF 4	
91651	228	18	2/4	16/18	47/50		P	AF 4	59
91652	110	19	1.5/3	17/18	50		P	AF 4	59
91653								BF 5	
91693								AF 4	60
91694	128	27	2/4.5	48/50			P	BF 4	
91696							O	AF 3	61
91725								AF 4	
91748	156	14	1.5/5	181			P	AF 4	61
91763	47	27	4	16				AF 4	
91764	62	17	4	13/17				AF 4	
91766	80	12	4	11				AF 4	
91767	73	18	16					AF 4	
92380								BF 3	
92381								BF 3	
92382								BF 3	
92440	212	26	3	22/25	50?		P?	BF 3	
92444	137	20	2.5	23	66?	8		BF 3	62
92449	170	24	2/3	54/57			P	BF 3	
92502	115	25	1.5/3					BF 3	63
92503	74	32	2.5/3	10		63			
92504	65	24						BF 4	63

TABLE 6-If STRAKES

Number	Length	Width	Thickn	Rd	Td	Scl	M	Date	Notes
92529									64
92530									64
92733	114	24	1.5/3	9&12			P	BF 3	65
92734	56	25	1.5/5					BF 3	65
92735	121	17	1.5/3.5	19/20				BF 3	65
92737								BF 3	65
93198								BF 4	66
93220	68	12	2	16			O	BF 4	
93221	114	16	2	15/20			O	BF 4	
93362	397	13/16	1/2	44/90	12		O		67
93381	71	28	2/4	14/17			P	AF 4	
93382								AF 4	

Notes and comment to table 6–I

1 (27250) Very fragmentary piece.

2 (30166) Hood-end fragment (fig 6-1). The same scraper has been used for the moulding and the luting-cove. The strake is back-bevelled to fit against an unrabbeted stem.

3 (33062) Fragment of sheerstrake near stem or stern fig 6-2. The bottom edge is back-bevelled, in all probability to fit against an unrabbeted stem. Moulding on lower outside and upper inside edge. (See also note 9.)

4 (40048) The date, after fire IV, in this part of the excavation area means after the 1332 fire, as there was a local fire in 1527.

5 (43433) Probably sheerstrake fragment at stem (fig 6-3). (See also note 9.)

6 (49846) Very fragmentary piece. A loose patch has been fastened with iron-nails and treenails over a crack. Two pieces of rather fine twill is tied to the fragments: they were surely placed under the patch as luting.

7 (52670) Small fragment, moulding of type 1 along one edge.

8 (53960) Sheerstrake fragment near stem or stern. One treenail is still in position in one of two holes along the lower edge, showing that the strake was treenailed to the one below it. Near the top edge at the broken end is a treenail-hole which must be a fastening for an inwale or a breasthook. The bottom edge is back-bevelled and has a luting-cove on the inside and a moulding of type 4 on the outside. The fragment is slightly hollowed on the outside and the top edge has a slight s-curve when seen from above. After centuries in the ground, all twist will have left a strake if it is not shaped into it, so this is a strong indication that even sheerstrakes were shaped by axe, not bent and twisted to shape (fig 6-2). (See also note 9.)

9 (54401) Sheerstrake fragment (fig 6-2). One end shows a scarf. The strake was treenailed to the one below it. The lower outside and upper inside edges have mouldings of type 4. The inside of the lower edge shows a scored line along the lap and it has a luting-cove.

The four strake fragments 33062, 43433, 53960 and 54401 have many details in common and are best discussed and illustrated together. The mouldings are of the same type, but differ in width, so we have fragments of 3 or, more probably, 4 boats. The mouldings of 33062 and 53960 may just possibly have been made with the same scraper. 33062 was found in L6/K6, in the *bolverk* foundations for the quay-front below fire VI, while 53960 comes from M5, north of *bolverk 1*, below fire V. It is rather improbable that two pieces found in so different places are from the same vessel. All four fragments have a smooth upper edge with no traces of fastenings, so they are probably all from sheerstrakes. 33062 is back-bevelled for a stem or probably the strake below and has 3 nail or rivet holes. One treenail-hole may be for a breasthook or rib. The moulding is placed along the inside of the upper edge. 43433 probably comes from an abruptly curved hood end. The moulding is along what I take to be the forward edge, on the outside. There is one nail or rivet hole and the back-bevel is hollowed to act also as a luting cove. 53960 has a similar combined back-bevel and luting-cove. Here, the moulding is scraped along the outside of the lower edge. The strake was fastened to the one below with treenails, 2 holes are preserved. A third hole, where the strake is broken, is probably a breasthook fastening. In the broadest part, the fragment has a certain hollowness on the outside, showing that it was originally cut to an increasing twist away from the vertical as it ran away from the stem. 54401 has mouldings both on the outside of the lower edge and the inside of the top edge. The back-bevel and luting-cove are unusually broad (3.5 cm). Along the back-bevel there is a score mark made with a knife-point or an awl. The piece has a scarf with one uncertain rivet-hole. If the scarf opened aft in the usual manner, this would be a fragment of a strake from the port side aft. 33062 and 43433 are from port forward or starboard aft strakes, while 53960 came from a port aft or starboard forward strake. The use of treenails instead of rivets for fastening a sheerstrake, probably for economic reasons, is known from both Late Viking and Medieval vessels: Bryggen, Kalmar I, (Åkerlund 1951), Skuldelev 6 (Olsen and Crumlin-Pedersen 1967), Sjøvollen (Christensen 1968). The wood of 33062 is difficult to identify due to conservation, but seems to be oak. The other three are pine.

10 (55107) A small fragment of a thick strake with part of a scarf (fig 6-4) The impression of a nail head shows that the nail had small points on the underside of the head. Similar nails are known from the Bøle wreck (Molaug 1964) and in medieval churches (KLNM, Nagle fig 2-6).

11 (56159) The intact upper edge of the fragment shows no traces of fastenings, indicating that this is a sheerstrake. Two V-shaped shallow grooves are cut along the piece. Similar decorative grooves are found on the group of fragments 87658, 87661, 87663, 90045, 90046. However, this piece was found in square M5 and must stem from another boat (fig 6-5).

12 (64497) Possibly a strake fragment of unusual shape and cross-section. Difficult to explain as

a boat fragment, but it may be from a sheerstrake with the strengthening fillet cut in one piece with the strake, instead of being a nailed-on inwale (fig 6-6). The identification is far from certain, and the piece is illustrated with the hope that future finds may help in identification and interpretation. The date is also somewhat uncertain.

13 (72062) Also numbered 92427. Very fragmentary piece. Moulding of type 3.

14 (72063) Also numbered 92428.

15 (72064) Also numbered 92429.

16 (73218) Also numbered 92503. Only a small piece of the strake was kept as a specimen. The cross-section is lentoid, and there is a moulding of type 3.

17 The 1979 excavations in the upper parts of Bugården and Engelgården gave some boat fragments that I have considered of sufficient importance to be included, even though the other material had been worked through and the catalogue closed at that time. In addition to the keel 87888, there are 3 strake fragments, which show a number of interesting features. Other strake fragments found at the same time do not show much detail and were not included. 87661 is a small fragment, probably originally placed close to 87663. All 3 are sheerstrake fragments with some original upper edge intact. 87663 shows moulding along the lower edge and on the inner top corner. Both 87658 and 87663 have holes for small treenails along the upper edge. In my opinion, the treenails originally held the inwale. In the case of 87663, the moulding on the top edge must have been scraped partly into the strake, partly into the wale. 87658 lacks a considerable amount of wood along the lower edge, while 87663 has rivet-holes and some of the moulding intact, but lacks a little along the edge. On the inner surface of 87658 and 87663 there are traces of vertical auger marks, with less than half the hole surviving. I can suggest two possible explanations for this. One is that the splitting of the planks was done by boring a row of vertical holes along the middle of the log, as seating for wedges, and that the holes were not quite removed by the subsequent dressing of the plank. Another possibility, more likely in my opinion is that the boat had rowlocks on top of the wale, held by vertical treenails. When boring for the treenails, the auger has left marks on the inside of the strake. All 3 fragments show incised grooves on the outside. They are V-shaped, cut with axe or knife, and not scraped with a moulding scraper. The grooves are smoothly curved, probably following the overall sheer of the boat.

Similar grooves are found on 56159, 90045 and 90046. 56159 was found in square M5, too far from the others to be part of the same boat, but 90045, 90046, 87658, 87661 and 87663 were used in the same drain, and in all probability came from the same vessel. 90043 and 90044 were also part of the drain, found in close context with 90045 an 90046. 90044 has the same moulding and rib distance as 87663, while 90043 seems to have the same moulding. I think it may safely be stated that they are more parts of the same boat. I also think that the complex of boat fragments 90018/19, 90022-90025, 90027-29 may well come from the same boat, probably with the exception of the beam 90019, which seems to be different in character and workmanship. The various fragments have been stored in different places, some of them inaccessible, so I have not been able to match all the pieces visually at the same time. At any rate there is not enough for a reconstruction. I know of no exact parallels to the decorative treatment of the grooved strakes. However, the practice of continuing strake runs on stems and stealers are expressions of the same sculptural approach to boatbuilding. Decorative planed grooves on sheerstrakes are not unknown in modern boatbuilding. In all cases, the idea is literally to underline the sheer of the boat. 56159 may be a fragment of a winged stem where the grooves indicate the termination of strake runs, while the grooves on the remainder seems to be pure decoration (figs 6-5 and 6-7).

18 (90022–25 and 90027–29) The fragments were found close together and most likely come from the same boat. In all probability, the beam fragment 90026 is also from this vessel. The thin, broad strakes and the rib distances of c 75-80 cm indicate that this is a boat, not a ship, but there is not enough left to indicate its size. Several of the strakes show strong edge-curve, and 90024 is part of a "stealer" hood-end, so the fragments come from one end of the vessel. 90024 has clearly been shaped by the axe to its twisted form, and is strongly back-bevelled, so it must have flared considerably. The middle rivet-hole has the impression of a square rove on the outside. This indicates firstly that the piece was so near stem or stern, that there was not room inside the boat to swing a riveting hammer. The same detail can be seen near the stems of the Oseberg and Gokstad ships. Secondly, the rove mark also proves that the strake was rivetted to another strake beneath it, or possibly to a "wing" on a winged stem, not nailed to a keel or a stem (figs 6-8, 6-9 and 6-10).

19 (90149/150/151/152). Slabs of ships' sides, found together and in all probability from the same ship. Part of 90151 was available for

study in 1974, the rest of the fragments are known to me from the drawings made at the time of discovery. The scarfs on 90151 show that this piece came from the starboard forward part of the ship. 90150 has two scarfs opening the opposite way and is most probably part of the port side. 90149 may be from the starboard side aft, but more likely from the port side forward, near 90150, but with some wood missing between the two fragments. 90152 is more difficult to place. When found 90151 had remains of 9 strakes, but the ship probably had more originally (figs 6-11, 6-12 and 6-13).

20 (90208) In the section cut along Bugården søndre, against Bredsgården, there were a couple of strakes standing vertically, or nearly so, probably as part of a drain. The most interesting feature is the use of staple-like iron nails for repairing a crack in one strake. This expedient is also known from modern boatbuilding practice. It should be stressed that the use of staples represents a different boatbuilding tradition from that indicated by the staples found on 90513. The Norse staples are pure repairwork, while the Continental staples are part of the building process.

21 (90217 and 90219) Both are probably from the same vessel.

22 (90218) Similar in character to 90217 and 90219, but as this piece was found in square K12, while the other two are from K10, it is probably from another vessel.

23 (90273) fig 6-15.

24 (90306) Badly decayed when seen. The measurements in the table were taken from the supplementary plan.

25 (90326) Four small strake fragments of little significance.

26 (90360) Two strake fragments, held together by treenails and some iron rivets. Holes for larger treenails indicate ribs set with distances of c 82 and 75 cm. Other holes seem to be secondary. Along the upper edge of the upper strake are small treenail-holes, some in pairs. Other examples of treenailed strakes like in Kalmar I (Åkerlund 1951) are sheerstrakes. I suggest that this is also a sheerstrake, where the small treenails along the upper edge originally fastened an inwale (fig 6-14).

27 (90361) is a strake of unusual shape and thickness. It is best explained as a kind of *meginhufr*, an extra strong strake placed near the waterline or somewhat below the sheerstrake. The use of thicker strakes with unusual cross-section is well known from Viking vessels (Gokstad, Tune, Oseberg, Grønhaug, Klåstad, Äskekärr). The early medieval vessel from Lynæs has a strake of extra thickness, and as the Old Norse word is known in medieval contexts, such strakes may have been common in medieval shipbuilding (fig 6-16).

28 (90372/73) Strakes of unusual thickness and cross-section, probably from a *meginhufr*. When I saw the pieces in 1974, they were badly decayed, so it was impossible to check the cross-section in detail. The illustration fig 6-16, is taken from the supplementary plan, and shows what the cross-section looked like at the time of excavation. It is not possible to say how the two strakes were connected.

29 (90377/78) Badly decayed fragments of oak boards. No significant detail was observed, and they may not be ships' strakes at all.

30 (90396/97) Two fragments rivetted together (fig 6-17).

31 (90404) The same iron was probably used for the moulding and luting-cove.

32 (90418 and 90430) This is probably one piece, numbered twice by mistake.

33 (90460), found with 90361, also has an unusually sturdy cross-section. The distances between rivets and rib treenails indicate that the pieces may come from the same vessel. The two fragments may be from the same strake, a *meginhufr*, with a cross-section changing from amidships to near the stems. Both rib distance as shown by the treenails and rivet distance are unusually long (fig 6-15).

34 (90498/99/500) The fragments are similar in character and probably come from the same vessel, even if the treenail (rib) distances vary considerably.

35 The heavy oak strake 90513 stands out clearly in the material. It is the only piece excavated which is definitely not from a clinker-built vessel. When I saw the piece in 1974 and again in May 1977, it was in a bad state of conservation, so the drawing made by Egill Reimers at the time of excavation is a very important piece of documentation. Fig 6-18 is redrawn by me from Reimers' drawing, with a reconstruction added. The piece has four treenail holes, of unusually large diameter, 3.5 cm. In two holes, the remains of treenails are still in place. Both taper slightly from the side shown in the drawing, and one is wedged. On the side not shown, there are faint traces of ribs, c 15 cm wide, with the treenails placed in the middle. The holes are spaced 64, 63 and 15 cm centre to centre.This fits well with 3 ribs fastened c 63 cm apart, one of them doubled. One edge is clearly missing, the strake having split along the grain. Along one edge there are fragments of iron, small wedge-shaped pieces hammered into the wood from 5 to 8 cm apart. The only explanation I can suggest is that the wedges are the remains of broken staples, which originally

held a lath over the seam between two strakes. There are no signs of clinker fastenings, so the planks must have been set edge to edge carvel-fashion. On Continental vessels of cog type, the luting material is placed on the inside of the seams and held in place by a triangular lath secured by staples. The large vessel found at Bøle near Skien has traces of similar staples on the upper side of the keel and on some of the best preserved strakes. Iconographic sources from the Continent show examples of smooth-skinned vessels with laths and staples (fig 16-7). Our plank may come from such a vessel. Another possibility is that this is a bottom plank from a cog, where the flat bottom was smooth, with caulking laths, and the sides clinker-built. The strake has some edge-curve, which is possible in both places, and some curve when seen from the edge. This would indicate that it is a side plank, but it may be a secondary shape as a result of pressure in the ground, so a definite answer cannot be given. No other fragments can be attributed to the same vessel, so we must suppose that she was repaired in Bergen, not broken up and discarded. The year-rings run as shown in the section. This may indicate a sawn strake, but no saw-marks could be seen, and the strake may be cloven.

36 (90521) When found, fragments of 3 strakes were rivetted together. Fig 6-16 shows the cross-section of the two most intact ones.

37 (90522/23) The fragments may be from the same vessel. 90522 was badly decayed in 1974, and 90523 was unavailable for study. The scantlings are heavy, and the fragments must be from a large ship.

38 (90586/587) Originally, fragments of respectively 2 and 3 strakes rivetted together. Badly decayed.

39 (90588) A short fragment of a strake with an unusual cross-section. Similar cross-sections are known from garboards, Folderøyhamn (Thowsen 1965), Sjøvollen (Christensen 1968), but the placing of the rivets show that this is a strake from the ship side, not next to the keel. It must be placed in the *meginhufr* category. It would give a rather acute break in the line of the ship's side, a "hard chine" (fig 6-19).

40 (90598) The most interesting detail in this complex of strake fragments is the way one strake suddenly changes its width. A parallel to this is found in Skuldelev wreck 3. I would guess that in both cases a strake that was already riveted to the hull had its top edge damaged when fairing, and the damage was corrected during the building by making the next strake wider in this section of the hull (fig 6-20).

41 (90716) A narrow sliver along the bottom edge of a strake, shows two interesting features. The same tool was used to make the decorative moulding along the outside edge and the luting-cove, and the fastenings are alternately rivets and treenails. The use of the same scraper for the moulding and the luting-cove is seen also on 90361, 90393, 90396 and 90402 (fig 6-21).

42 (90784) Very fragmentary when seen in 1974, no significant detail.

43 (90800) Very fragmentary, no significant detail.

44 (90803/804/805/806). Unusual cross-section and large scantlings indicate that the pieces came from a large vessel. The find-spot makes it possible that the strakes are from the same big vessel as the headbeams 90773 and 90789.

45 (90821/822) The pieces are too fragmentary to warrant further description.

46 (90842/43/44 and 90884) I am not at all certain that these fragments are part of a ship. Even where the edges seem to be intact, there are no traces of rivets. The treenail pattern is not regular. Indications that the fragments may be from a vessel are the double treenails with 90 cm intervals and the scarf at one end. The fragments are illustrated in fig 6-20 with the hope that future finds may help in attribution and interpretation.

47 (90847) Not available for study in 1974.

48 (90851) Not available for study in 1974..

49 (90887) Too fragmentary to warrant further description.

50 (90910) This short strake fragment has a decorative moulding cut along the upper part, close below the edge of the next strake. The cross-section is illustrated in fig 6-24. This decorative treatment would in my opinion indicate that the strake was originally placed in a part of the ship where it was easily seen. As there is very little or no edge-curve in the fragment, it was probably placed amidships and presumably rather high up, probably the strake beneath the sheerstrake. (Cf note 17 for strakes with similar decorations.)

51 (91358) Not available for study in 1974.

52 (91428) Not available for study in 1974.

53 (91431) Strake fragment, lost before further documentation.

54 (91433/34, 91436/37) All pieces were too decayed and fragmentary when seen in 1974 to warrant further description.

55 (91438) A 60 cm long and 6.5 cm wide repair patch is riveted on to seal a crack in the strake.

56 (91440/441/442) All pieces are too fragmentary to warrant further description.

57 (91513) Too fragmentary when seen in 1974 to warrant further description.

58 (91514) The piece is lost. To judge from the drawing, the rib distance may have been 95 or 120 cm. The latter is unparalleled.

59 (91651/652) The fragments are similar in character and probably come from the same vessel, but they do not fit together.

60 (91693 and 91696) Both pieces are too fragmentary to warrant further description.

61 (91748) This piece has modern saw cuts at both ends, original length not recorded.

62 (92444) A date well before 1413 is suggested by the excavator, as the piece was found in level 3 below fire III.

63 (92502/503/504) Badly decayed strake fragments found together. Traces of a moulding of type 3.

64 (92529/530) Pieces were not available for study in 1974. The strakes were reused as lining in a well. The date is probably early 15th century.

65 Of the set of fragments 92733/34/35 and 92737, the most interesting piece is 92735. As can be seen from fig 6-23, the back bevel and luting-cove of the lower strake is angled. There can be no doubt that it was fitted against one of the steps of a stepped or winged stem. The next strake is damaged at the end and no trace of a back bevel has survived, so the strake must have run on for some distance, probably to rest against the next step of the stem. The two treenail-holes indicate the place of a breast-hook or inclined rib. The date is somewhat uncertain.

66 (93198)The piece was unavailable for study in 1974, but the drawings indicate that it is not quite certain if it is as a ship's timber.

67 (93362) The material, oak, and the wedge-shaped cross-section make this a typical example of planks split radially from the log.

68 (93381) fig 6-14. The lentoid cross-section is typical of most of the pine strakes. Year-ring patterns suggest that in most cases, pine logs were split in two, and one plank was cut from each half.

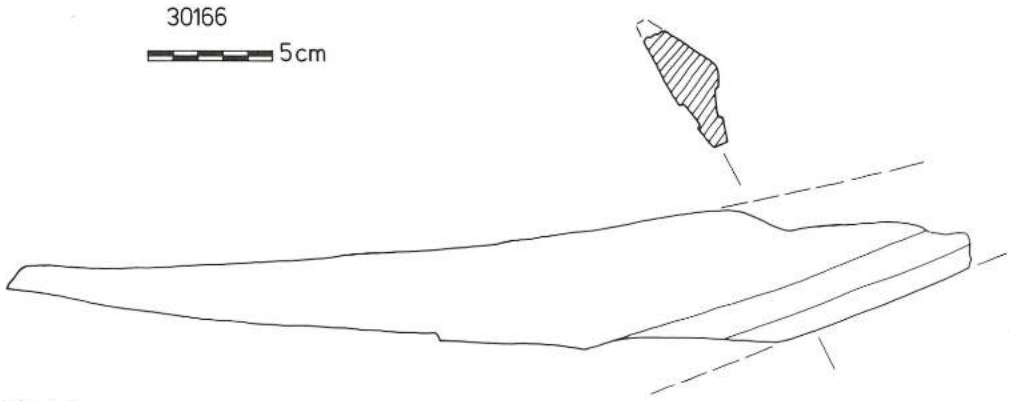
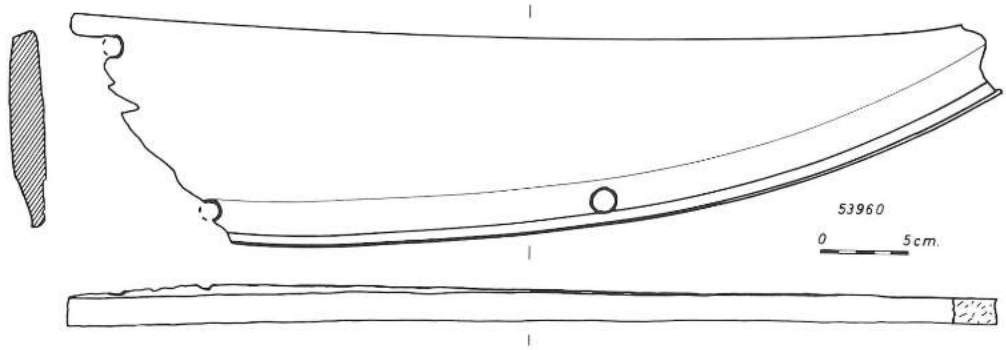
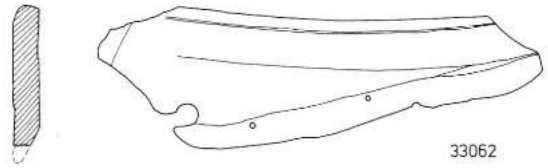


Fig 6-1





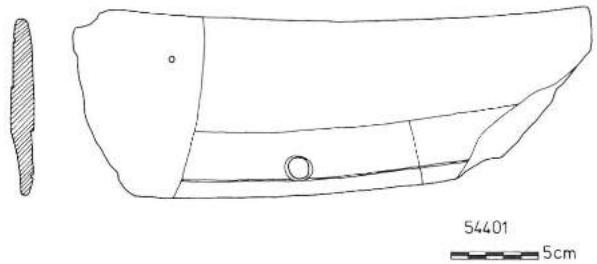


Fig 6-2

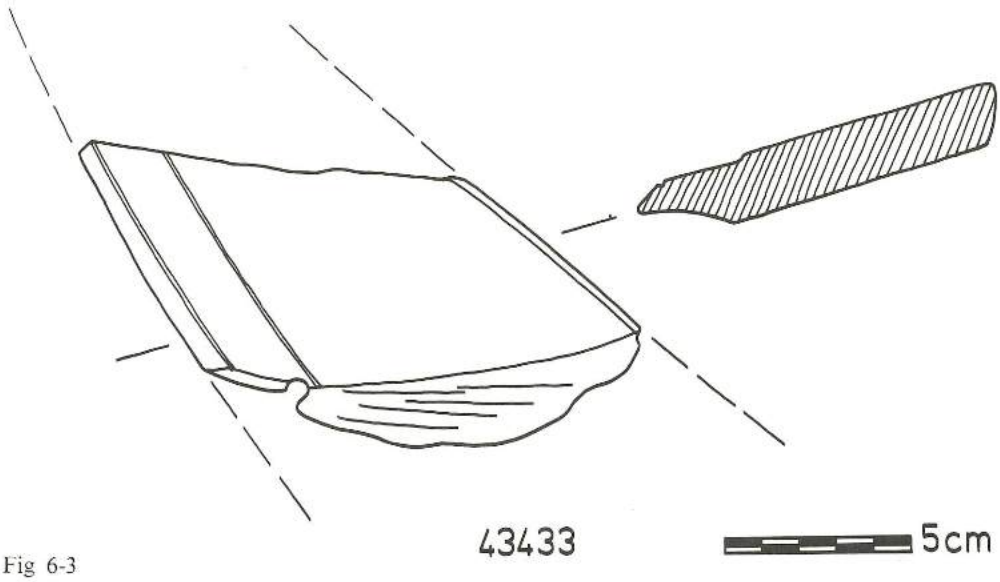


Fig 6-3

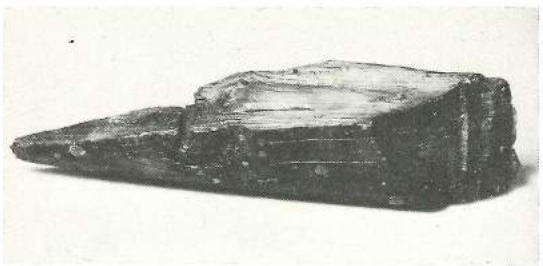


Fig 6-4a

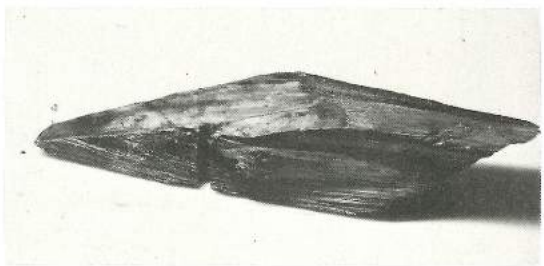


Fig 6-4b

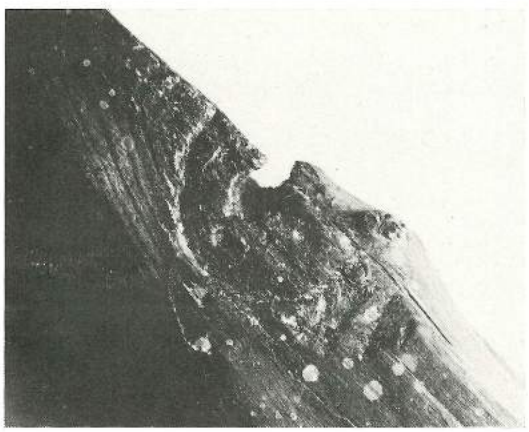


Fig 6-4c Close up of nail impression on 55107, showing that the nail had small points on the underside of the head

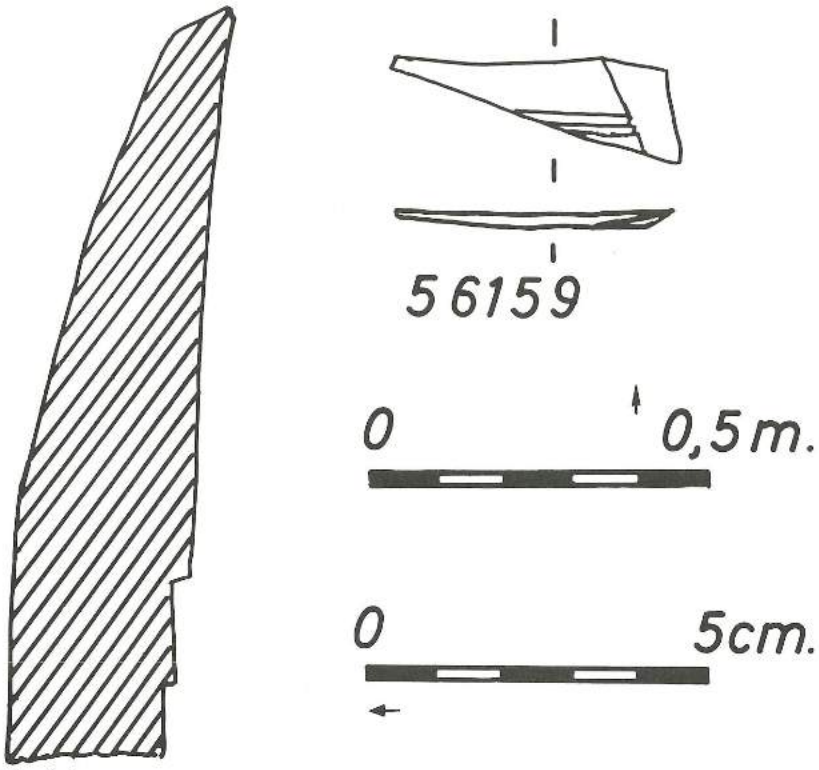


Fig 6-5

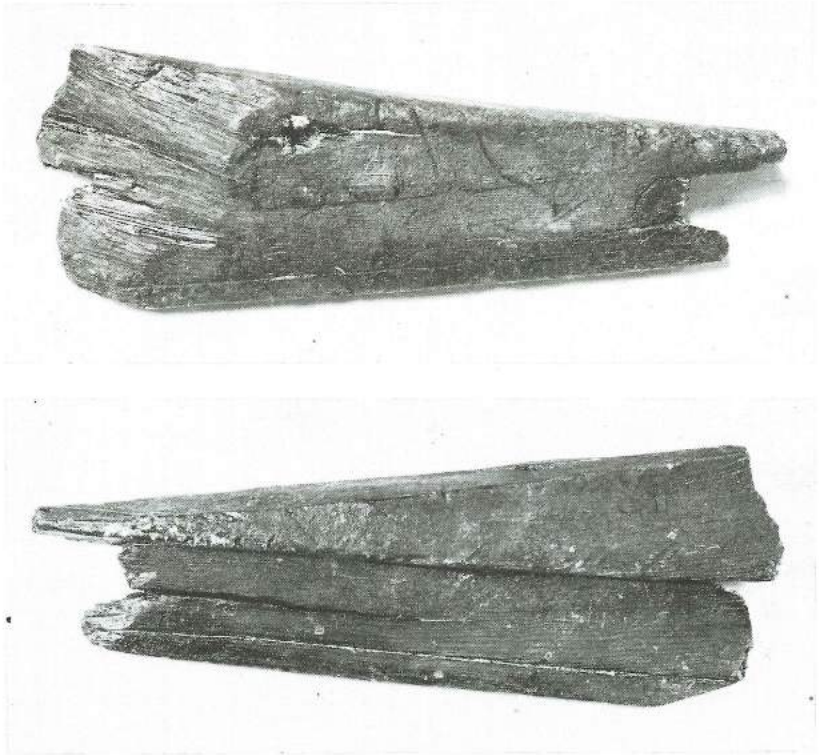


Fig 6-6

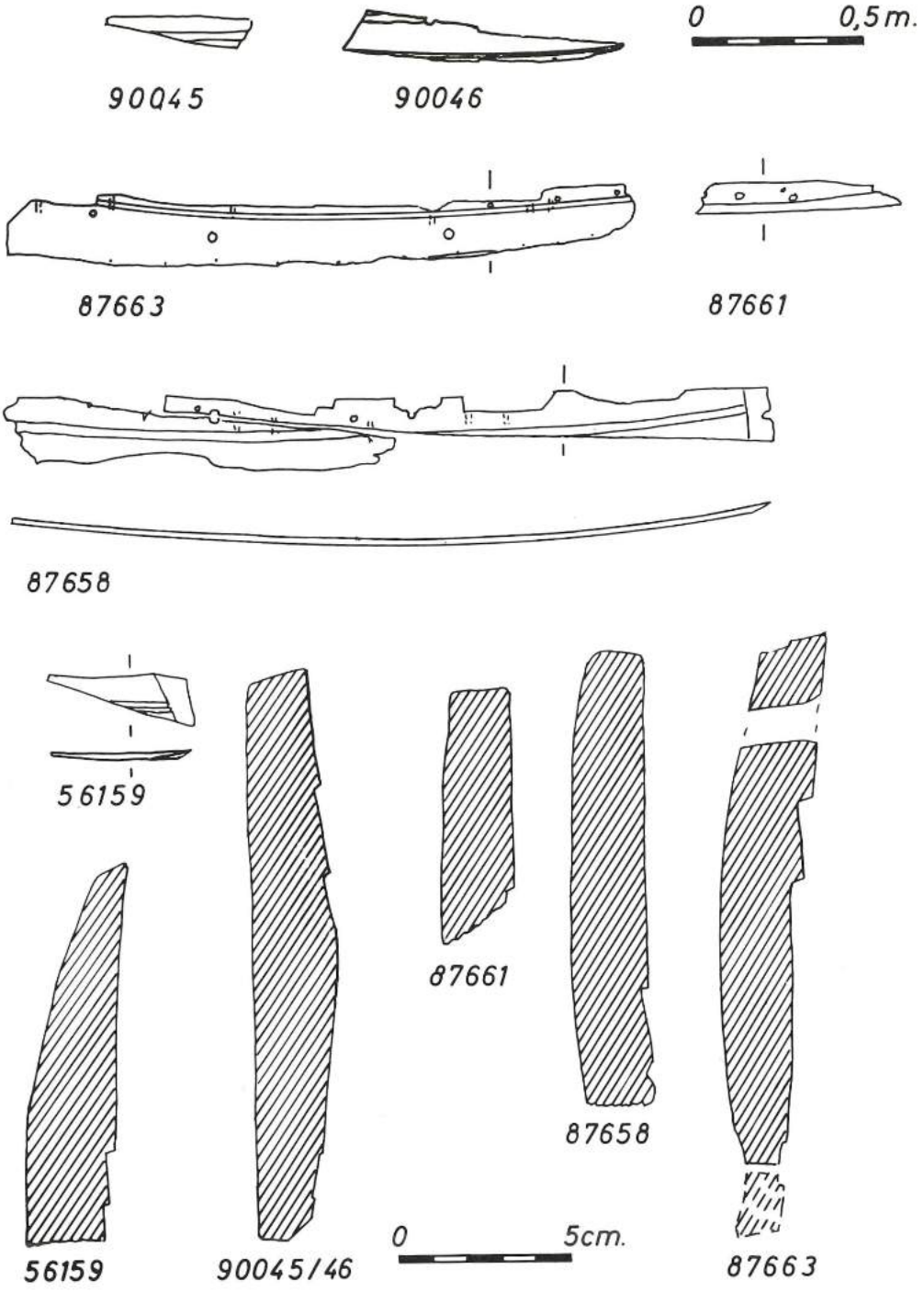

0 0,5m.
90045
90046
87663
87661
87658
56159
87661
87658
0 5cm.
56159
90045/46
87663

Fig 6-7

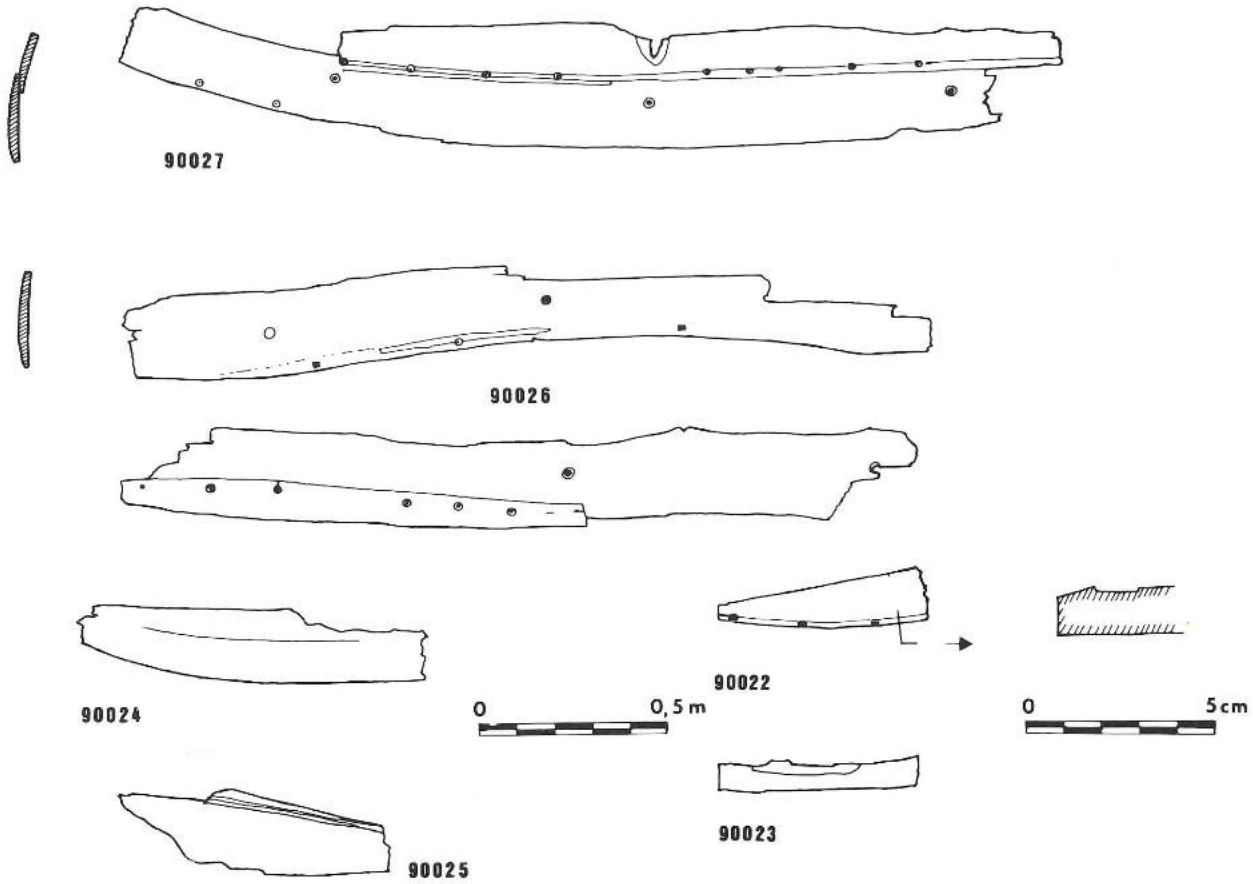


Fig 6-8

Fig 6-9 The inside of 90022, showing axe marks, score line along overlap and carefully worked luting cove

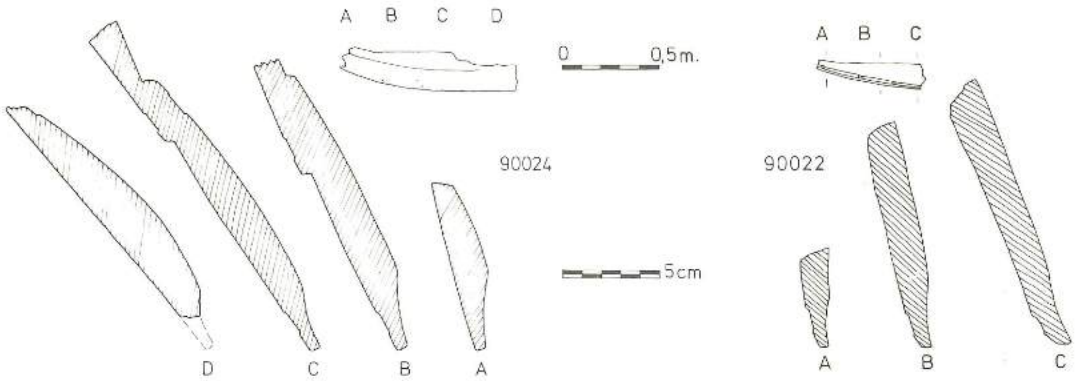


Fig 6-10 Cross-sections of 90022 and 90024 showing the twist axed into the boards, and the complicated cross-section of the "assembly-plank" 90024

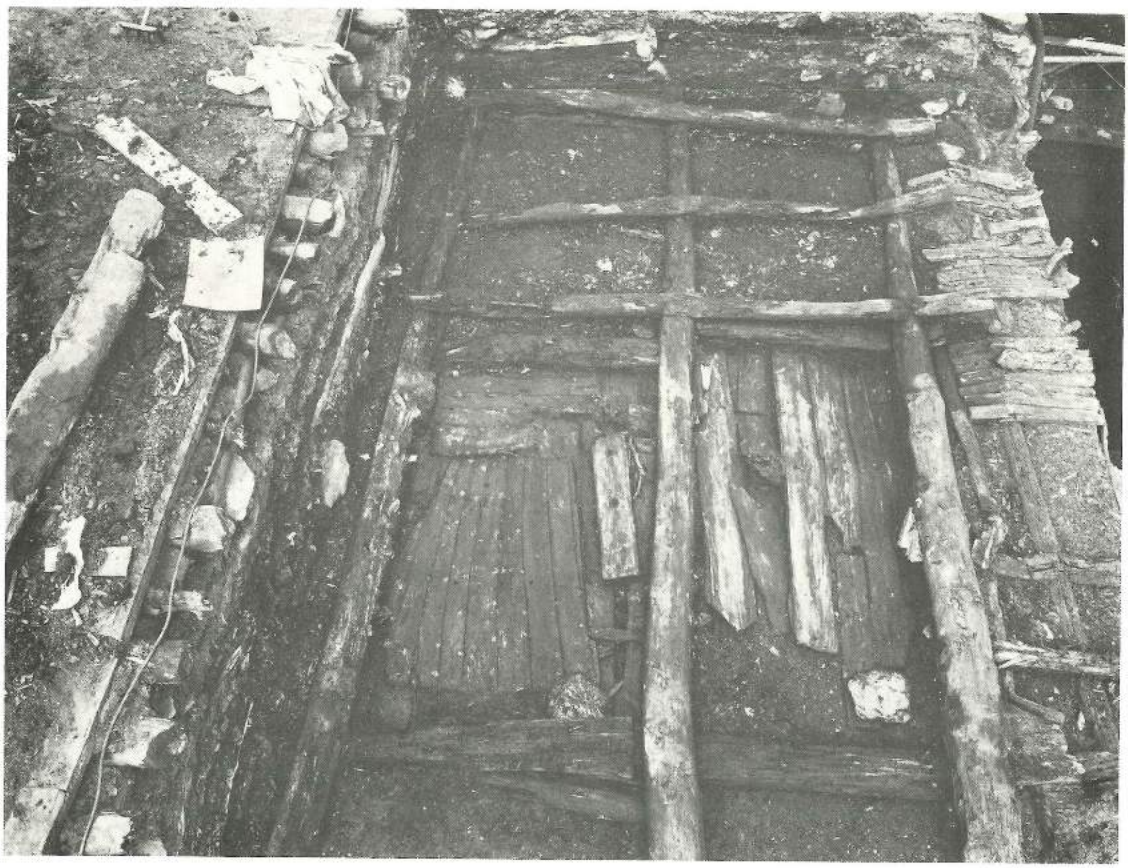


Fig 6-11 Fragments of ship's sides used in foundations

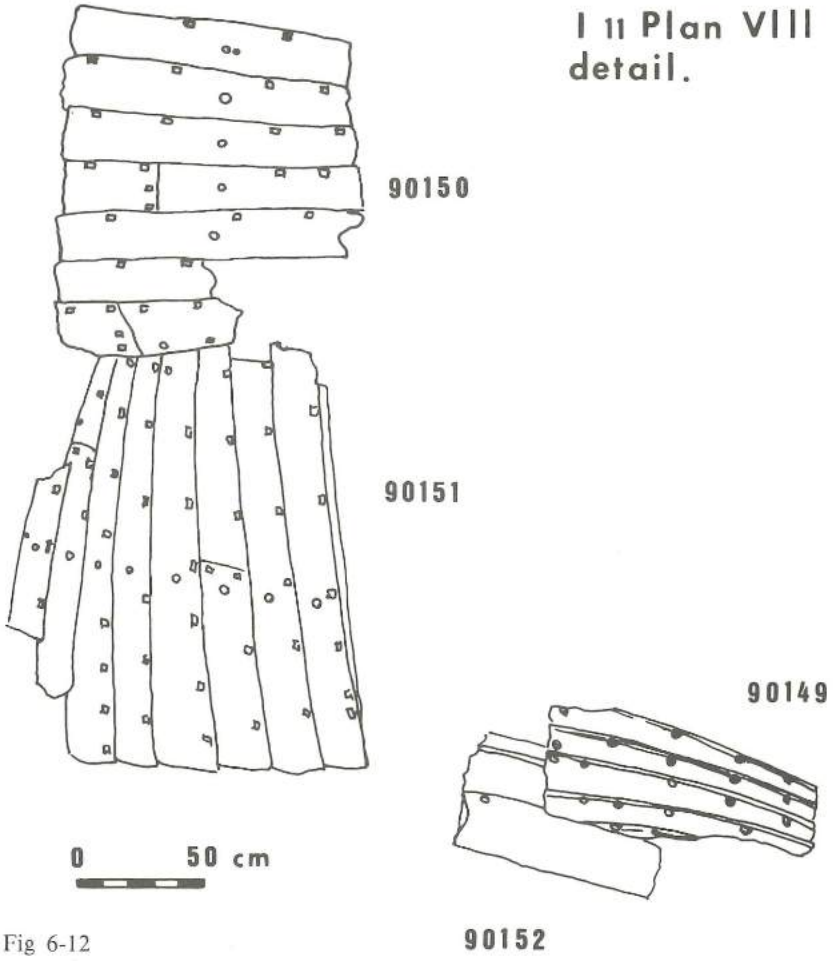


Fig 6-12

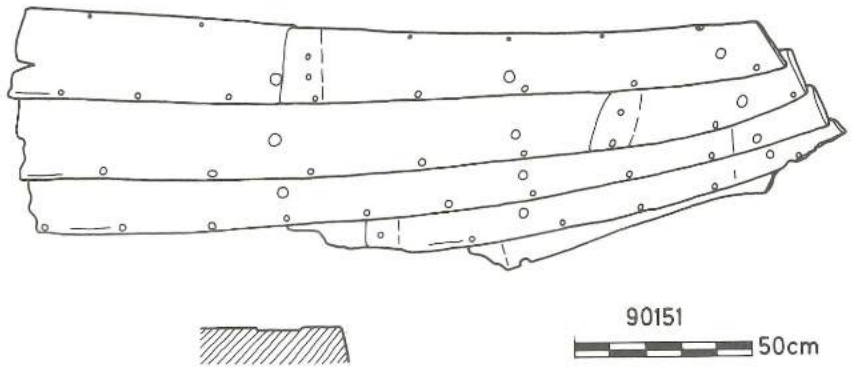


Fig 6-13

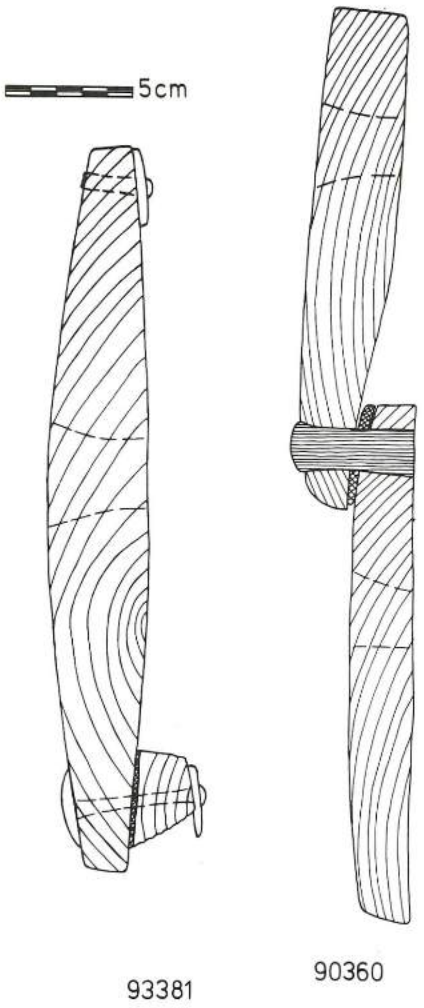


Fig 6-14

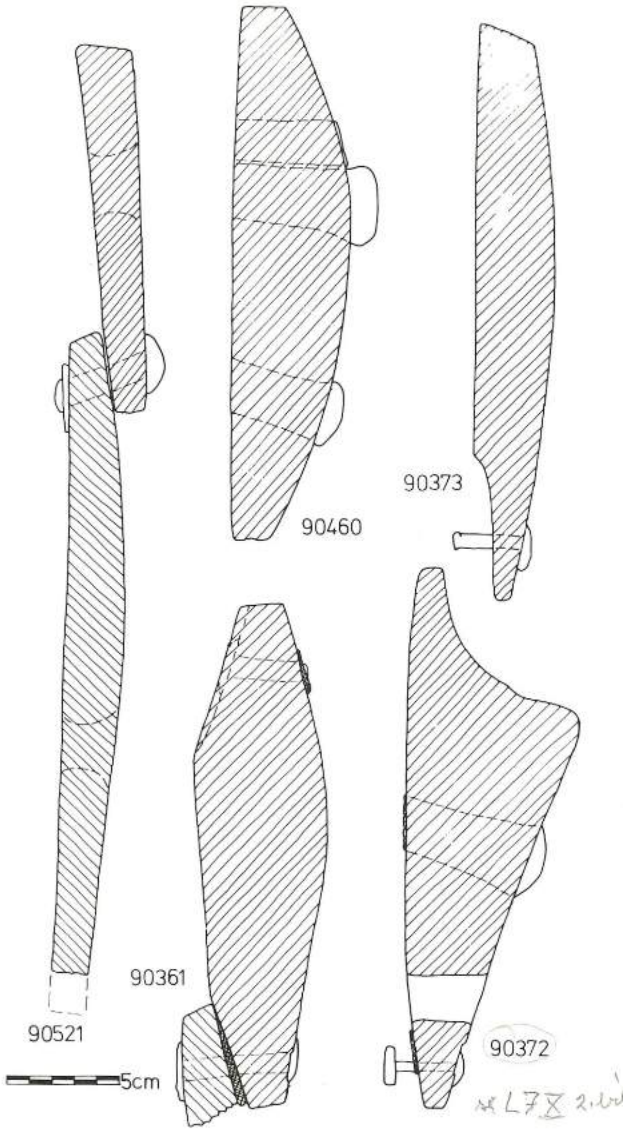


Fig 6-16

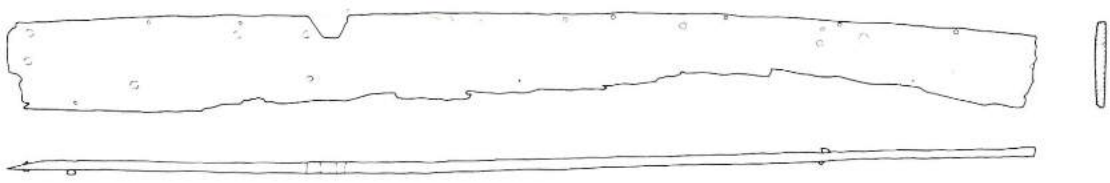


Fig 6-15

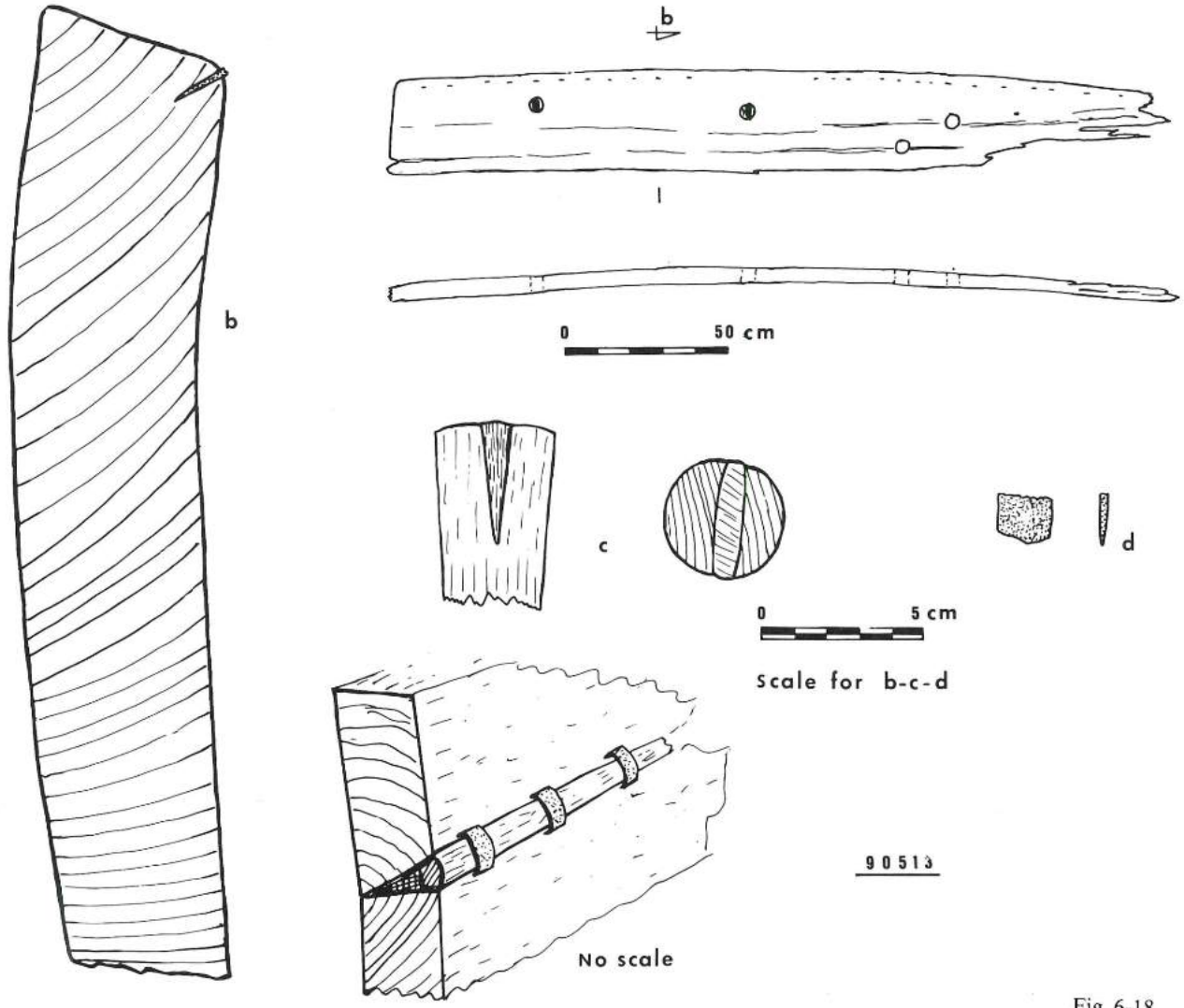


Fig 6-18

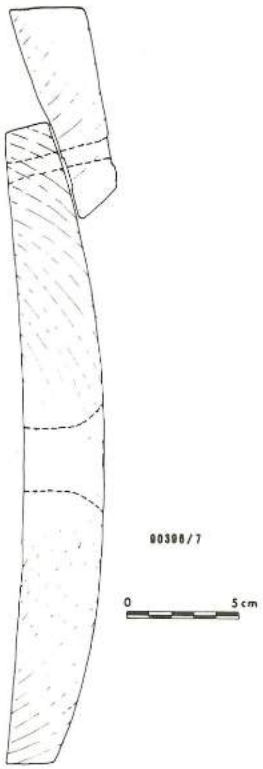


Fig 6-17

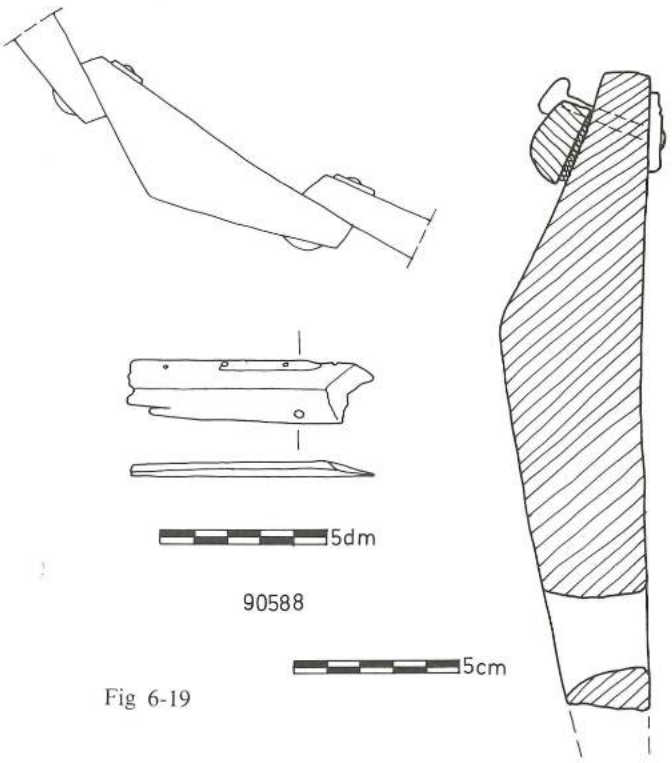


Fig 6-19

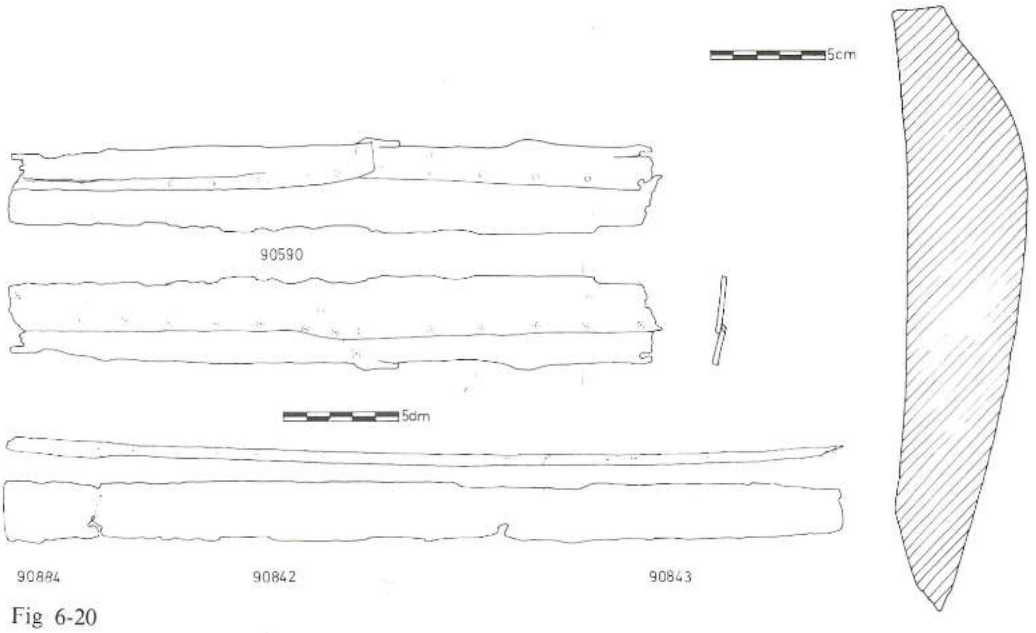


Fig 6-20

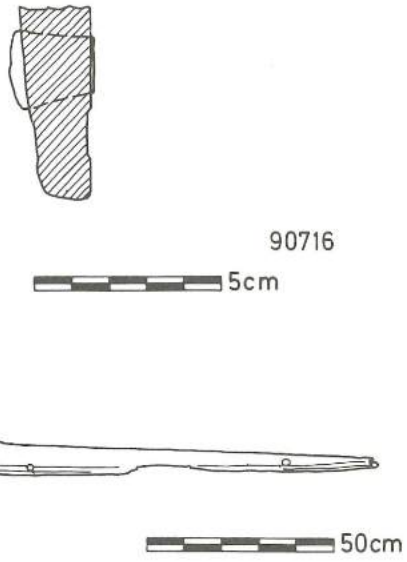


Fig 6-21

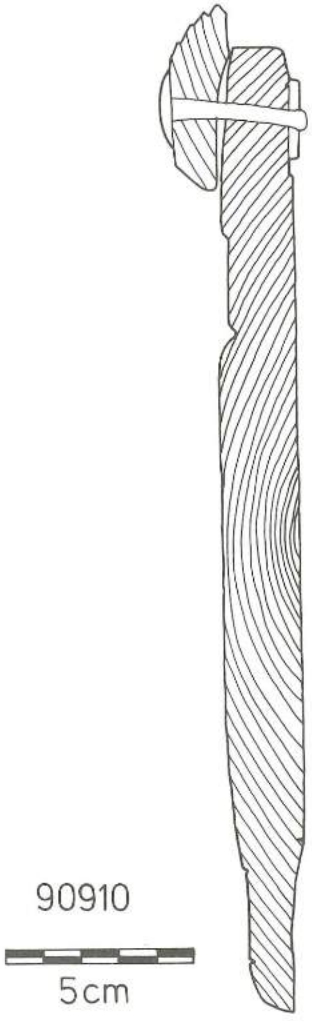


Fig 6-22

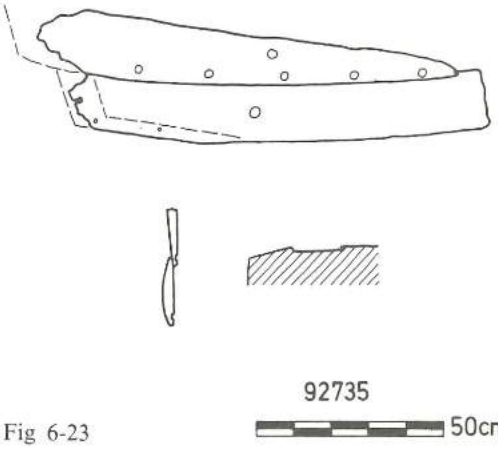


Fig 6-23

FLOORBOARDS

Floorboards are known in Old Norse as *tilja* while the modern Norwegian dialects have *tilje*. In Northern Norway *plitt* or *plekt* is used, which is probably derived from Dutch or Low German.

In ships, the boards run from crossbeam to crossbeam, resting in a rabbet cut in the beam. The boards run alongships, and are generally held together by laths on the underside. Treenails connect boards and laths. The system is well represented by the Oseberg and Gokstad ships and by the numerous cross-beams with deckboard rabbets found at Bryggen. In small boats, the floorboards rest on the strakes and the keel. They run athwartships, are assembled by hidden dowels and one or rarely two laths on the underside. As a general rule, the floorboards are bevelled on the underside to fit the slope of the strakes, while the central lath rests on top of the keel. The construction described for floorboards is still in general use among Norwegian boatbuilders, but today galvanized iron nails are substituted for the treenails and dowels. Treenails used for connecting boards and lath are always driven from the top, with a countersunk flaring head in the usual manner, and wedged on the underside of the lath. In most cases the heads are round in cross-section, but they may be square and then set in holes where the countersinking has been done with a chisel.

On morphological criteria, it should be possible to divide the material into floorboards for small boats and deckboards for ships. The deckboards lack the strake bevels and are generally parallel-sided, while the floorboards are usually more or less trapezoidal in order to fit the taper of the boat towards the stem or the stern. The Bryggen material consists of floorboards from small boats with the possible exception of 32246 a-b, which may be fragments of a deckboard. Nearly all the Bryggen floorboards are damaged and have seen secondary use as paving, drain covers etc. Some small fragments have been found in fill, together with other debris. One would suppose that deckboards from ships, as well as floorboards would have been found. A deckboard without its lath is nearly impossible to identify among a mass of secondarily used boards, many with two sets of treenail-holes from their primary and secondary functions. I think that the lack of deckboards is due to the fact that I have simply not been able to identify them.

The material is listed in tables 7-I and 7-II. Some pieces were inaccessible as I worked through the material, and are only known from the representations on the plans. This accounts for the lacunae in measurements. The nearly complete floorboard shown on fig 7-2 could not be identified or related to the files, nor could I find it in the storerooms. I have included the illustration in order to show an endboard of triangular shape. It also shows decorative mouldings along the edges and a rather elaborate finger-hole. Modern triangular endboards are often made in one piece with the wood-grain running alongships: none of this type has been found on Bryggen.

In modern boats, the floorboards are often tightly fitted and for convenient lifting a finger-hole is often bored near one end. Among the Bryggen floorboards, 31091, 31397, 61820 and 64925 show finger-holes. The last one has an added refinement – the treenails are staggered, in order to lessen the risk of splitting the lath along the grain as the treenails were driven. Some of the archaeological parallels show decorated floor boards. The Gokstad ship has a system of concentric circles scratched on the deckboards and both the ship and small boats have the board edges decorated with the same moulding scraper which was used on the strakes and timbers. From North-West Norway we have an undated bog find of a triangular board decorated with a lozenge-patten of incised lines around a finger-hole. The board has treenail-holes for 2 laths and is probably the centre-piece of a triangular end-board for a fairly large vessel (T 14573, TMT 1932). In a Viking grave from Lammøya, Tjølling, Vestfold, there are small remains of floorboards with decorative mouldings (C 21960b). Compared to this, the Bryggen boards are plain, with the exception of fig 7-2 and 32115, which has a plain V-groove scraped along the intact longships edge. A detail not observed either in the other archaeological material known to me or in modern comparative material is the groove or grooves cut along some of the boards (fig 7-3). In some cases the grooves correspond to triangular notches cut in the edge of the board. I can find no other explanation for this than that the groove and notch form a kind of drain intended

to lead spray or rainwater down into the bilge of the boat. As a rule, the boards are of pine, with hardwood laths, appearing on visual inspection to be oak. (The lath found with the Lammøya floorboard fragments, C 21960, is ash, *Fraxinus sp.*) When compared to modern parallels, the Bryggen boards have very slender laths and they are comparatively narrow. The values given under headings B and C in table 7-I are smaller than in the case of modern boards. Modern boards generally have pine laths, which are often about double the scantlings of the medieval laths. The relative strength of sawn pine and split oak will explain this fact. The narrowness of the boards is less easy to explain. In chapter 16 I have suggested one of several possible explanations. The dimensions listed in table 7-I are shown in the diagram fig 7-1. The distance A is the maximum length of the floorboard. Where the board is fragmentary, the lath sometimes gives a value closer to the original - this is specified in the notes. The B and C values show how much the board tapers toward the ends of the boat. The D, E and F values are the thickness of the board and the scantlings of the lath.

The material (Matr) is given as oak (O) or pine (P) where appropriate. The dating is before (BF) or after (AF) the fire as numbered. All measurements are in cm.

TABLE 7-Ia FLOORBOARDS

Number	A	B	C	D	E	F	Matr	Date	Note
4124	22				4		O	AF 5	1
5968	8	26	26	1.5			O	AF 4	1
8905	8	12	13	1			P	BF 4	2
9260	33	25	26	1	4.6	1.8		BF 4	3
10257	6	31	31	1.5				BF 5	4
18067	37	2	4	2				AF 6	5
19707	44	18	31	1.2	4	2.5		AF 4	6
28596	19.5	14.5	18.5	2				BF 4	7
29587								?	8
29621	22/34	13	14/20	1	5	2		BF 5	9
31091	29.3	14.5	19	1	1.3	2.7		BF 5	10
31397	15.5	20	22.5	1.5				BF 5	11
32115	11.5	20.5	21.5	1.5				BF 4	12
32246a	18.5	35	37	1.2	3.5	1.5	O	BF 5	13
32246b	21.5	37.5	37.5	1.2	3.5	1.5	O	BF 5	14
43043	21/31	21	23	1.5	3.5	1.5		BF 5	15
55221	10	14.5	14.5	1.2				BF 6	16
59923	62	34	37	1.5	6.2	2.1		AF 3	17
61820	63/72	c 23	c 27	2	4.7	1.3		AF 5	18
62800	30	24	26	1.8	5	1		BF 5	19
62915	17	18	16.5	1.6				BF 4	
63307									
64647	6.5	31.5	31.5	1.5				BF 6	20
64924	25/33	24.5	27	2	3.5	2		BF 5	
64925	33/42	18.5	21.5	2	6.5	2		BF 5	21
78458	4	26	26	1				AF 3	
78459	26	26	1					AF 3	

TABLE 7-Ib FLOORBOARDS

Number	A	B	C	D	E	F	Matr	Date	Note
80190	4	18.5	18.5	1.5				BF 5	24
80675	8	23	23	1.1				BF 5	25
90164	48	23/20	22	1.5	3	1.5		BF 4	26
90733								BF 5	27
90734								BF 5	27
90766									28
90848									29
90861	51	29	50	1.6	4	2.5	P		30
90905									31
90942									32
90954									33
91721									34
92374								AF 2	35
92736									
93386	c 35		c 54						36
93387	c 32		c 30						37

Notes to table 7-I

1 4124 and 5968 Lath only preserved.
2 8905 The treenails have square heads.
3 9260 Lath of semicircular section, moulding of type 1.
4 10257 Diameter of treenail-hole 1.5 cm.
5 18067 Lath with treenails only preserved.
6 19707 Lath 13.5 cm longer than surviving board fragment.
7 28596 Two treenails have square heads.
8 29587 Not seen.
9 29621 Lath longer than boards. B originally c 18.
10 31091 Intact finger-hole.
11 31397 Finger-hole. Grooves on upper side. Two treenails have square heads.
12 32115 The treenails have square heads.
13 32246a Two laths on underside, 15 cm apart.
14 32246b The treenails have square heads.
15 43043 Two laths on underside.
16 55221 Grooves on upper side and triangular cuts at edge. Diameter of treenail holes 1.5 cm.
17 59923 Not seen.
18 61820 Finger-hole intact.
19 62800 Two grooves on upper side.
20 64647 Diameter of treenail-hole 1.2 cm.
21 64925 Finger-hole intact. Treenails have square heads and are staggered on lath.
22 78458 The treenails have square heads.
23 78459 Fragment of previous no?.
24 80190 Diameter of treenails 1 cm.
25 80675 The treenails have square heads. B and C values were originally c 30 cm.
26 90164 Very fragmentary.
27 90733 /34 Fragments of same board. Not seen.
28 90766 See 59924.
29 90848 See 61820.
30 90861 Square finger-hole. Two laths on underside. The treenails have square heads.
31 90905 See 62800.
32 90942 See 64924.
33 90954 See 64925.
34 91721 See 29587.
35 92374 Not seen.
36 93386 Two laths on underside? Known from plan only.
37 93387 Known from plan only.

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	X
3	1413	XXX
4	1332	XX
5	1248	XXXXXXXX
6	1198	XXXXXXXXXXXX
7	1170	XX

X

TABLE 7 - II

DATED FLOORBOARDS

6 OF THE FLOORBOARDS CAN NOT BE DATED.

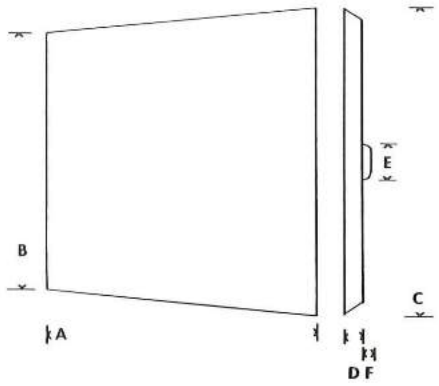


Fig 7-1 Sketch of floorboard measurements given in table 7-I

Fig 7-2

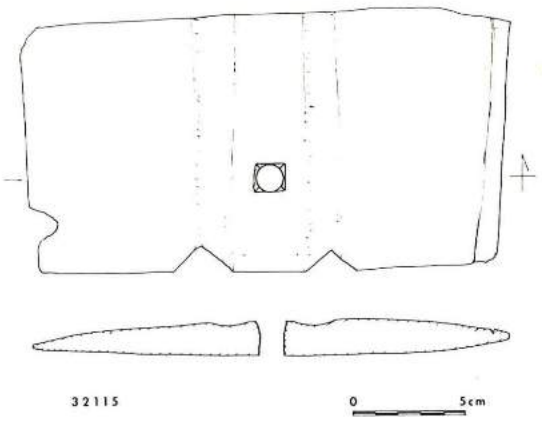


Fig 7-3

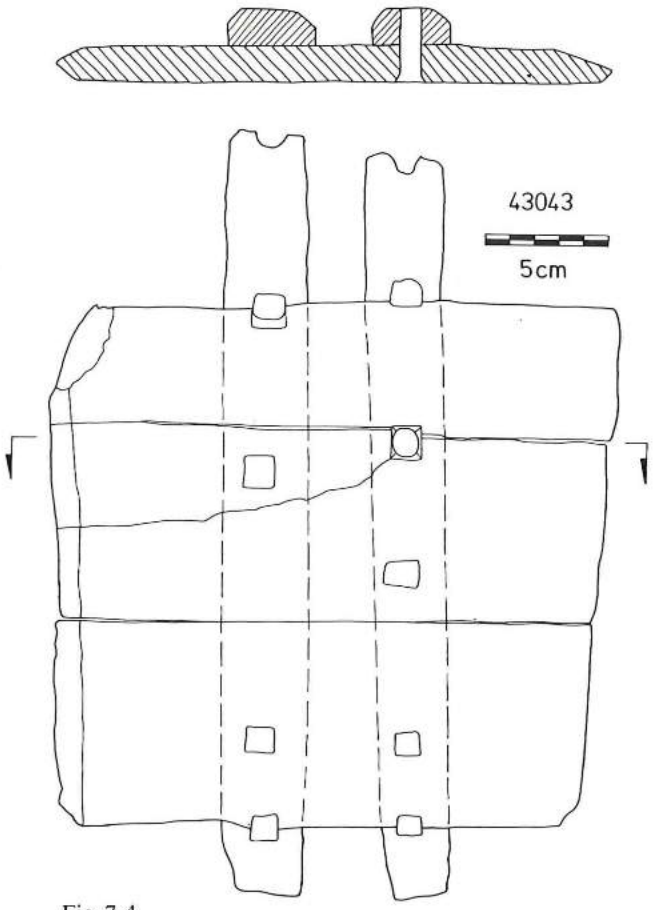


Fig 7-4

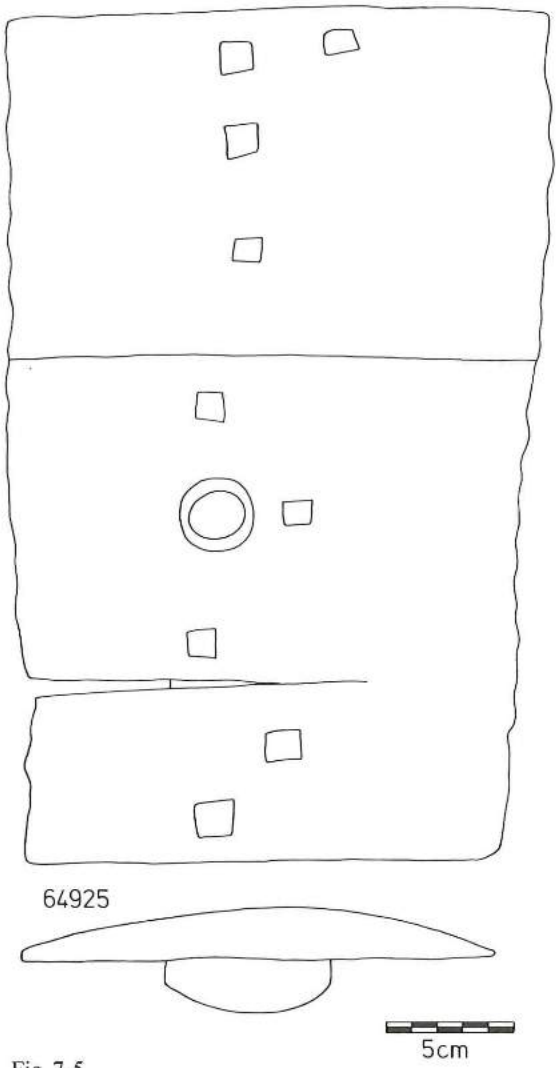


Fig 7-5

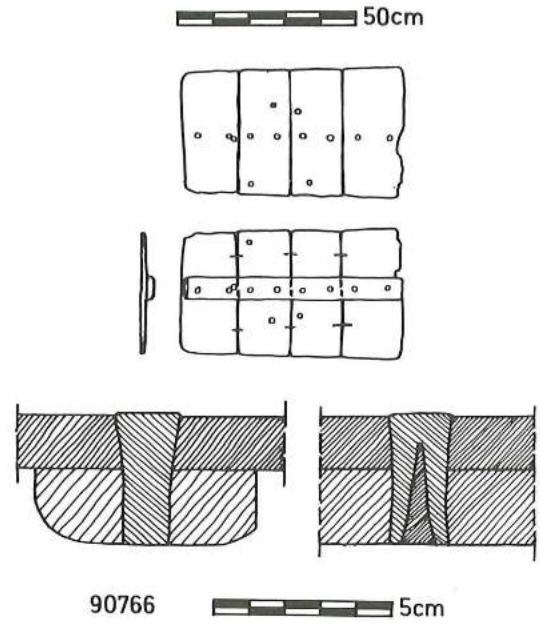


Fig 7-6

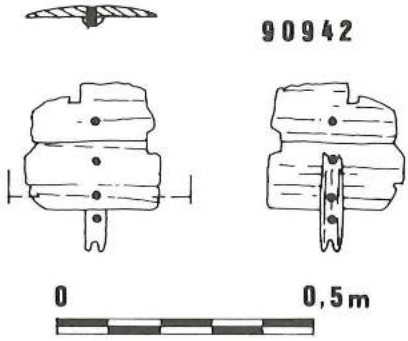


Fig 7-7

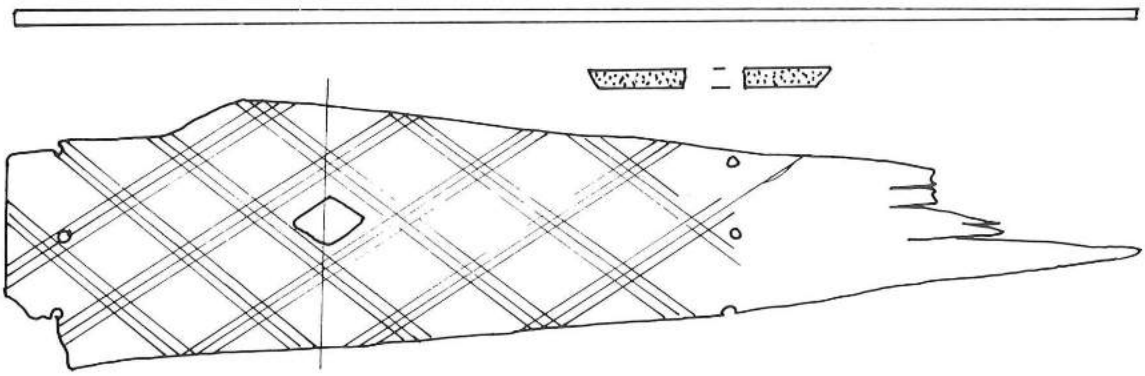


Fig 7-8 Decorated floorboard fragment from Bjørnrem in Aukra, Møre and Romsdal (T 14573)

OARS AND ROWLOCKS

Oars

Surprisingly few oars have been found: 2 fragments of oar blades and one large nearly complete sweep. This, 40029 (also numbered 90602) has a total length of 550 cm, with probably as much as c 100 cm of the blade missing. The leg is round in cross-section, changing to square cross-section on the loom. The blade is 15 cm wide where it is broken. There is little wear from the rowlock, so the oar cannot have seen much use. It may have been discarded when the blade broke. 93388 also seems to be part of a sweep rather than an oar. The total length of the fragment is 315 cm. The blade is c 200 cm long and 17 cm wide. At the break, the leg is rectangular in cross-section. A fragmentary oar blade, damaged at both ends, seems to come from a smaller oar. This piece has lost its original number and has been renumbered 93392. The present length is 60 cm and the blade is 9 cm wide. The surface is nicely smoothed, and a decorative moulding of type 2 runs along the edges. The material of the oars seem to be pine. 40029 is dated to before fire III (II) (figs 8-1, 8-2, 8-3).

Rowlocks

Rowlocks from small boats are numerous in the Bryggen material. All of them show wear and many are fragmentary. They are best explained as pieces discarded during repair or when old boats were broken up. They are of the type known in modern West and North Norwegian dialects as *keip*. The Old Norse name was either *keipr* or *há*. (The latter word is found more often as an element in the Old Norse name for a crewmember, *háseta*, literally: he who sits by the rowlock.) In recent boatbuilding, boats from the east coast of Norway have used tholepins placed in holes in the inwale, commonly with a hardwood saddle to take the wear of the oar, while the West and North have remained faithful to the traditional *keip*, which has changed little between the Nydam boat of c AD 350 and the present day.

The oldest example of a boat with tholepins known to me is the small medieval fishing boat known as Kalmar III, dated by Åkerlund to the 13th century. Loose tholepins have been found at Bryggen, 1801 and 2823, both are of oak and show signs of wear. The date of 1801 is c 1300, while 2823 is undated. In the archaeological material, the *keip* is found in 2 variations. One is placed on top of the thick moulding or fillet cut in one with the sheerstrake. It may be fastened with lashings as in the Halsnøy and Nydam boats, with vertical iron spikes as in Sutton Hoo, or with vertical treenails as found in both the Kvalsund vessels and in the Klåstad ship (type 1). The other type is placed on the inside of the sheerstrake. A lashed rowlock of this type is known from one find (Yttersø, Hedrum C 27076), while the use of horizontal treenails is common (small boats from Gokstad, Årby, Kongshavn in Randesund, Helle in Høgsfjord) (type 2). In the wreckage found at Hasnæs on the east coast of Jutland, there is one *keip* of each type, obviously from different vessels (Crumlin-Pedersen 1967, 167). The *keips* placed inside the sheerstrake are usually part of a long lath running from rib to rib. Where the oar rests, the lath is wider, forming a saddle resting on top of, or let into the sheerstrake (figs 8-5, 8-6, 8-7). In the 19th century boats of Western Norway, we find the same two main types in somewhat modified form. Geographically, the type placed on top of the inwale is used south of Bergen, where the boats have the inwale along the upper edge of the sheerstrake (modern Norwegian *esing*). North of Bergen, the *esing* is placed along the top of the strake below the sheerstrake and the *keip* is set on the inside of the sheerstrake. However, the lath running from rib to rib has been omitted on the modern examples.

The fact that both types are found in the Bryggen material, indicates that the present geographical division may be an old one.

The rowlocks show considerable variation in detail, especially in the shape of the *horn* (modern Norwegian *keipsnev*). In a few cases the horn is decorated (figs 8-6/8-13). Decorated rowlocks are known from the Nydam find and from the small Gokstad boats.

Among the rowlocks from Bryggen, 15 are broken-off horns. They do not tell us much except that they were used with round oars. When many boats are lying side by side in a busy harbour, the *keips* are a weak point. They often catch under the side of larger vessels or against one another, with a loose *keip* or broken horn as the result (The author has personally experienced this with a modern "os-

elver" boat). According to the boatbuilder Alfred Søvik, from Os, south of Bergen, the fishermen and coastal smallholders who sold their produce in Bergen in the 19th century had found a remedy for this. The *keips* of their boats were of the type placed on top of the inwale. Usually, the *keip* was dovetailed into the inwale and fastened by two treenails. The treenails were made long enough to reach well below the inwale. When in harbour, they were knocked up and out and the *keip* could be removed. The numerous broken horns in the Bryggen material show that the problem is an old one, and indicate that the solution Alfred Søvik knew may be a post-medieval one. A selection of the broken horns, all of them typical specimens, is illustrated in fig 8 and two decorated ones in figs 8-6/8-13. (Museum nos and summary descriptions in table 8-I.) 8 rowlocks could be identified as of type 1. None of them can be positively identified as port or starboard rowlocks, but the sloping underside of 17307 may indicate a port rowlock. The inwale is taken to slope outwards, as it always does in modern boats. If this is right, the withy hole slopes the other way from what is usual in "modern" rowlocks. The spiral decoration on the front of the horn on 7278 is similar in character to the spirals used in Ringerike style ornaments, but a simple motif like this cannot be used as dating evidence. 12 rowlocks can be identified as belonging to type 2. Four are starboard and three are port rowlocks, while for the remainder the side cannot be identified. 77565, of reindeer - or stag - horn, must be specially mentioned. The traces of wear and the general shape indicates that this is a rowlock, with a loose tholepin instead of the withy. This material for a rowlock is unparalleled and the piece may be an experiment or a repair (fig 8-11). A very rough parallel to the shape is a rowlock from Kalmar (Åkerlund 1951, 120, figs 87/88 and pl 29a). In modern Norwegian boatbuilding *keip* rowlocks with one tholepin instead of the grommet are not uncommon.

The numeric and other information on rowlocks has been tabulated as follows:

Type Type 1 are rowlocks placed on top of an inwale or thickened sheerstrake. Type 2 are rowlocks placed on the inside of the sheerstrake.
Material (M) O oak, P pine, H horn or antler.
S/P Starboard or port rowlock, where this could be identified.
Dec Rowlocks with decorative treatment are marked with an X.
C/F Complete or fragmentary state when found.
Length Total length of piece, whether complete or fragmentary.
Hh Height of *horn*.
Wh Withy hole. The symbols indicate whether the hole is bored vertically or horizontally, or whether it slopes, when seen from the inside of the boat.
Date Before fire (BF) as numbered.

TABLE 8-I ROWLOCKS

Number	Type	M	S/P	Dec	C/F	Length	Hh	Wh	Date	Notes
1115		O			F	20.3	8		BF 2	
1840	2	P?	P		F			/	BF 3	1
3836		P				18.2	7.5	I	BF 4	2
4903					F	11	9.5		BF 5	
5442	1				F			/	BF 3	
6850	1	O			F	41	8		?	3
6866	1				F				BF 4	3
6989	2	O?			F	112		/	BF 3	4
7272	1	O	P		F			-	BF 3	
7278	1	O	P	X	F	43	7		BF 3	
11654		P			F	17	10	-	BF 7	
12368	2?	P	S		F	44		I	BF 4	5
12820		P			F			-	BF 4	
15810	2		P		F	26	6	I	BF 4	6

TABLE 8-I ROWLOCKS

Number	Type	M	S/P	Dec	C/F	Length	Hh	Wh	Date	Notes
17307	1	O			F	35.5	7	/	?	7
17748	2	P	P		F	61	7.5	/	BF 5	8
19118	2		S	X	F	61	9		?	
29629	2	O?	P		F	26	5.5	/	BF 4	
30518				X	F	13	8		BF 3	
31351			P?	X	F	23.5	7	/	BF 4	
31619	2		S		F	32	6.5	I	BF 5	
33775	2	O?	S		C?	78	13		BF 6	
35793	2?				F	20.5	11.5	–	?	9
42309					F				BF 5	10
43049	2				F	32	8.5	–	BF 5	11
43681		P?			F				BF 6	
46184		P?			F	17.5	8.5	–	BF 6	
46730	1?	P			F	18	11	–	BF 6	
52751					F				BF 6	12
53232	1		S?		F	68	4.5	I	BF 4	13
53392	1	P?			C?	69.5	11.5	–	BF 4	14
53416		P			F	17			BF 5	
53932		P			F	15.5			BF 5	
54503					F	10	9	–?	BF 6	15
54563	2		S		F			I?	BF 5	
55630		P			F			–	BF 5	
62791	2				C	114	15	–	BF 5	
77565	2	H	P		C	21	6		BF 6	16
78104		P			F			–	BF 6	17
78105		P?	P		F			/	BF 6	
78330		P?			F				BF 5	18
79817	2	P?	S		F			I	?	
80329	1?	P?	S?		F			/	BF 5	19
80674		P		X	F			–	BF 5	20
93391	2	O?	P		C?	81	4.5	I	?	21

Notes to table 8-I

1 Horn cut to decorative shape.
2 Horn shaped like that of 7278.
3 No withy-hole.
4 Dated just after the 1332 fire.
5 Lath only, probably broken off in front of horn. There is a rectangular piece of wood cut away on the surface which originally fitted against the sheerstrake. The opening is probably for placing a *vabein*, the horn or wood saddle used as an anti-friction device for fishing lines.
6 Found just above fire V.
7 Horn is cut to unusual shape.
8 The only Bryggen rowlock where the withy-hole slopes upwards-inwards.
9 This rowlock may possibly be for an oar with a shape like contemporary oars in Western Norway, right-angled where they rest in the rowlock.
10 Unusual shape, top of horn cut to decorative shape.
11 Two withy-holes, one oblique, one horizontal.
12 Horn cut to unusual, decorative shape.
13 A rowlock of type 1, with vertical withy-hole. This combination is unusual.
14 Probably complete. Shape of the ends indicates that the boat may have had a continuous row of rowlocks like the Sutton Hoo vessel and one of the boats from the Helgeandsholmen excavation in Stockholm.
15 Horn of unusual shape.
16 Possibly a rowlock, made from reindeer horn. A vertical hole behind the horn is probably for a loose tholepin, but may be for a withy. This place for a withy-hole would be unique, but so is the material.
17 Decorative knob on top of horn.
18 Only a small fragment of the horn is preserved.

19 Narrow horn on a flat base, indicating a rowlock of type 1. If the withy hole slopes outwards-upwards, it is a starboard rowlock.

20 Horn only preserved, decorated with mouldings and incised grooves.

21 Top of horn missing, otherwise complete. Worn by oar far back from the horn. This indicates a user who did much pushing with slack withies.

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	0
3	1413	0111
4	1332	00011222
5	1248	00000022222
6	1198	0012
7	1170	0

TABLE 8 - II
DATED ROWLOCKS

6 OF THE
ROWLOCKS
CAN NOT BE
DATED.
NUMBERS REFER TO
ROWLOCK TYPES
0 = UNCERTAIN TYPE

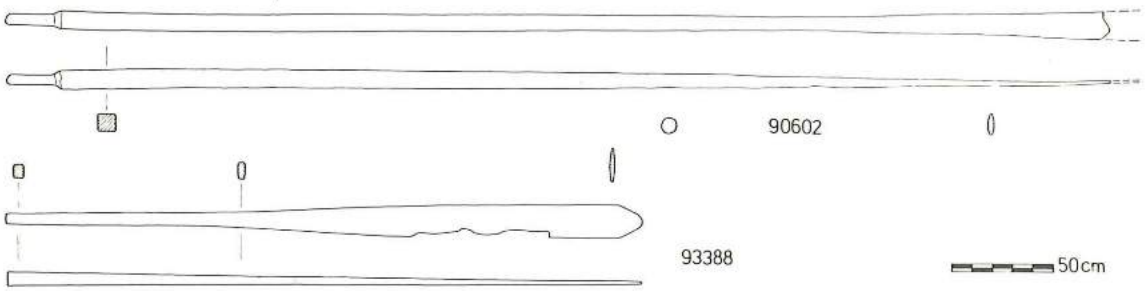


Fig 8-1

Fig 8-2 The sweep 90602 in situ

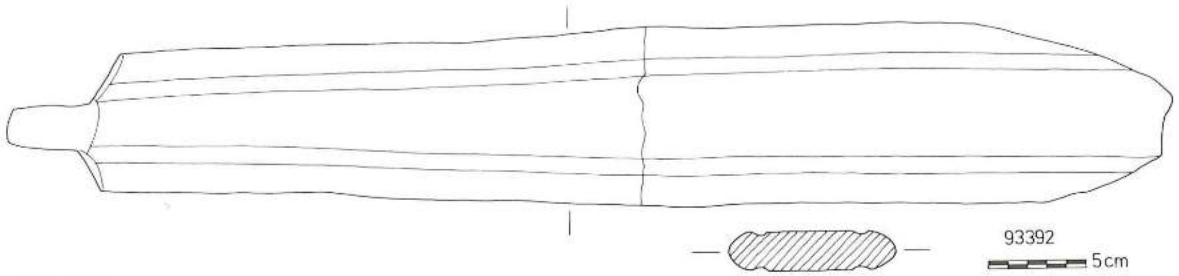


Fig 8-3

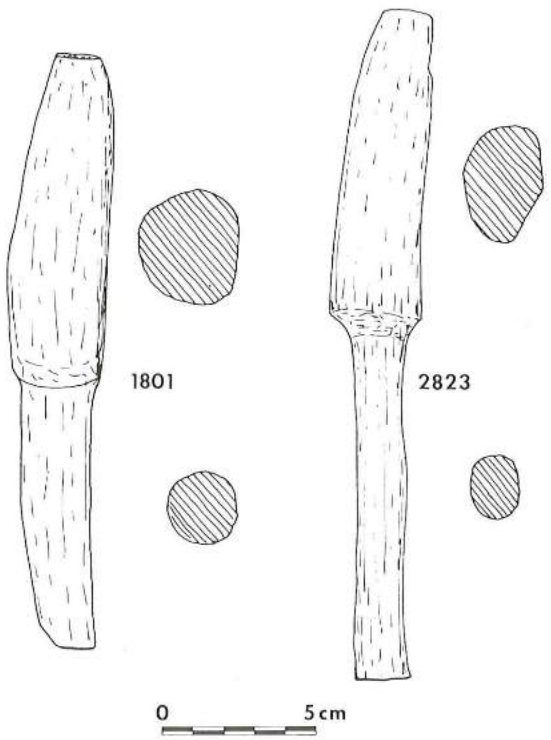


Fig 8-4

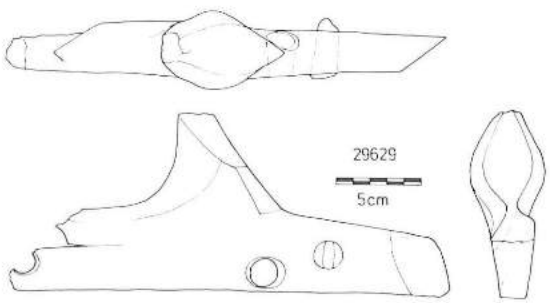


Fig 8-5

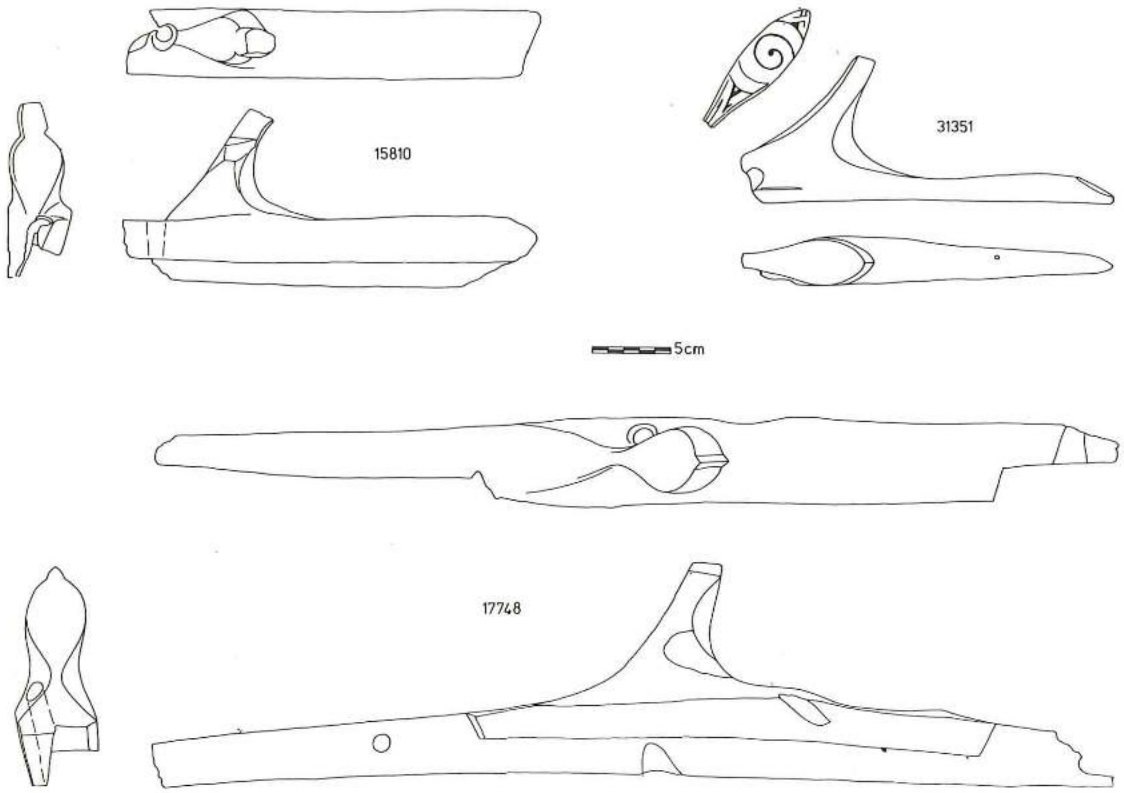


Fig 8-6

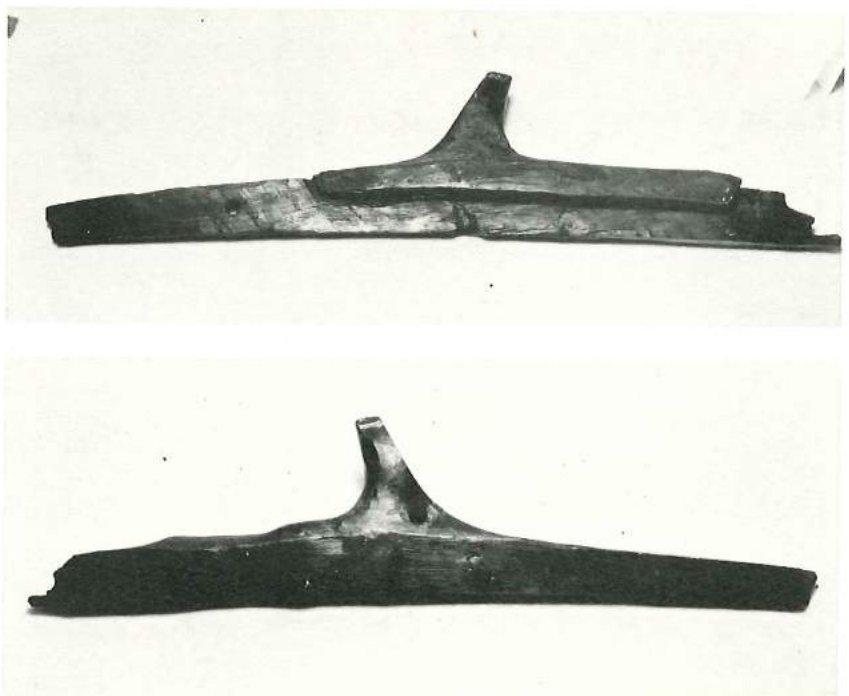


Fig 8-7

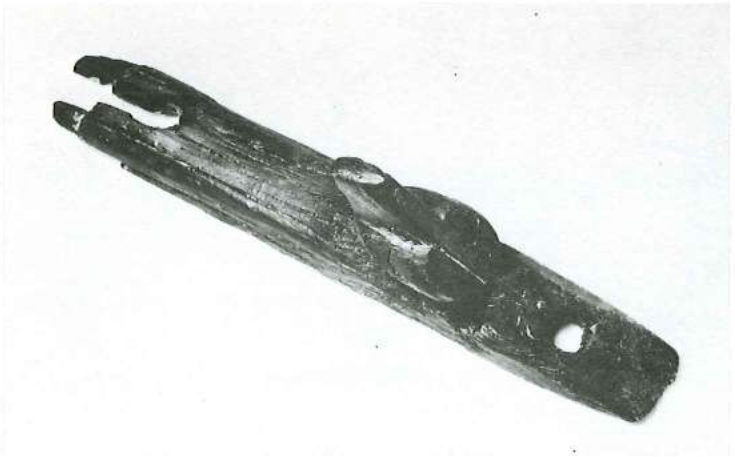
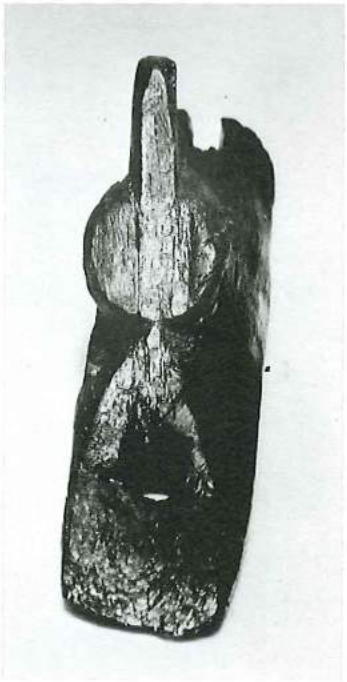


Fig 8-8



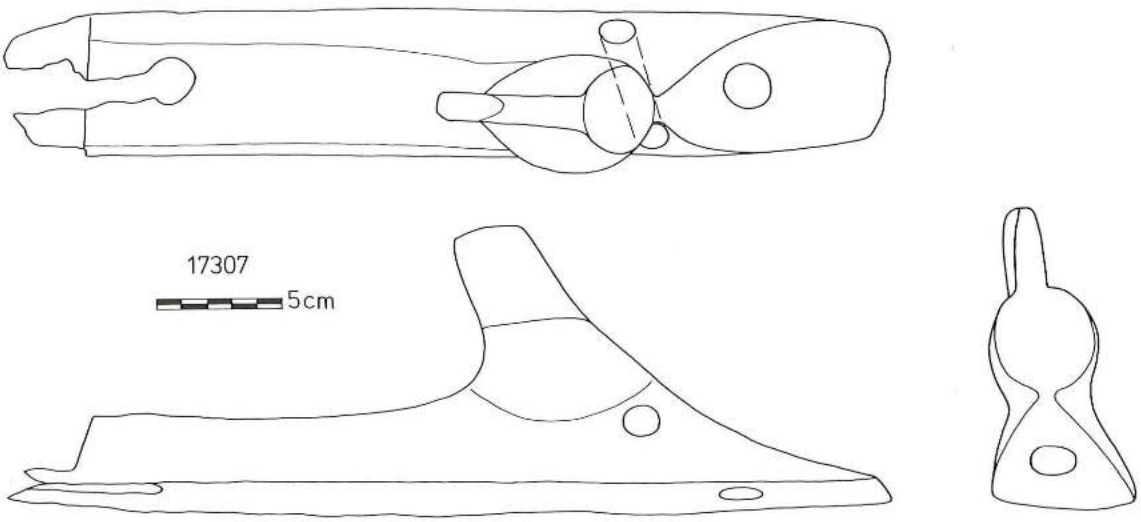


Fig 8-9

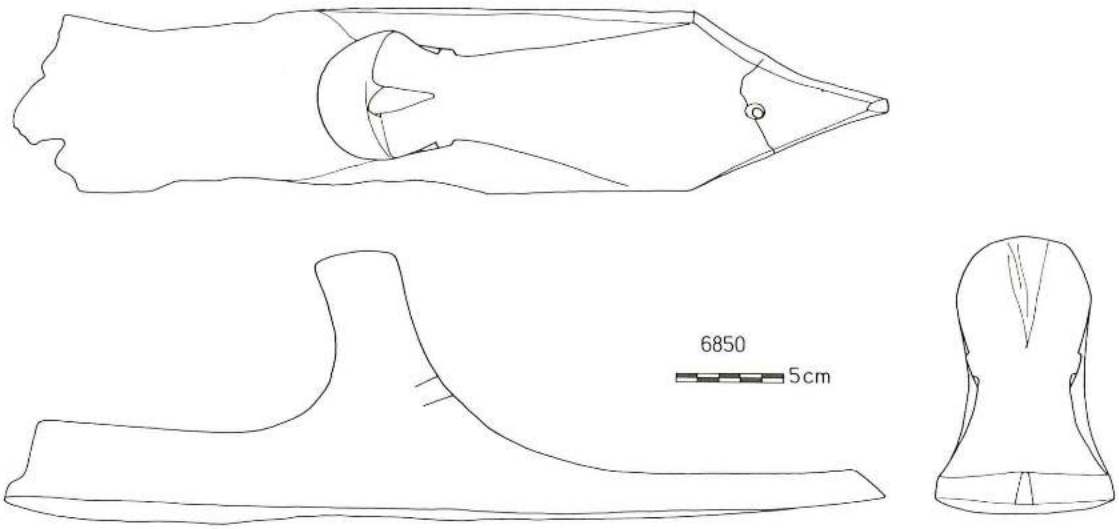


Fig 8-10

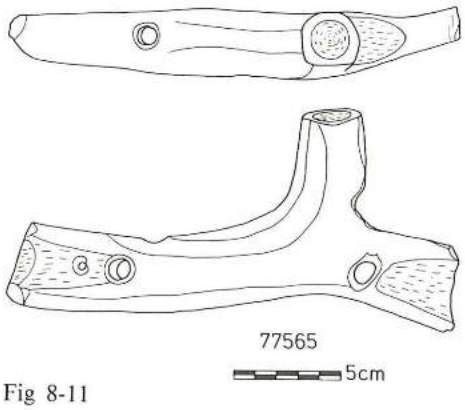


Fig 8-11

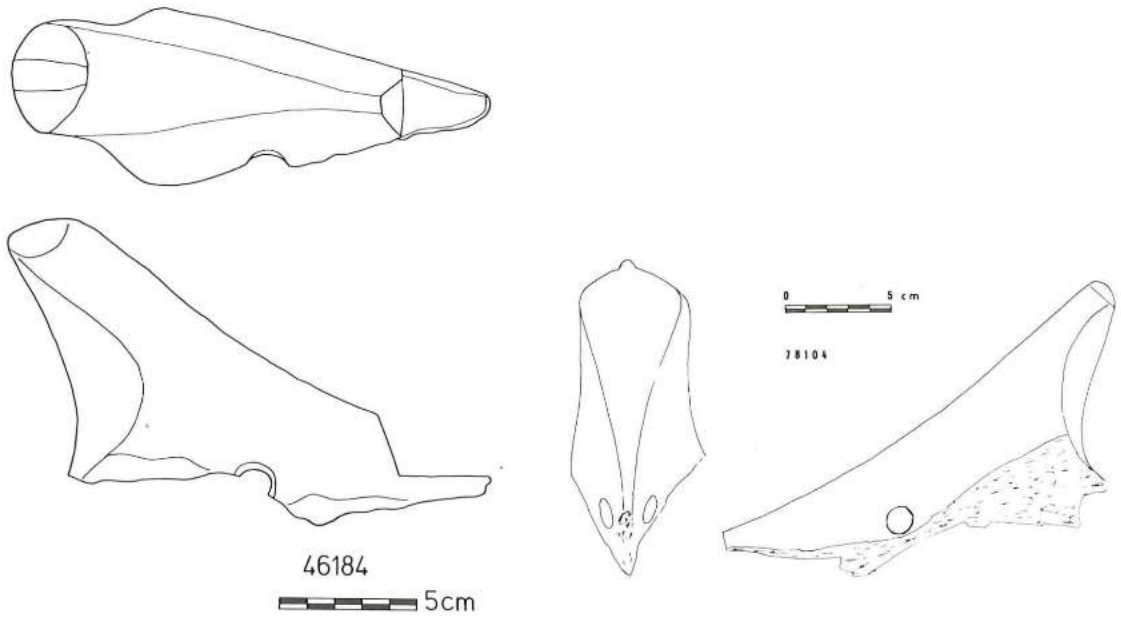


Fig 8-12

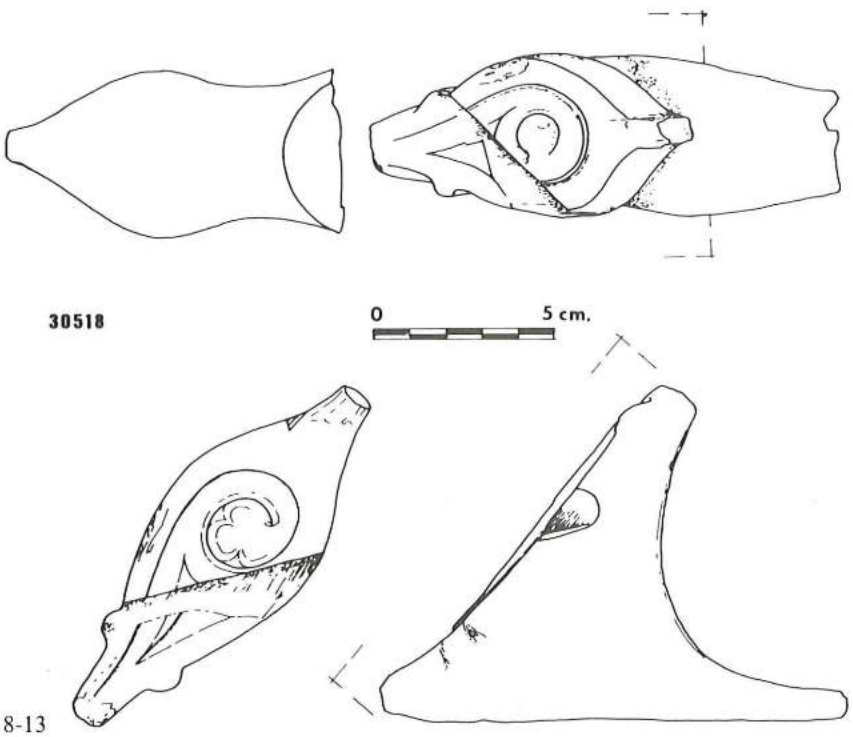


Fig 8-13

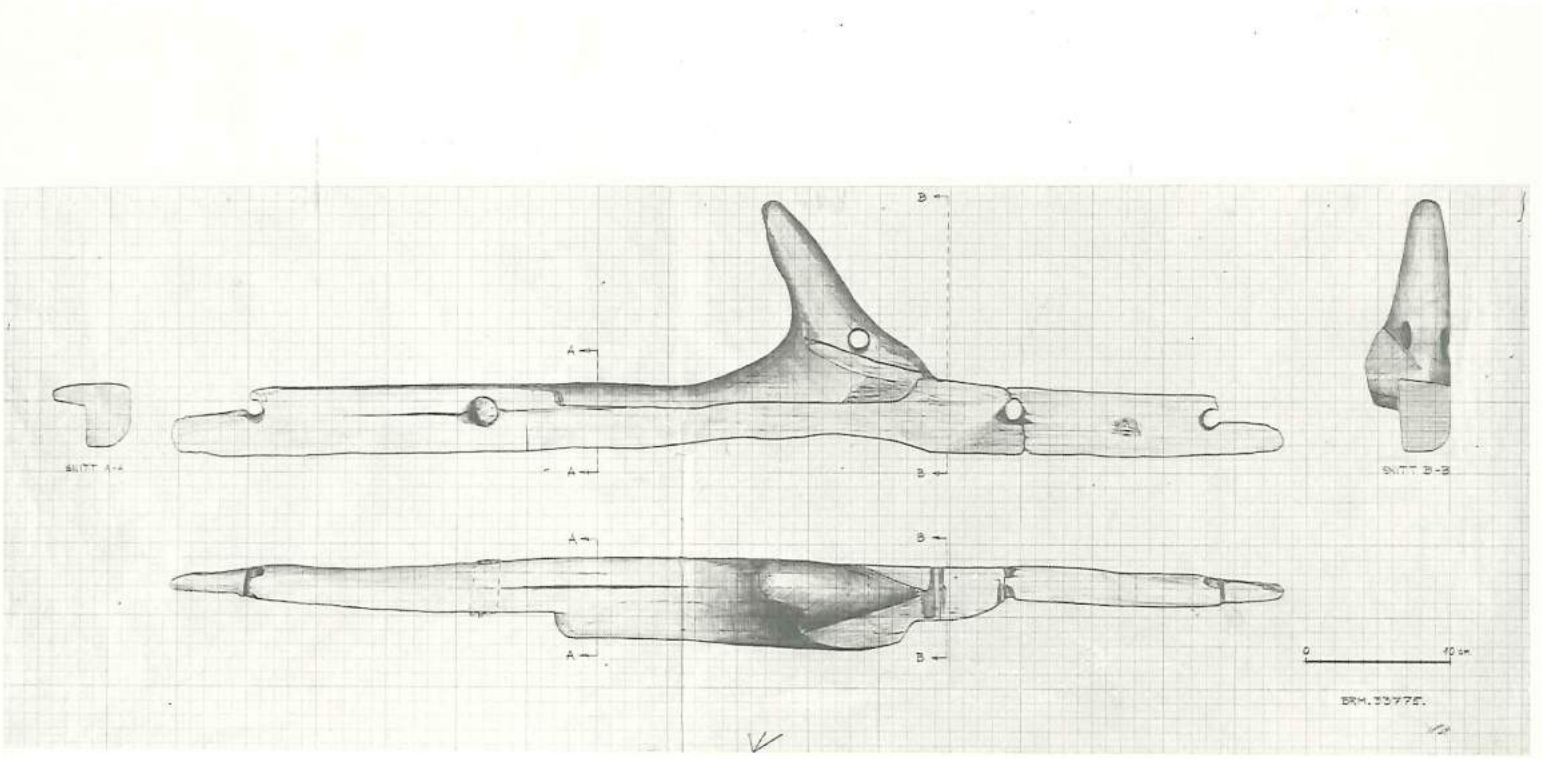


Fig 8-14

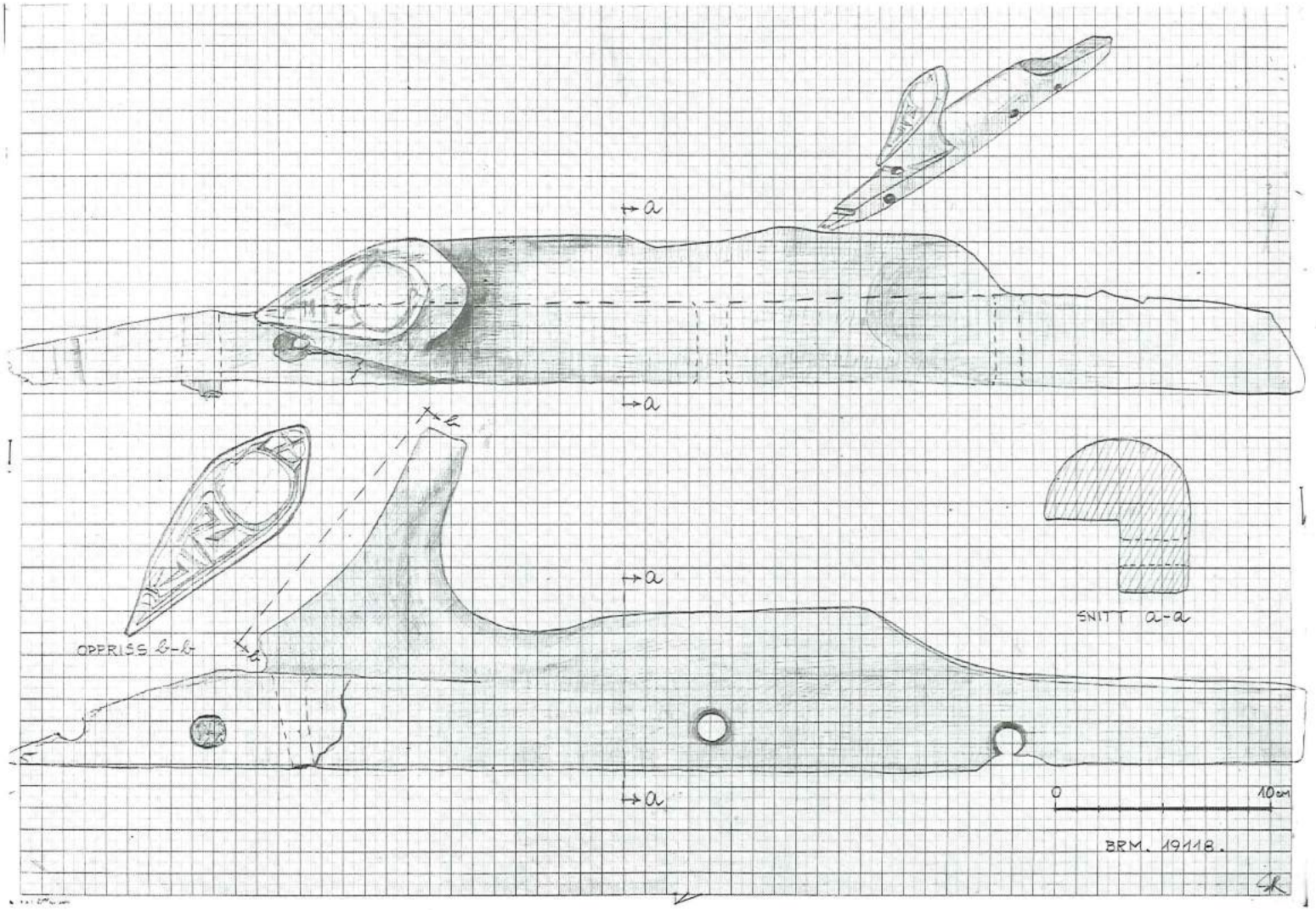


Fig 8-15

RIGGING

Masts and yards

One complete mast has been found, 90301, figs 9-1 and 9-2. The material is pine or spruce, most probably pine, and the mast has been worked to a nice finish. It is nearly round in cross-section, but one side, presumably the front, has a flat surface with two decorative mouldings. This cross-section is, as far as I know, unparalleled in archaeological material, except for the other mast from Bryggen, the fragments 90613/614. Masts with a flat surface on the front are known from Sunnmøre. "The mast was equally thick at top and bottom, and had a flat surface on the front. The cross-section was elliptical or oval, with the long axis parallel to the keel" (Færøyvik 1935). Jon B Godal knows of masts with a flat front from Trøndelag and Nordland and has heard the following explanations for this shape: 1. The yard runs better. 2. It is easier to position the mast when rigging the boat at night (Pers comm June 1981). The latter explanation is also given by M Mentzoni (1969).

There is a shoulder for the standing rigging, and just below this is the halyard-hole. At the bottom of this, another hole has been bored sideways, into which a piece of bone has been inserted. The bone has not been properly identified by a zoologist, but with my limited knowledge I would suggest that it is part of a sheep's leg-bone. The purpose of this is certainly to diminish friction when the sail was hoisted. There is considerable wear on the bone, so the mast must have seen much use before it was discarded.

In modern practice there is generally a sheave in the halyard-holes and B Færøyvik has noted the use of a smooth hardwood half-sheave inserted to lessen friction where our mast has the bone inset (Færøyvik 1929, 173). The overall length of the mast is 750 cm, while the distance from the centre of the halyard-hole to the mast top is 20 cm. The mast does not change diameter much for most of its length, the diameter being 12.5 cm.

According to the traditional rule in Western Norway, a squarerigged boat should have a mast where the distance from heel to halyard hole was equal to the greatest girth of the boat.

This rule will permit a longer mast on a beamy and stable cargo boat than on a slender rowing vessel with the same overall length. In this case, we do not now the type of vessel for which the mast was originally intended and the size of the boat can only be suggested approximately. Among the material of 19th century fishing boats, the 12-oared boat from Gimmestad in Nordfjord has a mast of slightly less than 6 m, to a total boat length of 9.15 m and a max beam of 2.16 m. The large *fembøring* from Trøndelag, which was rigged with a topsail above the squaresail has a mast of 8.20 m to a boat length of 12.17 m and a beam of 3.2 m. In between comes the small coaster from Holmedal in Sunnfjord, 9.9 m long and 3.08 m beam, with a mast like ours, 7.5 m long (Færøyvik/Christensen 1979). Depending on how beamy the vessel was, our mast must come from a boat in the 10–11 m range.

90613/614 are in all probability fragments of a similar mast. The flat surface is more pronounced and there are no mouldings. The 2 fragments together are 620 cm long. It is impossible to say how much is missing, but as no traces of heel or top are present, we must assume that the mast was at least 650 cm long. It is more slender in proportions than the other mast, with a cross-section of c 8 cm against 12.5 cm for the complete one. The cross-section is shown in fig 9-3. Fig 9-28 shows the mast beam of a small 19th century boat from Namdal, North Trøndelag, with a hole for a mast of similar cross-section.

90572 is a nicely worked, round, tapering spar, broken at the thicker end. It cannot, in my opinion, be anything else than half, or somewhat less than half a yard. The material is pine. At the thin end there is a hole and a very slight shoulder. Several treenails in bored holes are surely secondary. The fragment is 265 cm long, giving a minimum length of 530 cm for the yard. The hole and shoulder, intended for the lashings stretching the corners of the sail outwards, are 14 cm from the end. The diameter near the middle is 15 cm, tapering to c 8 cm at the yardarm. Compared to the 12 cm cross-section of the 750 cm long mast, 15 cm seems sturdy for a yard of only 530 cm, and I would accordingly suggest that the yard was originally longer than this minimum size (fig 9-4).

90351 is 48 cm long and 8 cm in diameter. It may be a spar fragment, or a piece of oar-loom. It is not further documented or discussed here.

According to the list of timbers from houses

and ships kept by Egill Reimers, 90576 is a mast fragment, of which the rest was left standing in the section during excavation. This piece has not been available for study and is not further treated here.

Parrels

The most numerous rigging detail among the Bryggen material are parrels for small boats. The shape is characteristic, and similar parrels were part of the equipment for square-rigged boats until c 1900, so there should be little doubt about their identification. In the Oseberg ship a parrel was found (Shetelig 1917, fig 121) and there are parrels from numerous excavations in various medieval towns (Kolcin 1968, fig 49 and pl 59, Arbman 1926, fig 140, C 23784 from Gamlebyen, Oslo).The Bryggen material shows the parrel in two variations (1) a plain, naturally curved piece of wood with a hole at either end for lashing to the yard; (2) of similar shape, but with one or two holes near the middle for the downhaul. The 19th century parallels I have seen in local museums are generally of birch or juniper, but one in "Sogn Folk Museum", Amla, Sogn, is made of ramshorn and this is reported to be the favourite material in the Faroe Islands. The parrels are listed in table 9-I. Larger ships in more recent times used parrels made from one or more rows of wooden balls or rollers. A rope through the rollers held the yard to the mast. If there were several rows of rollers, laths with evenly spaced holes held the system pl together. (The type is well illustrated in Rålamb 1690/1943, pl M 44–47.) In the Bryggen material, this type of parrel is in all probability represented by one fragmentary roller, 53582. The roller is spherical, with a diameter of 8 cm. It was found in layers dated before the 1248 fire. Judging from the iconographic evidence I have seen, this must be considered an early date for a composite parrel.

In the lists of small finds from Bryggen, many of the parrels have been classified as bucket or basket handles. It is, of course, possible that some of the pieces that I have interpreted as parrels are, in fact, handles but most of them show wear from the mast and what I have seen of handles found in a secure context, are generally slacker in the curve (figs 9-5 to 9-8).

TABLE 9-I PARRELS

Number	A	B	C	D	E	F	Date	Notes
5042	27+	17.5+	14	10	5	2.1	IF 5	1
8697	20.4	13	12	8.5	3.5		IF 4?	
9272	21+	15+	15+	10+	4.8	1.8	?	
12574	27+	16+	15+	4	2.5		BF 4	
16473	16+	8+	9.5	6	3.4	1	BF 5	
17436	17.6	11	8.7	6	3	2.5/1.2	BF 5	
25959	12.5	6	7.5	4.5	2.7		?	
29243	22	17+	10	6.8	3.3	1.6	AF 3	
32778	19.6	13.5	11	6	6	1.9	AF 5	
38383	26.5+	20+	9.5	6+	3.5	2.5	AF 3?	
54673	23+	18+	11+	7.5+	3.4	1.6	BF 5	
61057	17+	10+	11.5	7.2	4.5	1.2	AF 4	
68342	21	15.5	11.5	7.5	4	1.4	BF 2	
80949							AF 4	

Notes to table 9-I

1. The piece has an extra pair of holes for the downhaul

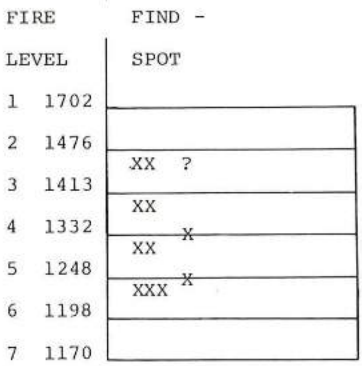


TABLE 9 - II

DATED PARRELS

3 OF THE
PARRELS
CAN NOT BE
DATED.

Rope-end toggles

None of the objects identified as rope-end toggles have been found with rope attached to them, but the shape is quite characteristic, and I know of no other suggested use for similar pieces (figs 9-9 to 9-11). The rope-end toggles may of course have been used on land as well as in the rigging of ships. In the Oseberg find, there is a large number and the size varies greatly. In addition to their use in the rigging of the ship, the Oseberg toggles were probably used also on tent ropes.

Apart from Oseberg, parallels to the toggles are known from most of the medieval town excavations published. A number are illustrated by Kolcin from Novgorod, interpreted as ship's equipment (Kolcin 1968, pl 59). Toggles were numerous among the Gdansk finds; some are illustrated by Smolarek (1969 fig 98), who also interpreted the toggles as rigging details. Many of the Oseberg toggles retain part of the rope, knotted or spliced around the middle of the toggle. During excavation, one toggle was found on the end of a rope knotted through an oar-hole. Logically, the toggles would be an excellent means of fastening a rope temporarily, by "buttoning" the toggle through a loop in another rope, or by knotting as seen in the Oseberg find. Modern parallels are surprisingly rare, but Ashley (1960, figs 1929 and 3181) illustrates toggles spliced to signal flags and blocks for easy fastening and unfastening.

TABLE 9-III ROPE-END TOGGLES

Number	A	B	C	D	Date	Notes
11772					BF 4	1
26836	12.5	1.5	1	0.5	IF 3	
30828	20	4.4	3.5	1.4	AF 4	
35411	10	2.5	1.7	2.5	AF 5	
45510	6.6	2.5	1.8	1.2	BF 5	
49955	11	1.6	1.2	0.6	IF 3	
78756	12	2.7	1.8	1	AF 4	
79982	14	2.1	1.4	0.8	BF 4	2
85795	12.5	1.5	1	0.5		

See fig 9-9 (upper) for the position of the measurements (cms) given in columns A-D. The dating is given as before (BF), contemporary with (IF) or after (AF) the fire as numbered

Notes to table 9-III

1 (11772) This piece was not available for study.
2 (79982) This piece seems to be latheturned.

Fairleads

The objects that I have labelled *fairleads* could probably just as well be called sheave-less blocks, but I think we are safe in classifying them as rigging details (figs 9-12 to 9-15). Archaeological parallels from Norway are few. There are three in the Gokstad find, one of which is decorated, one well-worn example of bone from Oslo, probably medieval, and one, undated, from a bog in Northern Norway (Ts 839), (figs 9-16 and 9-18). There are also some unpublished specimens from excavations in Oslo and Tønsberg, found in medieval contexts. Åkerlund illustrates one (1951, pl 28, fig C) and suggests a function as the fairlead for bowlines as the most probable.

From more modern vessels they are well known. On the huge square sail used by the *jekt* type of coaster, a middle sheet held the belly of the sail to the mast (fig 9-19). The fairleads for this rope are identical. Fig 16-12 shows part of the rigging of model *jekts* in Tromsø Museum. One model is reported to have been given to Træna Church in 1770, and the rigging seems to be original. Another function for similar objects was in the two or three part crowsfoot used as a middle sheet on smaller boats (fig 9-20). Of the fairleads from Bryggen, some show considerable wear in the holes, generally one hole is much more worn than the other. One would suppose that one hole was for a running rope, while the other was for a line bending the fairlead or block to the hull or standing rigging. Two variations have been found, the holes being either parallel or at right angles to one another, and it is possible that they served different functions. One piece, in Sunnmøre Museum (fig 9-17) is labelled *siglekaus* (sailing thimble), but no detailed information of its use is recorded by the museum. On the evidence of the modern parallels, I would suggest that those with holes at right angles served as sheaveless blocks, while those with parallel holes were fairleads for middle sheets.

In his publication of the wooden artefacts from the Novgorod excavations, Kolcin (1968) depicts similar fairleads (pl 74) and they are included in the chronological table fig 56. The rest of the objects in this table are parts of horizontal looms, however, and the fairleads are not described, nor are they shown on the reconstruction sketch of a loom (Kolcin fig 57).

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	
3	1413	XX
4	1332	XX
5	1248	XX
6	1198	XX
7	1170	X

TABLE 9 - IV

DATED ROPE - END TOGGLES

I suppose that Kolcin has interpreted the fairleads as blocks used in setting up the heddles of a horizontal loom, even if this is not stated in the book. I can see no other reason for including the fairleads among the weaving equipment. This is, of course, a possible interpretation, but one would expect blocks for a loom to be smaller and to be pierced for ropes of smaller diameter than those used on ships. Kolcin does not give the dimensions of the Novgorod fairleads, so they cannot be compared to our material. One of those depicted by Kolcin (pl 74) has parallel holes, the remainder having the holes at right angles to one another.

TABLE 9-V FAIRLEADS

Number	A	B	C	Date
9829	13	3.7	2.3	IF 7
12085	10.5	4.5	1.5	BF 4
15298	15	6	2	AF 5
16560	20	6.5	1.9/2.6	AF 6
17563	12	4	2.5	BF 5
17563(b)	11	5	2.5	BF 5
35884	18	5	2.5	?
44145	12.5	4.5	2	BF 5
51681	21	7	2.7	BF 3
54550	32	7.2	2	BF 5

See fig 9-9 (lower) for the position of the dimensions (cms) given in columns A-C. The dating is given as before (BF), contemporary with (IF) or after (AF) the fire as numbered.

Other rigging details

Among the finds are four belaying-cleats, 1357, 5753, 27588 and 44618. The shape is similar to those still in use, as well as to those found in the Oseberg and Gokstad ships. 1357 is uncommon in having the iron nails for fastening outside the central wooden part (fig 9-18). It is decorated with an incised ship, shown with a curved stem, a straight stern-post and a stern rudder.There can be little doubt that this is a representation of a *jekt*. Numerous parallels exist among the graffiti found in old wooden houses along the Norwegian coast (two examples are given in fig 9-20).

The date of our piece is a little uncertain. It was found "clearly above fire III, probably above fire II." I am inclined to date it securely after 1476. The rather sketchy nature of the boat makes it impossible to date it more closely within the span 1476–1702. In any case, it is among the oldest representations we have of *jekts*. Usually, the cabin or *veng* of the *jekt* is clearly shown in the graffitti. In this case, there is also a raised foredeck.

It is impossible to say definitely that the cleats came from ships, as similar pieces were probably used ashore for belaying the ropes of hoists etc, but the most probable use would be for belaying the running rigging aboard ships and boats. The special shape of 5753 suggests that it is a "snatch cleat" for a sheet or halyard (fig 9-22a). In the Bryggen material there are a number of pieces shaped like fig 9-22b. The one selected for illustration 44727 is typical in shape and dimensions. They may also be snatch-cleats, for securing the sheets of small boats, but their function is uncertain, and they have not been further recorded or discussed here.

One complete and one fragmentary block sheave have been found, 59021 and 36558. The complete one is rather asymmetrical and not lathe-turned so it is in fact rather dubious as a sheave. This surprisingly low number is of some importance when discussing medieval rigging in Northern Europe (fig 9-23). 30005 is a well-finished piece of bone, with incised decorative lines. Even in this nicely finished state, I think the piece is not yet ready for use, as the holes are very small when compared to the parallels (fig 9-24). Four specimens of the same shape and size, but in wood, were found in the Oseberg ship, and two others in bone come from other Norwegian Viking graves (C 4314,

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	
3	1413	
4	1332	X
5	1248	XX
6	1198	XXXXXX
7	1170	

TABLE 9 - VI

DATED FAIRLEADS

1 OF THE FAIRLEADS CAN NOT BE DATED.

S Kaupang, Tjølling, Vestfold; S 6186 ii, Strand, Strand, Rogaland). In the case of the Oseberg specimens, one at least still had a piece of rope knotted in one of the holes. In his work on Viking Age tools, Jan Petersen classifies these pieces as "rope-stretchers" and treats them with the fishing gear (Petersen 1951, 282 and fig 153/154).

N Nicolaysen, who excavated the piece from Kaupang, also used the term rope-stretcher and suggests that this may be tent equipment. Modern tents are equipped with similar pieces in metal for stretching the tent-ropes (fig 9-25), but it may be significant that the graves at Kaupang and Strand are well-equipped boat graves, even though they do not reach the standard of Oseberg. It may well be that the stretchers were used in rigging as well as on tents.

The 3 cleats 18417, 78190 and 78429 are best discussed with the rigging equipment. They are notched to rest against clinker strakes and all have a semicircular groove cut out on the side resting against the strakes. 78429 is fragmentary at both ends; the other two seem to be complete. I interpret them as cleats fastened to the inner or outside of the hull with the purpose of securing standing rigging. The principle is well demonstrated in Skuldelev wreck 3 where simi-

lar clamps of more elaborate shape are placed both inside and outside the hull. In one case a withy ring was still in place through the hole in the clamp (Olsen & Crumlin-Pedersen 1967, fig 40 and 43).

The only Norwegian parallel known to me is an undated but probably medieval piece from Gamlebyen, Oslo (C 26509c, fig 9-27).

A number of rib and knee fragments from Bryggen and other finds have semicircular cuts like these cleats, but they are placed at the notches of the ribs. Their main function seems to be to ensure airing at this point, in order to prevent rot in rib and strake. In modern boats, where the ribs are often fitted tightly at this point, moisture collects in the corner between rib and strake, sometimes causing serious rot damage. Many of the cuts seen on medieval and prehistoric ribs are larger than necessary to ensure airing and the edges are often rounded or bevelled. The best explanation for this is that they also served as rope-fasteners, probably for lashing cargo, in addition to securing standing rigging. The purpose of the cleats would then probably be to secure ropes on the outside of a hull, and inside, when the direction of a rope did not correspond to the holes in nearby ribs. It is not possible to say which way up the cleats should go, nor accordingly whether they were placed on the inside or outside of the hull. The cleats are illustrated together on fig 9-26 with a sketch showing their probable use.

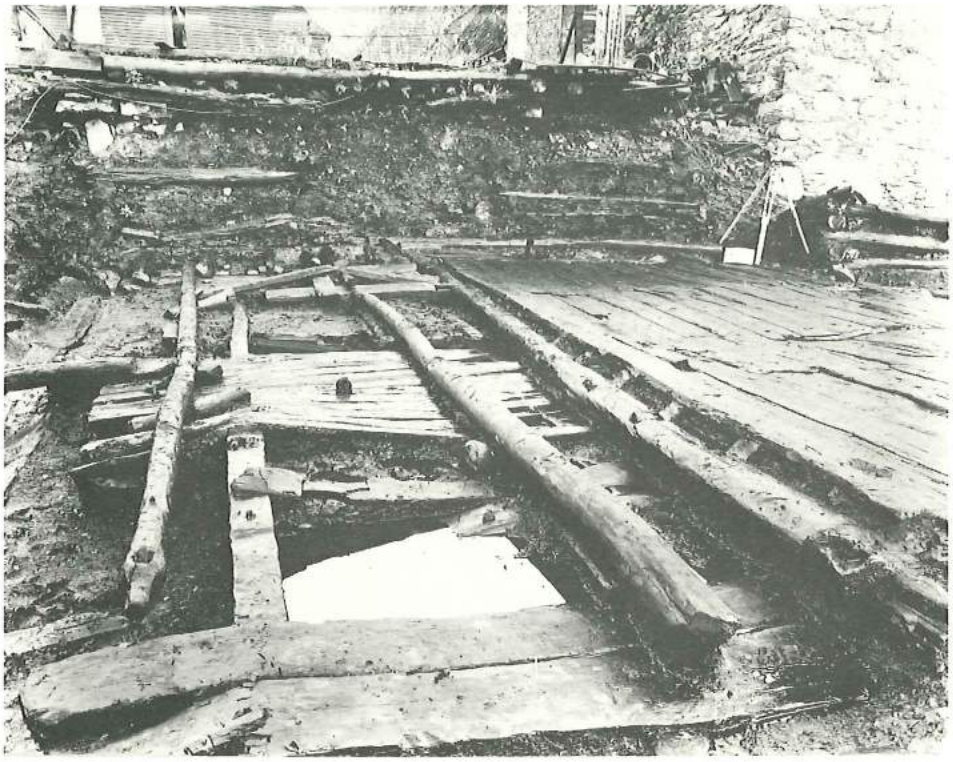


Fig 9-1 The mast 90301 in situ

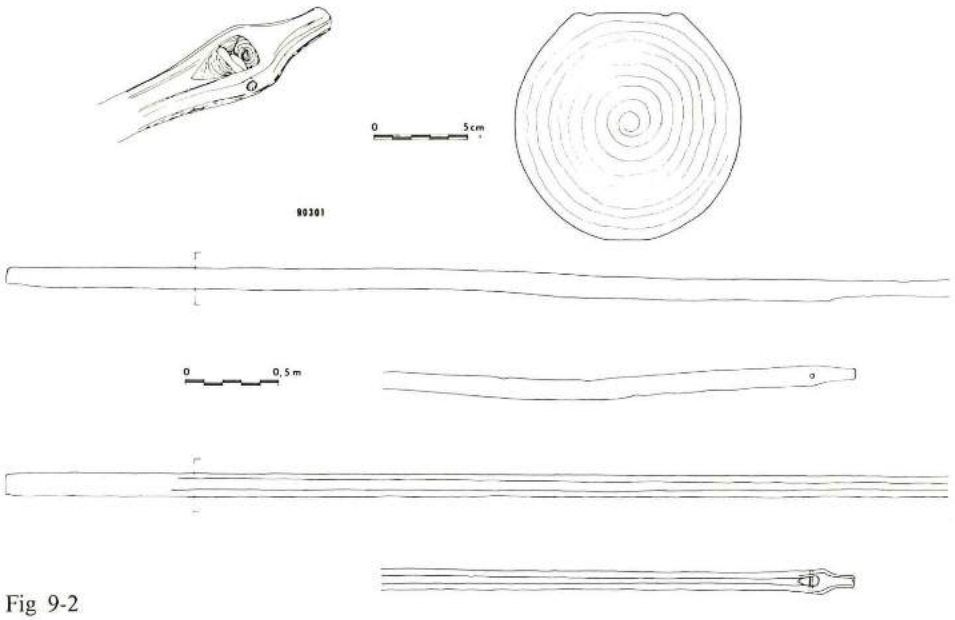


Fig 9-2

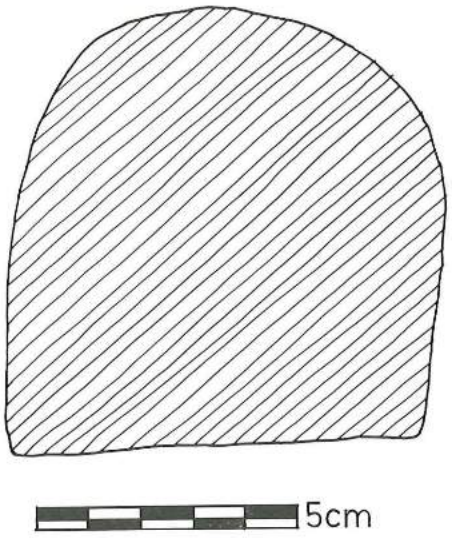


Fig 9-3 90613/614

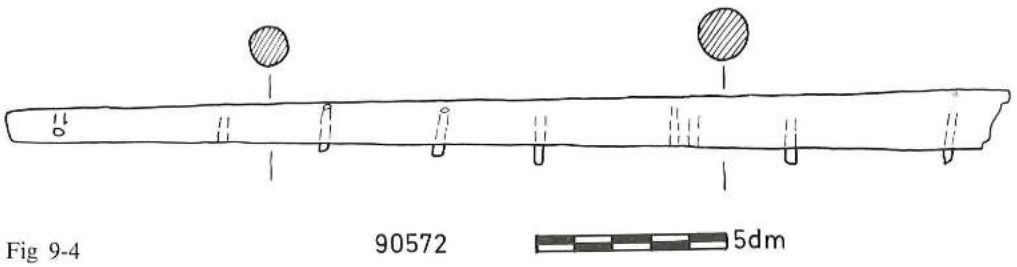


Fig 9-4 90572

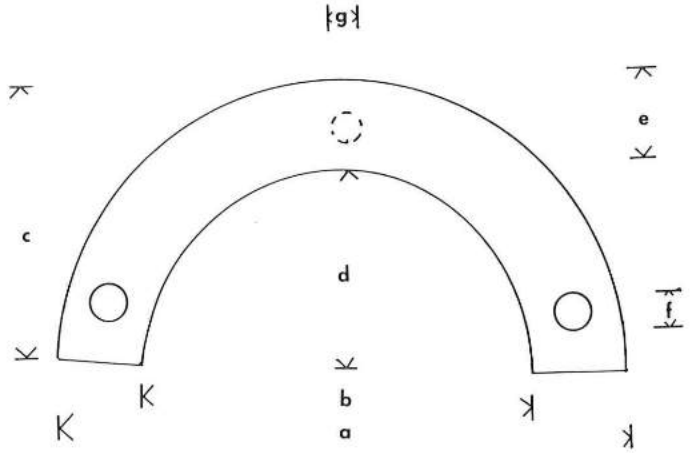


Fig 9-5 Sketch of parrel measurements given in table 9-1

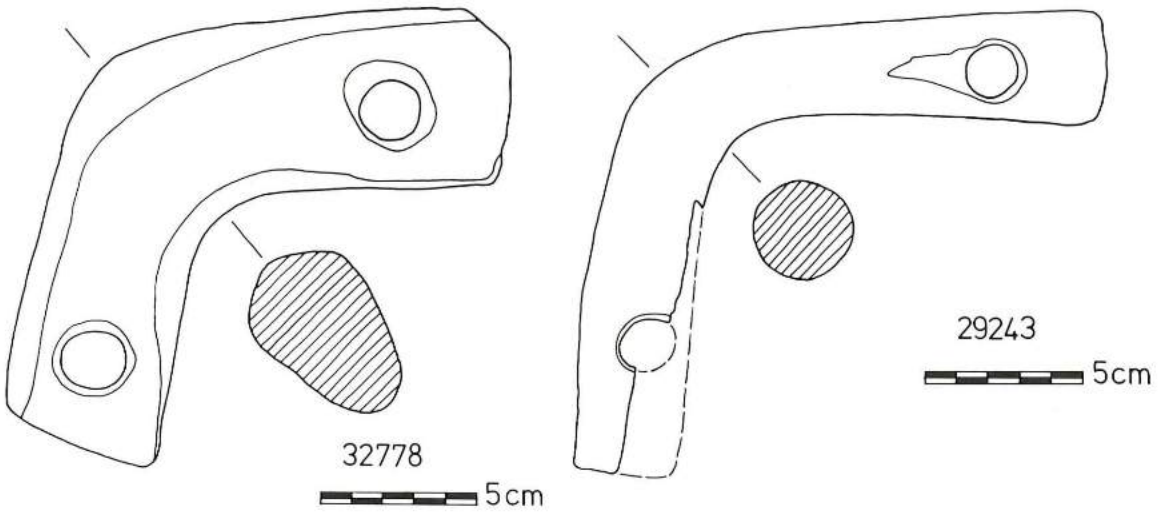


Fig 9-6

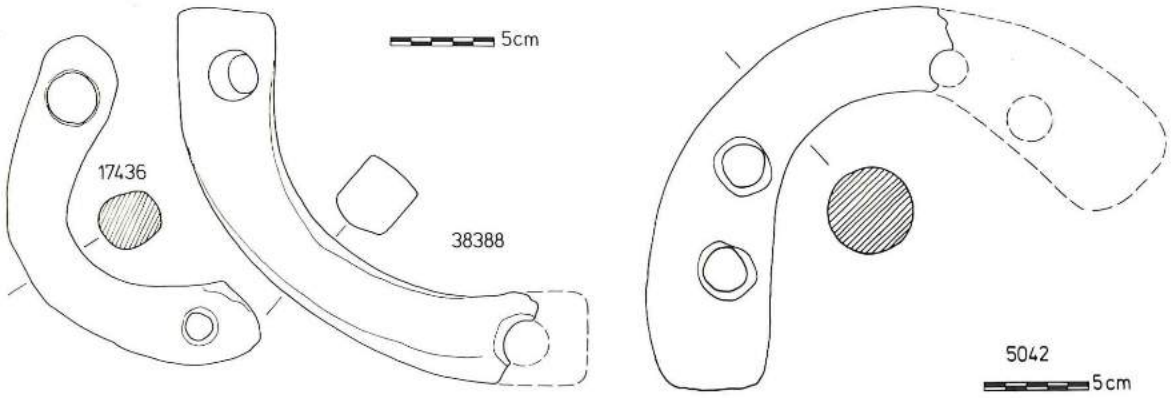
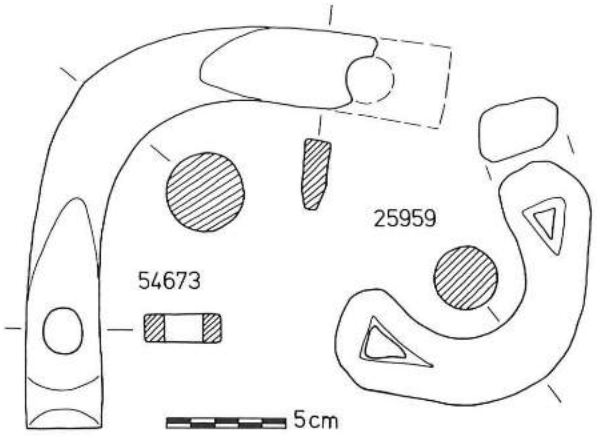


Fig 9-7



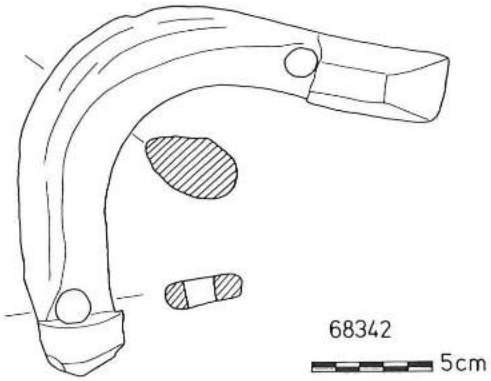


Fig 9-8

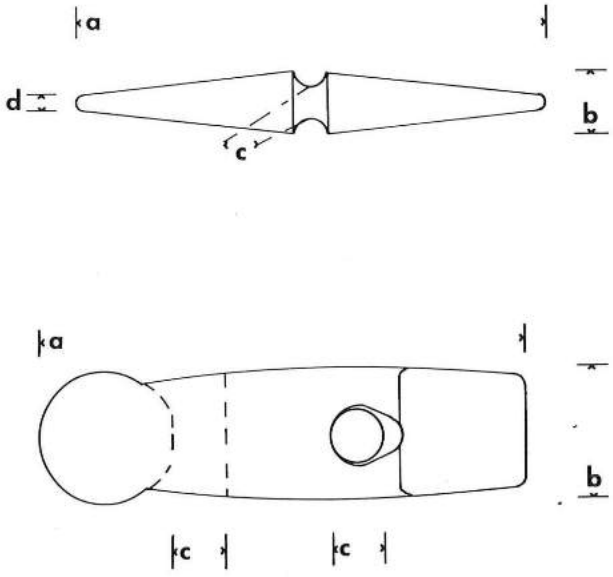


Fig 9-9 Sketch of rope-end toggle and fairlead measurements given in tables 9-III and 9-V

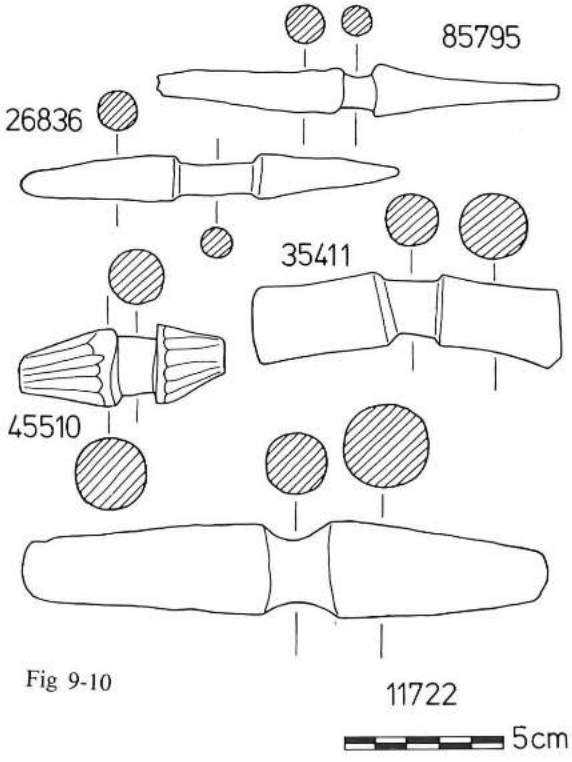


Fig 9-10

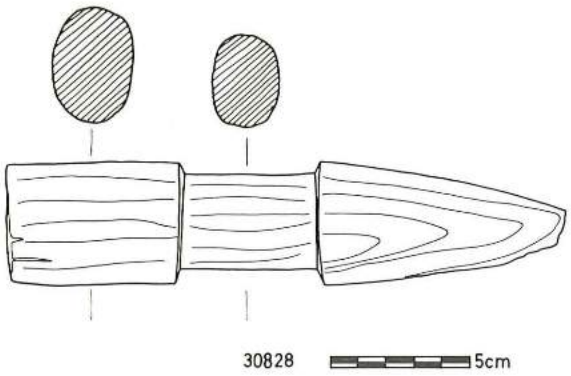


Fig 9-11

Fig 9-12

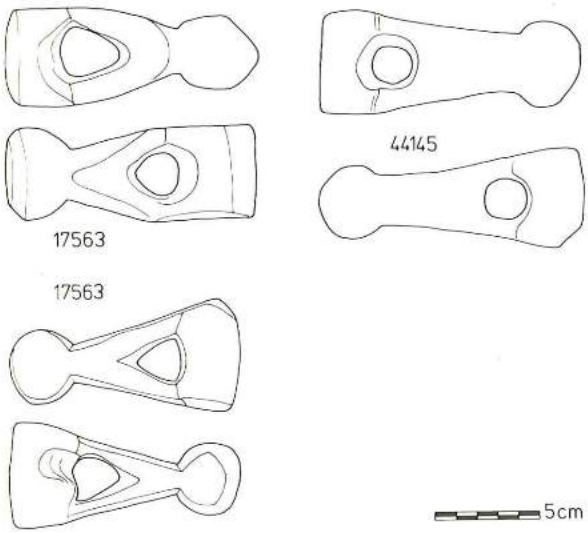


Fig 9-13

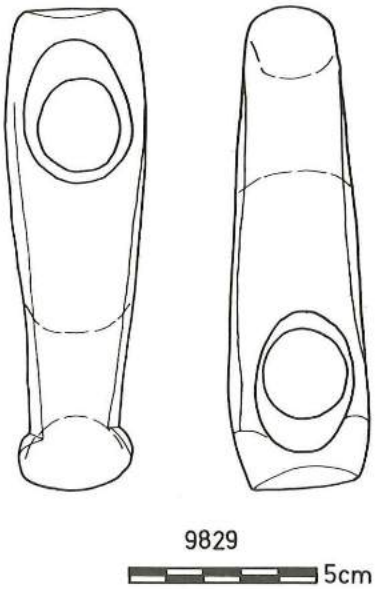


Fig 9-14

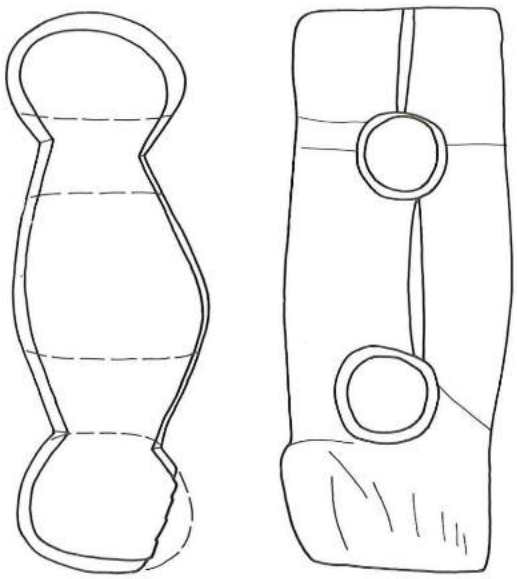


Fig 9-15

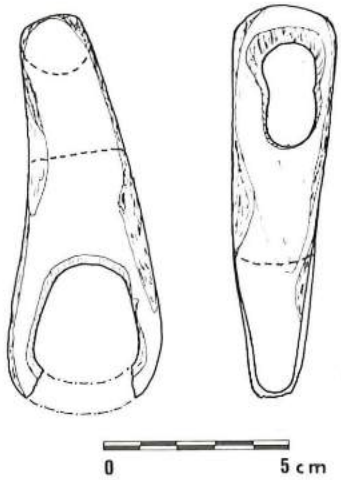


Fig 9-16 Bone fairlead from medieval layers in Oslo (C 17103)

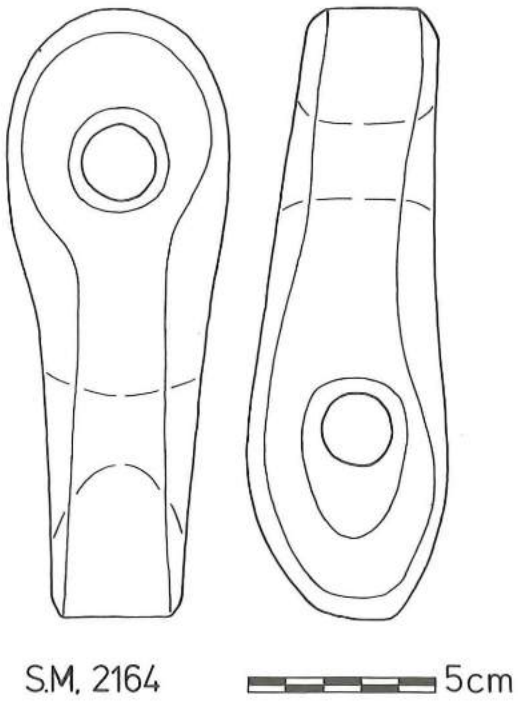


Fig 9-17 19th or early 20th century fairlead (*siglekaus*) from Sunnmøre (SM 2164)

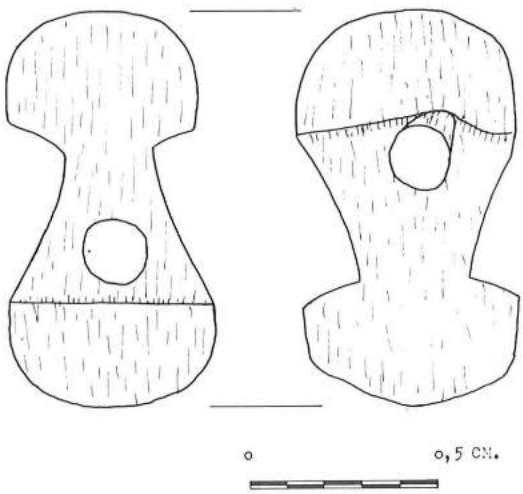


Fig 9-18 Undated fairlead, bog find from Northern Norway (Ts 697)

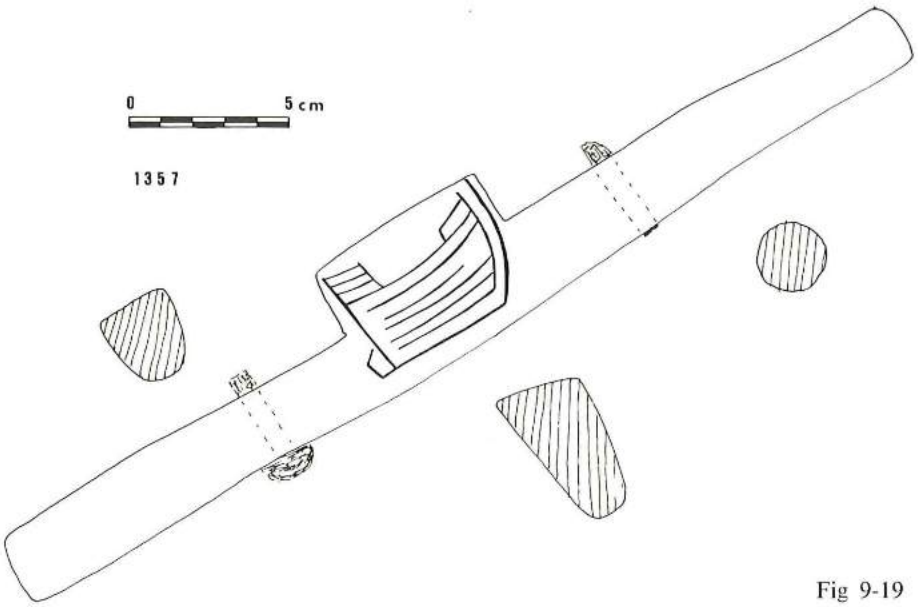


Fig 9-19

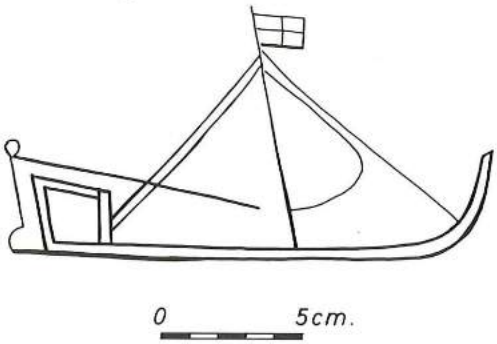
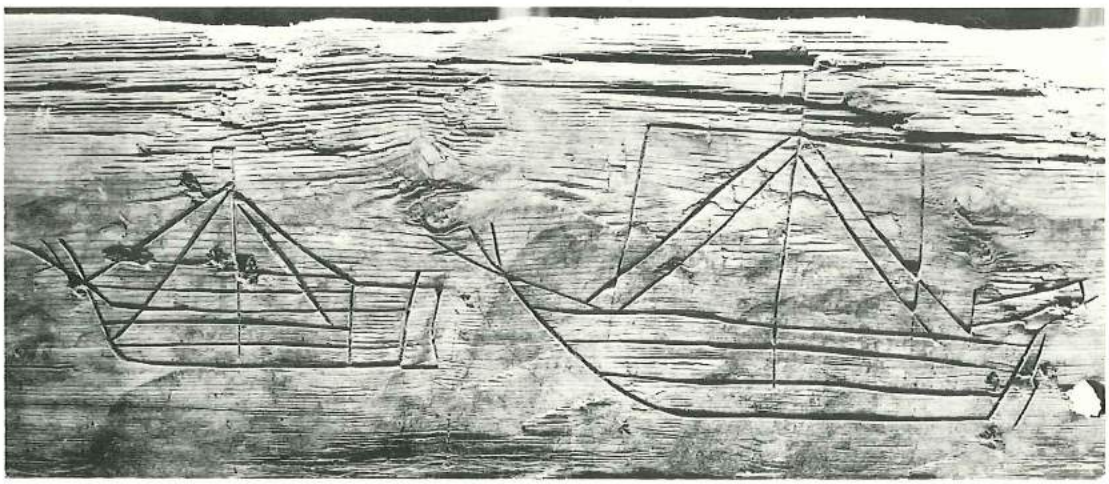


Fig 9-20 Graffiti of coasters of *jekt* type, (a) on a plank from a mill at Hosteland in Masfjorden, Hordaland, (b) on a plank from Rødven, Møre and Romsdal. (a) probably 19th century, (b) undated but probably considerably older



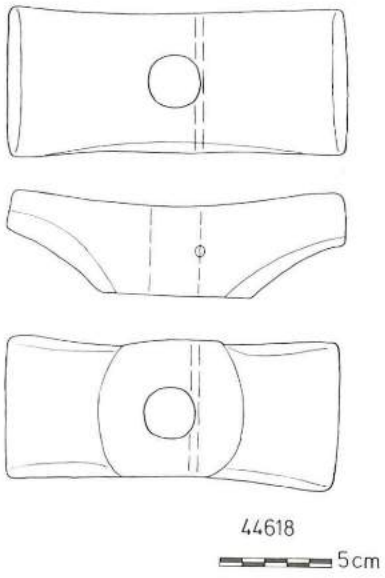
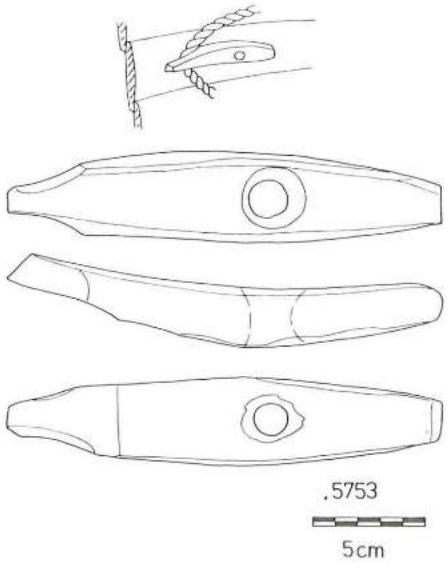


Fig 9-21



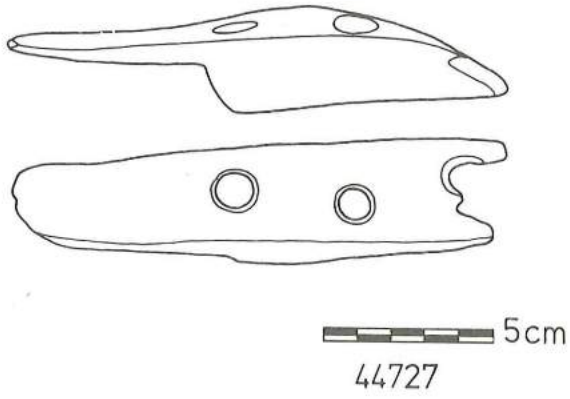


Fig 9-22

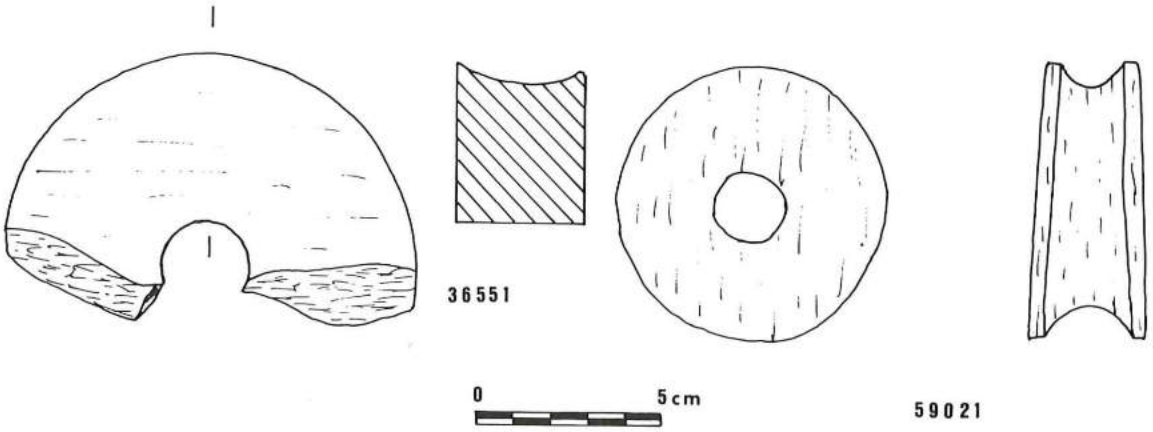


Fig 9-23

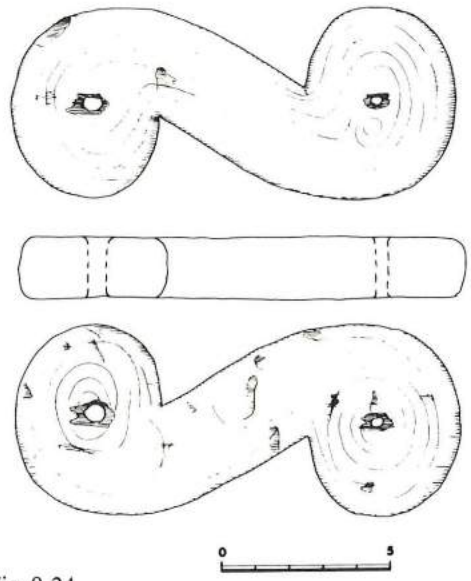


Fig 9-24

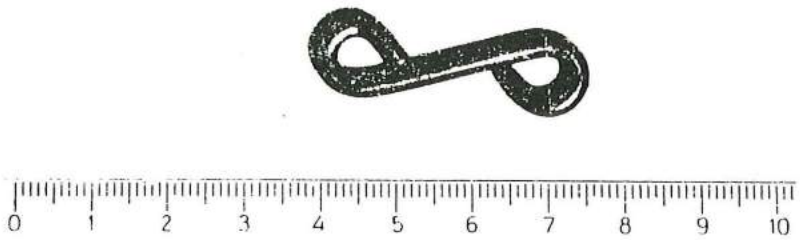


Fig 9-25 Modern metal stretcher for tent-ropes

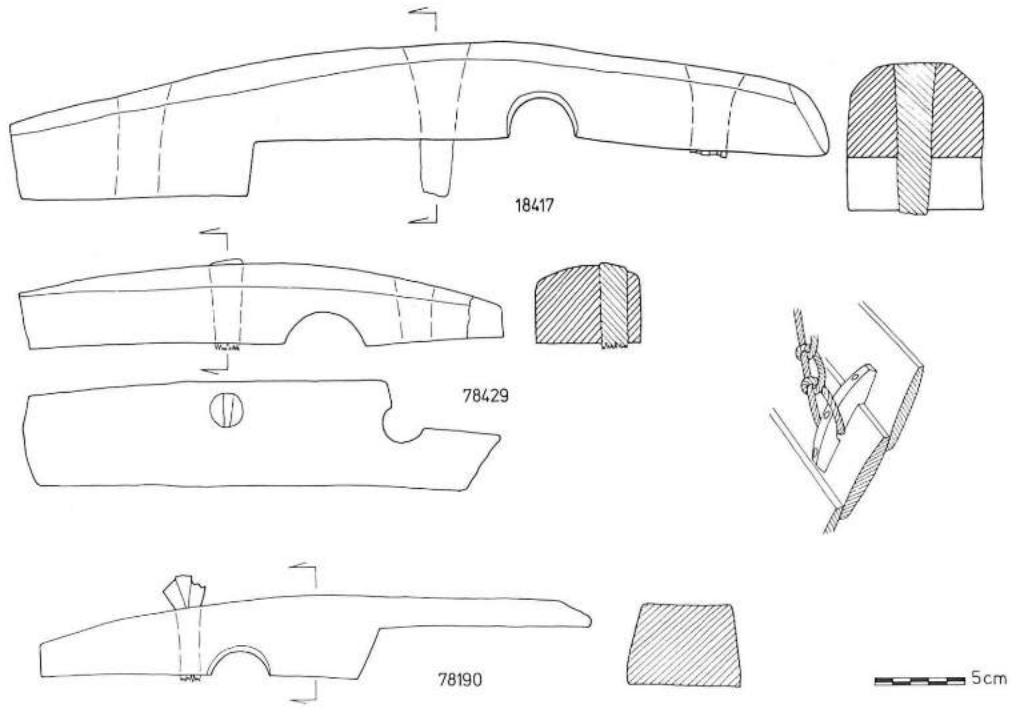


Fig 9-26

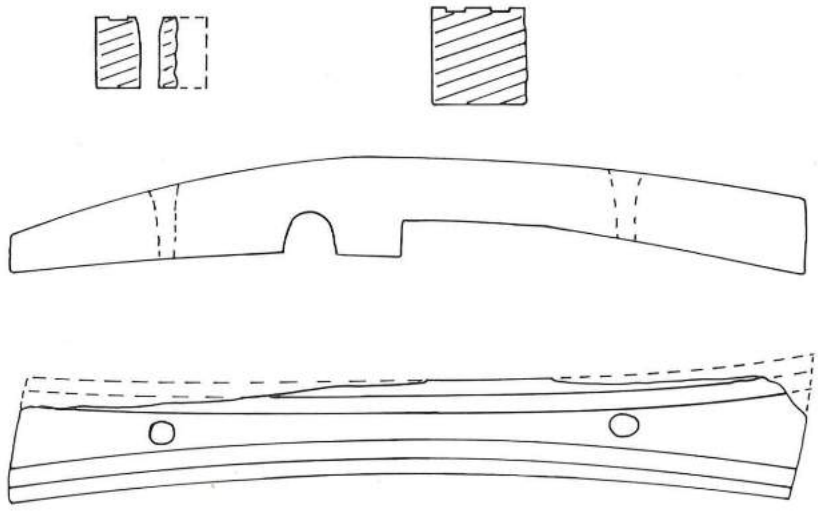
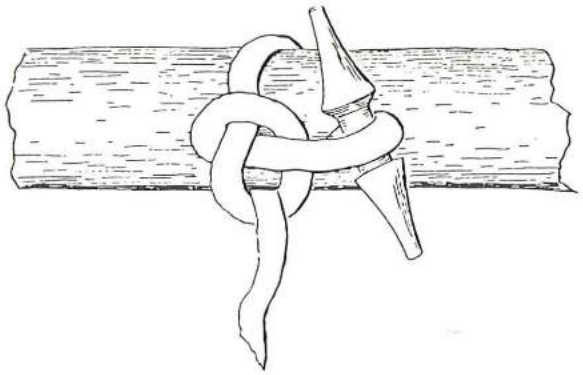
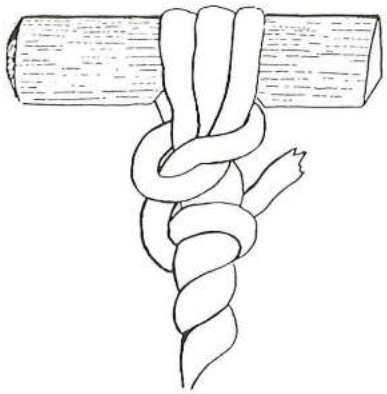


Fig 9-27 Cleat from medieval layers in Oslo. (C 26509c)

10 cm



b.



d.

Fig 9-28 Rope-end toggles from the Oseberg find (after Shetelig 1917)

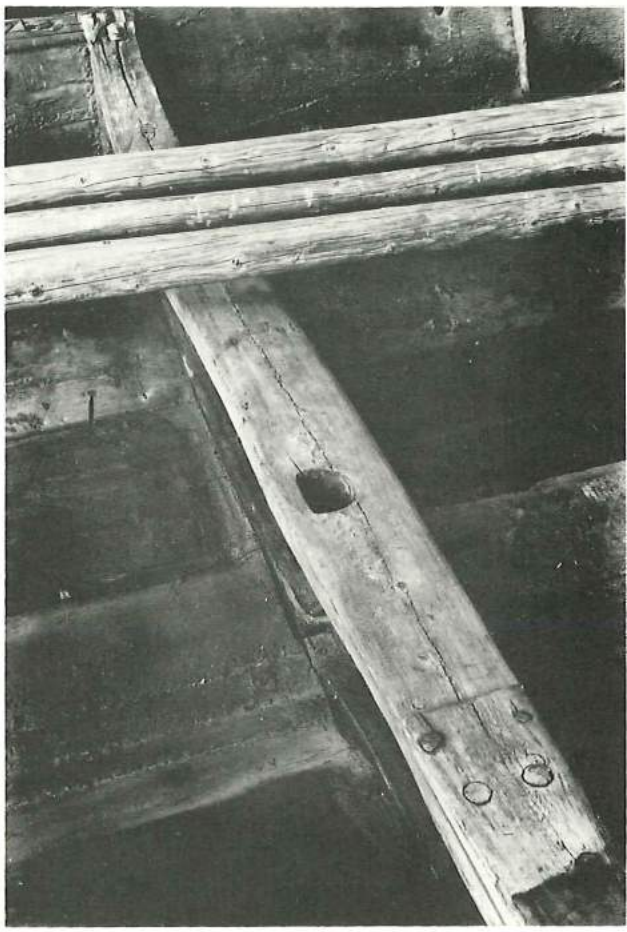


Fig 9-29 The mast beam of a small four-oared boat from Namdal, 19th century. The mast hole is for a mast with flat front surface, like 90301 and 90613

BAILERS

The bailers from Bryggen need little comment, as this tool has remained practically unchanged for centuries. All are of the one-hand variety known and used to this day. The archaeological parallels are few. In the Oseberg ship a bailer of a different type is represented, shaped like a shovel and used with both hands. In the Gokstad ship a fragmentary bailer with a little carved decoration was found (Nicolaysen pl VII, fig 16). From the 1960 excavations in Tønsberg comes a large, one-hand bailer found in a medieval context. Finally, there is a small, neat bailer from a North Norwegian bog find, Ts 5412. which cannot be dated (fig 10-7). Similar bailers may have been in use ashore, for splashing water on the hot stones in a bathhouse, or possibly as grain shovels, but their main function is maritime. In the 19th century, the fishermen of Northern Norway had two bailers in the larger boats. One was the small one-hand variety. The other was a large affair, with a withy across to act as a second handle. When the boat shipped much water, the large bailer was used by two men.

To be really efficient, a bailer should be used in a fairly small boat, where the water can be thrown over the sheerstrake with a rhythmic scooping action. According to written sources, larger vessels were bailed with buckets until pumps came into use in the 15th century (Nicolaysen 1881, 17 f, Falk 1912, 6). A detail worth noticing is the forward slope of the "back wall" near the handle. This is found on several of the Bryggen bailers and on the bailers from Gokstad and Andøya, as well as on some modern bailers.The function of this detail is to prevent any of the water being scooped out from splashing upwards into the face of the user. Anyone who has used a modern plastic bailer will appreciate the point. The plastic bailers have kept the shape of their wooden models, except for the "back wall" which unfortunately slopes backwards to enable easy extraction from the mould during the manufacturing process. That bailers occasionally saw other uses than scooping water out of a boat can be seen from an entry in the accounts of Bergenhus in 1567. Among the fines for blows, quarrels and knifing, one Magne from Sunnfjord is fined one mark for "striking his neighbour a blow with the bailer" (Lensregnskaper IV, 192).

The dimensions listed in table 10-I are shown in the diagram fig 10-1. This should be self-explaining.

TABLE 10-I BAILERS

Number	A	B	C	D	E	F	Date	Notes
14261								
18013	34	11	14	16	8.5	7.5	BF 6	1
28450	43	12	18	17	8.5	6.7	BF 3	
54083		17	2.5	15		6	BF 4	2
55519	48.6	18.2	24.2	19.5	6	5	BF 5	3
61906	50	18	22	21.6	8	8	BF 5	
70401	41	14	18	18.2	5.8	5	BF 5	
85455	39	13	16.5	18	8	6	?	

See fig 10-1 for the position of the measurements (cm) given in columns A–F. The dating is given as before the fire (BF) as numbered.

Notes to table 12-I

1 Rather fragmentary

2 Only handle intact, bowl lost

3 A z-like owner's mark is cut twice into the bailer

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	
3	1413	
4	1332	XX
5	1248	XX
6	1198	X
7	1170	X

TABLE 10 - II

DATED BAILERS

1 OF THE BAILERS CAN NOT BE DATED.

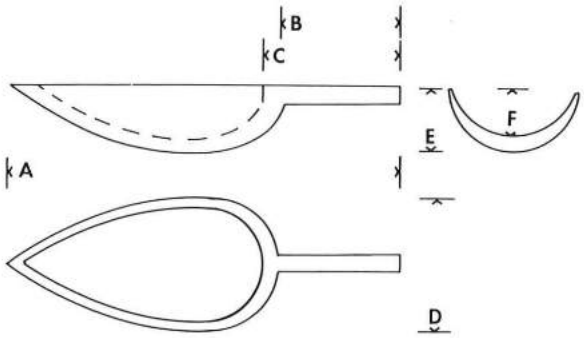


Fig 10-1 Sketch of bailer measurements given in table 10-I

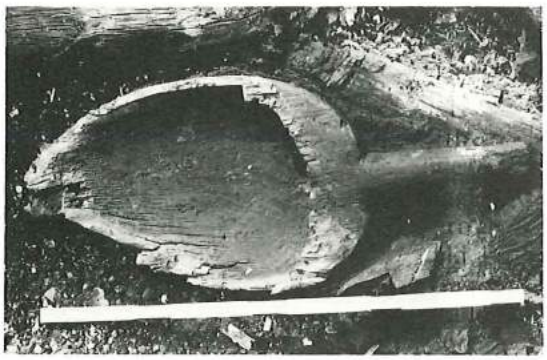


Fig 10-2 Bailer 70401 in situ

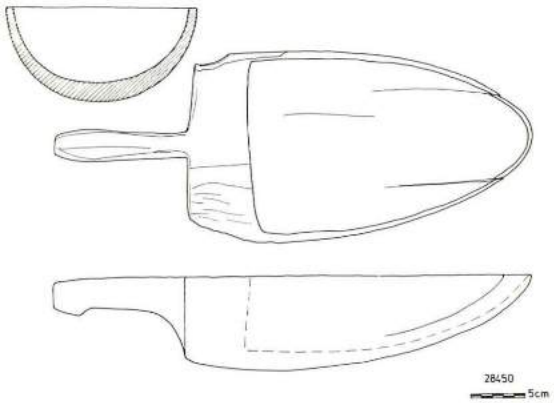


Fig 10-3

Fig 10-4

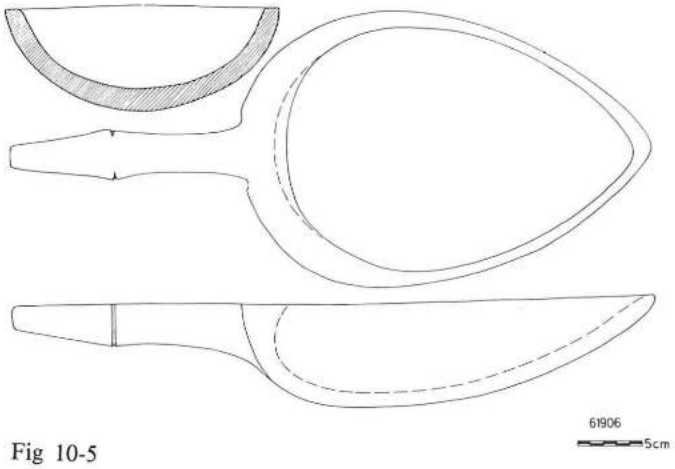


Fig 10-5

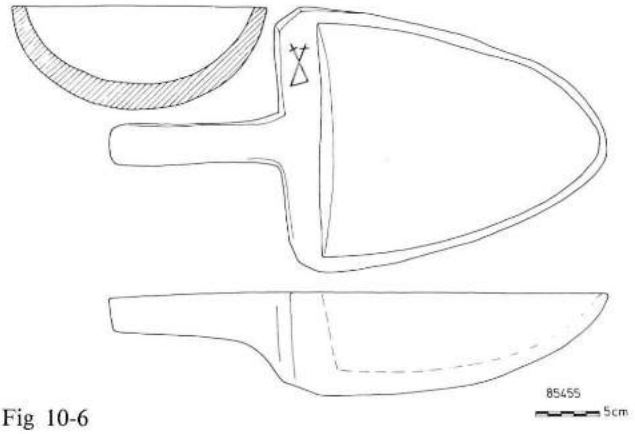


Fig 10-6

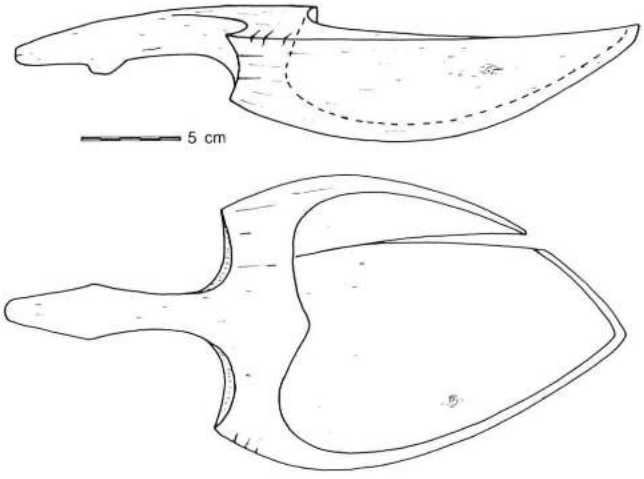


Fig 10-7 Undated bailer from a North Norwegian bog find (Ts 5412)

STEERING EQUIPMENT

In the period covered by the Bryggen finds, the transition from side rudder to stern rudder took place in Northern Europe. The iconographic evidence, mainly the town seals, seems to prove that the stern rudder first came into use in the Baltic on ships of the cog type and later spread to the shores around the North Sea (Brindley 1938, Wiechell 1971). Here, the adoption of the stern rudder led to a change in the shape of the hull, and the curved stern post was abandoned in favour of a straight one, more suited for mounting a stern rudder (the shape of the hull before and after the change is well illustrated by the seals of Winchelsea and Ipswich, Brindley 1938, figs 27 and 3). It is to be expected that there was a long transition period, when ships with different steering equipment were lying side by side in the harbour and it is quite possible that ships built with a side rudder were modernized to take a stern rudder during their working life. The fishing boats of Western and Northern Norway clearly show that a curved sternpost does not exclude a stern rudder. Four complete and fragmentary side rudders, one unfinished or badly damaged side rudder and two *rudder bosses* from small boats make up the material of this group.

In the Bryggen material, there are no remains of stern rudders. The two complete side rudders 91446 and 92738 are rather different in shape. The latter is long and slender, the former squat. 92738 was broken during mechanical excavation, but only a small part of the lower edge was lost. Remains of treenails in the aft edge show that the blade was originally widened by a piece being nailed on to it, such as has survived in 91446 (figs 11-1 and 11-2). The fragmentary rudder 92741 seems to have been smaller than 91446, but like it, of squat proportions. The fragment has the rectangular tiller-hole preserved, as well as two fastening holes, the main one of which is remarkably large (fig 11-3). 92741 is either an unfinished side rudder or one with much secondary damage. Tiller or fastening holes are not preserved. The shape resembles 91446 and the piece has been taken out of the tree-trunk in the same way. Treenails along the aft edge are evidence of a nailed-on piece, now lost (fig 11-3). 90830 and 90830b are fragments of a small side rudder. One piece was under conservation and therefore unavailable for study during my stay in Bergen to survey the material, so I know it only from the supplementary plan (fig 11-4). The top of the rudder head with the tiller hole was available and could be checked against the drawings. The rudder was drawn on P2 plan IV, where it is c 1.55 m long. Part of the lower edge may already have been missing, so the total length is unknown. On the supplementary plan two dowels are indicated, so this rudder also carried a nailed-on edge, unless the dowels are secondary. The rudder must have come from a small boat, with the rudders of the small Gokstad boats as the nearest parallels. The two rudder-bosses 4665 and 54773 are similar in shape and size. Both show some secondary damage, mainly on the surface which originally lay against the strakes of the hull. 54773 also has some damage on the top of the *wart*. 4665 has two holes for iron nails; 54733 has one. The grain of both pieces show that they have been taken from a tree trunk with part of a branch protruding at approximately right angles. The hole for the rope or withy which held the rudder is drilled through the centre of the branch.The parallels are few. Gokstad and Oseberg have the original bosses, while those of the small Gokstad boats are reconstructions. The boss of the Kvalsund ship exists in a very fragmentary state. Among the medieval finds, the Elling Aa ship had its boss preserved, while one loose piece has been found in medieval Gdansk, Poland (Smolarek 1969, fig 102). Where it rests against the strakes, the Gokstad boss is round in section, the Oseberg one lentoid, while the others are elongated. When discussing the mounting of the side rudder from Östra Aros, Åkerlund postulates a mounting inside a curved beam placed horizontally on the hull. His reconstruction is based partly on the Winchelsea seal which shows such a beam, and partly on a ship carved on the font of Löderup Church in Scania (Åkerlund 1952-1, fig 7). The Bryggen finds show that the Viking Age type of boss continued in use at least for small boats until c AD 1250. Naturally, this does not exclude other technical solutions of the rudder mounting for larger vessels.

The fastening hole of the large Bryggen rudder has a wedge-shaped mortice cut on the outside and the surface here carries traces of rust. These may be secondary features but if they are original, they bear witness to a differ-

ent mounting from the osier of Oseberg and Gokstad. If a thick withy or rope was used, it may have been secured by an iron "linch pin" on the outside, instead of the knob on the end seen in Oseberg. In his paper on the Rebek rudder, S Skov shows a reconstruction where the rudder is hung on an iron pintle. The reconstruction is based on a suggestion by H Åkerlund (Skov 1944, 17). 91446, 92738 and 92894 all have a second smaller hole below the main fastening hole. The Rebek rudder shows similar detail, in this case two small holes. An unpublished fragmentary rudder from the excavations in Rosenkrantz gate in Bergen also shows a similar hole, but with a treenail sitting in the hole. I would suggest that this is not a secondary feature, but that the treenail originally held a block of wood supporting the rudder against the side of the ship, and that this detail may have been a regular feature on larger medieval side rudders.

Of the rudders, 92738 was found during mechanical excavation and cannot be closely dated. 90830 was found below fire III, 91446 is probably from below fire IV, while 92741 and 92894 are both tentatively dated to c AD 1200–1250. Both rudder bosses were found below fire V.

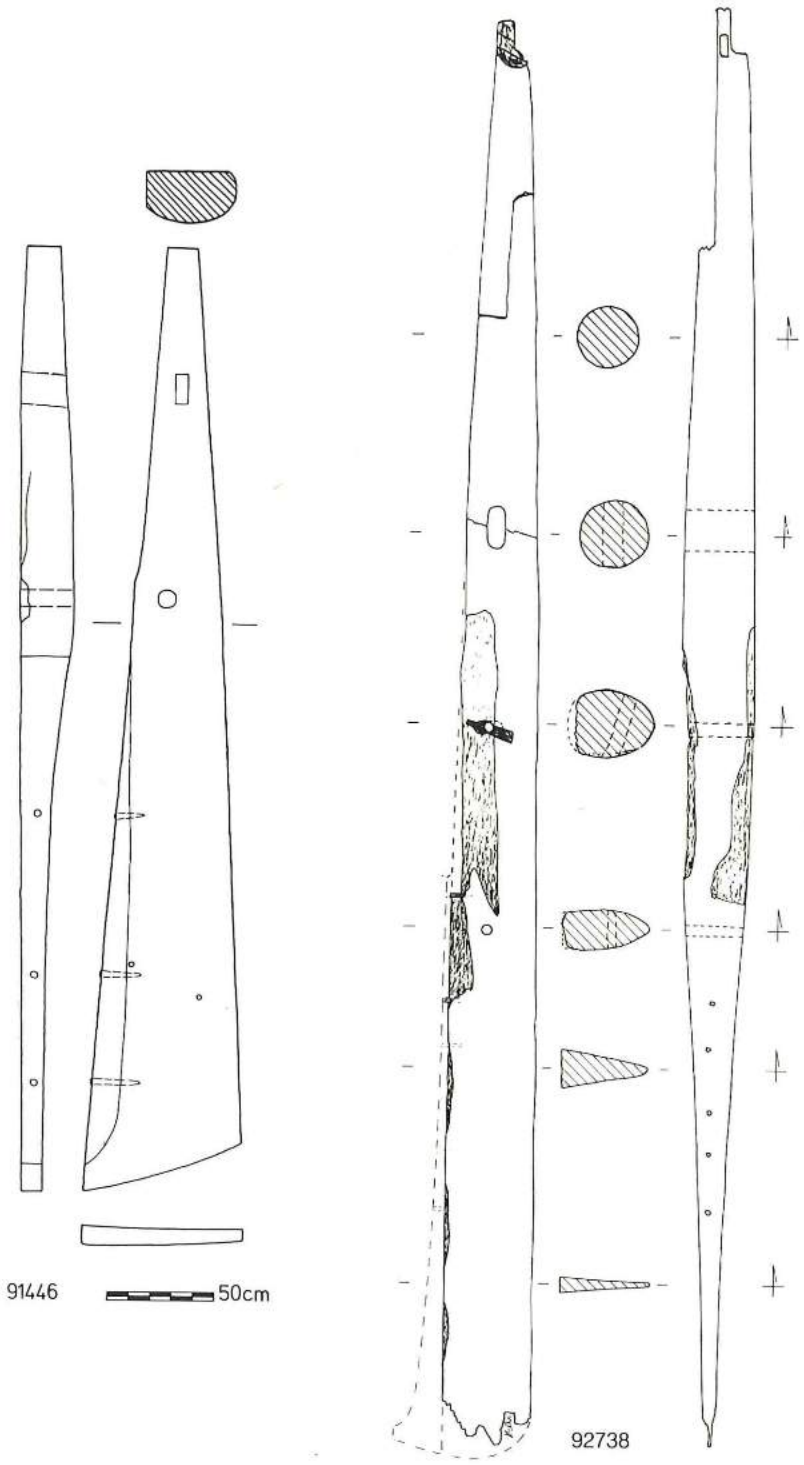


Fig 11-1

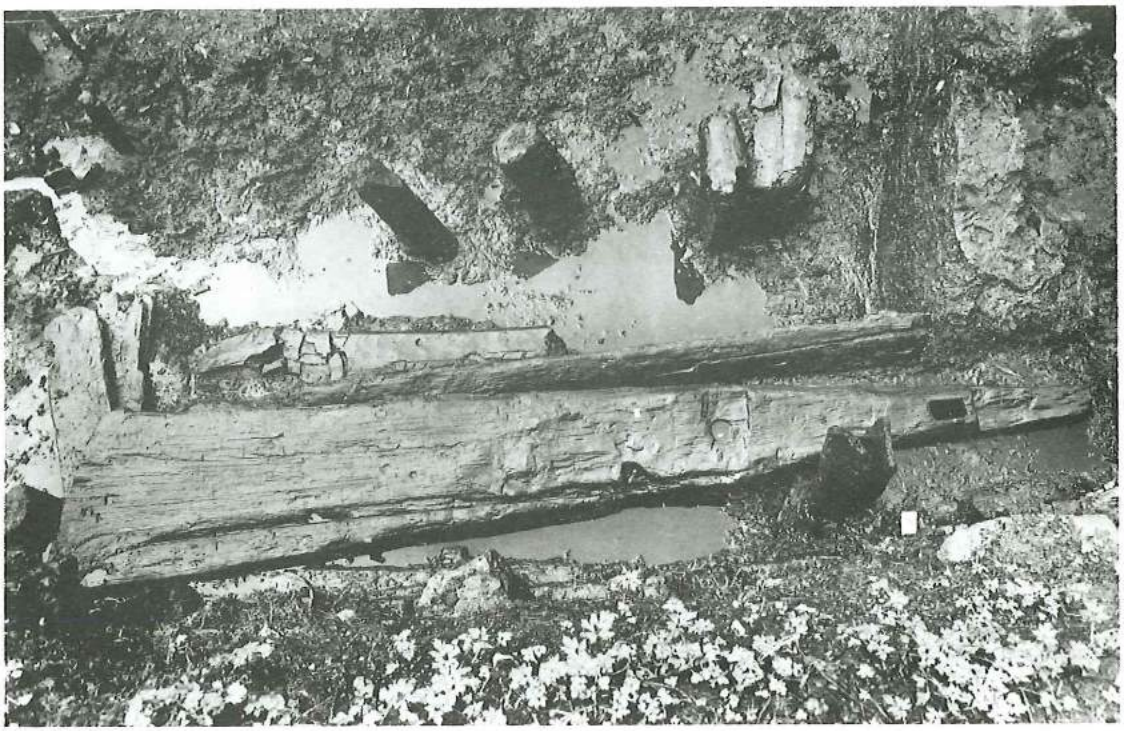


Fig 11-2 The rudder 91446 in situ

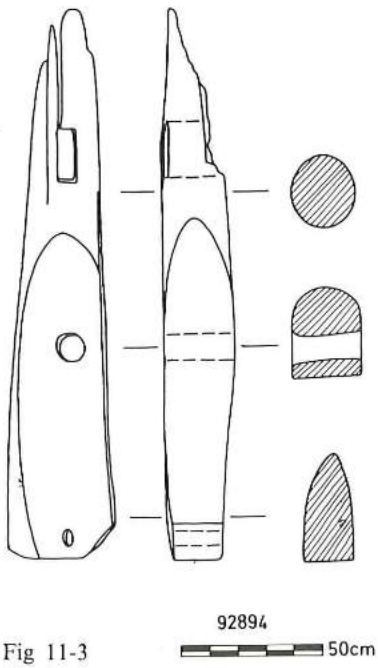
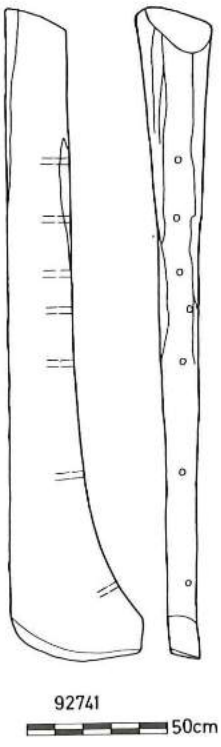


Fig 11-3



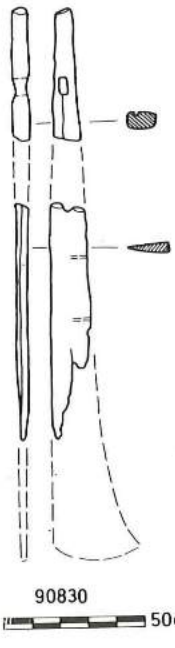


Fig 11-4

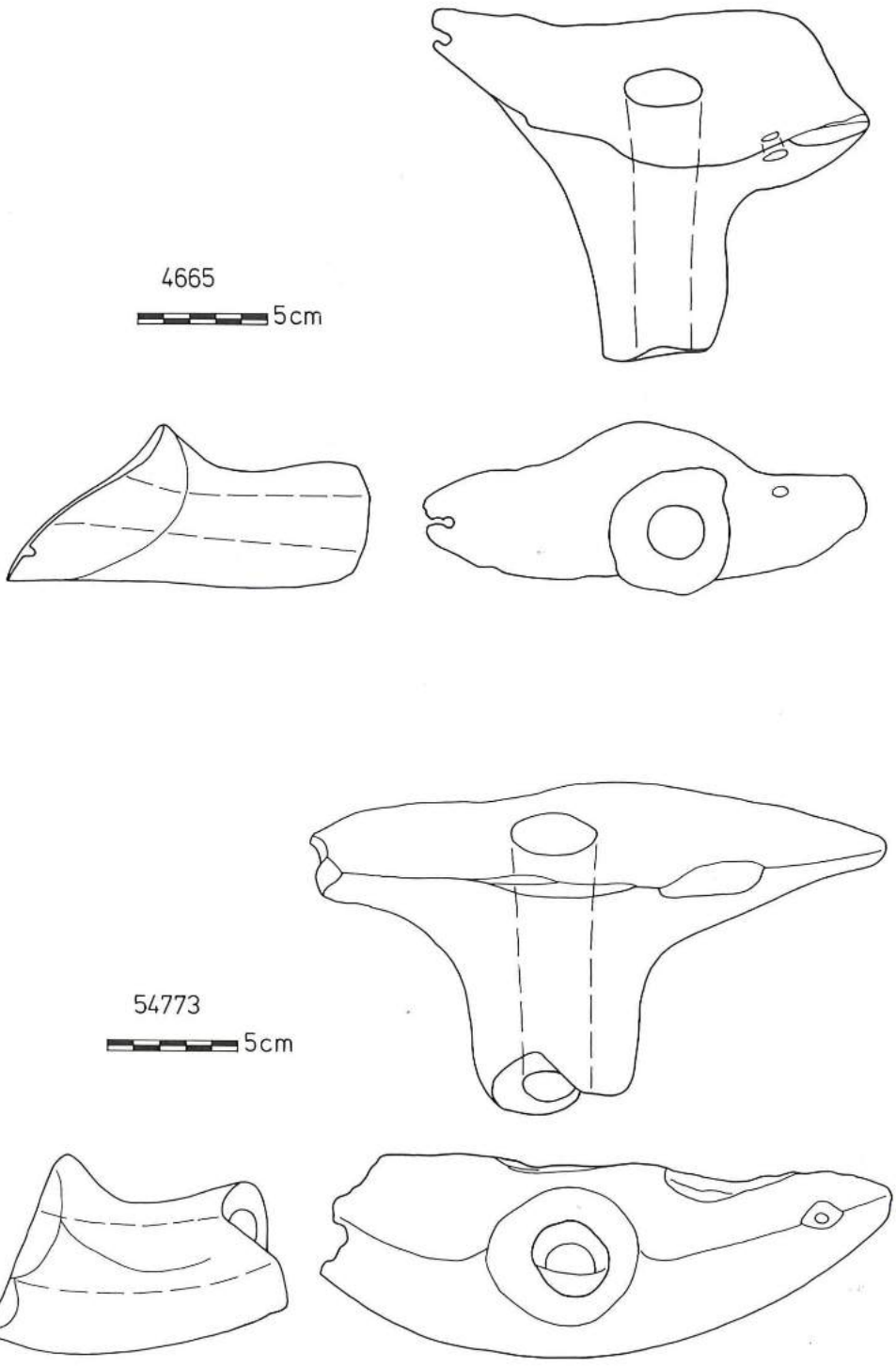


Fig 11-5

MODELS

Boat and ship models are not uncommon among the finds from medieval excavations. They have been found in great number in medieval Gdansk, Poland (Smolarek 1969, 185 ff). They also occur in the material from Oslo, Dublin (O'Riordain 1972) and the Norse settlement in Greenland (Olsen and Crumlin-Pedersen 1967, fig 74). From Bryggen there are eight, four are fragmentary and the others are small and with little detail, with one exception, the fragment 10082, which will be treated in greater detail later.

62790 and 64308 are rather uncertain as boat models. Herteig illustrates one of them as a boat model (1969, fig 58) but if they are indeed models of vessels, they are definitely of non-Nordic type. The closest parallels to 62790 are among Continental river craft like the vessels from Egernsund, (Crumlin-Pedersen 1977, 7) and Kreefeld (Ellmers 1972). Both of these are flat-bottomed craft, however, while our model has a round bottom. 64308 may not be a model boat at all but the supporting block or "bearing" of a breast auger. All things considered, I am not willing to accept the two as boat models until furter proof is forthcoming of the existence of such types in the Norwegian Middle Ages (62790 is illustrated on fig 12-1).

The boat models 17545, 39900, 54768, 72760, 81065 and 93394 are all double-enders. 31234 is a small fragment of a sharp stem from a boat model (fig 12-1). 17545 and 39900 are sharp narrow boats, probably intended as models of small rowing vessels of Nordic type (figs 12-2 and 12-3). 39900 has a square block of wood left above the sheerline, with a pair of incised lines crossing one another on top. Other incised lines on the sides clearly represent strakes. It is tempting to interpret the block of wood as a representation of cargo, covered by a tarpaulin and lashed. One of the ships painted on the wall of Siljan church, Telemark, shows a similar detail by the mast, which might also be interpreted as cargo. Based on the description in the *Kongespeilet* of fighting-castles on ships R Morcken has interpreted the detail on the Siljan ship as a midships fighting-platform or castle (Morcken 1980, 82). 54768 and 72760 are double-ended keel boats, while 93394 has a flat bottom with no keel indicated, sharp stems, and more beam than the other models (figs 12-2 and 12-3). The shape is probably due to the coarseness of the model, which may have been cut by a child. The curved stems makes it unlikely that the model is a representation of a flat bottomed craft of the cog type.

Pine bark has been a popular material among Norwegian children until today for making toy vessels. It is soft and easily cut with a knife, floats well, and can be found up to c 5 cm thick on old pine trees. One of the model boats from Bryggen, 81065, is in this material (fig 12-4). It is complete, rather roughly cut, but clearly intended to look like a double-ended keel boat of Nordic type. It has very little sheer and is only slightly hollowed, but both features may however be due to the material. It splits easily and is not very strong, so thin-walled elegant models are difficult to make. The entire character of the boat is very like the ones still made by children, including the ones I carved myself some 35 years ago, and I find it most likely that the boat is the work of a child. Numerous parallels were found in the Gdansk excavations, where pine bark is the most common material for model boats. The Gdansk models, discussed in detail by Smolarek (1969), have been interpreted as toys. Model horses, swords etc. in the Gdansk material, all made of wood, strengthens this interpretation and there is little reason to regard the models from Bryggen as otherwise.

The rest of the "maritime" models from Bryggen are 14 stems and stemtops, four masts, one parrel, two bailers, one bearing for a windlass and a mould for a model weather vane. Some of these are probably toys like the model boats; some of them may have had other functions.

The bailers 7501 and 93395 are shaped like the full-sized ones. Both have lost the handle. The bowls are 7.5 cm long, 4.2 cm broad and 2.7 cm deep on 7501, and 9.5/4.8 and 1.7 on 93395. The possibility that they may be wooden spoons has been rejected, as this shape of spoon blade did not come into use until a much later date. Wooden spoons are not uncommon in medieval excavations, but to my knowledge, none has been found with this shape to the blade (figs 12-5 and 12-6). Of the four model masts (4127, 19372, 20661 and 23086), 23086 is broken, while the others are complete, including the square heel at the bottom end. The lengths are: 4127-25.3 cm, 19372-37.6 cm

20061-31 cm, 23068-19.2 cm. All four have a wider part at the mast head forming a shoulder for the shrouds and stay and strengthening the mast at the halyard-hole. None of the models has the carefully shaped cross-section of the full-size mast 90301, which is round with a flattened front. 19372 and 23086 are round, while the other two are flattish. Their realistic shape and nice finish and the heel carved on the complete ones indicate that they were originally intended for use in model boats (figs 12-6 and 12-7). Two model boats have been found with masts; both are undated bog finds. The model from Båsmyr, Vestfold, has the bottom of the mast intact with a square heel for the mast step, while the model T 17740, from Ryggaunet, Ørlandet, S Trøndelag, has an intact mast in two fragments. The shroud shoulder and halyard-hole are lacking, so the Bryggen model masts are more like the real masts than this one.

The piece 30891, found above the 1332 fire, must be a model of a bollard with a bearing for a windlass, like the full-sized pieces 90124 and 90153. There are two small fastening holes at the bottom and the outer side is bevelled to follow the curves of a ship's side, but without plank steps. The hole for the windlass axle is not quite round and seems to be cut, not bored. The fastening holes show that the piece has been, or was intended for, a model vessel (fig 12-9). Of the stem models, seven are model stems, and seven are loose stemtops with a fastening tenon at the bottom. The stem models have parallels among the full-sized stems found in West Norwegian bogs, while full-sized parallels to the stem-tops have not been found so far.

44760 (fig 12-10) is a model of the stem type used in the Gokstad ship, the type being also known from the unused stem found at Sunnanå, Rogaland (S 2596) and the Polish wreck Gdansk-Orunia 2 (Smolarek 1969, fig 56). Among the West Norwegian bog finds, the unused stems from Haukenes, Huftarøy, Hordaland have the same general shape, but a different stem-top. The Sunnanå stem is a close parallel to the Gokstad stems and should in all probability be given a Viking Age date. Haukenes and Gdansk-Orunia are difficult to date closely, both are medieval, and the Gdansk-Oruna boats according to Smolarek are Slavonic in type and probably antedate the conquest of Gdansk in 1308 by the German Order. The Bryggen model is found above the 1198 fire and should probably be given an early 13th century date. There is some damage to the top, but there seems to be little doubt that 44760 originally ended in a slender point, like the Sunnanå stem.

The model stems 5066, 9277, 29674, 43563 and 81062 all have step-like cuts for strakes on the inside. 5066, broken at the top, has two, 81062 has four, the remainder have three. 5066, 29674 and 81062 have the keel scarf indicated, 81062 has incised lines indicating strake runs, like those seen in the winged stems of the Gokstad four-oared boat, Skuldelev wrecks 3 and 5 and the best finished Eigg stem (Grieg 1940, fig 87). Stepped stems like these are not uncommon in Viking Age and medieval boat finds. It is a matter of taste whether the "winged" stems of the Gokstad four-oared boat, Skuldelev 3 and 5, Eigg, Dalland and Midtvaage should be classified as stepped stems or as a separate type (figs 12-10, 12-11, 12-12, 12-13 and 12-14).

Of the loose stem-tops, 8779 is damaged at top and bottom, while the others are complete or nearly so. 8256, 8681 and 19732 are remarkably similar. 8779 is of the same general type but smaller and with two longitudinal grooves on the sides at the bottom end. 39606 is smaller and less elegant, while 54420 has a more squat shape than the rest. All the intact pieces have a tenon at the base, while the bottom surface of 8779 shows traces of a cut-off tenon. 8681 and 54420 have a small hole drilled sideways through the tenon. 25547 differ somewhat from the others. It has 2 steps on the outside at the top and a longitudinal hole here. As mentioned above, no full-size parallels to the stem-tops have been found (figs 12-15, 12-16, 12-17,12-18 12-19).

10082 is a very interesting piece, when seen in connection with the loose stem-tops. It is a small fragment of a model boat, part of a stem, broken at the bottom along the grain of the wood (figs 12-20 and 12-21). The V-shaped interior shows that the model was hollow, and there are incised lines indicating strakes and a moulding along the edge of the stem. The top is shaped to make a small flat surface. In this surface there has been cut a mortice with a small pin going through the wood from side to side. This shows that the piece belonged to a model boat originally equipped with loose stem-tops of the type just described. It is unfortunate that so little of the model is intact, as no indication of the size can be given from the

fragment. The surface where the loose stem-top rested is only 2.4 x 0.8 cm so the model must have been equipped with stemtops smaller than any of those found.

In connection with the stem-tops it is natural to deal with 26924. This is a rectangular piece of pine, 8 x 8 x 3 cm. On one side is cut a V-shaped mould, probably for a fish-line sinker. (Several similar moulds were observed as I went through the material.) On the other side a mould for a model weather vane has been cut (figs 12-22 and 12-23). A mould of wood like this one can only be used for a few casts in metals of low melting point, such as pewter or lead. Both sides are charred and both must have been used, so we can safely presume that one or more model weather vanes have been cast in the mould. The shape of the vane is characteristic: a segment-shaped sheet of metal with an animal head at the outer end, mounted on a pole with a cross at the top. In addition to the 6 full-sized vanes from the Late Viking and Medieval period which have been found, model vanes are also known. A Bugge (1931) has published the full sized ones. The closest parallels to our mould are the Norderhov and Høyjord vanes, which according to Bugge can be dated to c 1300 and the mid 13th century respectively. The vane fragment from Winchester and the "vane animal" from Denmark show that vanes were also used outside Sweden and Norway, but as the shape of the vanes is unknown, they are of less interest in this context.

Of even greater interest than the full-sized vanes is the fact that they are also known in model form. The ship-formed candlesticks from Urnes and Dale churches have model vanes. A similar model vane has been excavated in Lund (Kulturen mus no. 8977). Of Viking Age date are two model vanes, cast in bronze, one from Birka, the other one is from Åland (Åkerlund 1959, 61). The vane from Åland is illustrated on the cover of Ålandsk Odling.

They are slightly different from the medieval ones and show the same shape as the vanes carried at the mast-head of some ships on the Gotland picture stones. This is in contrast to the medieval iconographic material, which shows the vanes carried at the stem. The best illustration is the Bryggen fleet, while another nice representation is on a gaming piece found at Gamla Lödöse (fig 16-20). A parallel but not a very close one to a mould of this kind is the slate mould for a dragon head found at Birka (Åkerlund 1959, 34 f). Incidentally, this mould shows a fastening bolt or pin through a tenon, like the loose stem-tops from Bryggen. The model vanes from Dale, Urnes and Lund are made from sheet metal, but there seems to be little reason to doubt that our cast one, of lead or pewter, served the same purpose on a model vessel of some kind.

Of the models, the parrel, masts, bailers and bollard are best explained as equipment for model boats, probably toys. These must have been much more elaborate than the actual model boats which have been found at Bryggen, and larger. The model parrel, for example has the characteristic curved shape of full-sized parrels, but heavier scantlings and it was probably originally intended for large model boat (51628, fig 12-24). It is well-known that children in maritime communities all over the world and at all times have played with toy boats. However, boat models have also had other functions, so all boat models should not be classified as toys without discussion in each particular case. It is sufficient to mention the funerary boat models of ancient Egypt, votive ship models in churches, the *silver nefs* found among medieval tableware, shipbuilders' models, and the decorative models found in shipowners' offices today to show the wide range of functions that a boat model may have.

The loose stem-tops from Bryggen are best explained as parts of complete boat models. The fragment 10082 is probably part of such a model. The stem-tops are carefully made, with good surface finish and elegant lines. A comparison with the Dale and Urnes candle-holders indicates a size of 0.5–1 m maximum length, if proportions were the same.These models may of course have been toys, made with loving care by a sailor or shipbuilder for his children, but they may as well be the remains of wooden candle-holders of the same type as the wrought iron ones from Dale and Urnes. Wooden candle-holders may seem a serious fire hazard, but they have not been uncommon. Another possibility is that the models originally graced a table, either as humble parallels to the silver salts in ship form (Oman 1963) or as drinking bowls in the form of ships.

The models of complete stems show no fastenings or other indications of having ever been part of model vessels.

As a rule, they are not as well finished as the stem-tops. On the other hand, they are good

representations of the full-size stems from bog finds. Models have had no place in traditional clinker boatbuilding procedure, as far as we know, but the models may have been made by shipwrights, to demonstrate shape to potential customers. They may be the work of children, playing shipwrights. Again, they may be the results of whittling by men who would use knife and wood to spend idle moments, and whose thoughts often lingered on ships. If this is the explanation for the stem models, and I rather tend to think so, the models can be seen as a three-dimensional parallel to the ship grafitti found in medieval churches and elsewhere, with the Bryggen fleet as a superb example. It may be significant that the grafitti often show stems only, not full ships. Both carver and whittler may have chosen to depict the most significant detail of a ship, the bold curves of the stem (Blindheim 1977).

TABLE 12-I BOAT MODELS

Number	L	B	D	L/B	B/D	M	Date	Notes
4127							IF 5	
10082	5.5	2	5			P	BF 5	1
17545	10.5	2.4	1.4	4.35	1.7	P	BF 5	
19372							BF 5	
20661							BF 6	
23086							BF 6	
31234	11.5	1.4	2			P	BF 4	2
39900	10.8	1.5	1.5	7.2	1	P	BF 2?	3
54768	25.5	7.2	3.2			P	BF 5	4
62790	8.6	3.5	2.1			P	BF 6	5
64308	10	3.5	2.1			O	IF 6	5
72760	10.7	2.5	2.2	4.28	1.13	P	IF 5?	
81065	14	4.1	1.6	3.46	2.56	Bark		
93394	13	5.4	2.2			P	?	6

Notes to table 12-I

1 Fragmentary, only a piece of the stem intact (figs 12-20 and 21)
2 Small fragment of stem (fig 12-1)
3 fig 12-2
4 fig 12-2
5 Uncertain boat model
6 Unusually broad and flat-bottomed model (fig 12-2)

FIRE LEVEL		FIND - SPOT
1	1702	
2	1476	
3	1413	/ / -
4	1332	/ / XX / X
5	1248	- -
6	1198	/ / X - - - -
7	1170	/ X

TABLE 12 - II

DATED BOAT MODELS

1 OF THE BOAT MODELS CAN NOT BE DATED.

X MODELS OF STEPPED STEMS

/ MODELS OF STEM-TOPS

\- BOAT MODELS

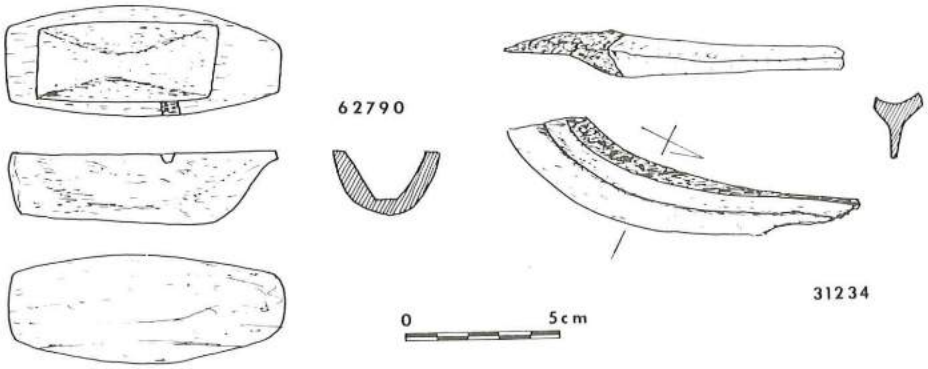


Fig 12-1

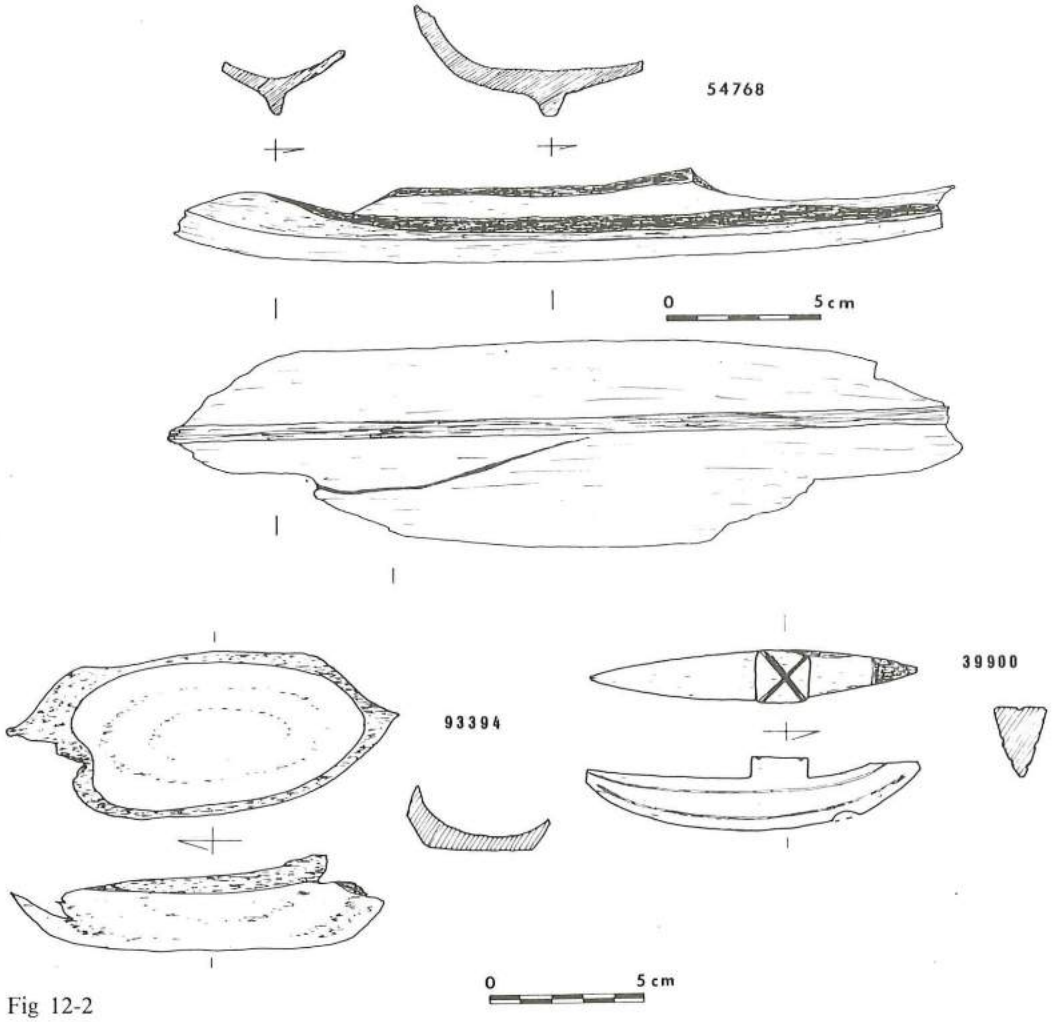


Fig 12-2

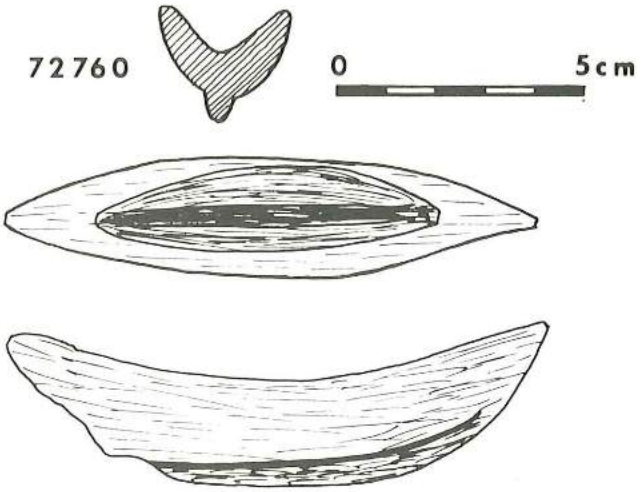
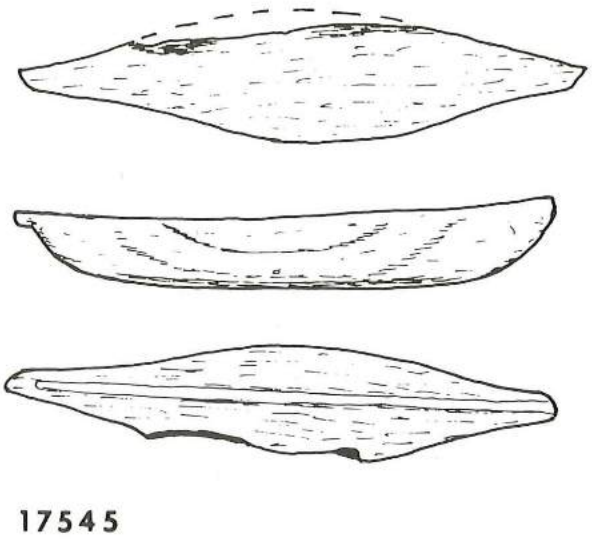


Fig 12-3



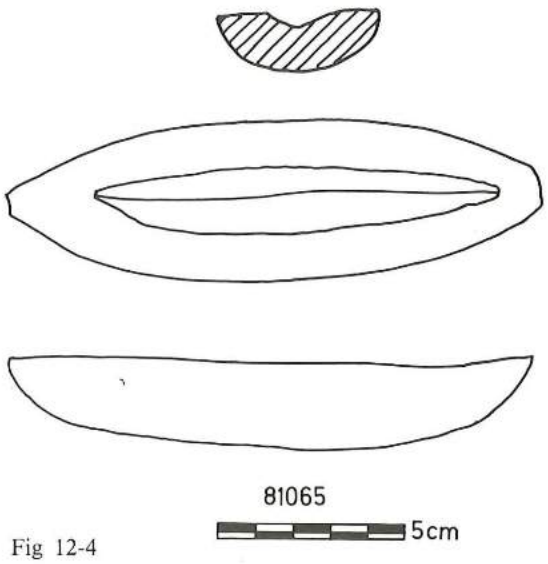


Fig 12-4

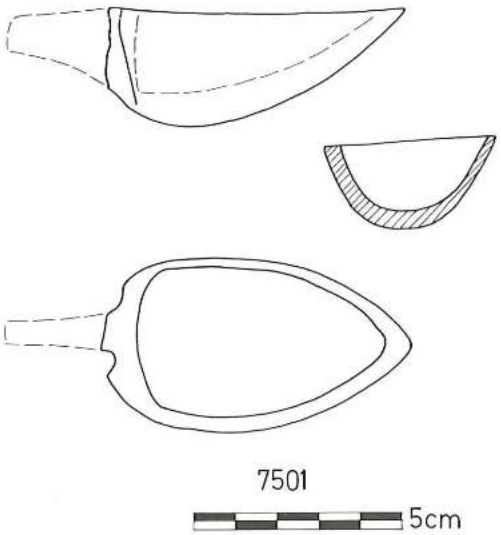


Fig 12-5

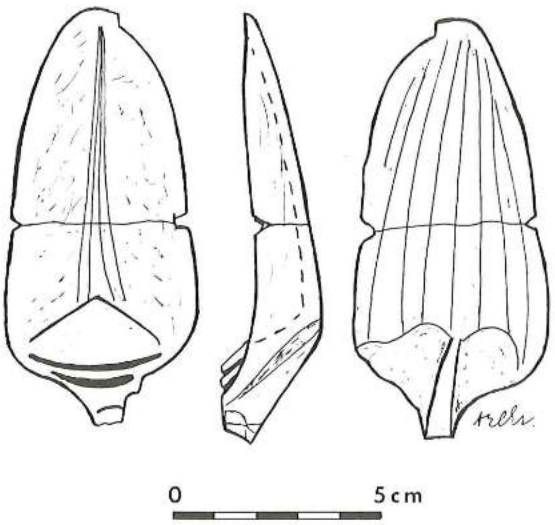


Fig 12-6

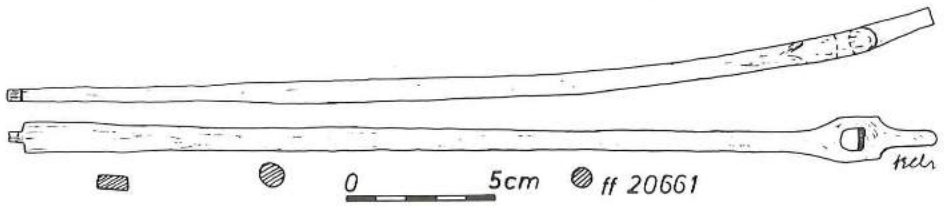


Fig 12-7

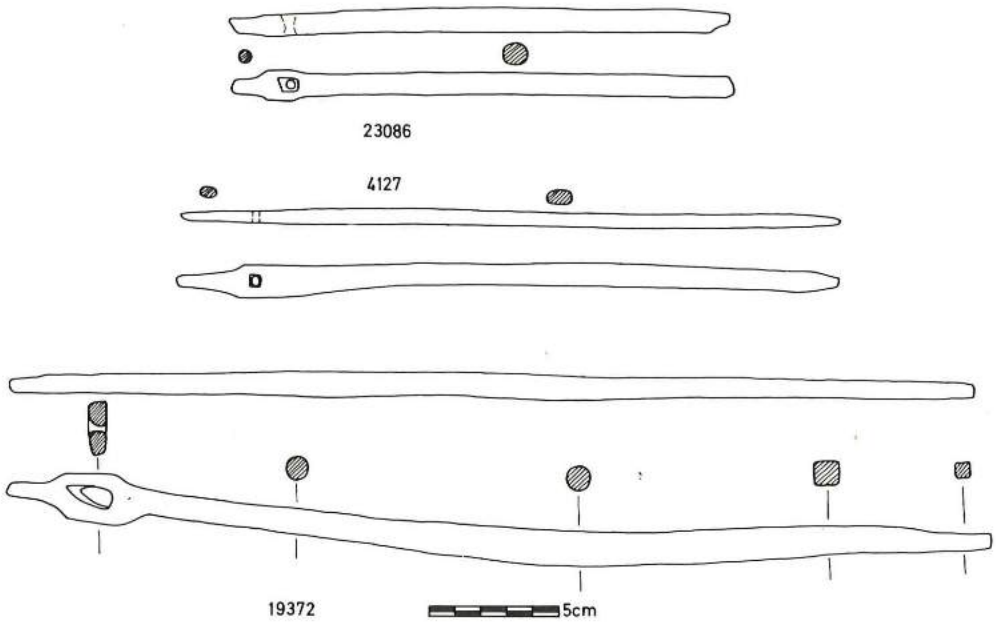


Fig 12-8

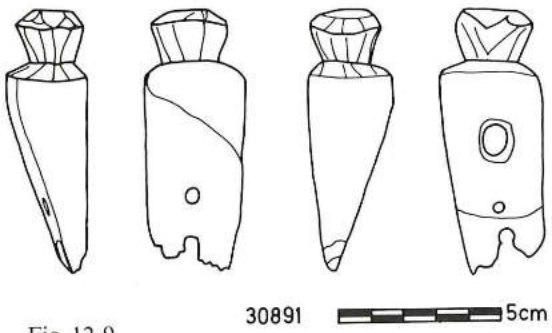


Fig 12-9

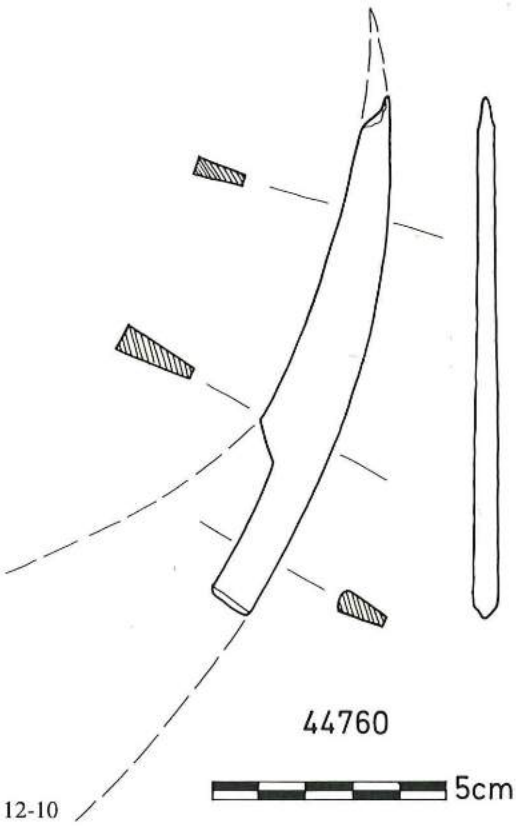
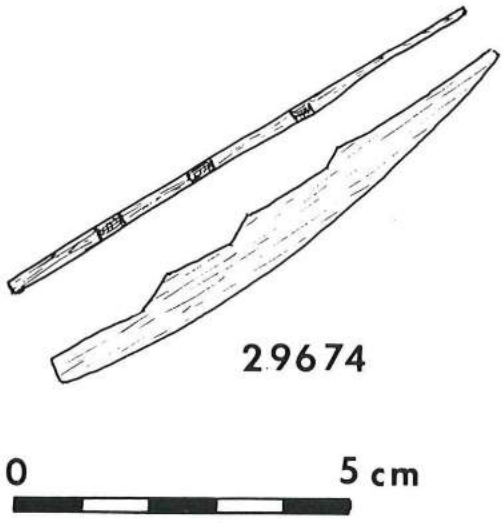


Fig 12-10



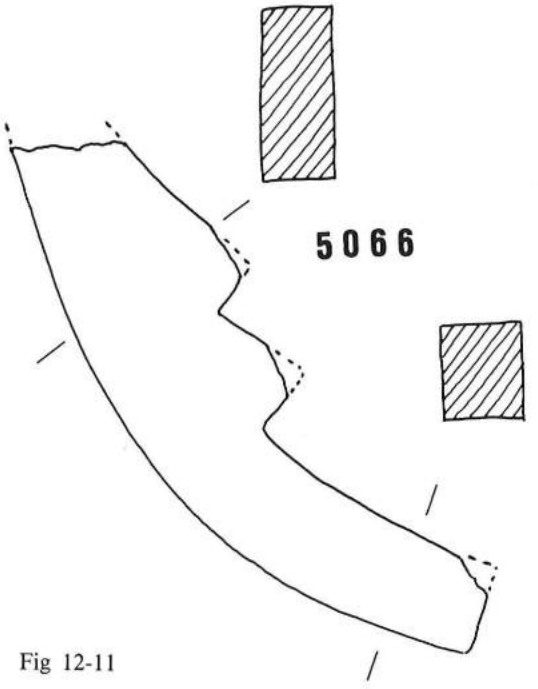
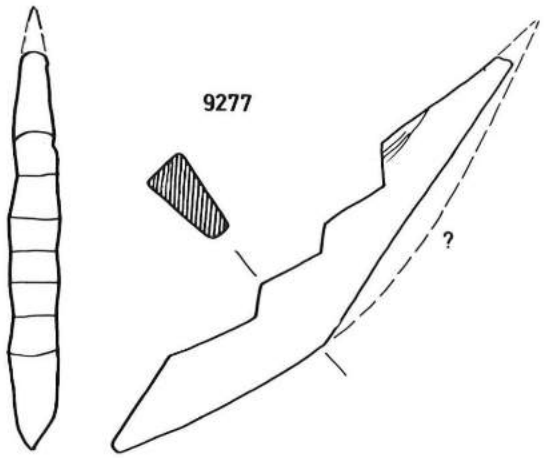


Fig 12-11



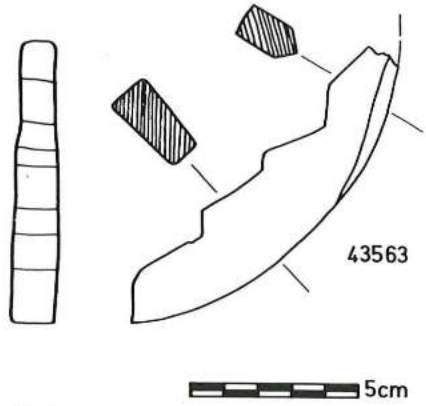


Fig 12-12

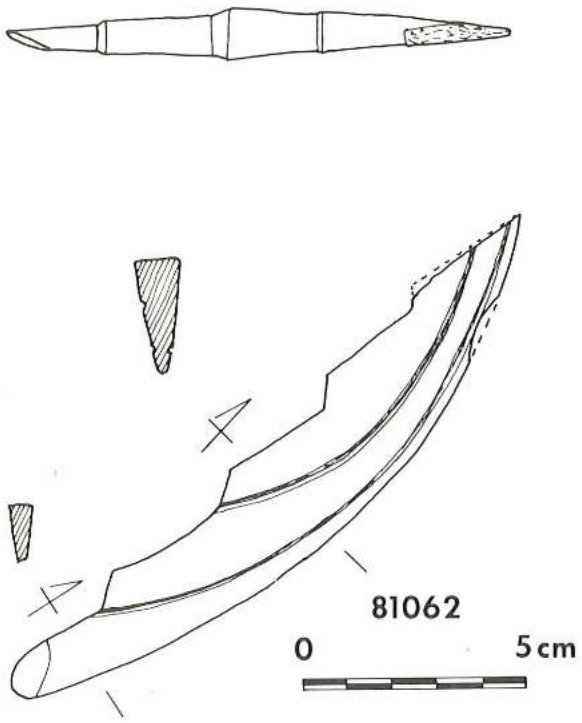


Fig 12-13

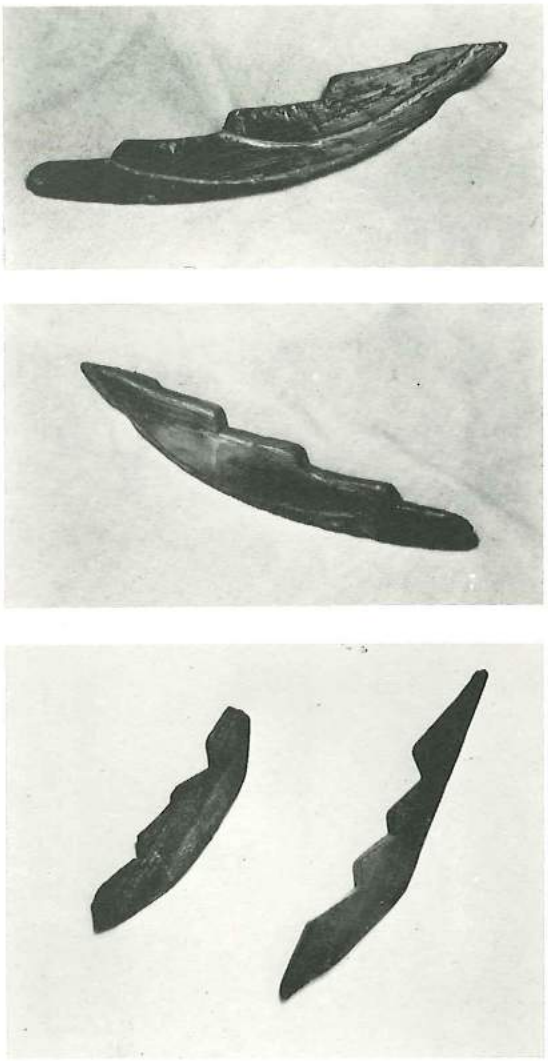


Fig 12-14

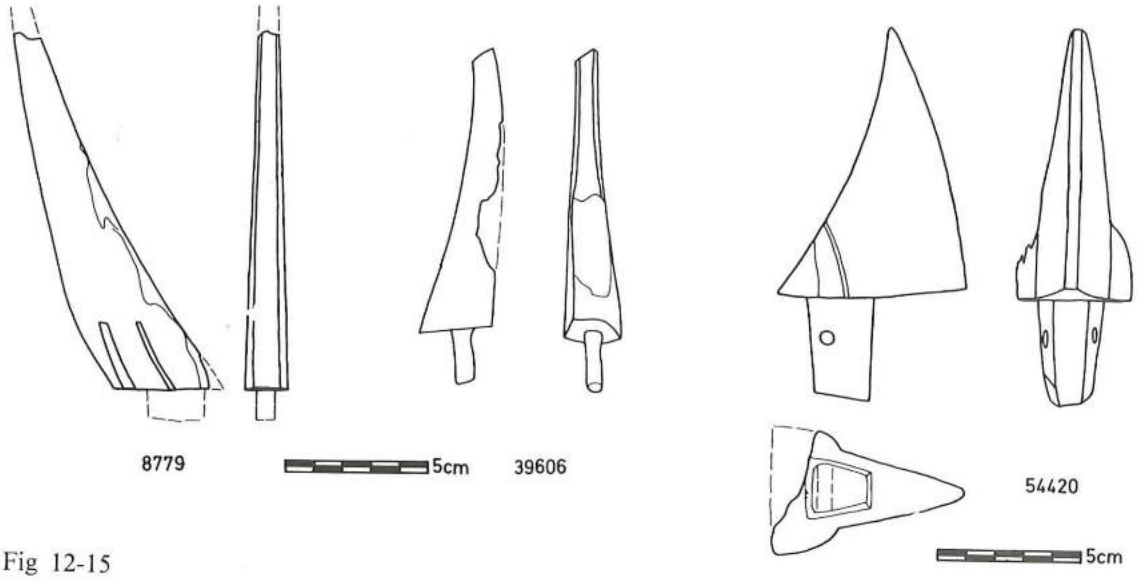


Fig 12-15

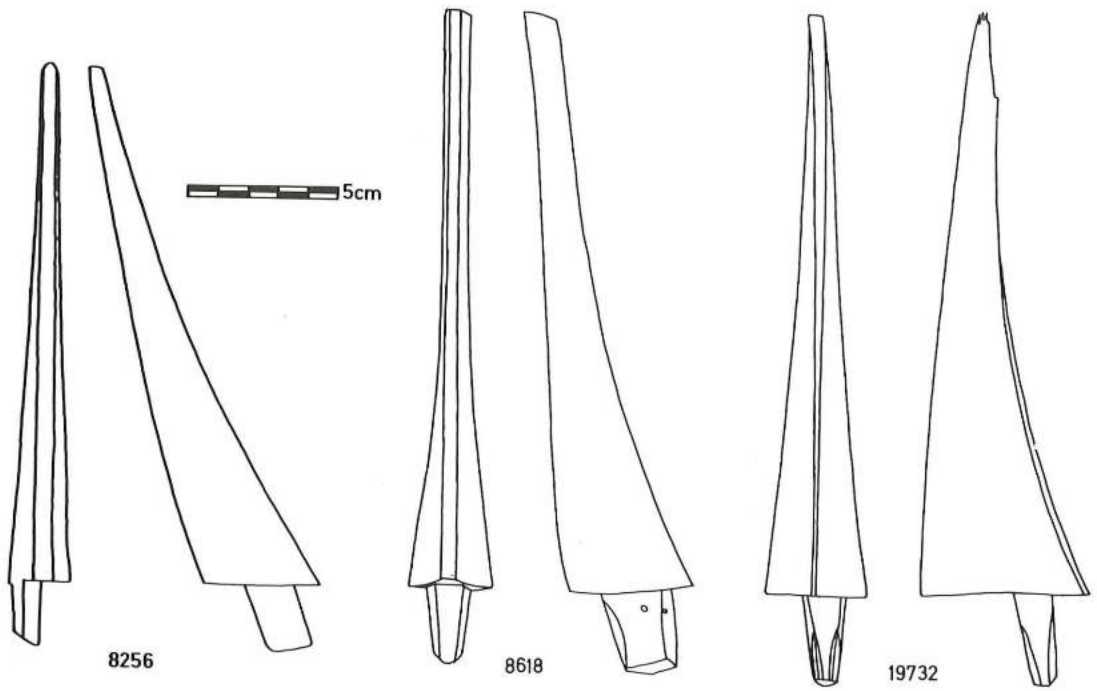


Fig 12-16

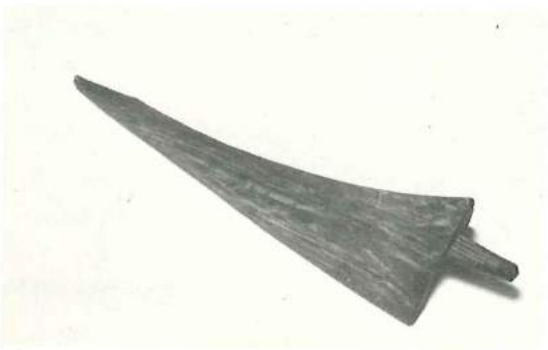


Fig 12-17

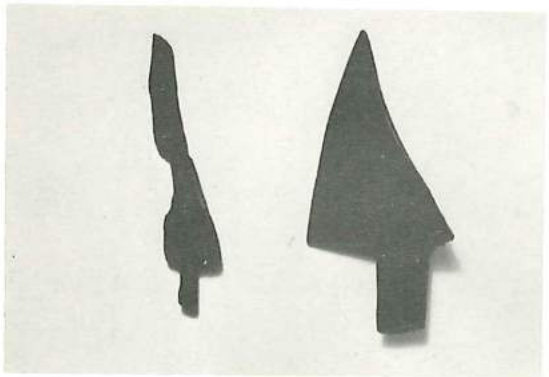


Fig 12-18

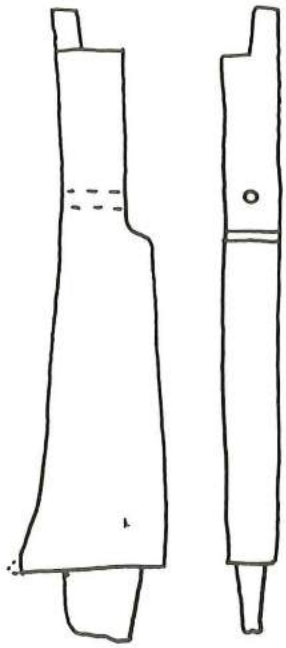


Fig 12-19

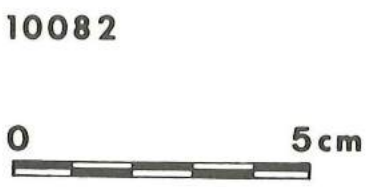


Fig 12-20

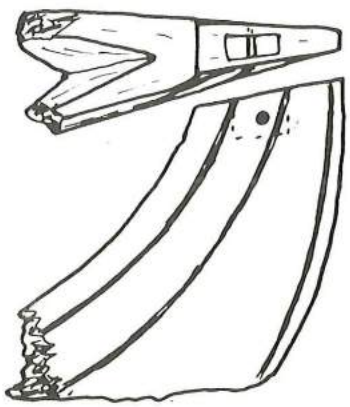


Fig 12-21

Fig 12-22

Fig 12-24

Fig 12-23

MISCELLANEOUS TIMBERS

On fig 13-1 I have collected a number of beams of characteristic shape but of uncertain funtion. They are difficult to place in either house or ship structures as we know them. The most likely explanation I can give is that they served as inwales along the sheerstrake of fairly big ships. (One piece, similar to 91359/60, is not illustrated. This (91435) was not available for study when I went through the material.)

All the pieces are notched at fairly regular intervals, ranging from a regular 45 cm centre to centre in 92499, to between 50 and 70 in 90388. The group 91359–362, which may come from the same vessel, has notch intervals which vary between 50 and 65 cm. All distances are within the known rib distances found in the Bryggen material, and similar irregularities are known in rib distances. This would indicate that they are beams placed alongships, notched to fit over ribs. If we postulate that the beams had one broad side horizontal, this would explain the bevel on the notched side, which would fit against the strakes. Where the angle is nearly 90 degrees, this can be explained as coming from a ship where the sheerstrake was nearly vertical. The main objection to this theory is the shape of the notches. For some time I wondered whether the beams had been placed on top of crossbeams, with the notches along-ships shaped to fit crossbeams with deckboard rabbets. However, a beam like 90388 would fit no known pattern of deckboard/open hold, and the fastening treenails, placed between the notches, would rest in the air between the beams. If the same beams were placed as inwales along the sheerstrake, they would be secured by treenails to the strakes only, not to the ribs. The extra notches might then be for loose uprights, placed temporarily to secure a "deck" cargo. It is interesting that the large lodging knee 90222 has one notch with the same shape.

90388 and 91359 has a certain edge-curve that may support the suggestion. 92420 has a groove along one edge, which may be secondary, but it may also have been for securing deckboards laid athwartships and forced into the groove in order to be securely fastened. However, I know of no parallel to this.

With these beams it is natural to include 90573, which also seems to be notched for ribs at similar intervals, ranging from 50 to 72 cm (fig 13-2). I can give no convincing interpretation of this piece. The flat side has axemarks, which are rare on ships, at least on surfaces that were seen. There is some edge-curve. The edges seem to be intact. One possibility is that the piece rested on top of crossbeams as a catwalk along the ship's side. Another is that this is not a piece of ship's timber at all.

The curved beam 90392 must also be classified as a wale or stringer. It is curved to follow the ship's side and bevelled to fit against strakes with considerable flare, providing that the upper face was horizontal, which is likely. The beam is notched on the underside for two ribs, spaced 93 cm centre to centre. The curve indicates a place far forward or aft in the ship, and this also happens to be where the only published parallel is placed: the Lynæs ship has a similar timber placed near the end (Crumlin-Pedersen 1979, fig 2). The beam is illustrated on fig 13-3.

The three pieces 90390/391 and 395 clearly served the same function as 90387. Most probably they were uprights between soleplate and top-plate in a stave-built house. All are reused timber. 90387 seems clearly to have been cut from a ship's deck-beam with rabbets for deckboards. 90390 and 90391 may also be ship beams, but I rather think that they saw service in two successive houses and originally were part of tie-beams, spanning an open hall where the moulding on both sides would be visible (fig 13-4).

Among the Bryggen finds are numerous loose treenails and wedges for treenails. Out of context, they cannot be attributed to specific constructions, but the wedged treenail seems to have been primarily a shipbuilder's fastening, even if it did see other uses.

The treenails were mainly used for connecting strakes and ribs but were also used for knees and crossbeams and other "intimbers". Less common is the use of treenails in the planking. When this occurs, it is generally the sheerstrake which is tree-nailed.

One wooden anchor-stock was found, 90160. The leg of the iron anchor was originally secured by a piece of wood, dovetailed into and treenailed to the stock. One end is broken, but we must assume that the stock was symmetrical, so the original dimensions are easily reconstructed. The length was c 245 cm. In the middle it was c 14 cm thick (excluding the loose

piece) and at the ends c 8 cm, while the leg of the anchor was c 5x5 cm (fig 13-5). There are parallels to the system of fastening with a short loose piece in the anchor-stocks from Oseberg and Gokstad and the anchors found in Kalmar harbour (Åkerlund 1951, fig 86 and pl 27d). This manner of building an anchor-stock seems to be medieval or earlier. The anchors known from the 17th century onwards have two-piece stocks where both pieces are the full length of the stock, held together with treenails and iron bands.

The windlass from the "Big Ship" has short axles at both ends for mounting, like its close parallel the windlass of Kalmar I (Åkerlund 1951, fig 15 and pl 5b). The Kalmar windlass was mounted in sturdy vertical bitts fastened to crossbeams. The windlass of the Bremen cog seems to be similarly mounted, judging from the published pictures of the reconstruction model (Abel 1969, fig 110). This type of mounting is also known from iconographic sources (Asaert 1974, colour plate facing 32, top). In the Bryggen material we also have examples of another type of mounting. The two pieces 90124 and 90153 are similar in shape, but differ considerably in size and must be from two different vessels (fig 13-6). Both are notched for strakes and were originally placed on the inside of a hull where the strakes converged towards stem or stern. Both have a hole on the inside that can hardly be anything but a "bearing" for a windlass. The larger piece has a bollard on top and must have reached above the sheerstrake. It is possible that the smaller piece was originally equipped in the same way, as the top seems to have secondary cuts. It is interesting that the same type of mounting is also represented by a model among the Bryggen finds (30891).

There may be boatbuilders' tools among the iron artefacts from Bryggen but their treatment is outside the scope of this work. Moreover, we still lack the necessary knowledge to distinguish between the edged tools of the boatbuilder and those of other woodworkers, if differences did, in fact, exist. What might be expected in the material are the wooden tools made by the boatbuilder for his own use and restricted to his trade. On the other hand, it is probable that the building and repair of boats took place in other parts of the town, so if the tools should be found at Bryggen, they would simply be part of the rubbish infill in the quays. Of the measuring sticks and levels used by recent boatbuilding I have found none. This is not surprising, as these tools contained trade secrets and it would not be likely that they were discarded on the rubbish heap, or lost in a part of the town where there would be little boatbuilding activity.

Absolutely necessary tools for the clinker boatbuilder are the clamps used to hold unfastened strakes in place when fitting and adjusting, and when riveting the strake. In recent material we find two varieties. One has two fixed legs and is generally made from a naturally grown fork with two branches. When in use, the clamp is secured with a counterwedge. The other variety has movable legs, closed by a screw or wedge. The screw clamps seem to be a 19th century innovation, used mainly in Western and Northern Norway. Wedged clamps have the two legs held together in the middle by a rather loose-fitting crosspiece. A wedge driven at one end will close the clamp (fig 13-8). The shape of the crosspiece is a characteristic one, and I know of no other artefact with this shape. I have identified five such pieces among the Bryggen material. As other fragments of clamps have not been found, the crosspieces must be regarded as discarded or broken tools and they cannot be taken as evidence of boatbuilding on Bryggen itself. One parallel, a complete clamp, comes from the excavations in medieval Gdansk, Poland (fig 13-10). A crosspiece similar to those from Bryggen was found in Skien in 1979. It was found in layers dated provisionally to the 13th century or earlier by the excavator (personal communication from Siri Myrvoll 1982).

Miniatures of bone or reindeer horn, are known from a Viking Age grave in Norway (Simonsen 1953), from Greenland, from Trelleborg in Denmark and from Hedeby. One has been found at Bryggen (43978). The small tools, of horn or bone, are in all probability intended for metalwork, but they show that the wedged clamp was a generally known tool. A 12 cm long piece, entirely of iron, was found among the smith's tools in the Roman fort of Newstead (Curle 1911, pl LXIV-9).

TABLE 13-I CROSSPIECES FOR BOATBUILDER'S CLAMPS

Number	A	B	C	D	E	F	G	H	Date	Notes
8929	22.5	20.5	12/15	5	4	3.5	1.5		BF 4	
37109	28.5	24	21.5	6.5	4.5	5.5	1.8		BF 4	1
44136	26	21.5	16	5.5	5	5	1.7	2	BF 4	
44353	27	22	11/14.5	8	4.5	6	2	2.4	IF 6	
63583	32	26.5	16.5	5.3	4.2	4.5	2		BF 5	

See fig 13-9 for the position of the measurements (cms) given in columns A–H. The dating is given as before (BF) or contemporary with (IF) the fire as numbered.

Notes to table 13-I

1 Damaged and incomplete piece.

In connection with the clamps, it is natural to discuss 89342. This is a flattish piece of wood, continuing into a round handle. It is broken, and the original length is not known. Around the flat part is wound a piece of hide with the hair on and heavily soaked in tar. The find listing of the piece is incomplete, and no information exists about the date or find-spot within the excavation area. A similar piece was found in the Revierstredet excavations in Oslo: R 8104 (Schia ed 1981, 185). In my opinion, this is a tool for tarring boats (and other objects), a "tar mop". The mop from Revierstredet is made in the same way as 89342, but with textile instead of the furry hide. Before brushes became common and inexpensive, this must have been the standard tool for tarring boats as well as houses etc (fig 13–11). The fragment is 23 cm long, the "head" is 10 cm wide and 4.5 cm thick. The 1981 excavation in Tønsberg has given one or two more, and Asbjørn Herteig has informed me that lumps of heavily tarred textiles have been found at Bryggen (pers comm 1982). A full survey of the material has not been possible in this work, as I did not know of the existence of all the material until after the manuscript was finished. In the accounts for Akershus Castle for 1557, we find the following item listed under expenses: "Seven ells of wadmal made into tar mops for His Majesty's ship 'The Cow', sloops and the boats of the castle". (My transl.) (Norske Lensrekneskapsbøker 1548–1567, I p 2.)

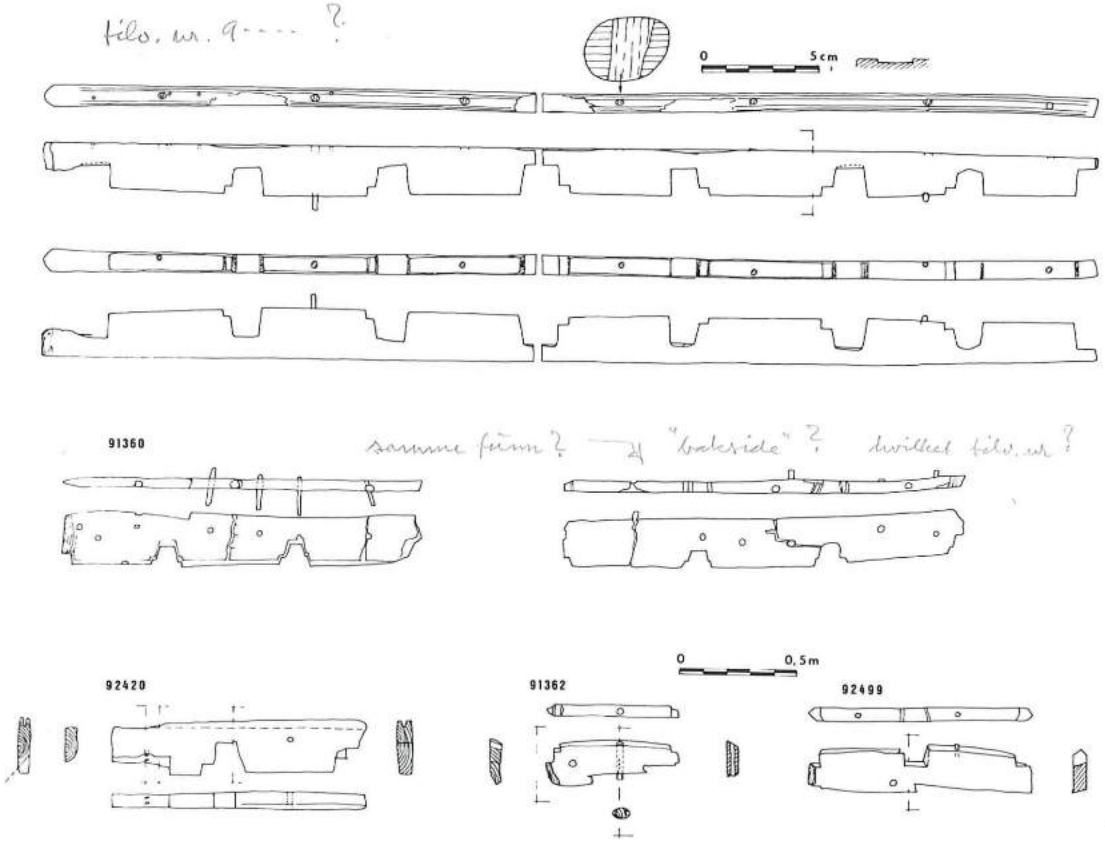


Fig 13-1

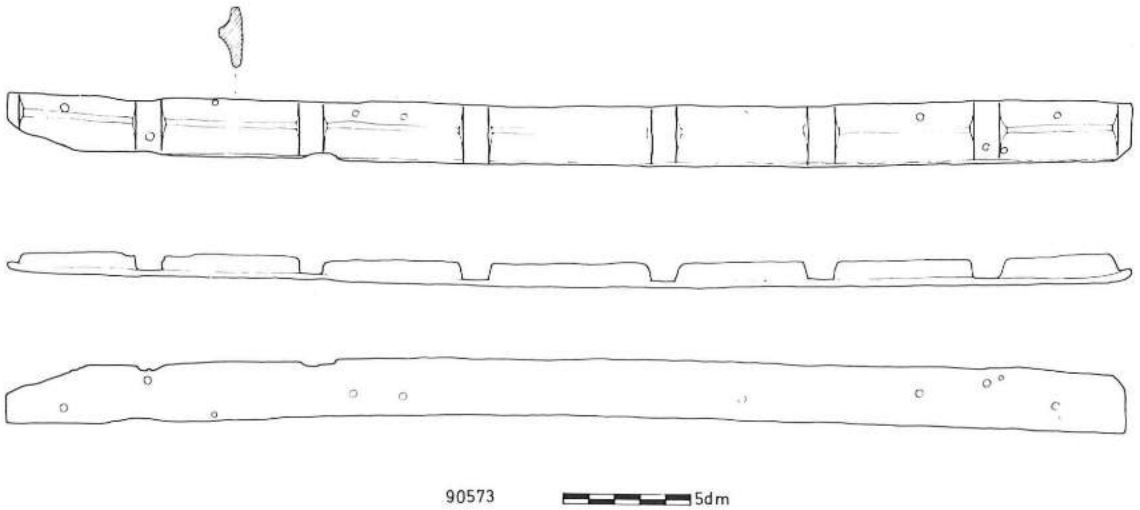


Fig 13-2

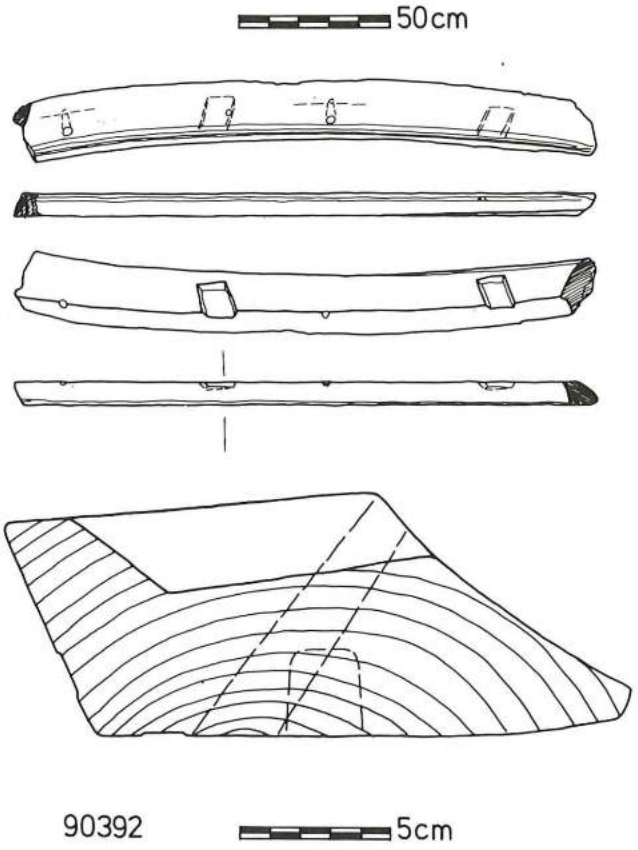


Fig 13-3

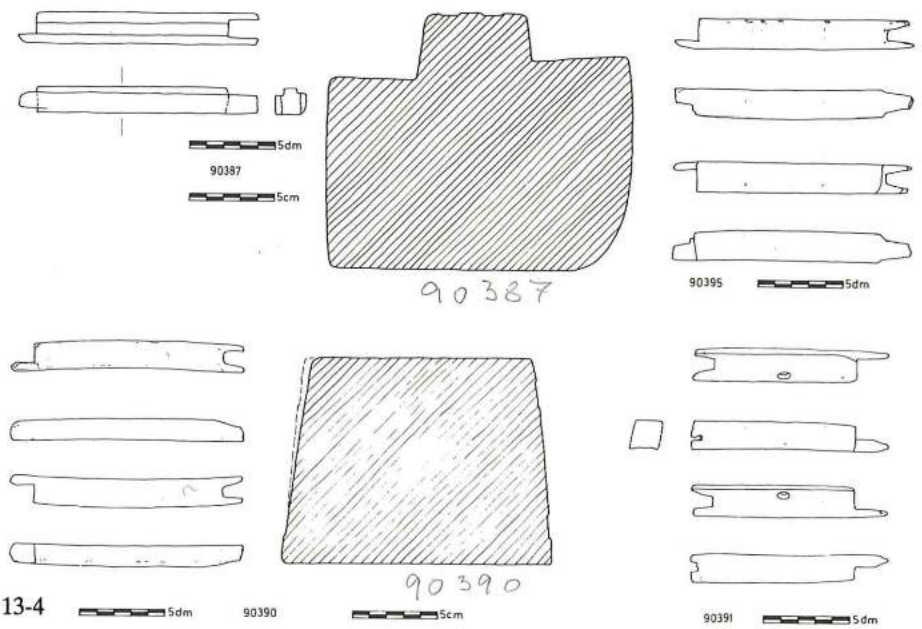


Fig 13-4

og 90391 og 90395 illustrert? Se s.170 og s.74

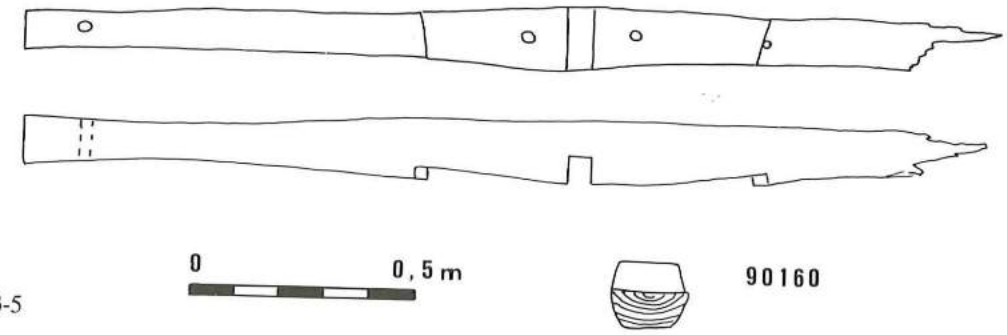


Fig 13-5

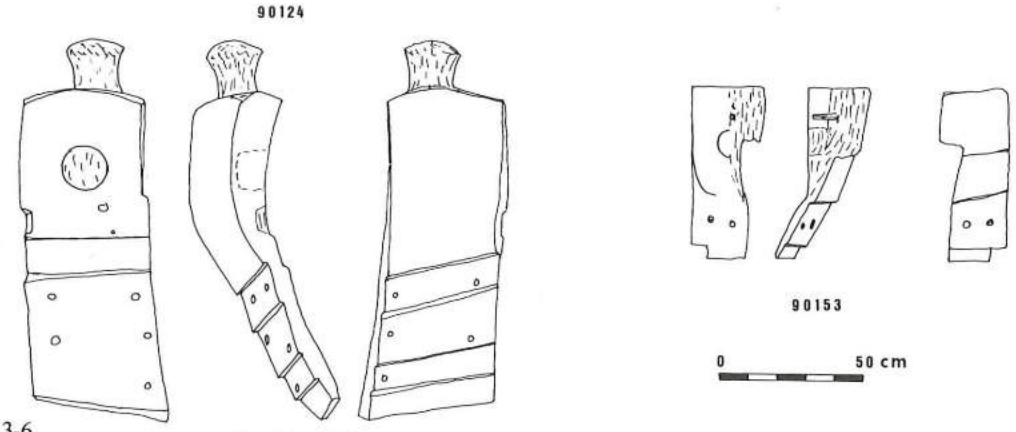


Fig 13-6

Fig 13-7

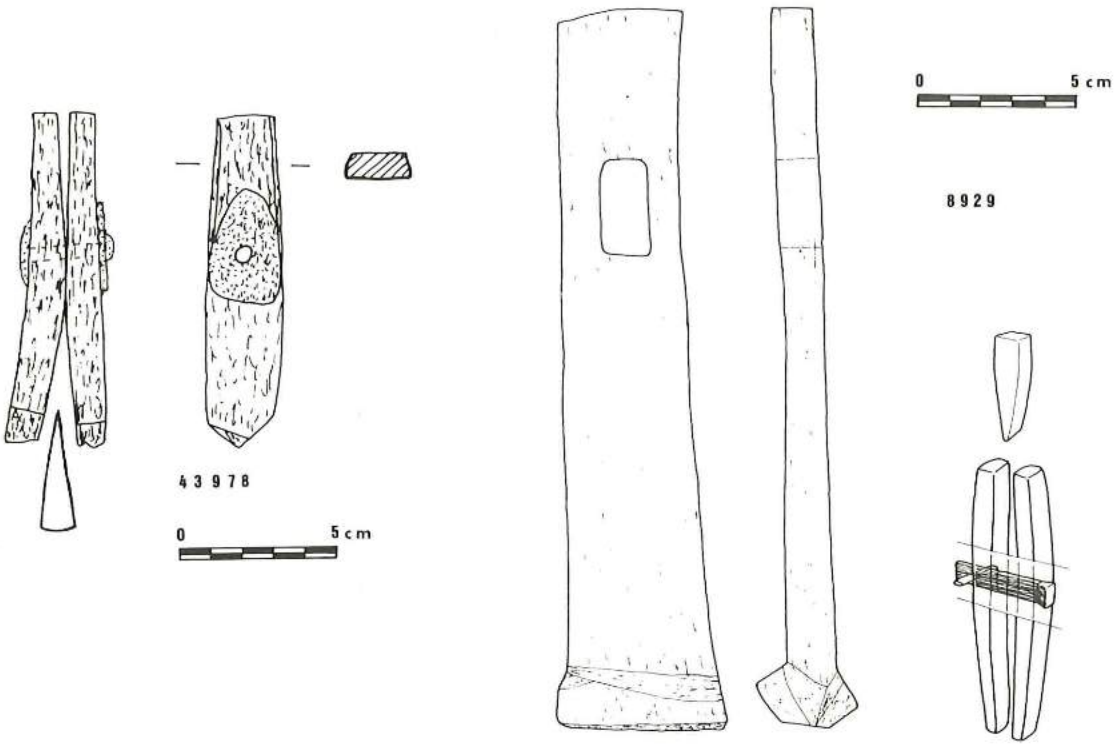


Fig 13-8 The crosspiece 8929 with a sketch showing its use. For comparison, a small horn clamp found at Bryggen is shown, with the wedge reconstructed

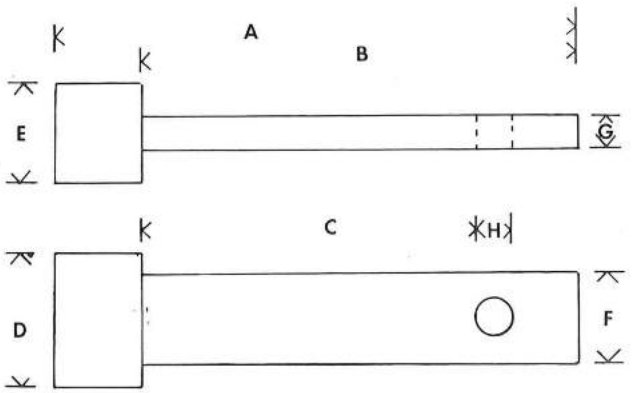


Fig 13-9 Sketch of crosspiece measurements given in table 13-I

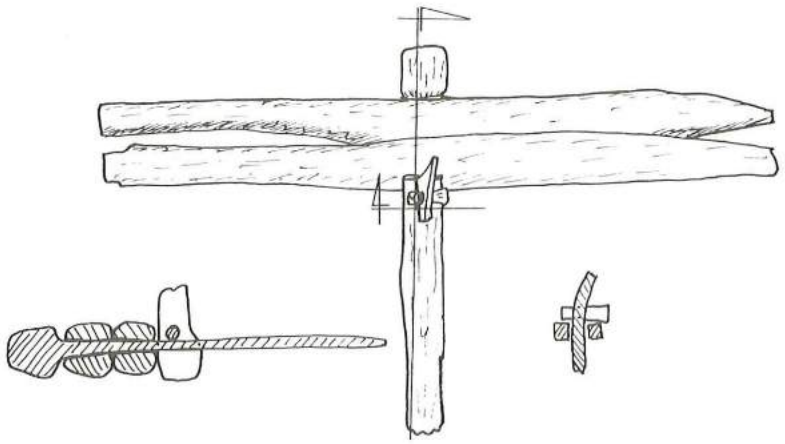


Fig 13-10 Boatbuilders clamp found in medieval layers in Gdansk, Poland. Tracing of sketch in the files of the archaeological museum, Gdansk

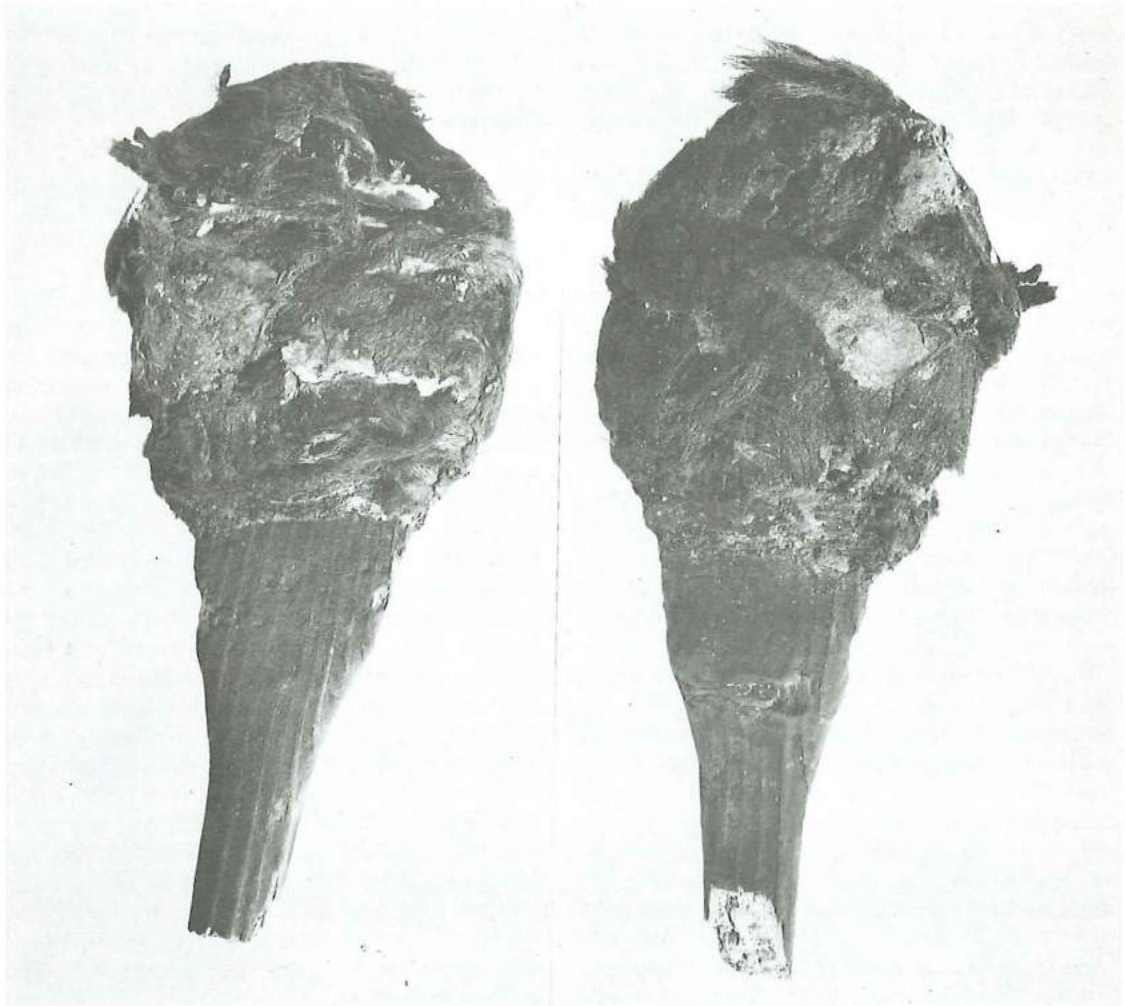


Fig 13-11

THE "BIG SHIP"

The group of fragments known as the "Big Ship" were mostly found during a special excavation campaign in 1962. At first, a few fragments were found and identified as parts of a very large vessel and the excavation was then extended to salvage other ship's timbers reused in the same block of foundations (Herteig 1969, 83 ff). These foundations, which were of *bolverk* construction were part of the rebuilding after the 1248 fire (fire V). Some of the timbers show fire damage, and as this occurs on pieces that were placed deep in the foundations, it is very unlikely that the timbers were burned in their secondary position. The rabbeted deck-beam 93199, for instance, which was situated well below water-level in the *bolverk*, has fire damage. It is a tempting guess that the ship from which the timbers have come was in Bergen harbour during the 1248 fire, and was damaged beyond repair and broken up. Those timbers that were straight enough for re-use, went into the foundations. The ship may have been fairly new, for the timbers show little wear, so it should be dated to shortly before 1248.

As this is a fairly numerous group of fragments from one vessel, I have chosen to treat them together, instead of breaking up the group for systematic treatment with the other material. Fig 14-1 shows how the fragments, not including strakes, were distributed within the excavation area. All the timbers are of pine. Details characteristic of the workmanship on pieces like the keelson and mast beams have helped in identifying other fragments as part of the "Big Ship". The treenails connecting strakes and ribs are larger than in most of the other ship fragments, the holes have been bored with an auger of c 28 mm diameter. On the inside of the timbers, holes for wedged treenails have been worked to quite a characteristic and uniform oval shape. Another identification aid is the moulding scraped along the edges of the timbers. Two different scrapers have been used, the difference, though not great, is definite (fig 14-2). On the mast beam 90726 one scraper has been used on the port side, and the other on the starboard side. This may well be evidence of two shipwrights working together. Size has also been a factor in identifying certain timbers. Strake fragments have been attributed to the "Big Ship" on treenail diamenter, moulding, strake width (corresponding to that seen on the ribs) and find-spot in the relevant area. However, the strakes that can be attributed to the "Big Ship" with any certainty are both few and of little significance.

The keelson of the vessel is made in two pieces, joined c 220 cm aft of the mast-step with a vertical scarf, secured with one treenail. The total length of the keelson is 12.50 m. Around the mast-step, the keelson is round and little wood seems to have been removed from the original tree-trunk except for the shaping necessary to fit the crossbeams and floortimbers. The rest of the keelson is lentoid or hexagonal in cross-section, with the greatest dimension vertical. The underside is notched for 27 floortimbers, spaced c 48 cm centre to centre. This corresponds well to the shorter of the two ells known from medieval Norway. According to Steinnes' calculations this was c 47.4 cm long (Steinnes 1936, 123 ff).

The ribs are sided c 15 cm. On the upper surface of the keelson there are notches or pressure marks for corresponding crossbeams. 24 are clearly indicated, but there were probably originally 25, while the floortimbers at the extreme ends of the keelson seem to have been without crossbeams. The height of the keelson increases towards the stems. Between each rib there is an upward curve cut into the underside of the keelson. There are numerous parallels to this. Among the Bryggen finds, the same detail is found on the other keelsons (cf 90125). Other parallels are the Sjøvollen ship (Christensen 1968) and wrecks from Kalmar and Skuldelev (Åkerlund 1951, Olsen and Crumlin-Pedersen 1967).The purpose of the detail is probably to lessen the chance of rot, as the shape gives little surface to surface contact between keel and keelson. Cutting away some wood where it is not needed also reduces weight and this seems to have been an important consideration in Norse shipbuilding. In front of the mast-step the keelson is notched for 12 floortimbers and this part is 1.45 m shorter than the aft part, which is notched for 15 floortimbers. On the starboard side, a hole is bored through the keelson from the bottom of the mast-step, the purpose of which is surely to drain the mast-step of water in order to prevent rot. The mast-step is square, cut partly into the keelson, partly into two specially shaped beams

(fig 14-3). These crossbeams have the round shape of the tree-trunk nearly intact by the mast step and have been worked down to a square cross-section near the ends. One beam has heavier scantlings than the other and a large mortice by the mast-step. With support in the parallel material, I take this to be the beam in front of the mast. As the crossbeams fit the keelson precisely and do not fit when reversed, this also gives us the aft-forward direction of the keelson. The mast-step is 33 cm square at the top of the crossbeams, tapering to 24 cm square at the bottom. The step is 38 cm deep. This size gives us a mast diameter of c 50 cm just above the mast-step. In later ships, the mast had its greatest diameter at deck-level, tapering both downwards to the step and upwards, but the complete mast found at Bryggen does not show this shape. A mast-diameter of 50 cm seems small when compared to the scantlings of the rest of the fragments. The diameter may have been considerably greater if the squared part for the mast-step was cut down from the round shape by making long tapering surfaces to form the square. The remainder of the crossbeams are square in cross-section. Of the original 23, 19 complete or fragmentary beams have been found. A temporary assembly was done in 1969 and 8 beams were then found to fit notches on the upper side of the keelson well enough to prove that they had found their right place (figs 14-4 and 14-5). The two beams fore and aft of the mast-step are easily identified due to the special shape of the keelson notches. Both are incomplete, but one lacks only about 45 cm at one end. The complete beam 91915 has its place furthest forward on the keelson, and this beam is an important piece for the proper understanding of how the ship was built. All crossbeams are shaped to straddle the keelson. On each side of the cut for the keelson, the underside of the beam is cut to a shallow curve. At the ends, the beams have notches to fit the faying surfaces of strakes, the number of notches differing from beam to beam. As usual, strakes and framing were connected by treenails having countersunk heads on the outside of the planking and wedges on the inside of the ribs. Treenails broken on the top surface and lacking wedges are found at the ends of the crossbeams. This shows that knee-shaped futtocks were fitted above the crossbeams and that the knees covered the top surface of the beams for a distance that varies between 60 cm and 20 cm. All beams with intact surfaces have mouldings along the edges of the top surface. One complete floortimber was found, 91680, the shape of which shows that it came from the middle part of the ship and must originally have had its place under the keelson (figs 14-6 and 14-14).

The surface which rested on the keel is 17 cm wide, with limber-holes cut where the faying surface for the garboard starts. One side has faying surfaces for four strakes, the other for five. A blind hole has been bored from the top surface, over the middle of the keel. If this is taken to represent the centreline, the faying surfaces for the garboards are symmetrical, while the rest of the surfaces are not. This is probably a result of deformation due to pressure in the ground. The rib has been tested against all crossbeams having the middle notch intact, using tracings on transparent paper. When the centreline is established using the keel surface, blind hole and garboard surfaces, it is clear that the outer treenail holes are not equidistant from the centreline. This makes it an easy task to exclude a number of crossbeams. The faying surfaces for the strakes do not slope towards stem or stern, indicating that the rib was placed near midships. The best treenail correspondence is with the forward mast beam. As this is incorporated in the reconstructed midship section in Bryggens Museum, it has not been possible to test the pieces themselves for correspondence. There is always a risk of small inaccuracies in the drawings that makes it somewhat uncertain to test drawings against one another instead of the real artefacts, but although this was all that was possible in this case, the correspondence is good. However, I am not prepared to state that this *was* the place where the rib originally sat. One problem is the blind hole in the centre of the floortimber. Holes like this are not uncommon either for a stanchion to a crossbeam or, more rarely, for a treenail connecting floortimber and keelson. A stanchion is out of the question in this case and there is no corresponding hole in the keelson. (My thanks are due to Egill Reimers, who personally checked this for me in the storerooms.) On the other hand, the shape, scantlings and treenail holes correspond so well that this can hardly be a floortimber from another ship. If we accept that this is the right place for the rib, then the hole must have been bored by mistake or else plans were changed during

building, omitting the treenail, or maybe the rib has been salvaged from another vessel, recut and used for building the "Big Ship". Some floortimbers in the Sjøvollen ship, by the way, may also be reused from another vessel (Christensen 1968, fig 9).

The fragmentary timber 91913/914 was probably damaged when being cut to fit the foundations. The original shape is not known nor is centreline definite, but the inward-upward angle of the strake surfaces shows that it was placed rather further forward than the beam 91915, or in a similar position aft, and I have chosen to interpret it as a large floor-timber, tentatively placed between the keelson and the position of the sharp floortimbers 91919 and 91920 (fig 14-8).

Of the three sharp floortimbers 91220, 91919 and 91920, 91220 does not have such sturdy scantlings as the other two and moreover the find-spot, square O4, makes it a very doubtful fragment of the "Big Ship". It was originally classified as such, but I have returned it to the general group of intimbers, cf ch 4. The character of the other two is definitely "Big Ship" and they were found in square K4, where other pieces of the vessel were located. If the strake runs are sketched in continuation of the surfaces on 91919, 91920 will fit the lines when placed c 90 cm nearer the stem or stern. If we postulate the same rib distance as amidships, there is one timber missing between the two we have. 91920 has arms of unequal length, which may be due to secondary damage, but this can also be a result of fitting a two-piece crossbeam on top of the rib, like those found in the Gokstad and Skuldelev ships. It is tempting to see the knee 90477 as part of such a beam and to place it above 91919, as I have done tentatively in fig 14-14. 91368 is either a beam-knee, or the lower part of a knee-futtock. The rather shallow angle between the horizontal surface and the first strake surface speaks for the latter. The piece is nearly square in cross-section and must have had its place in the midship section. It can originally have belonged to the forward mast beam (90726) or to one of the beams 90425 or 91910. In all three cases there is fair treenail correspondence. If this is indeed a knee-futtock from the midship area, the "Big Ship" had quite an amount of flare amidships, like the smaller Sjøvollen ship (fig 16-4). 91720 is also best explained as a fragmentary futtock, cut off at the lower end, so that nearly all of the horizontal knee part is missing. It is rather decayed and is broken at the top through a treenail-hole, so it must originally have been longer (fig 14-7).

The fragment 90416, secondarily cut at both ends, may be part of a sharp floortimber of heavy scantlings. However, the decrease in moulded dimension from bottom to top is similar to that of the knee-futtocks and I think this is yet another knee-futtock, too fragmentary to be placed in context with other parts of the ship. The angles of the faying surfaces for the strakes indicate a place rather far forward or aft in the keelson area.

A cross-beam with deckboard rabbets, 93199 (fig 14-9), can be attributed to the "Big Ship" from its find-spot and mouldings. It was used secondarily as a sole-plate for piles in the quay and has secondary damage at both ends. However, the sloping end-surfaces may be original. Their angles indicate that the beam was placed rather far forward or aft in the ship. This is what one would expect, if the ship had the same arrangement as that known for other merchant vessels of the period - an open hold amidships and small decks fore and aft.

A huge windlass drum was found in close contact with the keelson and mast beams (fig 14-11). By size alone, this must be part of the "Big Ship". The length is 540 cm and the diameter c 50 cm. A close parallel is the much smaller windlass found in Kalmar I (Åkerlund 1951, fig 23). No trace of the mounting was found, so it is uncertain whether the windlass was mounted in bitts like the Kalmar one or in bollards like nos 90124 and 90153. A mounting like the one in Kalmar I with a passage between the windlass and the ship's side would give a beam of c 6.5 m where the windlass was mounted, presumably far aft in the ship. If the windlass was mounted in bollards, it would reach to the ship's sides, but again far aft, so the length of the windlass is considerably less than maximum beam. Bollard mounting for a windlass is found on the Elling Aa ship, dated to the 12th or 13th century (Crumlin-Pedersen 1981-3). The mounting in bollards of a windlass as large as this would seem to be an obstacle in the ship.

Apart from the archaeological parallels, we have an excellent iconographic source in the Winchelsea seal showing a windlass of this type in use. Åkerlund noted this and also commented on the fact that the anchor cable is handled

with a windlass so far aft in the ship. The reason for this is surely that the windlass also served other purposes. Most likely the halyard was taken to the windlass when making sail. In this context it is interesting to note that the Bremen cog has both a similar windlass and a capstan aft.

The windlass is pierced for 3 sets of handspikes and had chafe-strips of semicircular cross-section treenailed on.

90511, fig 14-11, has been interpreted as a seat, to be placed near the stem or stern of a small boat, as indicated on the illustration. No parallel to this is known to me. However, the piece may have been placed as shown, not as a seat, but to support the top of a mast when temporarily unshipped. It would then serve the same function as the large fork or U-shaped piece shown near the stem of several ships in medieval pictures. The piece was found during mechanical excavation in I 5, and the precise location and date is uncertain. The find-spot makes it possible that it was part of the "Big Ship".

93225 would also belong to the "Big Ship" on the evidence of the moulding. The shape corresponds closely to 90222 if we imagine the short arm of the knee cut away. I choose to interpret this as a lodging knee, part of a system similar to that seen in Skuldelev I (fig 14-11).

In the squares that have produced fragments of the "Big Ship" there are also other ship fragments, among them several strake fragments. A number of these could be excluded from the "Big Ship" from the evidence of rib distance, while others were not available as I worked through the material. Evidently, the strakes were among the fragments used for purposes other than quay-building when the "Big Ship" was broken up.

Even though the number of fragments from the "Big Ship" is considerable, there is not enough material for a reliable reconstruction of the vessel. However, the fragments give an indication of size and a number of technical solutions are well documented.

Previously, I have made sketch reconstructions of the midship area of the ship, for use in a partial reconstruction set up in the temporary museum in 1965, and again for the cross-section exhibited in Bryggens Museum. In 1964 Herteig published two tentative reconstructions of the midship cross-section that I had drawn up. In the light of later work, I can definitely say that one of these, showing inner planking between the crossbeams and floortimbers, is wrong.

For the Museum reconstructions, I gave the ship a rather narrow beam to be on the safe side and I am now convinced that both reconstructions show the ship too wall-sided. One of my reconstructions, Herteig's alternative 2 (Herteig 1964) has, moreover, been published by Crumlin-Pedersen (1977) in a redrawn version which gives the impression that more is preserved of the midship section than is actually the case.

The construction with low-set crossbeams over each floortimber, notched over the keelson to give it support sideways, is known from other medieval ships. The best parallels are Sjøvollen (Christensen 1964 and 1968), Galtabäck (Niklasson and Johannessen 1933, Humbla and von Post 1937, Åkerlund 1942 and 1948), Lynæs (Crumlin-Pedersen 1979) and Elling Aa (Crumlin-Pedersen 1981-3). Ole Crumlin-Pedersen has discussed this technical solution and sees it as a typological link in the evolution of Norse medieval shipbuilding (Crumlin-Pedersen 1958). As all the vessels mentioned are more complete than the "Big Ship", they are valuable parallels for explaining the Bryggen fragments.

We know that the ship was clinker-built in the Norse manner. We can then postulate a keel and sharp garboards, probably hewn to shape as I have suggested in the reconstructed cross-section exhibited in the Bryggens Museum. The strakes were supported by short floor timbers and by the ends of the numerous crossbeams resting on the long keelson. The notches underneath and on top of the keelson show that each beam had a corresponding floortimber.

In my first reconstruction of the midship bend of this ship, I postulated an inner planking between the floortimbers and the beams. This is certainly wrong. As can be seen from the end beam 91915 as compared to the two mast beams, more strakes come in close contact with the beam as the hull gets sharper towards the ends. I am now inclined to think that the rather irregular small notches in the underside of most beams were cut for the "inner corner " of the strake laps, but without the more careful fitting seen both at the turn of the bilge and further aft and forward. The possibility of a bottom with strakes laid edge to edge as in a cog must be excluded because of the huge keelson and the floortimbers found. Both indicate a sharp bot-

tom amidships. The general "Nordic " character of the vessel also excludes this possibility.

In the Sjøvollen ship, our closest parallel, there seem to have been few crossbeams further up in the hull amidships. Most of the futtock on the lower crossbeams run to the sheerstrake or nearly so, often with a short top timber scarfed on. When there is a crossbeam, the futtock is shorter and butts against the underside of the beam. At the mast, a hole in the planking shows that one beam had heads. Based on the parallels of Sjøvollen, Kalmar I and II, and the loose headbeams found at Bryggen, I have given the reconstructions for exhibition in Bergen double crossbeams with heads at the mast, even though direct evidence for this is lacking. After a new survey of the material, my opinion of what the vessel may have looked like is presented in fig 14-14. The material does not permit a reconstruction carried further than this. The background for calculating the dimensions of the vessel is as follows. The long keelson may have extended nearly the whole length of the keel, but this is hardly probable in a ship of this date. The long, two-piece keelson of the Skuldelev wreck 2, admittedly earlier, is 13.3 m long, to a hull which originally measured some 28 m total length with a keel of about 22/23 m. In the Kalmar wrecks, wreck I has a keelson which runs the length of the central piece of the keel, but there are additional scarfed-on pieces at both ends, so the keelson is shorter than the full keel. In all other medieval wrecks known to me, the keelson is shorter than the keel. Accordingly, we must add an unknown number of metres to the keelson to find the keel length of the "Big Ship", and then add more for the curve of the stems. A comparison between the crossbeam 91915, and the sharp floortimbers 91919 and 91920 indicate that we must place the sharp ribs at least 3 m from the end of the keelson in order to get smoothly running planking lines. The angle of the sharp floortimbers show that there is still some distance to the stem. A minimum figure for total length would be around 30 m. The greatest beam must have exceeded the length of the mast crossbeams, rabbeted crossbeam and windlass. The most secure figure is the mast crossbeam, as its place in the ship is known, but as we do not know the amount of flare at the bilge and have no means of calculating the height to the sheerstrake, it is difficult to arrive at a definite figure.

If we postulate that the futtock 91720 was placed on one of the mast beams with a flare like 91368, we get a beam of between 9 and 10 m and a minimum height to the sheerstrake of about 3 m. If the long futtock butted against the underside of an inwale, this may be close to the correct figure, but still a minimum one, as the top of the futtock is incomplete. The maximum figure may exceed this considerably, if the futtock butted against the underside of a crossbeam. If we select a set of figures and try to estimate loading capacity, we are faced with the problem that we do not know if this was a full or a sharp vessel. The only piece of information which is rather more certain is the area of the space or "floor " formed by the crossbeams over the keelson. Very roughly, we can calculate this as two trapezes, using the length of the keelson, mast beams and forward crossbeam (fig 14-5).

This gives us a rough result of 66 square metres. If we multiply with the vertical height of the futtock 91720, we have a minimum cargo space of 165 cubic metres. This is as far as the material allows us to go.

In connection with the "Big Ship", the group of large timbers found in square P2/P3 poses problems (nos 90773 and 90789 to 90806 discussed as "Second Big Ship? " in chapter 4). The scantlings indicate that the timbers come from a ship of similar size. For instance, the futtocks 90791 and 90792 are quite similar to 91720.

Another possible connection with the "Big Ship" are the mouldings. Those on 90791 and 90792 are different, but they seem to correspond with the two mouldings found on the aft mast beam of the "Big Ship". This would be remarkable, if we do really have two different vessels. On the other hand, the find-spots and dates do not correspond; according to Asbjørn Herteig, the two groups of timbers belong to two quite different building strata (personal communication). I have chosen to take the fragments as parts of two different vessels, even if the mouldings indicate that they may come from the same ship. The timbers from the 2nd "Big Ship" would increase the material available but they still do not allow for a reconstruction of a complete hull, so we will not benefit by combining the material. I would suggest that the two vessels were built in the same workshop tradition. They show that the "Big Ship" was not a unique vessel. Other large timbers like the headbeam 90659 and the knee 90222 support this view.

LIST OF FRAGMENTS ATTRIBUTED TO THE BIG SHIP

TIMBERS

Number	Object	Grid-square
90333	crossbeam fragment	L05
90416	rib? fragment	L05
90425	crossbeam	K05
90447	knee	K05
90511?	seat? mast support?	I05
90603	crossbeam	M05
90604	crossbeam	M05
90605	crossbeam	M05
90606	crossbeam	M05
90615	crossbeam	M05
90726	forward mast crossbeam	K04
90727	aft mast crossbeam	K05
90728	part of keelson	K04
90363	crossbeam	N04
91364	crossbeam	N04
91365	crossbeam	N04
91366	crossbeam	N04
91367	crossbeam	N04
91368	knee	L04
91500	crossbeam	M04
91503	crossbeam	M04
91504	crossbeam	M04
91505	crossbeam	M04
91506	crossbeam	M04
91676	crossbeam	L04
91680	rib fragment	L04
91682	crossbeam	L04

TIMBERS

Number	Object	Grid-square
91720	rib (futtock)	L05
91727	crossbeam	L05
91792?	stringer	L06
91910	crossbeam	K04
91911	crossbeam	I04
91912	part of keelson	K04
91913	rib fragment	K04
91914	rib fragment	K04
91915	crossbeam	I04
91918	crossbeam	I04
91919	sharp floortimber	K04
91920	sharp floortimber	K04
91945	crossbeam	K04
91945	crossbeam	K05
91946	rib or crossbeam fragment	K05
93156	part of windlass	K&I04
93157	part of windlass	K05
93157a	chafe - strip from windlass	I04
93157b	chafe - strip from windlass	I04
93176a-b	crossbeam	I05
93177	crossbeam	I05
93178	crossbeam	I05
93179	crossbeam	I05
93199	crossbeam with deckboard rabbets	I05
93199b-c	fragments of 93199	I05
93221	crossbeam fragment?	I04
93225	lodging knee?	I05

Strakes

The following numbers may be fragments of the "Big Ship", on account of the find spot, square and layer. However, as will be seen from the tables in the strake chapter, there is little data available for these strakes which were either inaccessible or lost as I worked through the material. 91434 N4, 91513 M4, 91514 M4, 91516 M4, 91629 N4, 91631 M4, 91632 M4, 91639 N4, 91640 M4, 91725 L5, 93198 I5.

91630, which is found in the correct layer in N4, can be excluded, as the treenail distance does not correspond to the rib distance of the "Big Ship".

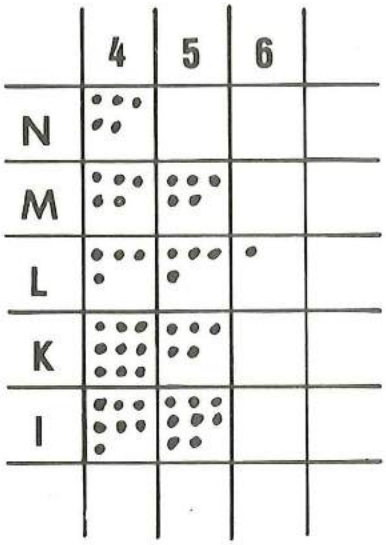


Fig 14-1

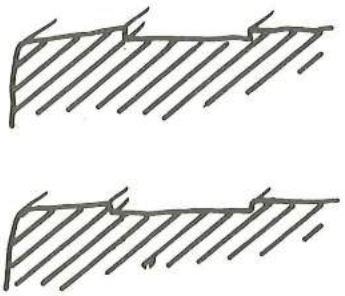


Fig 14-2

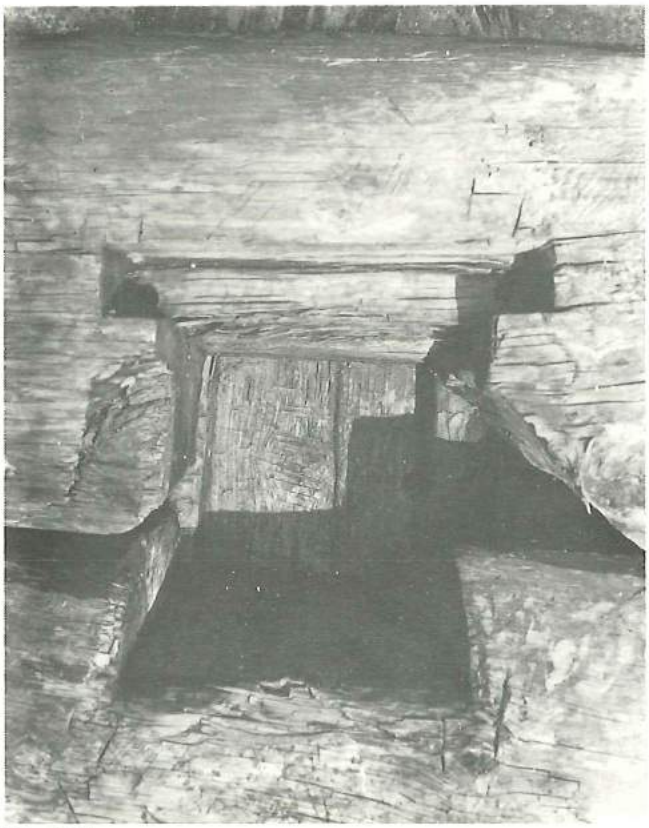


Fig 14-3

Fig 14-4

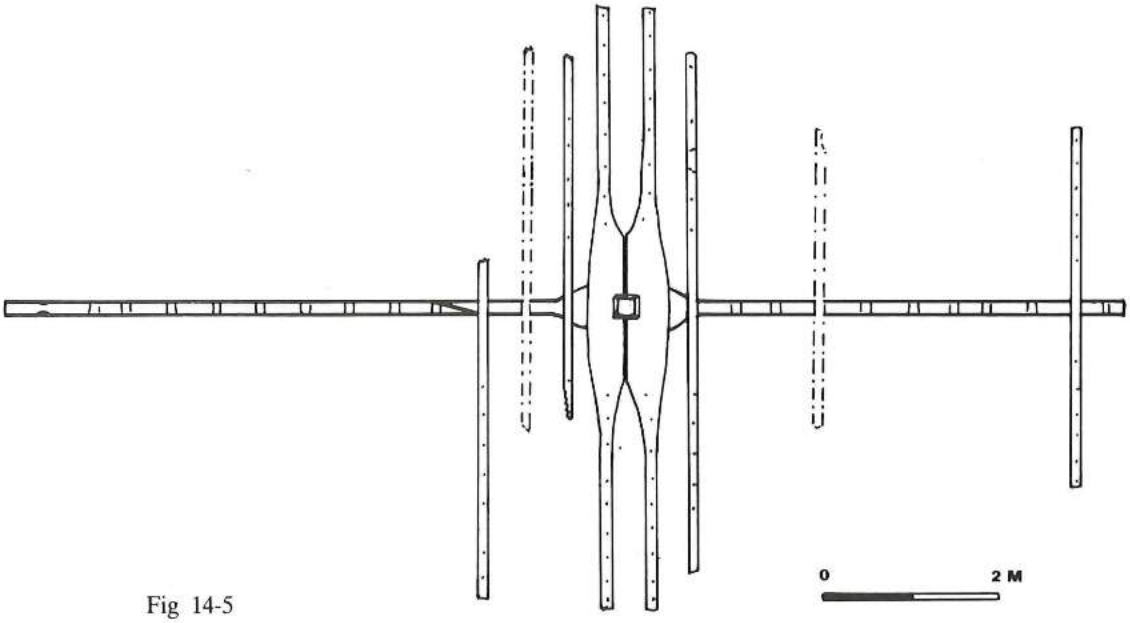


Fig 14-5

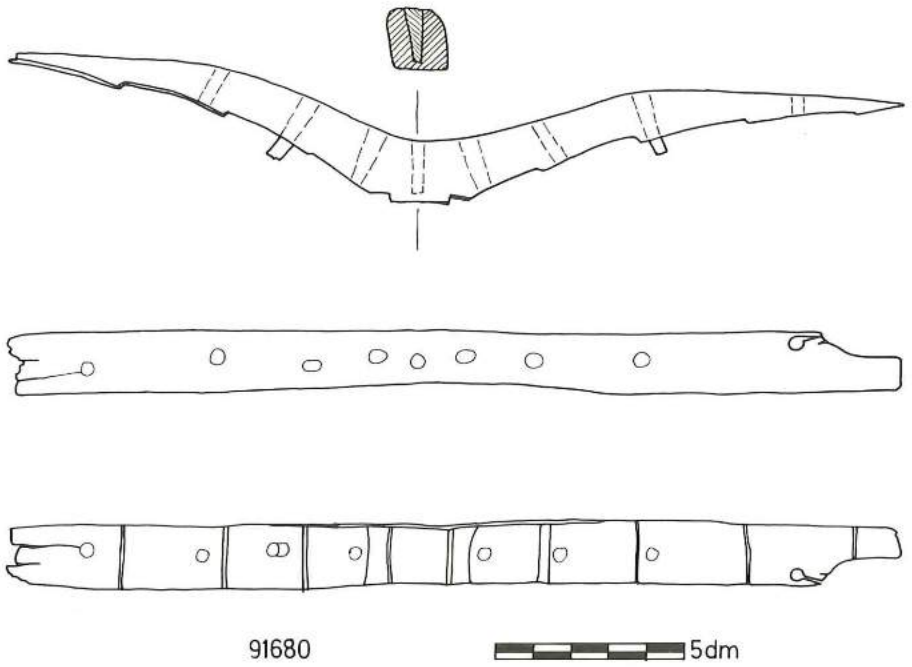


Fig 14-6

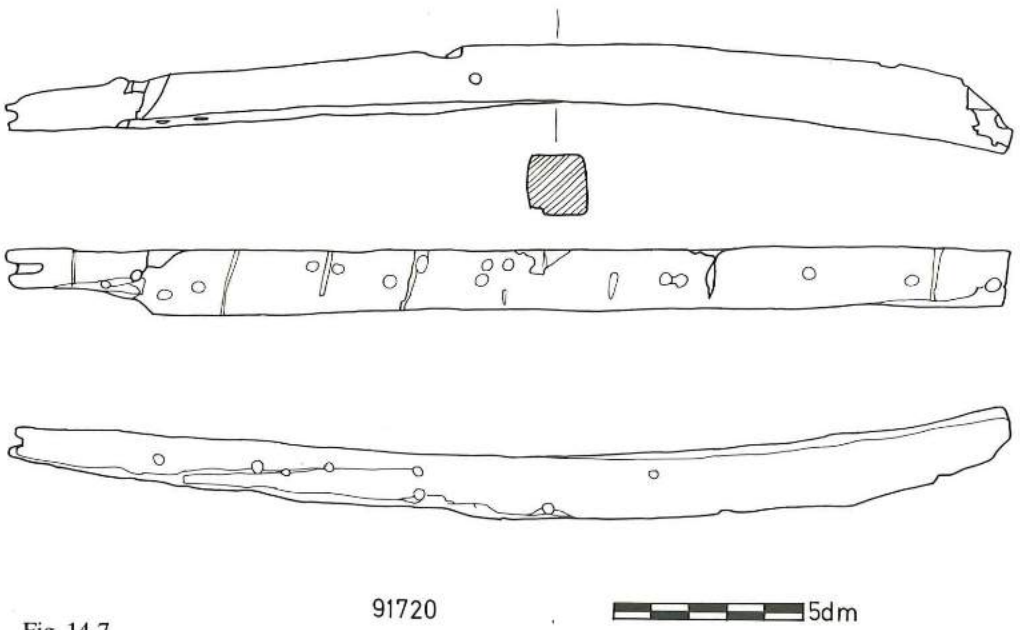


Fig 14-7

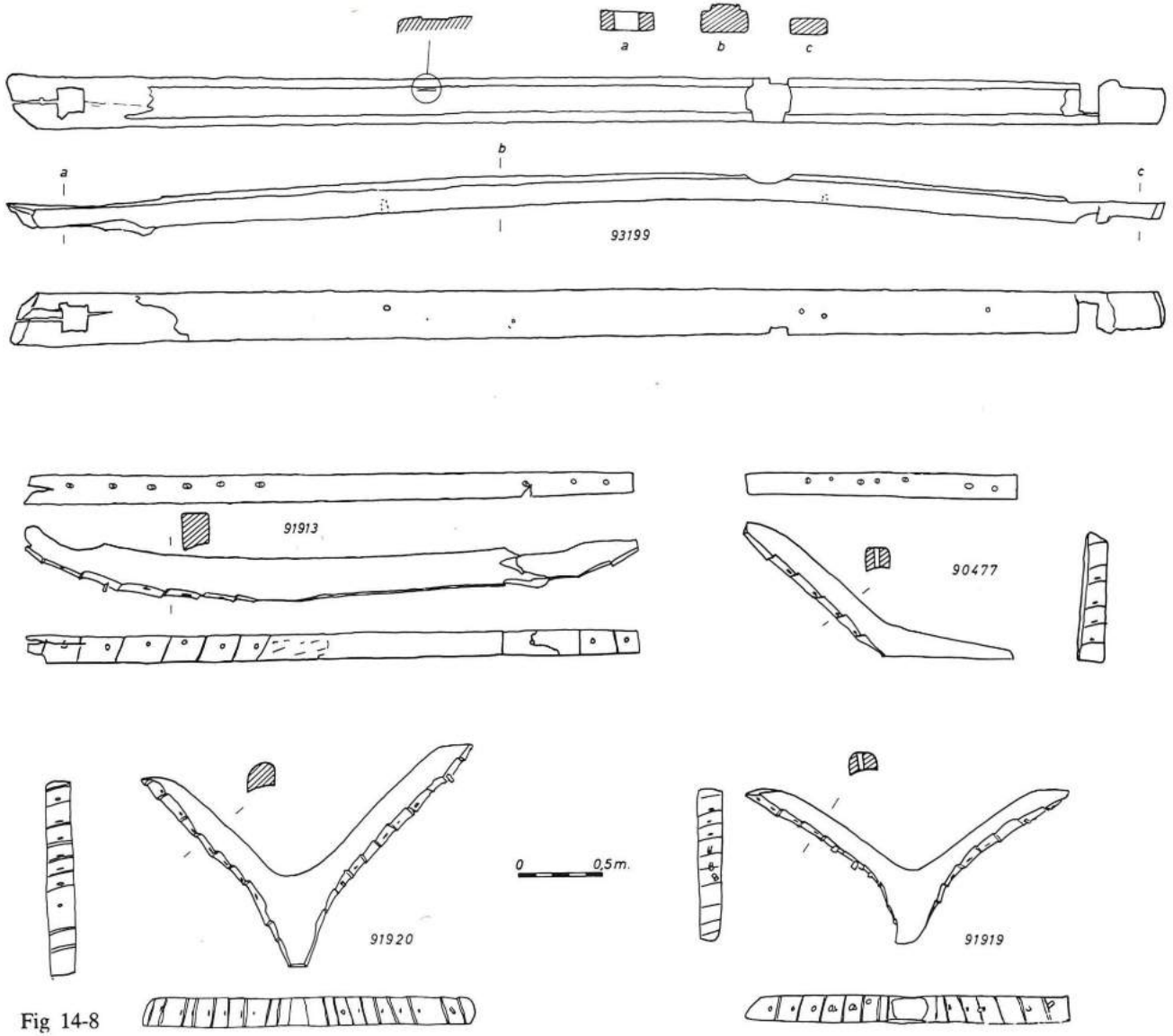


Fig 14-8

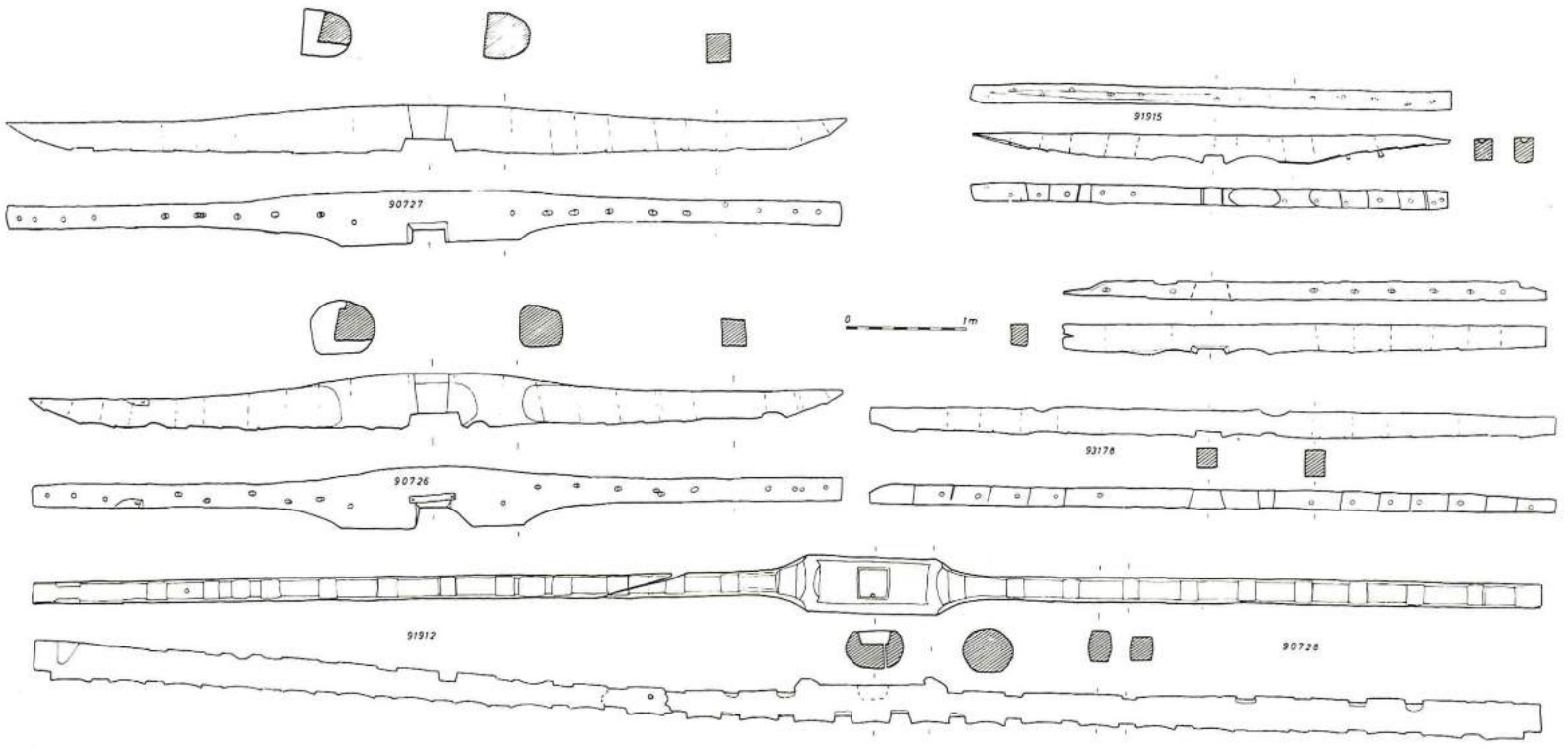


Fig 14-9

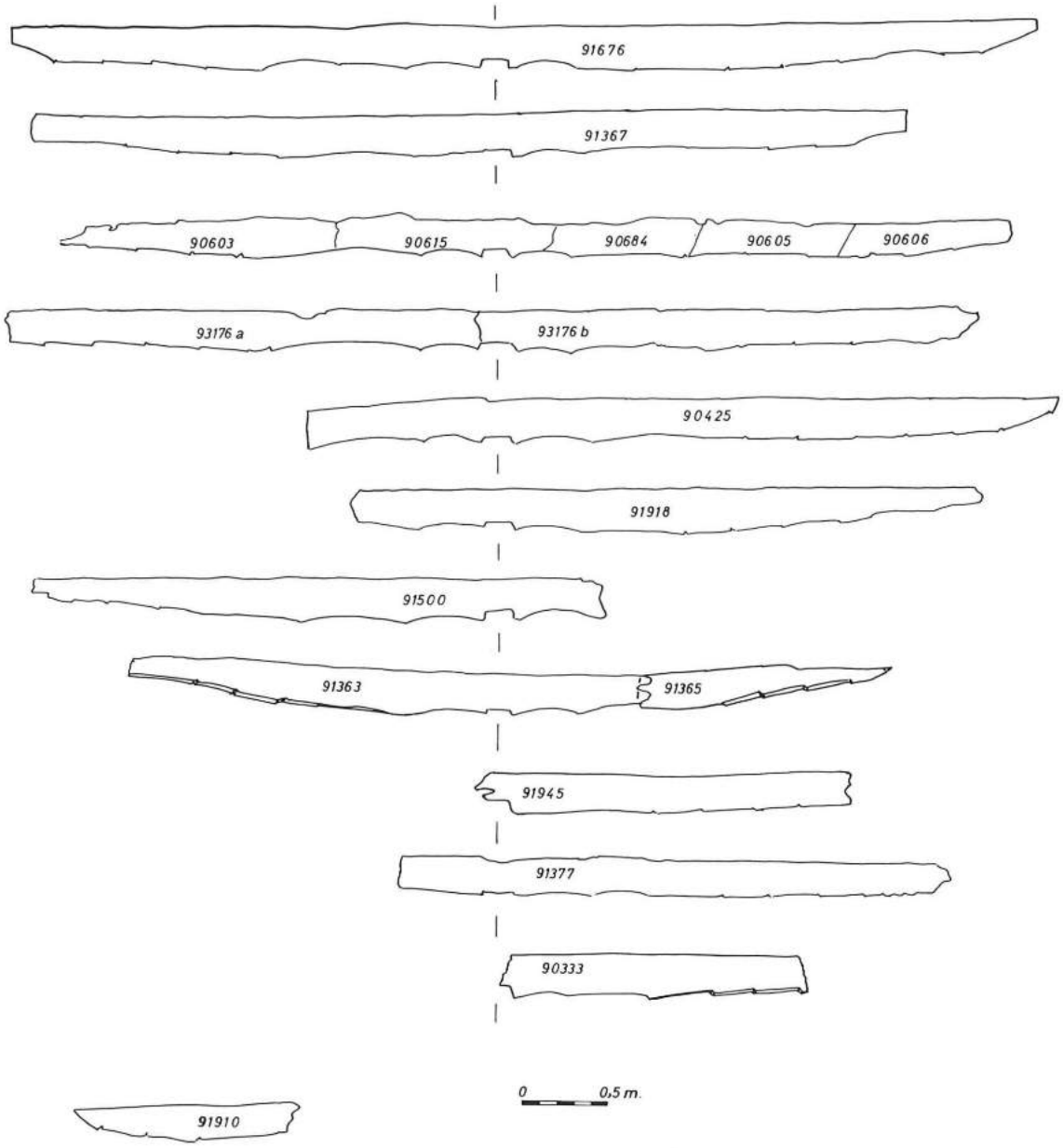

91676
91367
90603
90615
90684
90605
90606
93176 a
93176 b
90425
91918
91500
91363
91365
91945
91377
90333
0
0,5 m.
91910

Fig 14-10

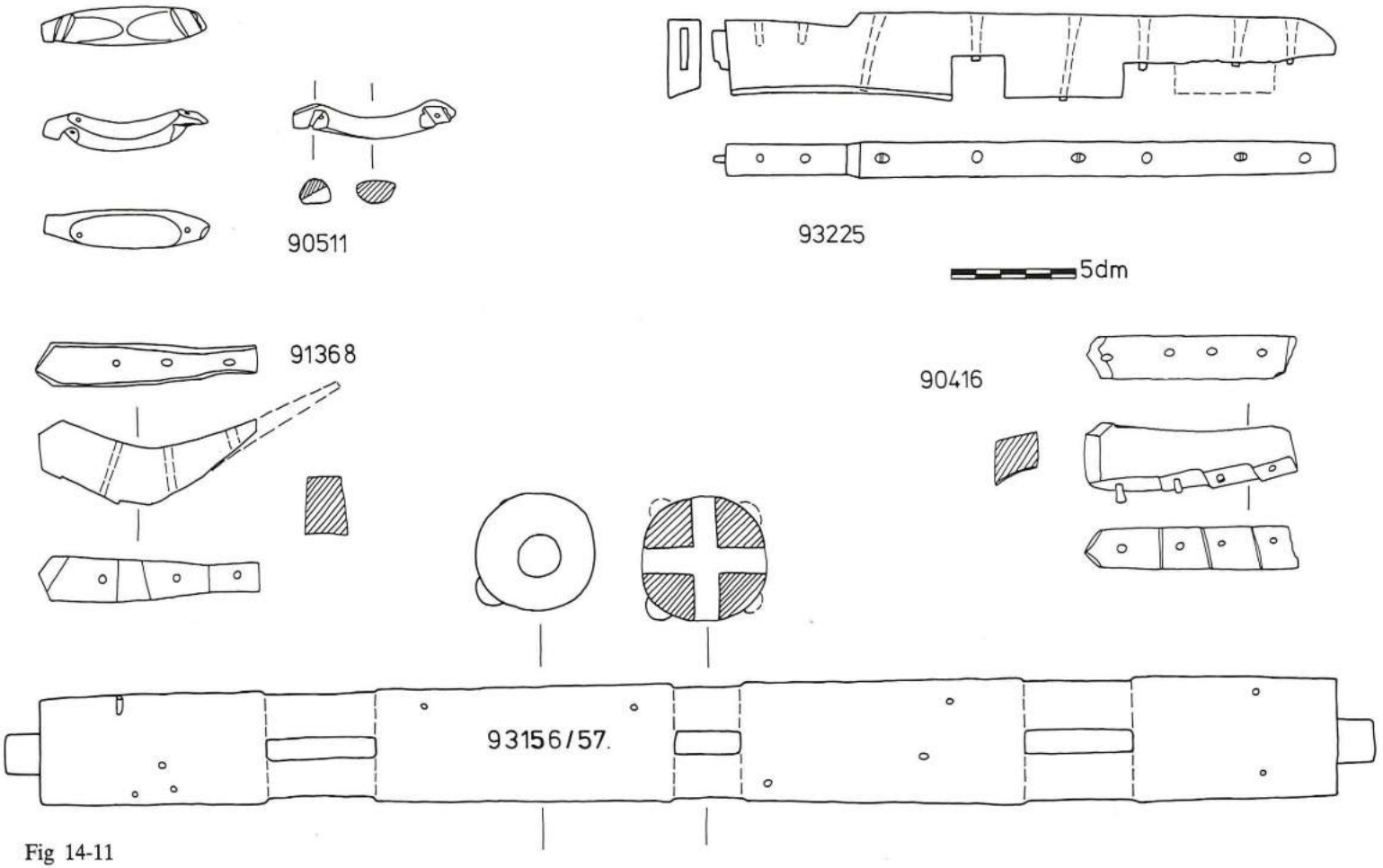


Fig 14-11

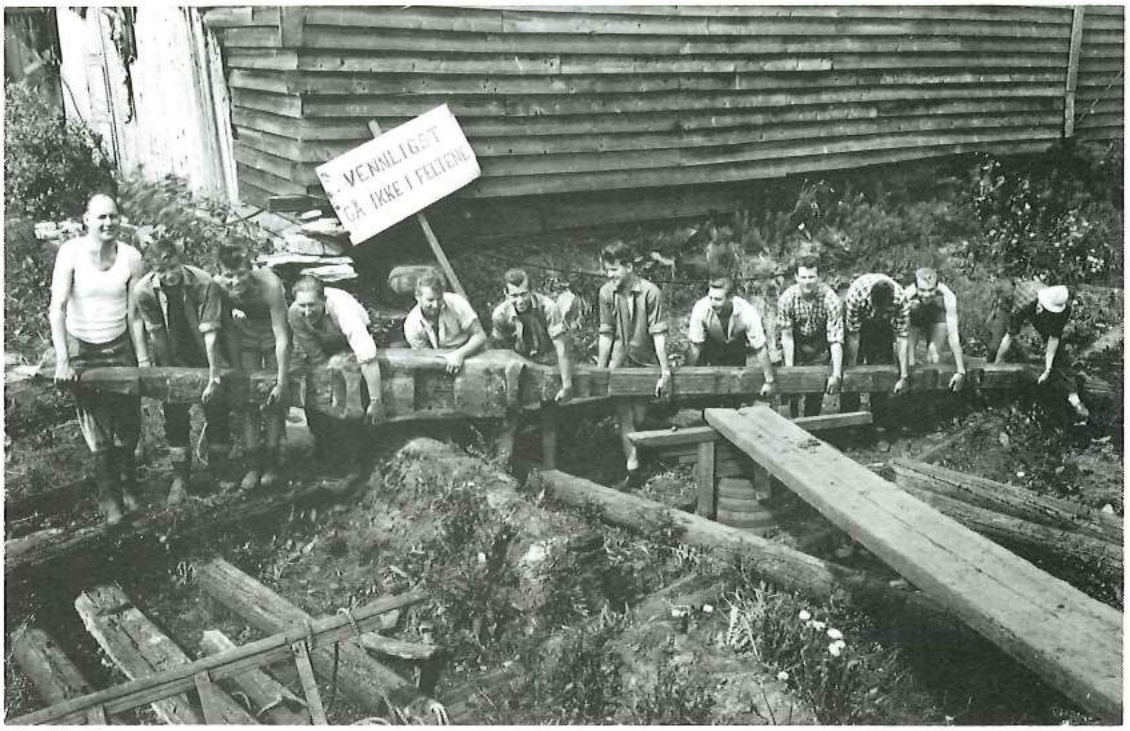


Fig 14-12


Fig 14-13

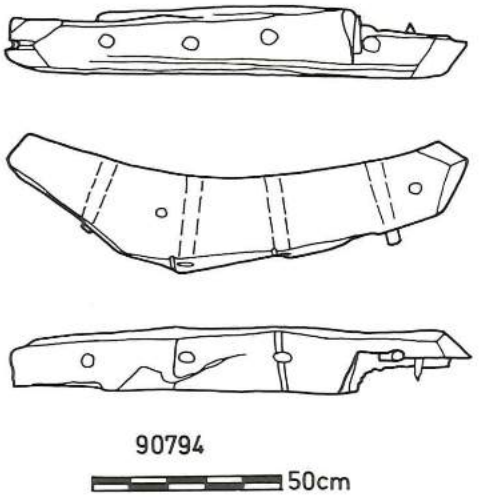


Fig 14-14

Fig 14-15

MOULDINGS

A considerable number of the Bryggen ship fragments carry decorative mouldings. This is not surprising, as nearly all the prehistoric ship finds show such decoration and so do other medieval ship finds. In Western and Northern Norway the practice continues to this day. Similar mouldings are found on medieval and later houses and on various wooden objects (Gjerder 1952, KLMN, Profil). In the Oseberg find, sleds, buckets and trays are moulded, while the same moulding iron has been used for ship, tentpoles and bed in the Gokstad find. In the late Viking Age grave found under Herning church in Denmark, the remains of a small table were found with mouldings scraped along all edges (Krog and Voss 1961).

The tool used by modern boatbuilders for strake edges and other relatively straight edges is a small moulding plane, often with a fence that can be changed from side to side to enable the plane to be used both ways. On the sharply curved insides of the ribs, however, a special scraping tool is used (fig 15-2).

This tool is identical to the ones used in "pre-plane " days, ie the Middle Ages and earlier. Similar scrapers have been used by other crafts as well and they were still commercially available in the last century. The factory-made specimens were generally two-handled, of spokeshave form, and often had interchangeable scraper blades. In the 1901 catalogue of Edward Preston and Sons, it is called a "patent hand reeder and moulding tool " (Reprint 1979 by Ken Roberts Publishing Co). As far as I know from interviews with boatbuilders in various parts of Norway, factory-made tools were not used by Norwegian boatbuilders, who stuck to the hand-forged, locally-made tool of ancient shape. The tool has been found in several Viking Age graves. It was identified by G F Heiberg as early as 1916 and two different variations were illustrated by Shetelig in Osebergfunnet I (328 and figs 134–135). In his book on Viking Age tools, Jan Petersen listed 10 specimens found in Norway (Petersen 1951, 226f). In the well known tool-chest found at Mästermyr on Gotland, Sweden, there is also one with a Late Viking/Early Medieval date.

G Fredriksen lists 16 examples of the tool from Viking Age graves in her MA paper on Viking woodworking tools (G Fredriksen 1978, 181). Some of them are from inland sites and were probably used by woodworkers other than boatbuilders.

The depth of both scraped and planed mouldings will vary according to the amount of pressure put on the tool, but the distance between the edge and the various "tops and bottoms " of the moulding will remain constant, so that measurements of these distances can be used to separate various tools. It is of course quite possible that one craftsman had several tools giving different mouldings, but it is improbable in the days of hand-made tools that several shipwrights or other craftsmen would each have had tools that made exactly similar mouldings. So the moulding may with care be used to separate fragments from several vessels or to identify pieces belonging to the same boat. When F Johannessen started on the reconstruction of the small Gokstad boats, all the material was stored together. Slightly different mouldings helped to identify the pieces belonging to the various boats (Johannessen 1940).

The mouldings from Bryggen fall into four groups (fig 15-1).

Type 1 In seven cases, the moulding is a narrow V-shaped groove, scraped at various distances from the edge.

Type 2 The mast 90301 and a fragmentary oar blade 93392 have shallow rounded grooves.

Type 3 By far the most numerous moulding found in the material is a shallow rectangular groove. The width varies, as does the distance from the edge. The moulding is found on strakes, ribs, beams and rowlocks. In a few cases, the same tool has been used to make both the decorative moulding and the luting-cove of a strake. (The usual luting-cove is a shallow, rounded groove.) The use of the same tool for moulding and luting-cove was observed by B Færøyvik on the boat found at Vågsbunnen in Bergen. The moulding is of our type 3. Færøyvik stated that this was practiced in Nordfjord in this century (Færøyvik 1948-2).

Type 4 The fourth type is better illustrated than described (fig 15-1–4). 11 specimens have been recorded. The strake fragment 64497 has two different mouldings, one of type 1 and one of type 4.

It is rather strange that there is one type of moulding which is not represented in the material, the shallow rounded groove flanked by two narrow V-grooves (fig 15-4). In recent boatbuilding, this is the most common moulding and it is also represented on medieval houses. A scraper of this type was used on the extension to Kaupanger Church (personal observations and Bjerknes 1976, fig 75) and another example from Western Norway is from Finneloftet, Voss (Berg, KLNM, Profil fig 7). These examples show that the moulding was known in Western Norway in the Middle Ages. The material of medieval mouldings from houses is not published systematically but I have the impression that the moulding is more common in Eastern Norway than in Western Norway. With caution, it might be suggested that its absence at Bryggen is due to different moulding fashions. If this is the case, fashion must have changed, as the moulding is the most common one in more recent material (fig 15-5). A survey of the mouldings found on prehistoric boats show that up to the Early Viking Age, mouldings consist of sets of V-grooves. They are known from the Nydam and Kvalsund vessels, from the Bårset boat, Gunnarshaug on Karmøy, and the Oseberg find.

A selection of typical mouldings is shown in fig 15-2 a-e. On the rudder and oars of the Oseberg ship, there are a couple of mouldings unparalleled in the rest of the material (fig 15-2, f and g).

The most common moulding in a Viking ship context is a rather complicated one, examples of which are shown in fig 15-3. The Gokstad find has four different variations: the ship, some of its equipment and one of the small boats seem to have identical mouldings, the two other small boats differ, and the fourth is found on two rowlocks which are probably a repair to one of the boats. Other examples of the type are found in the Tune ship, on the floor-boards from Lammøya, Tjølling, Vestfold (C 21960b, Oldtiden VIII), the mast partner from Rong, Herdla (Færøyvik 1946) and a fragmentary bog find from Northern Norway (Skagen at Åkervik, Herøy, Nordland T 16246, TMT 1943). The Rong and Skagen finds are not securely dated, but I believe them to be of Viking date.

I know of no example of this moulding securely dated outside the Viking Age. However, it was not the only moulding known to Viking woodworkers. The Klåstad ship has the oldest example found in Norway of the moulding still in use, fig 15-4, and this is also the moulding found on the Skuldelev wrecks. One of the Oseberg mouldings can be said to be a variant of this one, with double V-grooves instead of the usual single ones (fig 15-2).

The two most common medieval mouldings, to judge from published examples and personal observations, are our type 3 and the shallow groove flanked by V's. The latter lives on, sometimes inverted, while our types 3 and 4 have not to my knowledge been recorded outside medieval contexts.

With the introduction of moulding planes in Renaissance carpentry, the repertoire of mouldings is vastly increased. However, the old scraping tool seems to have lived on, especially in boatbuilding, as did the taste for the old style of moulding, set down into the wood a small distance from the corner, instead of breaking and moulding the corner itself, like most of the Rennaissance and later mouldings.

Even though the moulding fashion is long lived, I believe that mouldings may, with care and criticism, be used as dating evidence.

The material we have shows that the groups of V-grooves are not found after the Early Viking Age. What we may call "the Gokstad type " (fig 15-3) is, when dated, only found in Viking Age context, and even the less securely dated specimens seem to be Viking. Our types 3 and 4 have not been found outside a medieval context. Our type 1, the single V-groove, and the most common of all mouldings, at least in Norway, the rounded groove flanked by two V-grooves, have been in use too long to be reliable dating evidence. The latter, however, does not seem to appear before the Viking Age. Our type 2 is only known to me in the three examples from Bryggen, and one later example, the large storehouse (Norw *bur*) standing on the farm of Ose in Setesdal. Here the heads of the corner-timbered logs have a moulding of our type 2, while the lower edges of the logs have an inverted groove and V-cut moulding. The house was built around AD 1650.

TABLE 15-I MOULDINGS

TYPE 1

Number	Object	Date	Notes
12368	Rowlock lath	BF 4	
19049	Rib fragment	BF 5	
32115	Floorboard fragment	BF 4	
42665	Rib fragment	BF 5	
45382	Rib fragment	BF 5	
52670	Strake fragment	AF 5	
64497	Strake	BF 6?	
78280	Knee fragment	BF 5	

TYPE 2

Number	Object	Date	Notes
90301	Mast	BF 3	
93392	Oar fragment	?	

TYPE 3

Number	Object	Date	Notes
8705	Knee fragment	AF 5	
15810	Rowlock fragment	AF 5	
19133	Rib	BF 5	
29663	Knee	AF 6	
30166	Strake	AF 6	
30341	Knee	AF 4	
37029	Head from headbeam	BF 3	
37787	Strake fragment	BF 3	
52491	Knee	BF 5	
70643	Strake	BF 3	
80220	Stem-knee	BF 5	
90018	Crossbeam	BF 4	
90044	Strake	BF 4	
90046	Strake	BF 4	
90119	Breasthook	BF 2	1
90151	Strakes	AF 4	
90217 /218	Strakes	BF 4	
90220	Breasthook	BF 3	
90355	Headbeam	IF 2	
90359	Headbeam	AF 4	
90361	Strake	AF 4	2
90387	Crossbeam	BF 4	
90393	Rib	BF 4	
90396	Strake	BF 4	2
90402	Strake	BF 4	2
90716	Strake	AF 4	2
90726	Mast beam from the "Big Ship"	BF 4	3
90793	Stringer	AF 4	4
90797	Ship beam	AF 4	5
91446	Rudder	BF 4?	
92503	Strake	IF 4	
92735	Strakes	?	

TYPE 4

Number	Object	Date	Notes
33062	Strake	IF 6?	
43433	Strake	BF 6	
53960	Strake	BF 5	
54401	Strake	BF 4	
64497	Strake	BF 6?	6
80674	Rowlock	BF 5	
90863	Crossbeam	IF 5	
90867	Crossbeam	IF 5	
91439	Strake	IF 5	
93385	Crossbeam	?	

Notes to table 15-I

1 90119 The probable date of the piece is c AD 1450.
2 90361, 90393, 90396, 90402 The same scraping tool has been used to make the decorative moulding and the luting-cove.
3 90726 This beam shows the use of two moulding tools, one on the port side of the beam, the other on the starboard side. Both mouldings have been observed on other fragments of the "Big Ship".
4 90793 The moulding seems to be identical with that on the starboard side of 90726.
5 90797 The moulding seems to be identical with that on the port side of 90726.
6 The strake also has a moulding of type 1.

TABLE 15 - V DATED MOULDINGS

FIRE LEVEL / TYPE		FIND-SPOT 1	2	3	4
1	1702				
2	1476			X	
3	1413			XX	
4	1332			XXXXXX XXXXXX	
5	1248	XXX		XXXXX XXXXX	X X
6	1198	XXXX	X	XXXX	XX X
7	1170				XX

4 OF THE MOULDINGS CAN NOT BE DATED

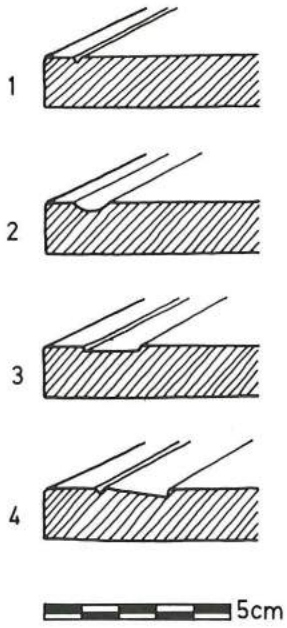


Fig 15-1
Sketch of the four moulding types found at Bryggen

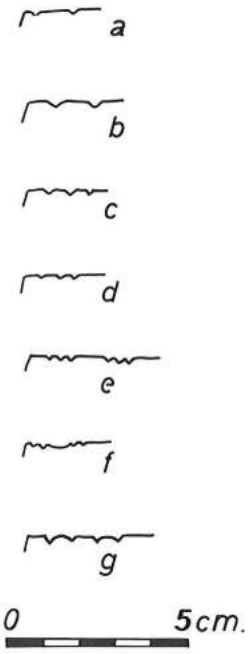


Fig 15-2,
Various pre-Viking and Viking age mouldings
a The small Kalsund boat
b The Oseberg ship
c The ship from Gunnarshaug, Karmøy
d The small boat, from Gunnarshaug, Karmøy
e The ship from Gunnarshaug, Karmøy, sheerstrake
f The oars of the Oseberg ship
g The rudder of the Oseberg ship

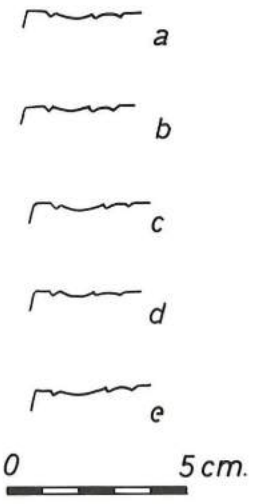


Fig 15-3
Various Viking age mouldings
a Gokstad, the ship
b Gokstad, the largest boat
c Gokstad, the small boat
d Fragments from grave at Lammøya, Tjølling (C 21960b)
e Mast partner from Rong in Herdla, Hordaland

Fig 15-4
The moulding used in the Klåstad ship

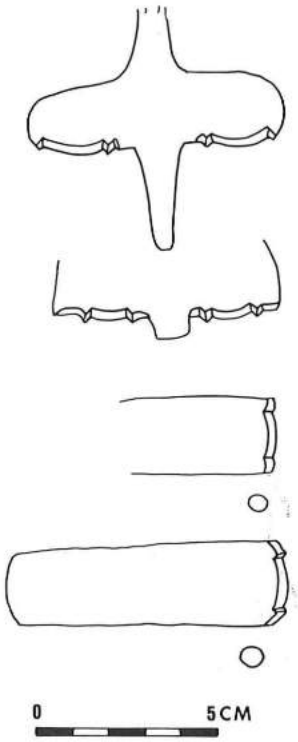


Fig 15-5
19th century moulding tools at De Heibergske Samlinger at Amla, Sogn. 2 scrapers and 2 plane irons are shown, all are variations on the same moulding

MEDIEVAL SHIPBUILDING IN WESTERN NORWAY: TYPES OF SHIPS AND BUILDING TECHNIQUE, DISCUSSED ON THE BASIS OF THE BRYGGEN FINDS AND OTHER SOURCES

After having described the ship and boat fragments from Bryggen, group by group, it is now time to ask whether this has given us new information about medieval ships and shipbuilding, or whether the finds merely confirm previous knowledge and offer nothing new.

I think it can safely be stated that even material like this which is so fragmentary that it does not allow a reconstruction of a complete hull, not even on paper, does still contain new data of considerable interest. Taken together, the fragments give a good impression of how rich and varied the repertoire of technical solutions was, within the limits of clinker shipbuilding.

A generation ago, when A W Brøgger and H Shetelig wrote their book "The Viking ships, their ancestry and evolution", they spoke of the intense interest in ships and the sea shown in medieval Norse literature. The archaeological sources for medieval ships were poor, however: "But of all these ships, we have not so much as a nail or a chip of board." If we think of the longships that the kings and nobles owned and sailed with such pride, Brøgger's statement still holds true, but if we consider medieval shipbuilding as a whole, then we are far better off than we were 30 years ago. Both conventional land excavations and underwater archaeology have yielded finds of medieval ships. Some are of what we should call Nordic type, close relatives of the Viking ships, some are of types that had scarcely been recognised when Brøgger and Shetelig were writing, like the cog, well known as a type-name but unidentified archaeologically, or the barge-like vessels of Falsterbo, Egernsund and the Rhine (Crumlin-Pedersen 1965 and 1977, Ellmers 1972). Thanks to the work of P Smolarek (1969), Slavonic shipbuilding in the Baltic has been properly recognised, and its special characteristics defined and described.

O Crumlin-Pedersen and D Ellmers have worked out definitions for the main types of North European vessels: the Nordic keeled vessel, the cog, the hulk and the pram, to use Crumlin-Pedersens type-names (Crumlin-Pedersen 1981, 274f). The Bryggen finds, fragmentary as they are, throw new light on one of these main types.

In other harbours, the "engineers" reclaiming land have left us complete ships, or at least fairly intact hulls, sunk as stabilising floors in the fill. Oslo has at least two (Christensen and Molaug 1965, Christensen 1973). Stockholm has a large number, and other harbours, like Kalmar, have sunken ships. Harbour builders in medieval Bergen dismantled the ships they used in foundations, and have left us with material that cannot form the basis of full reconstructions. However, the fragments enable us to learn much about shipbuilding technique, and we can look at other sources with fresh eyes and with new questions in mind.

In archaeology, one has commonly drawn on examples from exotic cultures and other chronological periods when constructing the model theories that are used to explain artefacts or recreate a picture of life in the past. One type of theory has recently been labelled the "folk-culture approach" or "direct historical approach" (Ascher 1961, 318).

The formation of theories is based on local tradition - oral, manual or institutional - projected backwards in time, or on written sources taken to be valid also for periods older than that in which they were written. Implicit in the use of this approach, which has also been labelled "retrospective analysis", is a belief that changes in the field under study have been so small that it is valid to project backwards. This way of formulating theories has been used by many Norwegian archaeologists, implicitly or explicitly. Good examples are the general surveys of Norwegian prehistory by A W Brøgger (Brøgger 1925 and 1979).

In more recent years, theories have been formulated with the help of data borrowed from social anthropology and ethnography. Good examples are the chiefdom models established by Service (1971) which have been used to explain prehistoric society in Norway, and the study of how people today in remote corners of the world practise Stone Age technology, with the aim of projecting that knowledge backwards to our own Stone Age. Another ap-

proach for assembling an empirical basis for the models is the experimental archaeology described by Coles (1979) and practised widely.

In the study of boats, a number of experiments have been carried out, most of them as replica-building projects. The scientific level of documentation and presentation has varied widely, in common with the aspirations of the people behind the experiments. Projects like the skin boat built for Sverre Marstrander and the replica of the Gokstad *færing* built by the National Maritime Museum, Greenwich, were experiments staged by scholars and museums with the aim of getting answers to academic problems. The Gokstad *færing* replica built by Danish Senior Scouts was mainly intended for the builders' and subsequent users' own fun, but their record of how the boat was made is nevertheless a valuable document. (Marstrander 1976, McGrail and McKee 1974, Vadstrup et al 1977.) Experiments of another kind are the sailing trials made with the *Nordlandsottring* belonging to the Viking Ship Museum at Roskilde, Denmark. The aim is to learn how to sail an open, square-rigged boat, before beginning to experiment with reconstructions of Viking Age rigging (Andersen et al 1980).

Ethnographic data have been used in Scandinavian "boat archaeology" mainly in the discussion on what kind of boats are shown on the rock carvings (Hallström 1925, Marstrander 1963, Hale 1980).

For the part of this work which deals with the identification of ships' timbers from Bryggen, I have relied mainly on retrospective analysis, using modern and 19th century parallel material. I have naturally also used a standard comparative technique, when archaeological finds of better preserved vessels have offered comparative material. I have been in the fortunate situation that the interpretations could be based on comparative research in a field where a strong living tradition exists, a tradition which goes back, unbroken, well beyond the period under study. Moreover, ecology, language and society have not changed too much in the centuries between the archaeological material and the contemporary comparative material (Christensen 1975). My theoretical and empirical background for the work includes the unpublished lectures on traditional crafts given by professor Hilmar Stigum in 1960, lectures which have given both information and inspiration. I have also, over the years, benefitted greatly from informal instruction and discussions with professor Dr Olof Hasslöf. His great knowledge, clear views on method and excellent field technique have set an example which has aided and inspired my own work in many ways. All retrospective analysis contains pitfalls, but when there is a possibility of working within the same cultural framework, as here, fewer pitfalls exist than when the "model" has to be transported from one area of the world to another, or where the chronological differences are greater.

If we go back to the material and survey it group by group, we will find that some fragments support previous knowledge; some offer new.

Keels and Stems

The small keel 90474 offers little that is new: it is a "standard" T-shaped keel, such as one would expect from a small medieval boat. On the other hand, the shallow, wide keel 87888 is unparalleled so far in medieval boat finds, and it shows that the backbone of some vessels was still adapted primarily to rowing even after several centuries of sailing ships. What type of boat had a keel like this? The keel shows that the vessel was a large boat rather than a ship, and the keel and garboard angle indicate that it was not intended for sail at all. The most probable solution is that the keel comes from a large travelling boat, belonging to someone high up on the social level, who might be called upon to travel fast, regardless of whether the wind failed or was contrary.

The stems do not supply new information, but 92389 is a rather large example of a stem intended for back-bevelled strakes, without the extra strength offered by a rabbeted stem. The model stems, described in chapter 12 and discussed on p 206f, are more rewarding than the full-sized specimens. Parallel material shows that in addition to the T-keels, the Late Viking and Medieval periods knew rabetted keels like Skuldelev 2, Bøle and Folderøyhamn (Olsen and Crumlin-Pedersen 1967, Molaug 1964, Thowsen 1965). Skuldelev 1 and 6 show T-shaped keels with rabbets (Olsen and Crumlin-Pedersen op cit). Keels of plain rectangular or Y-shaped cross section are also known from Sjøvollen and in the unfinished keels from Haukenes and Rimbareid in Hordaland (Christensen 1968, Færøyvik 1948 III) (fig 16-1).

Framing system

The frame system of Nordic vessels developed during the pre-Viking and Viking periods to a fairly standardized pattern. The ribs of pre-Viking vessels run from sheerstrake to sheerstrake in one piece. The fastenings are generally lashings but there seem to be examples of treenailing in the Grestedbro fragments and in the Sutton Hoo ship (Crumlin-Pedersen 1967, Evans 1975). The larger of the two vessels from Kvalsund shows some differentiation: the ribs are not lashed to the keel but still supported by cleats. There are lashing cleats on strakes 1 to 6 and additional treenails in some ribs through strake 6. Strake 7 is treenailed, and the rib top is fastened to the sheerstrake by an iron rivet. In Viking vessels, we find two variations of fastening and there are new elements in the system. The floortimbers, which in older vessels run from sheerstrake to sheerstrake, terminate at the waterline in Viking ships. Generally, they stop at a specially strengthened strake, the *Meginhufr* in Old Norse. In the Oseberg, Gokstad and Tune ships, the ribs are lashed to cleats on the strakes as in older ships. Other ships, eg Klåstad, Äskekärr and Skuldelev, have treenailed ribs. In Klåstad, the treenails are very sparingly used (Christensen and Leiro 1976). Over the floortimbers, the Viking vessels have transverse crossbeams. These rest on the top of the ribs and the *Meginhufr*, and are usually fastened by a treenail or rivet through strake, rib top and beam head. Above the waterline, the strakes are supported by knees standing on the crossbeams and there may be additional loose top ribs or futtocks placed between the knees. Fastenings above the waterline are treenails. Small craft from the Viking Age have treenailed ribs and crossbeams, generally with one rivet through the top of the rib and knees.

The 11th century Skuldelev ships show an elaboration on the beam system, where beams above the low-set *bite* are used to support the mast and strengthen the topsides at various points along the hull. Crumlin-Pedersen has published a typological sequence (Olsen and Crumlin-Pedersen 1958). Here he postulates that the old *bite*, placed above the floortimbers, gradually gets shorter and is placed lower in the hull, resting on much shorter floortimbers than before, till the *bite* finally is let into, or rests on the keelson, as can be seen in the Galtabäck and Eltang Vig vessels (fig 16-2). Since the theory was published, several vessels have been excavated that support it, among them two Norwegian ones, the Sjøvollen ship and the "Big Ship" from Bryggen. However, the development does not seem to have affected small boats in Western Norway, where the floortimber/*bite* system hardly differs between the Viking Age and today (fig 16-3).

It is also uncertain whether the development affected war vessels to the same degree as the trading vessels. Skuldelev 5, the smaller of the two warships, has a system where the *bite* is fairly low-set, with deckboard rabbets, and the ribs in the middle part of the hull have additional broad upper beams, or rather permanent thwarts for the rowers. In Western and Northern Norway, the word *bite*, *bete* or *bekk* is still used for the crossbeams in traditional boats. The number of *bites* in a small boat may equal the number of floortimbers, but some ribs may be without a *bite*. This varies from district to district. Boats built for cargo have as a rule fewer *bites*. The most common pattern is one amidships supporting the mast, one far aft, and one far forward. The end beams may support small half-decks. Examples are the two large *jekts* in the museums at Bodø and Sandane, and the smaller freighters at Sogn Folk Museum and in the fishing museum at Florø (Færøyvik 1979, Gøthesen 1980).

The material of ribs and beams at Bryggen show a wide-spread use of axe-shaped strakes, attested by curved faying surfaces on the ribs. This was to be expected, when the recent parallel material is considered. Otherwise, our knowledge of how medieval clinker vessels were framed is confirmed. This knowledge can be summarized as follows. Small boats had ribs that either ran from sheerstrake to sheerstrake in one piece, or ribs consisting of a floortimber and a *bite* (crossbeam) generally with one loose knee and one "grown" knee – being part of the *bite*. The small boats from the Gokstad find have only one *bite*, the rest of the ribs run in one piece, or are supplemented by "top ribs" in the largest boat. Generally the 19th century boats have a greater number of ribs with *bite*. How this was in medieval small boats is not known. The framing system used in Eastern Norway in the 19th century, where a sturdy thwart secured by knees takes the place of the *bite* and loose thwart is not known from the

Norwegian material of small medieval boats. Fore and aft, there were oblique ribs, breasthooks or canthooks, in one piece from sheerstrake to sheerstrake. In the small boats from Gokstad, the aft canthook has an asymmetrical shape, in order to act as a rudder rib. 93386 may be a fragment of such a rudder-rib. However, the two breasthooks 90528 and 90535 are so similar that they must come from the same boat. Maybe this was a pure rowboat with no need for a specially shaped rudder-rib.

Small freighters had composite frames, consisting of one floortimber and two futtocks in the open hold, with only a few floortimber/*bite* frames, one of which supported the mast. Whether the small freighters regularly had double beams is uncertain. Kalmar I has triple beams on three rib stations. Sjøvollen has traces of a double beam set at the mast in the form of one standing knee for the lower beam, which seems to have butted against the strake, and a square hole for the upper, which must have been a headbeam (Christensen 1968, figs 11 and 12), (fig 16-4). Fore and aft, some beams were rabbeted to take deckboards, with one characteristic beam, rabbeted on one side only, bordering the open hold. The Bryggen material does not contain breasthooks or rudder-ribs from this category of vessel. Large ships had a more complex framing system, with floortimbers, low-set crossbeams like those seen on the "Big Ship", long futtocks on the beams, and sets of headbeams further up in the hull. The headbeam 90659 from Bugården Søndre, was the first proof of this construction in Norway. Later, besides the other headbeams from Bryggen, headbeams have been demonstrated in an East Norwegian vessel, as traces on the planks of the Sjøvollen ship show (Christensen 1968). Åkerlund has traced the ancestry of the headbeams back to Mediterranean craft and has also demonstrated that they are of medieval date in Scandinavia, but he suggests that the Äskekärr wreck, of Viking Age date, may have had headbeams. On the technical side, he is of the opinion that the headbeams hardly had any advantage over beams secured by knees, but that they may have presented a serious hazard to the vessel, as damage would easily occur if the beam struck a quay or another vessel (Åkerlund 1951, 138f). I find it highly unlikely that medieval shipwrights would have introduced the headbeam into the framing system of the ships they built, if it was not, in their opinion, an improvement over the previous system of knees securing the beams. So far, the smallest vessels where headbeams have been found are Sjøvollen and Kalmar I. In both cases, the mast-beams are about 4 m long. Both vessels are high-sided in proportion to their size. All other headbeams found belong to larger vessels. When travelling with light cargo, and especially when beached, the sides of a clinker vessel tend to sag outwards. This fact is evident on some of the old clinker vessels kept in Norwegian museums, even on small craft. This tendency is much better counteracted by a headbeam than by a knee-fastened beam, where all the strain is taken by the treenails holding the knees to the strakes. In my opinion, the headbeams are the medieval shipwrights' answer to this problem as cargo ships were built larger and with higher sides. The headbeam may ultimately be derived from Mediterranean practice, but it is hard to point to intermediate stages between the Mediterranean shipbuilding in antiquity and Medieval Scandinavia. I would suggest that the headbeams may just as easily be an independent Scandinavian invention, probably inspired by the tie-beams used in both corner-timbered and stavebuilt houses (cf Bjerknes 1976, fig 42, and Christie 1976, fig 15).

Large ships had inwales or huge lodging knees like 90222. The inwale may have run over the tops of the futtocks, as seen in the Gokstad ship, or in shorter pieces, as knees, running from main frame to main frame, as seen in Skuldelev wreck 1.

A characteristic detail in Scandinavian shipbuilding is that in nearly all cases, crossbeams are directly connected to floortimbers or futtocks; they do not rest on a shelf or clamp set inside the ribs as they generally do in carvel work. In modern East Norwegian clinker work, thwarts are sometimes supported by a clamp, while the Slavonic boats from the Baltic show that the principle was known in the Middle Ages (Lienau 1934, fig 10-12). The wrecks 2, 3 and 5 from Skuldelev have stringers that support crossbeams, but they are fitted flush against a strake, not set inside the ribs.

In recent boatbuilding in Western and Northern Norway the *bite* (beam) usually rests on the flat top of rib or futtock, while medieval and older examples generally show that the top of the floortimber or futtock is let into the underside of the beam (characteristic mortises can be seen on figs 4-13 and 4-23). As a general rule,

beams have been selected from a log with a branch or root forming the standing knee at one end, while a corresponding knee is nailed on at the other end. Also in recent boatbuilding, the loose knees are generally placed alternating to port and starboard. The use of crossbeams with heads does not alter this general pattern, the headbeams are treated like other crossbeams, with mortises and standing knees. Naturally enough, no headbeams have been found with "grown" knees, however, as this would be next to impossible to fit.

The Bryggen frames mainly support and strengthen the picture that other finds have given of the way that medieval boats and merchant ships were framed. The small frame 19133 shows better than most of the strakes found, how the strakes were sculptured. The large timbers, especially the headbeams, bear witness to ships of a size previously not found in Scandinavia.

Mast support and Keelsons

The mast support in the earliest dated sailing vessels found in the north, Oseberg and Gokstad, consists of a rather short keelson housing the mast step, and a heavy block of oak, the mast partner. This is placed on the crossbeams above the keelson and supports the mast at deckboard level. In Norwegian ships, the mast was raised in a forward direction, but Danish finds show that other variations of the mast partner/keelson system existed, where the mast was raised the other way (Crumlin-Pedersen 1972). In the Late Viking merchant ships from Skuldelev, the mast is supported by crossbeams instead of the mast partner, and keelsons are longer. This seems to be the pattern followed in most medieval vessels. The small keelson 81442 is without parallels in the medieval and later material. The only other keelson known which only spans from one rib to the next is the one in the Oseberg ship. Oseberg gives the impression of being a very early sailing vessel, where the mast support was still in the experimental stage. Of different form, but equally delicate is the small keelson in Skuldelev wreck 6. It is questionable whether 81442 should be called a keelson at all, or whether it should be classified as a mast-step.

Ribs with mast-steps like 50131 and 93396 have been found in Tønsberg (unpublished) and in the Sørenga ship (Christensen 1973). The only medieval parallel from Western Norway known to me is the "mast rib" found with the boat fragments from Vågsbunnen, Bergen (Færøyvik 1948-2). The mast step is about 12 cm square and 6 cm deep, suitable for the mast of a 10-oared boat according to Færøyvik. Modern parallels from West Norway are restricted to the larger boats from Sunnmøre (Færøyvik 1979, plates on p 89 to 91).

It has been suggested by Crumlin-Pedersen that this feature is a Continental and/or Slavonic detail in medieval boatbuilding in Northern Europe. The Norwegian finds, both from Bryggen and East Norway, date from a period when Continental or Slavonic loans into Scandinavian boatbuilding are quite possible, so they cannot throw new light on the theory. They show, however, that this form of mast step had its place in the repertoire of Norwegian boatbuilders in the Middle Ages. A similar mast-rib has been found in Greenland (Roussell 1936).

The system of low-set crossbeams seen on the "Big Ship" is also found on the keelson 90125 and the mast crossbeam 90405/06. The only medieval parallel to this in Norway is the Sjøvollen ship. Other medieval parallels are the ships from Elling Aa in Denmark and Galtabäck in Sweden. The heavy side keelsons or bilge stringers 90020 and 90136 have one parallel, a similar timber in the Sjøvollen ship. Their place in the structure of the ships is not yet fully understood and future work on a full reconstruction of the Sjøvollen ship may help in understanding this better. The possible mast support from a floorboard has no archaeological parallels, as far as I know. A modern parallel is shown in fig 5-8.

Strakes and Strake fastenings

The information given by the strakes mainly supports previous knowledge. It is worth noting that pine is much more common than oak for strakes. The use of stealers and shaped garboards have been reported before, but the specially shaped *meginhufr* strakes like 90372/90373 are unparalleled so far, apart from the Lynæs ship, which has one strake with unusual cross-section (Crumlin-Pedersen 1979, fig 4). The spacing of the rivets is less regular than has been observed on earlier finds.

The spacing of ribs, as shown by the treenails, is of considerable interest. In the Viking

vessels from Oseberg and Gokstad and in ships of pre-Viking date, ribs are spaced c 1 m apart. Modern Norwegian rowing boats also have this rib distance, which gives the average-sized rower a comfortable rowing position, sitting on the thwart above one rib with the feet braced against the next.

The longship from Skuldelev, wreck 2, has a rib distance of c 70 cm, and must have been rowed with short strokes. Rib distances from the Bryggen material have been set out in diagram form in table 16-I. As can be seen, there is great variation. In all cases except strake 90598 the distances are less than one metre. No distances predominate, but there are noticeable clusters around 47 to 50 cm and 63–65 cm. It is tempting to suggest that the values from 47 to 50 cm correspond to the shorter medieval ell, calculated to 47.4 cm by Steinnes (1936). The three values around 55 cm may be the "long ell" of 55.3 cm. The values between 63 and 65 cm, again a small cluster, are hard to explain. The most usual foot-length found in Viking and Medieval buildings varies between 26 and 33 cm, so the values may correspond to two feet of c 31 cm. However, feet seem to be mainly used in Sweden and Denmark, while ells dominate in Norwegian sources (KLNM, entries for *alen* and *fod*). The rather even distribution of values between 30 and 70 cm indicates that ribs were positioned by eye, even when the boatbuilder had the intention of spacing the ribs 1 or 1 1/4 ells apart.

It is of considerable interest to find treenails used for fastening planks in the Bryggen material.

In Slavonic Medieval boatbuilding, treenails are used in the planking, while iron rivets are used very sparingly. The only exception to this rule are the wrecks from Baumgart (Conwentz 1924) and Frauenburg (Heydeck 1934). In the opinion of Dr P Smolarek, the two vessels are the work of Baltic, probably Prussian, shipwrights, rather than Slavonic ones (personal communication).

In the modern parallel material, treenailed or "pinned" boats are found in South-East Norway, parts of Sweden and Denmark. In Sweden they are restricted to the west coast; in Denmark they are mainly found in the east and south. Along the Baltic coasts of Sweden, the west coast of Denmark and in the west and north of Norway iron rivets are used. When we find treenails in strakes in the medieval boats from Scandinavia, it is probably a matter of economy. Iron was expensive, while treenails could be made by the boatbuilder himself, and it was a job where less skilled labour could be used. When talking to old boatbuilders in South and East Norway, I have often been told that the first job a small boy was entrusted with, was to make treenails. Quite often, this was the evening work for the entire male side of the family, from grandfather down to boys of 8 to 10 years of age.

One may then ask why were iron rivets used at all? Geographically, the "pinned" strakes are restricted to those areas where boats in the 19th century were built of oak, with fairly thick strakes. The medieval Slavonic craft are also oakbuilt and with rather sturdy scantlings. In that case, a wedged treenail is a secure fastening. On the extremely thin pine strakes used in the Baltic and on the western and northern coasts of Norway, there is very little wood in a double strake thickness for countersinking a treenail head and driving in a wedge, and an iron rivet is therefore a better fastening. In the ribs, where there is greater thickness of wood, treenails are used in these districts also. Where treenails are found in the Bryggen material, it is in strakes from larger vessels, where the scantlings are sufficient to give a hold for the treenails.

In all cases, the treenail is cut with a head which is countersunk on the outside of the hull, an the wedge is set to press along the grain on the inside, in order to prevent splitting the wood. The wedge should be cut, according to information given by numerous boatbuilders, with the wood running as indicated in fig 16-5. This rule can be observed on all the medieval and earlier wedges I have seen. The explanation given by boatbuilders today is that the hard and soft parts of the year-rings form serrated edges which interlock with one another and help to hold the wedge in place, preventing it from working loose. All medieval and earlier treenails carry traces of having been made with the knife, and this was the common way of making them until recently in several parts of the "clinkerbuilding area" (Törnroos 1968, fig 20. NMA field reports 1966–67). It is important that the nails are of uniform size: too small nails cause leaks and are insecure as fastenings; a trifle too large, and the strake or rib splits. To ensure uniform size, a hole is bored in a piece of hard wood with the same auger that is going to

be used for the nail holes, and if a special countersink auger is in use, this would also be used. The finished nails are then hammered into this hole and come out nice and uniform (fig 16-6). It is not known how old this practice is but the treenails and nail holes from medieval and earlier ships look identical to the 19th century ones. I believe that a sizing tool is necessary, even when the countersinking is cut with a knife or gouge instead of with a special auger. This is possible and may have been practised.

Carvel planking

In the 15th century, ships of a new type are seen in Northern Europe, carvel built and with three masts. The transition from one to three masts was completed around 1450 in Western Europe. At a slightly later date, carvel building seems to appear in the Baltic and in Scandinavia. These two important changes, which were the principal technological foundation for the great voyages of discovery and subsequent expansion, are not reflected in the Bryggen material, and it lies outside the scope of this work to recapitulate it in detail (Hasslöf 1958-1 is the best survey of early carvel building technique).

In the Bryggen material, the only trace of the new technique is the heavy strake fragment 90513. This may be a plank from the smooth bottom of a cog, but I would rather classify it as a side plank from an early carvel vessel, with caulking laths over the seams, like that shown in fig 16-7. The date of the piece is somewhat uncertain, but according to the excavator, it belongs to a building phase after fire III, so the plank must have been reused shortly after 1413 (A Herteig, pers comm 1982). For a side plank from a carvel ship, this is quite an early date. The earliest examples of carvel vessels are mentioned in Norwegian sources, or sources related to Norway, around 1500. In the testament of Sir David Sinclair, an Orkney nobleman who for some years commanded Bergenhus castle, a carvel is mentioned. The testament was drawn up at Tyngwall in Orkney in 1506, and gives detailed instructions as to the division of Sir David's land and other goods. "To my Lorde Sincler" is left "my schipe callit the Carvell wyth hir pertinentis". In addition to the carvel, the will mentions "my litil schipe" and "my Inglis schipe wyth all geir". Nothing is said of where she was built, but she would in all probability have been seen in Bergen harbour.

The Dutch mercenaries hired by Archbishop Olaf in 1536 sailed to Norway on two ships, one of which was named "Blue Carvel". This ship was surely not built in Norway. In 1538, Frederik I wrote to the citizens of Oslo asking them to supply "a good, large carvel", with the king supplying half the money needed. This may also have been a foreign vessel of course, bought for the occasion, but the letter may indicate that there were shipbuilders in or around Oslo who were capable of building carvel ships (fig 16-8).

Floorboards

The floorboards found at Bryggen are made in the manner known both from the sparse archaeological material and in recent boatbuilding. The grooves and drainage holes have not been observed or described before, as far as I know.

Another factor worth mentioning is that the boards are narrower than the floorboards in some of the modern boat types found around Bergen. The "B–C values" in table 7-I are comparatively small. This is an indication that hull shape was somewhat different from what we see on the boats south of Bergen today. The height between thwart and floorboards should be about 30 cm for comfortable rowing, and narrow floorboards indicate either boats with a sharp bottom, or boats that were low on the water. In the latter case, both thwarts and floorboards must be set lower for comfortable rowing, as the vertical distance between rowlock and thwart is also a rather permanent factor. It should be about 15 cm. Fig 16-9 shows the cross sections of a modern Oselver *færing*, a modern Nordfjord *færing* and the Gokstad *færing*.

Oars and Rowlocks

One of the more important differences between East and West in recent Norwegian boatbuilding is the shape of oar and rowlock used on the West coast, roughly between Haugesund and Kristiansund N.

On the coast between the Swedish border and Rogaland, tholepins and oars of round cross-section are combined with a style of rowing

where the oar is turned a quarter turn at the end of the stroke and the blade held horizontal during the backstroke. A crewmember of a modern racing shell would say that the oars are feathered. Contrary to this, the fishermen of the West coast uses a *keip* where the *horn* meets the saddle at right angles, and oars of corresponding cross-section. Further north along the coast, in Trøndelag and Northern Norway, oars of round cross-section were used with rounded *keips*, but the oars were not feathered according to all the information I have been able to assemble (personal interviews and pers comm Asbjørn Klepp). It is, of course, not possible to feather oars with the "West Norwegian" cross-section. The oars of Western Norway are long, with a thin, elastic leg and a long slender blade. According to Færøyvik, most fishermen made their own oars, in order to get them "just right". The West Norwegian oar shape is scorned in East Norway, where proper rowing calls for feathering the oars. Contradicting this, the fishermen of West Norway maintain that on long trips you will strain the wrists badly if the oars are feathered. They also maintain that very few people are used to the long rowing trips that the West Norwegian fishermen had before engines became common in the fishing fleet. In Rogaland, both *keip* and tholes are used, but as far as I know, oars are not feathered, and quite a few of the oars I have seen are square in cross-section. On the Faroe Islands, a special form of *keip* is used, with oars of square cross-section.

The tholepins 1801 and 2823 show that these were not unknown in Bergen in the Middle Ages. Seen against this comparative background, it is important to note that all the rowlocks from Bryggen are for round oars. This is also the case for all comparative material from prehistoric and medieval finds. In the bog find from Li at Hatlestrand, Hordaland, there is an unfinished stepped stem, two roughly cut rowlocks, and 7 small unfinished stems. The small stems closely resemble the stems of traditional *færings* from Hordaland, of the Os, Hardanger and Sunnhordland types. A characteristic detail is the small lumps of wood left on the pieces. Until c 1940, stems for these boats were made with *kaning*, a small triangular knob of wood on each side of the stem, which partly covered the top of the sheerstrake. I do not know of any direct archaeological parallels to this, and the age of the detail is uncertain. The two rowlocks from this find have a shape which resembles modern rowlocks, shorter than the medieval and prehistoric ones found elsewhere. I am of the opinion that the Hatlestrand find is a mixed one, the stem medieval, the small stems and rowlocks of uncertain post-medieval date (fig 16-10). The dated rowlocks from Bryggen from fire II and downwards through the layers show that the West Norwegian style of *keip* and oar is post-medieval, even if the change cannot be dated more closely than within the timespan 1476–c 1750. The round oars in rounded rowlocks found in medieval and earlier contexts may of course have been feathered, as is done with similar oars in East Norway today, but I do not find this probable. The modern practice in Trøndelag and North Norway speaks against it, and some of the oars from the small Gokstad boats have hardwood chafe insets which seem to show that the oar was used in a fixed position against the rowlock, not feathered.

Rigging

Apart from the basic fact that ships carried a single squaresail on a mast set amidships, little precise knowledge exists of Viking and Early Medieval rigging. The most detailed sources are iconographic, but they pose serious problems of interpretation (Christensen 1980). A survey of the sources for Viking rigging (Christensen 1979) seems to indicate a change of rig type in the Late Viking Age, from the complicated system seen on the Gotland picture stones, to a simpler square rig which can be traced back to the 11th century and continuing up to the 19th, apparently without many changes.

Among the rigging details found at Bryggen, the complete mast is so far unique, no parallel being known in an archaeological context. The shape is well known from 19th century parallels and is confirmed by the model masts found at Bryggen. The best iconographic parallel is the ship on the tomb of Alexander McLeod, shown in fig 16-11. The use of a piece of bone to diminish chafe in the halyard hole is unparalleled as far as I know, but B Færøyvik has noted the use of a hardwood half-sheave on 19th century masts (Færøyvik 1929, 173).

The only parallel to the fragmentary yard is a complete one found in Tønsberg, TL2747. This is 6.3 m long, with a diameter of c 17 cm, in the middle and c 12 cm at the ends. The holes for

the head-earings are oval, 9 cm long and 6 cm wide. The date is medieval. The parrels, rope-end toggles and fairleads are all known from other finds. In medieval contexts they are found in most excavations, both in Norway and abroad. In the Oseberg find, the parrel still had fragments of rope in the holes when found (Shetelig 1917, fig 121). Many of the rope-end toggles also had fragments of rope adhering. Their size varies greatly, and many of them may be equipment for tents rather than a ship, but the larger ones are in all probability from the rigging. No fairleads were found at Oseberg, but there are three in the Gokstad find, one of which is decorated (Nicolaysen 1882, pl VI 3, 4 and 15). More modern fairleads are known from the rigging of the *jekt* type of coaster, most of them as illustrations or part of models.

In connection with the fairleads and their use as sheaveless blocks, the very limited number of block-sheaves which have been found must be discussed. In post-medieval maritime contexts, blocks and sheaves are among the most numerous artefacts found on maritime sites. Even on a small one-masted ship, many blocks were used in the rigging, and on a large fullrigged ship from around 1800 hundreds of blocks were needed to handle the rigging. When so few sheaves are present at Bryggen, we can postulate that the one-masted medieval ship in Northern Europe was rigged with few blocks, if any, until well into the Middle Ages. In the undated, but in all probability medieval vessel found at Træna (Molaug 1958 and 1959) blocks were found, those illustrated being sheaveless (Molaug 1958, fig on p 9).

It is of considerable interest in this context that boats as large as the *ottring* from Salten, of early 19th century date, now in the Norwegian Maritime Museum, has no blocks with sheaves in the rigging at all (the boat is published in Færøyvik 1979, 106f).

The belaying cleats are of a type well-known both in archaeological and recent material and offer little new information. If my interpretation of the snatch-cleats 5753 and 44727 is right, they are rigging details that have not been recorded before. On 19th century boats from Sunnmøre, a similar cleat for the sheet was part of the inwale (fig 16-14) and they are known from sprit-rigged and gaff-rigged vessels, also as sheet cleats.

The "rope-stretcher" 30005 is rather uncertain as a rigging detail, but as mentioned on p 136, the only archaeological parallels known to me are from boat-graves.

The cleats 18417, 78190 and 78429 are interesting parallels to those found on Skuldelev wreck 3, where they probably secured standing rigging.

Bailers

The bailers found at Bryggen show that the shape which was current in the 19th and 20th centuries goes back unchanged to the late 12th century at least (the bailer 18013 was found in layers from below fire level VI, 1198). The archaeological material offers parallels, but they are undated with the exception of a possible bailer fragment in the Gokstad ship (Nicolaysen 1882, pl VII no 16). The bailer from Tønsberg is probably medieval, but not closely dated, and Ts 5412 from Andøya cannot be dated at all. The Oseberg bailer has a different shape (Shetelig 1917, fig 102 and pl XXIV). The Gokstad "bailer" is, if the interpretation is right, a small one-hand bailer which probably was used in one of the small boats. It is, however, so fragmentary that the interpretation is uncertain, so the Bryggen find 18013 must rank as the oldest bailer of traditional form found in Norway.

Outside Norway, similar bailers are reported from Greenland (Roussell 1936). The excavator did not identify the bailers as such, but suggested that they might be scoops for grain, even though this was not likely in Greenland.

Steering equipment

Of the early boat finds, the Nydam ship has a large steering oar, which was probably fastened to the starboard quarter, in a way that is not known. The Sutton Hoo ship shows traces of a more permanent side rudder mounting, but as only the iron rivets are intact, details are still uncertain. Kvalsund, Bårset, Oseberg, Gokstad, Tune, the small Gokstad boats and probably Äskekärr have side rudders mounted on a rudder boss, and secured to a sturdy rudder rib of characteristic shape. Side rudders found out of context with wrecks were studied together with iconographic sources by Åkerlund who claimed that alternative systems to the rudder boss existed (Åkerlund 1954). After the introduction of the stern rudder around 1200 iconographic sources indicate that both types were in

use side by side for a considerable time. At what date the side rudder finally went out of use is not known.

Seen together, the steering equipment found at Bryggen mainly confirms what was previously known, ie that side rudders continued in use in Scandinavia well into the Middle Ages. A rather puzzling detail is the short distance between the fastening hole and the tiller hole in 92738 and 92894. This shows that the main fastening of the rudders must have been placed further up on the ship's side than is the case on the ships from Oseberg and Gokstad. On fig 16-15 I have assembled a collage of side rudders to the same scale, in order to show the range of variation found in the material. The two small rudder-bosses found are dated to before fire level V. They show that this way of mounting side rudders, well-known from the Norwegian Viking ships, continued in use until at least 1250.

Models

Models of boats, horses, swords etc. have been found in other medieval excavations - Oslo (Grieg 1933), Dublin (O'Riordain 1972), Gdansk (Kunicka-Okuliczowa 1959) to mention some of the more important - and they are usually interpreted as toys. Models of parts of boats, like those found at Bryggen, are few: the only published ones I know are those from Sandnes in Greenland (illustrated in Olsen and Crumlin-Pedersen 1967, fig 74).

As discussed on p 159 toy boats are known from many places, but model boats have also seen other uses.

Among the Bryggen models, the parrel, masts, bailer and bollard are most convincingly explained as equipment for model boats, as toys or with other functions. These must, however, have been larger than the actual model boats found at Bryggen and more elaborate. Possible parallels are the model found at Båsmyr in Vestfold (fig 16-16) and a model from Trøndelag (fig 16-17). The Båsmyr model is probably medieval, while the other is undated. Both are bog finds.

The 7 loose stem tops, all originally with a tenon at the bottom, are so far unparalleled in full-sized objects, so they are important reminders that we do not yet have examples of all the structural details used by medieval boatbuilders. A number of medieval ship graffiti showing a line across the stem, where the strakes terminate, are clearly illustrating similar loose stemtops, and demonstrating that this is not a model-builder's short-cut.

In addition to graffiti in several churches, the carved fleet from Bryggen show several examples, both stems that taper to a point like 54420, and stems ending in a small horizontal plane like 8256, 8681 and 39606. Whether 8779 and 19732 were terminated in one way or the other is impossible to say. The two grooves cut in 8779 must indicate strake runs (figs 16-18 to 16-20).

A passage in the saga of King Håkon Håkonsson must, in my opinion, describe a ship with a loose stemtop, like the models. "When King Håkon sailed east, Tore Greppson and Bård Groson from Hardanger collided with the ship of Archbishop Einar, so the stem became loose down by the bows, and the stem and the shields on it fell into the sea. The weather-vane stuck in the sail of Tore and he sailed away with it. The archbishop had a boat fetch the stem and the shields, and had it mounted on the ship again. He then sailed south to Öckerö to the king. The king greatly disliked that the ship of the archbishop was damaged. But some men said that the damage was not as bad as the men of the bishop claimed. When the archbishop heard of this, he had the stem taken off, and it lay awash on the foreshore."

The loose stemtops, whose dates are given in table 12-II show a wider chronological distribution than the models of stepped stems. 54420 was found between fire levels VI and VII, 39606 was found below a fire in Gullskoen which is either fire level II or III. The remainder are placed in between fires III and VI. The special shape of the top on 25547 indicates that this piece may have been intended to carry a weather vane or a loose dragon's head. A parallel to the shape is found on the "Noah's ark" carved on the portal from Nesland stave church (fig 16-21).

The other stem models have full-sized counterparts. 44760 (fig 12-10) is a model of the stem type used in the Gokstad ship. This shape of stem is also found in the unused stem from Sunnanå, and in the Polish vessel Gdansk-Orunia 2. Among the West Norwegian bog finds, the unused stems from Haukenes on Hufteren, Hordaland, has this shape. The Sunnanå stem is a very close parallel to the Gokstad

stems and should in all probability be dated to the Viking Age, while neither the Haukenes stems nor Gdansk-Orunia can be closely dated. The boats from Orunia are of Slavonic type and most probably antedate the conquest of Gdansk by the German Order in 1308 (Smolarek 1969). The model was found above the 1198 fire (fire level VI) and must be given an early 13th century date, showing that this particular stem shape was in use in Norway at least from c 850 to 1200.

The oldest dated example of a winged stem is the Gokstad four-oared boat, c 850–900, while the oldest known example of a stepped stem without wings is Skuldelev 1, dated by radiocarbon to c 1000. The hood-ends of the Äskekärr ship indicate that the stems were stepped or winged. The ship is dated by radiocarbon to 840 ± 75. I am inclined to consider this date as somewhat too early: the structure of the ship speaks for a date somewhat later in the Viking Age, as I see it. The Polish stems are dated to the 12th and 13th centuries while Falsterbo and Galtabäck have been dated by radiocarbon to c 1100 and c 1070. The Sjøvollen ship has been given a date to 1210 ± 80, again by radiocarbon. The West Norwegian bog finds are difficult to date, but the heads on the Dalland and Midtvåge fragments have 12th century parallels. The model stems from Sandnes, Greenland, were not dated by the excavator, but they are of course medieval. The five models of stepped stems come from different layers, as can be seen from table 12-II, and they do not help in giving firmer chronological limits. However, they help to establish medieval dates for the undated bog finds from Western Norway. The wages earned by stem cutters and the shape of the existing stepped and winged stems clearly show that the stem was a very important workpiece. It must have been the most difficult single piece in the hull, where one blow of the axe might ruin a large expensive piece of curved wood, and where the wrong shape would seriously affect not only the looks but maybe also the characteristics of the finished ship. I think that we can postulate that the stem was a prestigious object, and that good stem-cutters were highly regarded by others. This may be the reason or part of the reason, why the model stems were cut, either by men whose thoughts centered on ships, or by boys who dreamed of becoming stem-cutters when they grew up (cf figs 16-38 and 16-39).

Miscellaneous timbers

Of the miscellaneous timbers treated collectively in chapter 15, the possible stringers will not be fully explained until new finds show them in context.

The anchor stock, 90160, offers no new evidence. The two windlass "bearings" 90124 and 90153, supported by the model 30891, add to our knowledge of medieval ship anatomy. They show a windlass-mounting different from that seen in Kalmar I. The Elling Aa ship has a windlass-mounting similar to the Bryggen ones, but the vessel is not yet published in detail, so a closer comparison must wait. According to the available information, the windlass of the Bremen cog was mounted like that of Kalmar I (Fliedner 1964, fig 26). Fig 16-22 shows a manuscript illustration of a windlass in use, where it seems to be mounted on bollards on the ship's side. In the drawing, not only the halyard is taken to the windlass, but both sheets as well, the latter being difficult to accept. That the halyard was handled with the help of a windlass is not surprising, as it must have been very hard work to hoist a heavy yard and a large sail without the help of tackle. Fig 16-23 shows the anchor cable led aft to the windlass.

The crosspieces for boatbuilders' clamps attest to boatbuilding close enough to Bryggen for the clamp fragments to have ended up in the fill there. They also show that this type of clamp, more technically advanced than the simple 2-prong one, was in use from the Baltic to West Norway in the Middle Ages. Together with the "tar mop" 89342, the clamps are the only remains found of the tools necessary for building and maintaining the vessels whose remains were found at Bryggen.

The Big Ship

The most important information given by the "Big Ship" is the fact that such large vessels were indeed built in Norway in the 13th century. The construction indicates that she was a merchant vessel. She was built in Norse clinker technique, with the low-set crossbeams known from several smaller vessels, all of them roughly contemporary. The size of the timbers attest to the ability of West Norwegian shipwrights for handling work on a large scale,

probably close to the upper limits of manageable clinker vessels. We do not know how successful these huge vessels were, but they must have been heavy and difficult to handle. For instance, the weight of sail and yard must have made it a heavy task to make sail, even if the halyard was taken to the windlass aft. The sagas indicate that the large prestige vessels of the king were unwieldy, even if they did offer some tactical advantage in battle. One example is King Sverre's "MARIASUDIN". After the battle of Fimreite she was beached in Bergen and a boatshed was built over her. The ship was never used again, and when a launching was attempted, "she was so heavy that they tore the stems off before moving the vessel".

When "KROSSUDEN" which was built for King Håkon Håkonsson in Bohuslän around 1250, anchored for the night on her maiden voyage, the anchor cable ran out with such violence that the windlass caught fire.

"KRISTSUDEN", built for the Scottish campaign in 1263, with 37 rooms, was evidently successful during the campaign, but later King Magnus considered the ship too large and unwieldy for taking her up "Bågastraumen", a difficult passage in Göta River.

The "Big Ship", and the other large fragments found at Bryggen, show that large vessels also had a place in maritime trade. They must have been too large for the amount of goods generally carried on one keel in coastal trade. Overseas, the trade in fish and timber to ports in East England comes to mind as a possible use for so large ships, and it is also tempting to suggest that the trade with Greenland would benefit from large and sturdy ships.

As stated in chapter 14, there is not enough material for a full reconstruction of the vessel. If we sum up the results, it is still possible to compare the minimum values obtained with other, better preserved ships. Our minimum figures are: length c 30 m, beam amidships 9–10 m, depth in the hold amidships c 3 m. As a rough rule, most ships known from the Scandinavian Middle Ages have a length-beam ratio of more than 3:1, and a beam-depth ratio of around 2:1. The beam amidships is the most secure of our uncertain figures. Based on that, it is probable that the hull was deeper than 3 m, and probably considerably longer than 30 m.

I have calculated minimum cargo space as 165 cubic metres. This is surely too small, as the outward flare of the ship's sides is not included, nor is the space forward and aft of the keelson. As there is not enough material to estimate the weight of the empty hull, which would give the displacement unloaded, and as we know nothing definite of depth in hold and loaded freeboard, the cargo space cannot be used to establish real cargo capacity in lasts or tons. However, the two merchant ships from Skuldelev offer interesting comparative material. Wreck 1, whose main dimensions are 16.3 x 4.5 x c 2 m, has a cargo space of 30 cubic metres, while the smaller wreck 3, 13.8 x 3.4 x c 1.3 m, has a cargo space of 10 cubic metres. In his history of medieval Bergen, K Helle estimates the medieval last used in Western Norway as about 2 tons weight and around 2.8 cubic metres. This corresponds fairly well to the rye last of Lübeck, and also to the modern register ton of 100 cubic feet (Helle 1982, 396). Using this, the "Big Ship" had a minimum cargo capacity of about 60 lasts, probably considerably more, as the hull might well have been deeper than our quite modest estimate. Nedkvitne (1977) has calculated the tonnage of the ships mentioned in the English custom rolls from the early 14th century. The largest vessels, both Norwegian and German, carried between 60 and 80 lasts, with one ship of 90 lasts as the largest. The calculations are not certain, but they show that the "Big Ship" from Bryggen may be an example of the largest class of merchant vessels. Even the minimum capacity of the "Big Ship" is above the mean tonnage of the German cogs which traded with Bergen in the late 14th and the 15th century. The average capacity was 40–45 lasts, and the maximum known was 60 lasts (Helle 1982, 397).

Even a large group of *felager* would probably have trouble filling so large a hold with their goods, and it is tempting to suggest that the owner of the vessel was someone who really needed large cargo space for his own goods, not a shipowning merchant who based his travels on other men who would crew his ship in return for cargo space (See p 256). In Bergen, we must then search for the owner of the ship in the top level of society, ie among those whose income in "naturalia" was large enough to form the basis for a thriving export business. The king, the bishop of Bergen, the abbots of Halsnøy and Lyse, and nobles with large incomes from the cod-fishing districts are all possible candidates for ownership. The "Big Ship" was broken up after fire V (1248) and used for

foundations in Gullskogården. It is most probable that the owner was responsible for the dismantling and reuse, and we should then search for him among the owners of Gullskoen at that date.

Mouldings

All the moulding types found on ship's timbers at Bryggen have been recorded before. Consequently, they show what was known beforehand, that many ships and boats, but not all, were decorated in this way in the Middle Ages. The fact that one well-known moulding type is lacking in the material is worth noticing, as well as the frequency of mouldings. This may indicate a difference in moulding fashions between West and East Norway. The shallow groove, flanked by two V-cuts, lacking among the Bryggen ship timbers, seems to be more common in East Norway, while our types 3 and 4 are more often found in West Norway. This theory must be regarded as tentative, as no full survey of the mouldings found on standing buildings and excavation timbers has yet been undertaken.

Chronological implications

It will be seen from the discussion, that I have treated the material as one chronological unit, with little discussion of relative or absolute chronology. As stated in the introduction on material and method, I do not think that there are any morphological differences in the material that can be used as dating evidence. When compared to the Viking Age material, the Bryggen finds show some new details in construction. These are the low-set crossbeams notched over the keelson, the headbeams, the possible knees from a cog, and the fragment of a carvel strake. In all cases, other finds offer better possibilities for dating the introduction of these constructional details, and the iconographic sources from the Late Middle Ages indicate that headbeams were in use well after the date of those found at Bryggen. Both the low-set crossbeams and the headbeams are unknown in more recent clinker shipbuilding, but we do not know when their use was discontinued, and the Bryggen finds offer no help in settling this question. The many and well dated Fire Levels of Bryggen gave high hopes of the possibility of dating changes in shipbuilding. When these hopes have not been fulfilled for details other than the square oarloom - *keip*, and the general changes introduced by the saw, which will be discussed later, the reason is twofold. Even a detailed and rich material like that from Bryggen shows only a small part of what was originally there. The fragments of each boat are small, and they represent a small fraction of all the vessels that were used in the Middle Ages. The chronological distribution is uneven, with many finds in the 13th century fill, simply because an enormous amount of soil and debris was used, and there are very few finds after the 1413 fire, as the wood has not kept well in the upper layers.

Shipbuilding tools and their uses

What tools were at the disposal of the medieval shipbuilder for shaping the elements of his ships, whether they were split strakes or naturally curved timbers? The finds from Bryggen do not answer this question.

Apart from the crosspieces from boatbuilders' clamps (chapter 13), no boatbuilding tools have been found at Bryggen. In order to reconstruct the tool-chest of the medieval shipbuilder, and the way he used his tools, we must turn to the timbers for tool-marks, and try to find supplementary sources.

1 We have a few representations of shipbuilding in contemporary or near contemporary art.

2 There are a few written sources, nearly contemporary, that tell something about boatbuilding.

3 Then we have the artefacts themselves, tools found in Viking graves or on various medieval sites.

4 Last but not least, the comparative material offered by recent boatbuilding practice in Western and Northern Norway, where ancient traditions have been remarkably strong in boatbuilding.

To start with the iconographic sources, our best representation of Viking boatbuilding comes from one of the fringes of the Viking World, Normandy. The shipbuilders seen on the Bayeux tapestry are, nevertheless, working in a tradition which seems to be pure Norse, both as to tools and types of ship (fig 16-24).

The broad-axe used by the man roughing out plank stock is somewhat problematic. Similar axes are known but they are generally regarded as battle-axes, not as tools.

On the upper ship, the man on the right is using a breast auger, the oldest example I know. The other man holds a broad-axe in his left hand, and something else in his right.

My guess is that he is holding a shave and that he is finishing off the sheer, giving the top edge of the sheerstrake its curve from stem to stern. He is assisted by the master shipwright who stands outside the ship, sighting along the curve. The men working on the lower ship are again using axe and auger, the latter with a plain T-handle. Olsen and Crumlin-Pedersen (1967) have published one example of a woodworking scene from a medieval manuscript, a lovely initial showing two monks splitting timber (op cit fig 63).

In the book *Konungs Skuggsjá* (The King's Mirror), the father advises his son among other things on sea travel. "When setting out to sea you should have aboard axe, gouge and auger, and all other shipbuilding tools." In a previous paper, I have demonstrated that the gouge in this case is a repair tool (Christensen, unpublished MA thesis Oslo 1963).

When a strake split or cracked, the usual way to repair it was to cut a rounded or V-shaped groove along the crack and seal this with a strip of tarred cloth and a lath of the same cross-section as the groove. The lath was held in place by iron staples. A repair of this kind could well be done at sea, the gouge being an excellent tool for cutting the groove along the crack (Cristensen 1968 and Færøyvik 1948-1) (fig 16-25). It is rather distressing that the author of *Konungs Skuggsjá* leaves us with the sentence "and all other shipbuilding tools" instead of providing the names.

Snorri Sturlasson has a vivid description of the building of the "LONG SERPENT" in Trondheim in 999. "Many people were assembled for the work, some for rough axing, some for fitting, some forged nails, some handled the timber". Not much about tools, but when Torberg Skavhogg is told that his life is at stake if the damage to the sheerstrake is not made good, he takes his axe and smooths out the notches. "And all could see that this side was more handsome than the other side of the ship". For an exacting job like that of trimming the delicate sheer curve from stem to stern, Torberg "takes his axe". His nickname Skavhogg is best translated as "he who smoothes with the axe" (Heimskringla, the saga of Olaf Trygvasson). (see also p 243).

Based on the information given by boatbuilders today, we can divide the tools needed by Viking boatbuilders into 3 groups. The largest group consists of the tools for working wood directly, tools that remove chips from the raw material. The second group is tools for holding the piece of work, and the third; tools for marking and measuring.

Viking graves often contain tools for woodworking or blacksmithing, but in most cases it is difficult to do more than classify the tools as either ironworker's or woodworker's tools. The various crafts within woodworking can rarely be separated by the tools at this date, and some very rich graves contain such a number of different tools that the buried person must have worked in several crafts. There is reason to believe that the picture provided by the Viking graves is also valid for the Middle Ages.

The most common woodworking tools are axes and knives, both all-purpose tools used by all woodworkers. Adzes are found, most of them with a hollow edge for making troughs. Augers are found in various sizes, nearly all of the spoon-bit variety. Other tools found are shaves, moulding scrapers and hammers. An important find in this context is the tool chest from Mästermyr, Gotland (the find is not fully published; good illustrations of tools in Müller-Wille 1977 and Graham-Campbell 1980). The date is uncertain, but must be Late Viking or Early Medieval. The tools were evidently lost in what was then a shallow lake, by someone either in a boat or travelling over unreliable ice. The tools are those of a craftsman equipped to work in iron, wood, copper and probably precious metals. His woodworking activities may well have included boatbuilding. In addition to axes and adzes, he had a set of augers of different diameters, and a number of scrapers of the "shave" variety, tools known in the 19th century Norwegian dialects as *skjøve* or *skavl*. These tools, not uncommon in Viking Age graves, were used for finishing wooden surfaces, much as the plane is used today. The shave is not, however, a cutting tool like the plane, but a scraper. One of the Mästermyr examples is for scraping decorative mouldings along the edges of woodwork. This has been taken to be solely a boatbuilder's tool,

but finds show that other woodwork was decorated in this way as well (Krog and Voss 1961, Gjærder 1952) (fig 16-26). The great number of tools found in the Mästermyr chest and the variation that they show, indicate that few graves, even the richest ones, contain all the tools that the dead person possessed.

The adze is not an uncommon tool in Viking graves and several different types are represented. The adzes may be socketed or have a shaft-hole, and they may be either straight or hollow-edged. It can be presumed that the various forms had different uses, but the museum catalogues are not precise enough to separate adzes, hoes and other socketed tools, and a complete survey of the material lies outside the scope of this work. In traditional Norwegian clinkerbuilding today, the adze is very rarely used. It may be used on the inside of sharply curved timbers like stems and ribs, but the adze is considered a carvel-builder's tool. The axe is the preferred tool, often wielded with great skill.

However, Ole Crumlin-Pedersen has pointed out that the very wide adze found in the Mästermyr tool-chest (Graham-Campbell 1980, fig 415f) is an excellent tool for dressing boards after splitting. Replicas of this tool have been used with greater ease than axes by Danish boy-scouts building replicas of Viking ships. Only one parallel is known to me, an adze in a Norwegian grave of pre-Viking date, where the rest of the tools are those of a woodworker (C 26524, from Øverby, Vardal, Oppland.) (fig 16-27). I do not think it possible to distinguish between axe and adze marks, so a study of tool traces will not get us any further in this case. It would be rather astonishing if the adze had dropped out of the boatbuilder's set of tools, if it was a common tool in the Viking Age. One possible explanation is that the adze as a plank-shaping tool lost its importance with the coming of sawn timber, but I must say that I do not really believe this, as other timber shaping jobs have been done with the axe in recent times. At any rate, an adze or axe would surely be the boatbuilder's favourite tool for shaping wood, in the Middle Ages as well as in the 19th and early 20th century. It must be pointed out that it is a mistake to think of the axe as a coarse tool. In the hands of a skilled workman the axe will be used to shape to a high precision and good finish.

Typical axed surfaces can be seen on fig 6-9 and 13-7. When a better finish was wanted, the surface was smoothed with a *skjøve* (shave) to take away the axemarks. In the hands of a trained man it leaves a surface that compares favourably with a planed one. Most ships' timbers have the visible surfaces smoothed this way, with a moulding scraped along the edges with a smaller *skjøve* (cf ch 15). In some cases, the outside of the strakes are smoothly finished with the *skjøve*, while the inside shows axemarks. Most likely this is a short-cut to save building time. Judging from the nice finish usually given to ships' timbers, this may have been a practice frowned upon by the better builders.

Crumlin-Pedersen has found plane marks on a scarf in Skuldelev wreck 1 (Crumlin-Pedersen 1967, fig 67), but so far this is the only evidence of planes used in boatbuilding at so early a date. The planes found at Bryggen (Herteig 1969, fig 49), are small delicate tools, more like those used by a modern violin maker than ordinary woodworking planes. We can definitely state that the plane did not come into general use as a woodworking tool until the Renaissance, but the tool marks on Skuldelev 1, if they are indeed plane marks, indicate that a small plane may have been part of some boatbuilder's equipment.

Riveting and treenailing called for augers of various sizes for boring. There are a few small primitive twist bits of reliable Viking provenance, but the boring tool of the Viking Age was the spoon-bit or auger, in various sizes. Analysis by Guro Fredriksen has shown that they fall into groups corresponding to fractions of inches (fig 16-28). (Fredriksen op cit, 205 ff.)

Once the hole is bored, a nail is driven through, the rove forced on, the point of the nail nipped off and the end of the nail riveted over the rove. For this, a heavy dolley, axe hammer or something similar is held against the nailhead. The boatbuilder can hold this in his left hand or it can be held by an assistant.

Hammers are known in abundance from the Viking Age. Pointed chisels, like a modern centre-punch, are also found. This is a necessary tool for pre-punching the roves. A modern dolley is usually a heavy piece of iron, used both on the nailhead while riveting and for forcing the rove on to the nail. For this job, a hole, wide and deep enough to receive the nailpoint, is drilled in the dolley. A special tool like this is lacking in a Viking Age context.

However, any heavy piece, like an axe, will do for a counter-hold, and the driving dolley can be made of wood, as shown by modern parallels. Fig 16-29 shows one of ash (*Fraxinus*) made and used by boatbuilder Ingvald Sande from Gloppen in Nordfjord. The tool was in use in 1977.

Moreover, there is another tool which is lacking in the Viking Age material – proper pincers for cutting off the nail point. I have discussed this problem earlier (Christensen, unpublished MA thesis on Iron Age and Viking boatbuilding, Oslo 1963). My solution to the problem was that a chisel had probably been used, but I found it hard to understand how this could have been done without straining the strakes severely.

At Paviken on the west coast of Gotland, Per Lundström, director of the National Maritime Museum, Stockholm, has excavated a shipbuilding or ship-repairing site. The number of discarded rivets and cut-off rivet points attest to considerable activity, and the tools found have clear connection with boatbuilding and repair (Lundström 1972 and 1981). Chisels and centre-punch-like tools may also have seen uses outside boatbuilding, but a small, crowbar-like tool is definitely for removing rivets during repair work (Lundström 1972, 85 ff).

No pincers were found here. Lundström has convincingly demonstrated the use of chisels in repair work, for removing old rivets and roves, but he has not discussed the problem of how the many rivet points found were cut off, when riveting repair strakes or building new boats.

A possible solution to the problem came to me as the result of field work, when watching a modern boatbuilder at work on a clinker-built hull. When Sigurd Bjørkedal was building a full-size replica of the Kvalsund ship in 1973 I had the pleasure of following the work. One day Sigurd was preparing to rivet a strake. The strake was clamped, holes had been pre-drilled, the tools lay ready in the boat: hammer, dolley, nails and roves, and a pair of sturdy pincers, actually a farrier's tong. When the roves had been driven over the nail points, Sigurd gave each nail a single blow from the side, bending the nail point down over the rove. I thought: "Smart! This will keep the nails from slipping out in case a clamp loses its grip from the hammering". Then Sigurd started to rivet, and to my great surprise, the pincers lay unused. The peen of the hammer was ground sharp, and a few blows with this cut the nail point, after which the riveting was finished with the slightly domed face of the hammer. I had been given a demonstration of how it was possible to rivet without the tool I had missed in the Viking graves. I do not claim that it was done exactly this way in the Viking or Medieval period. The material does not contain hammers with peens ground sharp enough for this. If an assistant holds a dolley against the nail head on the outside of the strake, the nail point can easily be cut with a hammer and chisel. The secret is the bending of the nail, as a result of which the cutting force is parallel with the nail and is taken up by the dolley without straining the wood.

The lesson that can be learned from this example is that when we, as archaeologists, "explain the past", our explanations are governed by our imagination and experience. In concrete matters, the imagination seldom runs beyond experience. In this case, I found a new solution by watching a craftsman, and the solution is in all probability closer to the realities of the Viking and Middle Ages than I had suggested before.

Measuring tools were generally of wood in earlier periods, but to my knowledge none has been found from the Medieval period in Norway. However, some test measuring indicates that scantlings tend to come out in inches, not always too precise, and the rib distances of the "Big Ship" indicates the use of the shorter medieval ell. Foot rules found aboard the "VASA" show that at least by the beginning of the 17th century, a graduated measuring tool was part of the ship carpenter's chest. The "boat ell" and "boat level" used by boatbuilders today may well have a medieval or earlier ancestry, but this cannot be proved (Christensen 1972).

The ever-useful knife must be mentioned last, for cutting treenails, as a scratch-awl, and for numerous other purposes. If we try to sum up the probable contents of the medieval shipwright's toolbox, we know that he needed tools for shaping the wood, for holding and measuring. Among the shaping tools, we can be sure that he had an axe, maybe an adze, a shave for smoothing wood, another one for moulding, and in most cases, also a narrow, curved one for scraping the luting-cove in the strakes. He may also have had a small plane for special smoothing jobs. We can be fairly sure that he

carried a sheath knife on his belt, both as a boatbuilding tool, and for other chores.

For holding strakes when fitting and riveting, a number of clamps were needed - modern boatbuilders have at least a dozen. In additon to the wedged clamps, fixed two-prong clamps may well have been used (cf Færøyvik/Christensen 1979, 16 for modern parallels).

No definite proof exists for the use of measuring and marking tools, but score lines like that seen on fig 9-6 show that marking was done with the knife point or a scratch-awl. A string between the stems is common in later boatbuilding, and was probably used also in the Middle Ages, and an ell or foot rule may well have been included. I will not exclude the possibility of measuring tools of the "boat ell" or "boat level" category, but no definite proof exist.

In more recent times, many boatbuilders forged their own nails and roves, while others got their supplies from the local blacksmith. A boatbuilder doing his own ironwork would need access to a hearth with a pair of bellows, and would have a small set of blacksmith's tools. Hammer, tongs and nail iron, chisel and centre punch are a minimum for forging nails, cutting roves from strip iron and prepunching them.

For laying the luting string, whether it was 2-strand or laid from many strands of wool or goat hair, some kind of spinning implement would be necessary. No evidence exist from the Middle Ages, but it is tempting to project backwards the tool recorded by Færøyvik: *sikrok* (Færøyvik and Fett 1944, 20f). This is a hook, often a branch with the stub of a twig. It is twisted by hand, with the hook rotating the strands, while an assistant holds the other end.

A bucket of tar and a "tar mop" would complete the equipment. There are indications that some ships were painted. One ship, belonging to Bishop Nicolas, was named "REDSIDE", and in the saga of Egil Skallagrimsson, it is said that the boat of Ragnvald Eiriksson, which Egil sinks, was painted in various colours above the waterline. The most common surface treatment was pine tar, a well-known preservative for wooden boats to this day. In the "King's Mirror", the father councels his son: "Get your ship on the stocks early in autumn, tar it well, and let it stand with the tar over the winter". When the common law of Magnus specifies the restrictions put upon the tenants' use of the forests of the landowner, it is clear that the tenant is not supposed to make tar for sale: "He should not burn more tar than he needs to tar his own ship".

Axed and sawn boards in boatbuilding

Building boats and ships is a complicated technological system, where raw materials, tools, knowledge and the demands of the customers interact. The result, the vessel, may have one of many forms. In Scandinavia, the boat finds from Viking and pre-Viking times attest a high level of knowledge in the selection of materials, use of tools and knowledge of hull-shape. Archaeological and recent material show that the changes in the technological systems were slow and gradual.

Despite its fragmentary character, the Bryggen material throws light on this technological system, as I have shown in the previous chapters. We can now conclude that the finds indicate no changes in the tools or the use of raw material during the period covered, at least in Western Norway.

Our next question will be: What happens in the period after the Middle Ages, between the archaeological material and the 19th century vessels that I have used so freely as comparative material? I will point to one key fact, the introduction of saws for converting timber, and as a tool for the woodworking crafts.

In order to get a proper background for understanding the changes that occur in boatbuilding, it is necessary to make a rather long digression into the history of the waterdriven sawmill in Norway, and the adoption of handsaws by woodworkers. The use of the sawmill and general acceptance of the hand-saw are innovations that occur after the period covered by the Bryggen finds. The changes that the new tools generated do, however, add interest to some of the fragments found at Bryggen, as they show features which later disappear as a result of the use of sawn materials.

The introduction of water-powered sawmills in Norway can be roughly dated to the years between 1520 and 1550. The conversion of timber to planks by hand-saw may be somewhat older, but sources are lacking for definite dates (Fossum 1969). For our purpose, the general availability of sawn timber is of greater importance than the first introduction of the new machinery, and this will not have been before

c 1550. In other words, medieval shipwrights in Scandinavia cannot be expected to have used sawn boards to any extent, if at all. On the Continent, this was different, as the sawn strakes of the Bremen cog shows (personal observation).

The oldest boat with sawn strakes found in Norway is the small boat excavated jointly by the Norwegian Maritime Museum and the University Collection of National Antiquities near Kragerø in the summer of 1981. The boat is of East Norwegian type, built mainly of oak. A radiocarbon date from a piece of a spruce rib gave 1575 ± 65 years (T4219, report in the files of Universitetets Oldsaksamling, Oslo).

During the 2nd half of the 16th century the number of sawmills expanded rapidly and the timber export increased. So rapid was the expansion that the Crown feared a general devastation of the forests and strict conservation measures were enforced. One of the main reasons for the regulations was to ensure that the timber supply for the naval yards would be sufficient.

The number of saws was restricted, sawmill privileges were only sparingly issued, and each mill was given a quota of boards a year. The privilege system excluded most of the small landholders from building saws and converting their own timber. Sawmills became big business, and forest empires began to grow, with control assembled in few hands. In many cases the sawmill owners added to the number of deals in their quota by employing hand-sawyers on a large scale (Sundt 1900).

For the farmers and smallholders who owned or leased forested land, one source of income was to sell timber still growing to the mill owners or timber entrepeneurs. Another possibility was to convert timber by hand and manufacture boats, barrel staves, troughs, boxes or clogs. To some extent, hand-saws were used in converting the timber, but to a large extent, timber was still split and hewn to shape, especially by boatbuilders. When the sawmill privileges were abolished in 1867, large industrial companies set up a number of sawmills, but many small sawmills were also built, many of them serving only the needs of the owner and a few of his neighbours. Many of these mills were worked only during the spring floods, as the streams or brooks supplying power would not give enough water to turn the waterwheel during the rest of the year.

Sawn timber was accepted to various degrees and at different times by the various trades. The house-carpenter would use sawn and planed boards for panelling, floorboards and roofing, while the structure of the house remained unaltered – corner-timbered from axe-dressed logs.

In Bergen, where craftsmanship was highly controlled and the guilds strong, three different craftsmen were involved in erecting a house: the corner-timbering was done by a *tømmermann* (literally translated timberer), floors and roofing by a board-worker, while the finishing of the interior was left to the joiner.

It is common knowledge that the joiner as a specialist craftsman cannot be found in Scandinavia before the Renaissance, and that there is a definite connection between the use of sawn boards and the expansion of joinery, with the use of a number of planes for trueing, smoothing and moulding sawn timber, the widespread use of frames and panelling and the extensive adoption of glued joints in furniture-making. Some of the new tools and techniques of the joiners were accepted by other craftsmen working in wood, some were not. The planes and cross-cut and ripping handsaws found their way into the tool-chests of all woodworkers. The gluepot remained the trade-mark of joiners and cabinetmakers, as water-soluble glue had no place in outdoor carpentry of any sort.

If we survey 19th and 20th century boatbuilding in Norway we find marked differences between carvel and clinker work. In carvel shipbuilding, sawn strakes were probably used from the very beginning in Norway, while clinker craft have been built with a mixture of sawn and axed timbers to this day.

Carvel building spread slowly in Norway and was long reserved for big ships. During the 16th and 17th centuries foreign shipwrights were sometimes responsible for the large, important vessels. Even in the 18th century, most of the carvel ships built outside the navy yards were built in the towns, by or for the great timber merchants.

The only carvel plank found at Bryggen, 90513, is so decayed that the surface gives no indication of whether it was sawn or split from the log.

A remarkable feature of the Norwegian carvel yards is the lack of sawpits, and the very few indications for use of hand-saws in converting shipbuilding timber. It seems that the system of

pit-sawing is mainly restricted to Britain and Canada. In Scandinavia and in Continental Europe, the logs were sawn instead on trestles, so we should not expect the remains of pits in Norway. However, trestle sawing would leave oral and written sources, even if the traces in the ground are lacking, and such sources as there are do not indicate hand sawing. Surviving shipbuilding accounts do not make the division between ship carpenters and sawyers found in British yards. The explanation is surely that enough water power could be found in most places for the shipyards to have their timber sawn at the nearest sawmill.

The one example I know of planking being handsawn was in an emergency. Around 1870 a ship was on the stocks in the Ryfylke district, north of Stavanger. The building time was short, as the vessel should by contract be delivered the following spring. The winter was very cold, and the water supply for the nearest sawmill froze. In order to keep the contract, the planking was handsawn (Thue 1973, 88ff). It must be stressed that sawn boards (deals) and other timber was for centuries one of Norway's most important export products, so a woodworker buying sawn timber from a sawmill would have to compete with the prices paid by the foreign merchants. If he wanted his own logs sawn, he again had to compete, as many sawmills only ran during the spring floods, and the owner then wanted to saw as much as possible for export. The woodworkers in the cities would probably buy most of their wood from sawmills or merchants in a converted state, but there is little doubt that they also bought raw timber and converted it by handsaw in their shops.

The question of economy must clearly have played a part when axed or handsawn boards were in continuous use beside those that came from the sawmill, but quality seems to have been a factor in some cases when axed strake material was preferred. The use of sawn boards for strakes naturally saved a great amount of time and work for the boatbuilder. If he supplied his own pine logs to the sawmill, he would also get more strakes back than if he split the logs himself. When sawmills were far away or lacking, logs were split in the traditional manner, often to the great concern of local officials who feared that this would devastate the forests. The boatbuilding district of Rana in Northern Norway got its first sawmill as late as around 1860, when a State-owned mill was built. Until then, all the strake material was from split logs.

Many boatbuilders who owned land would have a sawmill as part of the farm. Those who had little or no forest land would often select and buy timber in the forest and then hire the use of a sawmill nearby. Even more economic ways existed, however, for those who had to watch expenses closely and who preferred to work themselves rather than hire help.

As late as around 1930, the boatbuilders of Holmsbu in Eastern Norway would convert timber by hand-saw for economic reasons. The saw-kerf of the hand-saw is narrower than that cut by a sawmill, and this would give one more board from each log when sawn by hand.

Before saws were common, all timber was converted by splitting, with axe and wedges as the main tools. A pine log was split in half and each half would give one board or plank, after the removal of an enormous amount of waste. Sawing a pine log would give many boards with the same mechanical properties (Sandvig 1931). For pine, sawing was a great economic improvement and it gave little loss in quality when compared to split strakes. Recent research in Denmark has shown that oak was split in a more sophisticated manner. Radial splitting, where each board ran from the pith to the sap, with a wedge-shaped cross-section, might give as many as 32 "clove-boards" (Olsen and Crumlin-Pedersen 1967, fig 62). (Mr Egon Hansen of Moesgaard Museum, Århus, Denmark, who has experimented extensively with Viking and Iron Age technology, has informed me that he finds it difficult to get more than 20 boards from a log, the remainder being failures.) Oak split in this manner provides boards of optimal quality (McGrail-McKee 1977, 44). If one is to get the same mechanical properties in sawn oak as in cloven, the log has to be quarter-sawn. This will give more waste than flitch sawing, and probably also more than splitting. The quality of flitch-sawn oak, however, is inferior to both quarter-sawn and split oak (fig 16-30). But there was an economical advantage in flitch sawing with more boards and less waste from the log, as well as a saving in labour. The boards were also wider. Nevertheless, this was accompanied by a definite loss in quality, at least for boatbuilding. This does not affect the boatbuilding in Western Norway so much, as strakes were mainly made from pine.

Following the introduction of the saw at the end of the Middle Ages, the complicated hewn details in vessels disappear. We find no assembly planks and the various types of stepped and winged stems are no longer used. *Meginhufr* strakes and strakes with special cross sections become very rare, even though relics of the technique can be found, noticeably in Lappish boatbuilding (fig 16-31). Stems are now plain curved timbers, rabetted or not. All strakes are generally led to stem and stern and most of the raw material for planking is literally "run of the mill". Thus, one technological innovation, the introduction of water-powered sawmills, led to a simplification of technique and a contraction of the technical repertoire in one of the crafts which could use the products of the sawmills. This is in contrast to what happened in other crafts. The joiner and cabinetmaker used the sawn timber as the starting point of their craft and house-carpentry was greatly improved by the availability of panelling and ready-made planks for floors and roofing.

In boatbuilding, the change was not total, axed details continued in use side by side with the new sawn boards. In clinker boatbuilding, there has been a strong tradition in most of Scandinavia for shaping some strakes with the axe. Generally it is the ends of garboards, the hood ends, that are treated this way, but the whole of a garboard may be axed, and some boats have several axed strakes. Concave, axed garboards are known from Finland, Sweden, Norway and the Faeroes. The practice was in common use well into this century and some boatbuilders still use it, even though in most cases today sawn boards are steam-treated prior to bending instead of the laborious axing. The last boatbuilder in Os, near Bergen, who built with axed garboards, Alfred Søvik, claimed that the steam-bent garboards were definitely inferior to axed ones. When new, the shape of a steamed board was as good as the axed one, but age and waterlogging would ruin this and make the entrance and run of the boat "baggy" with reduced speed and seaworthiness as a result. The cutting of shaped strakes by axe is not known from the districts in Southern Norway and Sweden where clinker-builders used oak for planking, nor from Denmark. Here prior to the time when steaming became common, strakes were sometimes heated over an open fire before being twisted and bent onto the boat (Nilsson 1971, fig 5-6). Several boatbuilders have told me that pine does not "take steam" as well as oak does. Pine is less easy to bend after steaming, even though it is a softer wood than oak. It is tempting to suggest that this difference in the natural properties of the main boatbuilding woods is one of the reasons why axed strakes have been in use longer in some parts of Scandinavia than in others.

Today, we are used to sawn planks of equal thickness, straight and parallel-sided, as the basis for nearly all woodwork. To us, the axing of twisted strakes with a lentoid cross-section seems a hard task, not to mention the winged stems, which very few woodworkers today would dare to try their hand at. However, as long as all planks were shaped with the axe, the amount of work would not differ much whether the strake was cut to a shape which would fit the intended place accurately, or whether it was given the shape that we today feel is "normal" for a plank. Put in other words, until sawmills became common, the only reason for cutting a flat, parallel-sided plank was that you really needed that shape, and this is rather rare in boatbuilding.

The introduction of sawn strakes in clinker boatbuilding must have resulted in technical changes of a qualitative nature. Naturally, strake timbers had been bent to shape even when they were axed, and the demand for good axemanship was still part of the craft, as considerable axe-shaping was done on stems, ribs and beams. However, the repertoire of technical solutions did change, and it was narrowed down considerably, with the loss of the complicated stem shapes and assembly strakes.

It is quite possible that the introduction of sawn timber into boatbuilding did in its time stir up controversies between old boatbuilders, who saw or imagined a drastic loss of quality, and younger and more enterprising men who visualised better income and less strenuous axework as a result of the new boards. The fact that axed strakes have continued in use in many parts of Scandinavia, probably shows that the customers wanted what they were used to and got it. Experiments in boatbuilding may be fatal if they are unsuccessful, and fishermen know this. As a result boatmen at all times have been unhappy about changes in the boats they were used to.

It is a matter of taste whether sawn timber and the adoption of planes for surface finishing were improvements or symptoms of decline.

The uses that the boats were put to did not change, so the customers must have accepted the changes, perhaps with some grumbling.

Some of the small boats still being built in Western Norway are at first glance identical to boats of the same type built a century ago. On closer inspection, there are differences. Strakes may be steamed instead of axed, ribs may be sawn from straight planks instead of crooks, the rib fastenings are rivets instead of treenails, inwale and stem fastenings are screws. The decorative mouldings are no longer used, and rowlocks may be screwed on top of the inwale, not let into it and treenailed. All these changes have made the boat easier to build. The question is, are they labour-saving and price-saving improvements, or shortcuts that reduce both the quality and the esthetic appeal of a boat? A century ago, the life of fishermen depended on the boat, and the fisherman was a customer who had a very good knowledge of boats. Today the same type of boat is used for pleasure, generally only in fair weather. Most of the customers will not miss the details that have gone out of use in this century, and the boats are perfectly good enough for their uses. But as a student of boatbuilding technique, I think I am entitled to state that the boat a century ago was better than the one made today. We may miss the painstaking attention to details that has followed boatbuilding for centuries. The building of boats has probably never been quite static, even with the remarkable conservatism seen in Norway. The first large change in historic times came with the sawn materials, the second with the spreading use of modern machinery and the adaptation of traditional types to a new market, as leisure craft. The changes that can be observed in boatbuilding during the last century are in the details, some of them quite minor details. The changes introduced with the use of sawn timber must have been more radical, of a qualitative rather than quantitative nature.

The Types of Vessels

Having looked at the ship finds from Bryggen as source material for the history of shipbuilding, it is now time to go further and ask what fields other than pure technology can be illuminated by the finds. What was the size and character of the vessels whose fragments have been found?

Ships and boats were indispensable in the coastal communities of Norway both for fishing and a wide range of transport purposes. Trade was dependent on waterborne transport and so were the administrators of the country, both in peace and war. Different types of ships were needed for the transport of men and cargo, for long and short trade routes, for both inshore and overseas travel. Where do the Bryggen fragments fit into this complex pattern?

After the Black Death in 1349, Norway was weakened politically and economically. Even before that time, the Hanseatic League handled a large percentage of Norway's foreign trade. During the second half of the 14th and the 15th centuries, trade overseas by Norwegians dwindled to practically nothing, all export of any consequence being shipped in Hanseatic cogs.

Several German historians have claimed that the Hanseatic superiority in trade was to a large extent based on better ships than those of their Norse competitors. The view was first expressed by B Hagedorn (1911) and V Vogel (1915) and later developed by Heinsius, who expressed it quite strongly in his book on the ship of the early Hanse (1956). Norwegian supporters of the theory have been A Bugge (1914), B E Bendixen (1915/1916), O A Johnsen (1924) and J Schreiner (1935).

In a simplified form, the view held by these scholars, more or less explicit, is that the Hanseatic cog was a capacious and seaworthy cargo ship with sail as its main propulsion, while the Norse ships were of the combined cargo/warship type seen in the Gokstad Viking ship. These ships had little cargo capacity and needed a large crew, as they were often rowed. In addition to their relatively small hold, their overall size was also less than the cogs. In popular history writing and in schoolbooks, this view is still alive, as Morcken has recently shown (1980, figs 21-26).

A less rigid view was put forward by S Steen (1934) who maintained that the differences between Norwegian and German ships were not as great as had been suggested. In 1964 A Herteig suggested that Norwegian shipwrights did indeed build large cargo vessels in the Middle Ages (Herteig 1964). He based his view on the ship finds from Bryggen, such as

the large head-beam from Bugården (90659) and the fragments of the "Big Ship" found in Gullskogården. In 1966 I still to some extent accepted that the cogs might be larger and more suited for trade than the Nordic ships, but maintained that the real reason for Hanseatic supremacy could not be found in shipbuilding, but in politics, economy and professional trading skill (Christensen 1966/1968). In his paper on the trade between Norway and England in the High Middle Ages, Nedkvitne reaches a similar conclusion. "The customs accounts indicate that the type of ship did not play any important role in the dominating position obtained by Hanseatic merchants in Norwegian overseas trade around 1300" (1977, 230). The same view is held by Morcken (1980).

The idea that Norwegian merchants in the Middle Ages traded overseas in ships of the Gokstad type is definitely wrong and has no support in the sources, when these are properly analysed. True enough, both the Gokstad ship and the medieval merchant ships were results of the same shipbuilding tradition and had many features in common, but within that shipbuilding tradition we can now see that there was great differentiation in hull shape and ship types (fig 16-32). Thanks to a number of new finds and the pioneering syntheses of Crumlin-Pedersen and Ellmers, we now have a much better grasp of the various types of ships and shipbuilding traditions that existed in Northern Europe in the Middle Ages.

On the large rivers of continental Europe there sailed barges of boxlike shape, some of them very large vessels. On the Rhine, the oldest finds are dated to the Roman period and, according to Ellmers, the type is based on Celtic shipbuilding traditions (M D de Weerd 1976, L Th Lehmann 1978, Ellmers 1969, 1972-2, 1973). Other Celtic vessels are the sailing barges, also of Roman date, found in London (Marsden 1965 and 1967). As far as we know from the material today, medieval Norway was not influenced at all by this shipbuilding tradition. Another continental type are the round-bottomed, banana-shaped vessels found at Utrecht and Antwerp (Ellmers 1972-1, figs 35 and 37). Ellmers and Crumlin-Pedersen have argued convincingly that this is the prototype of what were later to develop into a well-known ship type, the "hulc" or "holk". The rounded shape and lack of stemposts are characteristic features. The town seal of New Shoreham on the south coast of England is the best representation of a holk among the iconographic material (Wiechell pl 8), but according to Ellmers (1972-1) some of the ships on coins are also holks. One written source indicates that Norwegian shipwrights mastered the building of the type. In 1365, a letter from King Magnus to the inhabitants of Sande *skipreide* (levy district) of Vestfold, permits the building of a new, smaller levy-ship. One alternative is to give the ship stems like a holk: *buttu stœmfnt œder holka stœmfnt* (DN II, 385).

The cog has been under debate for a long time but until quite recently, the type was known only by name and from small-scale representations on town seals (for good examples see Wiechell figs 3, 4, 29, 43, 48 and 71).

The find of a nearly complete cog dated to c 1380 in Bremen in 1962 sparked off a new discussion. In 1965 O Crumlin-Pedersen defined the type-features of the cog: a flat bottom of edge-laid planks, straight stemposts and clinker-built sides. He also showed that both the name and the type was of Frisian origin and moreover pointed out that both the shape of the hull and the name live on in small craft in Denmark and Northern Germany.

In Scandinavia and Anglo-Saxon England, we meet the tradition of clinker-built vessels with a keel and curved stemposts. The evolution of the type was set out by Shetelig (1933, also in Brøgger and Shetelig 1951). His typological development and chronological framework were based on few finds widely scattered in time and space. Later finds have modified details in his theory, and widened the perspective, but up to the stage represented by the Oseberg, Gokstad and Tune ships, Shetelig's main framework still stands the test of time.

In a number of works within the literature on the history of boatbuilding, the Oseberg and especially the Gokstad ships have tended to figure as prototypes of what all Viking ships looked like. According to the written sources, they would have been small ships in the late 10th and the 11th centuries, but even so, the fact that they have survived in a complete state have made them overshadow the other sources.

Timely correction came with the excavation of the Skuldelev ships in 1962. Five ships of the same date, early 11th century, showed how great the variation could be within the framework of late Viking shipbuilding: two warships, one large, one small, two merchantmen, again

of different size, and one fishing or all-purpose vessel, all built within the Norse tradition (16-33).

In a general survey of ships and shipbuilding in Norway (Christensen 1966/1968), I have claimed that until c AD 850, the time of the Gokstad ship, there had been little differentiation in the ships used in Scandinavia. All-purpose vessels like the Gokstad and Tune ships would be equally suited for plunder and warfare, travel and trade with luxury goods where a relatively small cargo of valuable goods would still give good profit. The differentiation of Nordic ship types I placed in the 10th century.

The increase in trade with "bulk cargoes" like fish and timber would call for more cargo space in each vessel in order to make voyages profitable. This would lead to changes in the shape of the hull of vessels built for trade. The 10th century saw the establishment of a war-levy system, the *leidang*. Under this, the country was divided into districts, *skipreider*, each of which would build and maintain a ship for the king's use in warfare and supply men and provisions when needed (E Bull 1920). As these ships were to be used for warfare only, they could be built with that in mind.

I have postulated that this led to a specialisation of ship types in the course of the 10th and 11th centuries, from all-purpose vessels like the Gokstad ship to specialised craft for the transport of either cargo or warriors. I take the Skuldelev ships as examples of this specialisation at a well-advanced stage.

Ole Crumlin-Pedersen has opposed this view, mainly in unpublished discussions. In writing he has stated his view in the introduction to Treskib To (1977 II, p 2 f) "Strictly speaking, the merchantmen from Skuldelev are not the first sailing freighters in Danish waters. When they were sunk in order to block a sailing channel in Roskilde fiord between 1000 and 1050, mast and sail had been in use in the North for four or five centuries. However, we will have to use our imagination to visualise what the first Danish sailing freighters looked like. It must have been a long process to alter centuries of tradition of building long slender rowing ships into the building of capacious, stable and well-sailed freighters. However, finds in Norway and Sweden show that this change was a reality around 800" (my translation from Danish). The finds referred to are the Äskekärr ship from the Göta river in Sweden and the Klåstad ship from Tjølling in Vestfold, Norway (Humbla and Thomasson 1934, Christensen and Leiro 1976). In both cases the dating is based on radiocarbon analysis and I think that both dates may be too early. Both ships seem to be early trading vessels, Äskekärr more developed than Klåstad regarding the shape of the hull. This is not the place to continue that discussion; what concerns us more here is that the Skuldelev vessels firmly prove that merchant ships built in the Scandinavian tradition did exist at the transition from Viking to Middle Ages (see also Crumlin-Pedersen 1981).

If we look back to N Nicolaysens survey of Norse shipping in the Gokstad publication (1882) and H Falk's "Altnordisches Seewesen" (1912), they have both grasped the crucial differences between warships and merchantmen, in both cases based on the rather scanty written sources.

"These (saga) stories consequently show that trading vessels were not propelled by oars,.... further, that they had no flooring, except probably fore and abaft the cargo, ... and lastly, that throughout a voyage, their mast was up, and was not taken down until the vessel, when the winter came, was placed in the boathouse". (Nicolaysen 1882, 35). Flooring is used by Nicolaysen for what I have named deckboards.

"The hold of merchant-ships, situated by the mast, was known as *klofarum*. Fore and aft, it was bordered by upper and lower crossbeams, which supported a partition." (Falk 1912, 30). "The merchant ships had no continuous deck, but an open hold amidships" (p 48). "In the Saga period, there was a difference (in oar propulsion) as merchant ships had oars fore and aft only" (p 72), (quotations from Falk are my translations from German).

All these details are present in the Skuldelev merchantmen: the open hold amidships, small decks fore and aft, a rather permanent mast setup, its supporting crossbeams and a deep mast step, and oarports fore and aft only. The length-beam ratio also differs from the Skuldelev warships.

That the differences of the length-beam ratio were the same in the Middle Ages can be seen from the description in the saga of King Sverre, who in 1199 took some merchant vessels of the type known as *byrding*, and converted them to longships. They were cut in two, lengthened, and given oarports all along the sides.

Since the differentiation into war-vessels and

merchantmen existed in the early 11th century and is demonstrated in the scanty written sources of the Middle Ages, we are on perfectly safe ground when postulating that these two main types were known in medieval Norway. They were built in the same shipbuilding tradition, but differed in proportions and technical detail, according to whether they were built for war or trade. The ship fragments from Bryggen support this.

When we look at the scantlings of the Bryggen ship fragments, they fall in three groups. Group one consists of the remains of small boats, four, six or eight-oared. Some of them may be in the ten to twelve oar group.

The written sources from the Middle Ages seem to indicate that the borderline between a ship and a boat lies around this size, a twelve-oared vessel may be called ship or boat, smaller vessels are generally boats, larger ones, ships. For fishing and general transport the four- and six-oared vessels have been the most numerous until motor boats came into use. The larger categories were used in the 19th century in the large seasonal fisheries for cod or herring, and they might be called upon for freighting bulky cargo like firewood or hay. Some were used for travel, as the six, eight or ten-oared travelling-boats used by state officials and nobility, some were "church-boats", often jointly owned and used by several farms (Færøyvik 1979). Medieval society had the same needs: fishery, local transport, travel (fig 16-34).

When the written sources mention boats, it is often in connection with fishing gear. "One new seine and a six-oared boat" are among the goods listed in a testament of 1385 (DN XII, 115). An inventory concerning Tautra Abbey near Trondheim, dated 1531/32 groups together: "one herring net of 24 fathoms, one ten-oared boat with its gear, one six-oared boat with its gear" (DN XI, 582).

For local transport on a somewhat larger scale, the 19th century used a *storebåt* or *jekt*. These were coasters, usually much more beamy than the fishing boats, primarily intended for sailing, but equipped with sweeps for use in a calm, or in harbour. The sizes of the few that still exist differ, but there are two large *jekts* both of the late 19th century and there is no doubt that during the 19th century they were built larger than they had previously been. The average small coaster before 1800 seldom exceeded 20 lasts, according to the available sources. (Helset 1938, 10f, Gøthesen 1980). The oldest representations we have of the coasters with secure dates are from the beginning of the 17th century. At that date they were built with a transom, and this continued as long as they were in use. However, there seems to be no doubt that the transom is a loan from continental shipbuilding, and probably not older than the 16th century (the oldest representation I know of a transom is on the seal of Maximilian as prefect of Burgundy in 1493 (Abel et al 1969, fig 32)). Ships before that time may well have a square stern-castle, but below the castle they are double-ended. All scholars who have studied the *jekt* as a type, agree that apart from the transom, the vessel is a descendant from the smaller medieval cargo vessels, generally known under the type-name *byrding* in the medieval sources (fig 16-35). In my opinion, a number of the fragments from Bryggen are from small coasters and form what should be called group two.

The role of Bergen as the main transit port for stockfish from Northern Norway is well known and need not be further discussed here, but the ships used for the freight to Bergen merit a closer look. From later sources we know that the majority of *jekts* in existence along the coast were employed in the stockfish trade. The fishermen from Northern Norway travelled in large numbers to the Lofoten Islands for the winter cod fishery. Most of the catch was air-dried as "stockfish" which was subsequently taken to Bergen by local coasters and later exported. In the Late Middle Ages this was through the Hanseatic League mainly in exchange for rye from the Baltic ports, but in the Early and High Middle Ages, much of the export went by Norwegian keels, and England was an important market (A Nedkvitne 1977, and literature quoted by him). Several royal decrees forbade foreign merchants to sail north of Bergen, so the freight of stockfish to Bergen was by Norwegian vessels.

Apart from the stockfish, other goods went to Bergen from districts situated closer than the fishing districts of Northern Norway. All kinds of produce from agriculture and forestry were needed in the city, or exported. The numerous beams with one deckboard rabbet and sided-moulded dimensions in the range 10 to 18 cm, are the most characteristic remains of the small coasters. More complete wrecks of the same type are the Sjøvollen and Sørenga ships from

the Oslo fiord area (Christensen 1968 and 1973). The smaller Skuldelev merchantman, Wreck 3, is probably an early and fairly large example of the type. The small jekt from Holmedal in Sunnfjord and the "Big boat" from Skåsheim in Sogn show what the type looked like in later centuries (Færøyvik 1979, 49 f and 61 f. Figs 16-36 and 37).

The overseas tonnage is represented in the Bryggen material by the remains of a few large ships. (Group 3.) Their scantlings greatly exceed those of the coasters and small boats and such ships were probably few in number. These are the ships that we meet in the English customs accounts, carrying large amounts of stockfish, sometimes timber, occasionally strange cargo such as one live elk.

Largest among them are the "Big Ship" and the ship represented by the headbeams and other timbers from the area of P2/P3. The large headbeam from Bugården, the large sharp floortimber 91220 and the huge lodging knee 90222 are remains of other large ships. Somewhat smaller, but still in the overseas group, are the ships represented by the headbeam which has subsequently gone missing and the group of headbeams from Engelgården. It is important that the large ships are built of pine and in Norse clinker tradition.

The city law of Magnus, accepted for Bergen in 1276, rules that all citizens should take part when ships were beached for repairs or winter storage. Ships which were entitled to assistance had to be of more than five lasts, and they were divided into three classes: "Small byrdings", "Baltic traders", and "Ocean ships". The fine for absence was 1/2 *øre* for the small ships, 1 *øre* for the Baltic traders, then rose sharply to 1 *ørtug* (3 øre) for not helping when a big ship was beached. Our division of the material is less refined, but some of the timbers that do not belong in either the small coasters or the "Big Ship" category may be from the "Baltic trader" group, for instance, the group of headbeams from Engelgården.

None of the timbers found at Bryggen can be attributed to warships with any degree of probability. This is to be expected, as warships would hardly be broken up in Bergen. In peaceful periods, the levy ships stayed in the boatsheds along the coast, and were presumably broken up locally when they were too old for service, but only after the stems of the replacement ship had been rivetted to the keel, if the law was followed. In the troubled years of the civil wars in the late 12th and early 13th centuries, it might be expected that warships would sometimes be damaged beyond repair in Bergen and end in the foundations. However, the sagas seem to indicate that when ships were unserviceable, they were burned, so that they could not be repaired and used by the enemy. The only possible warship fragment is the keel 87888. It may have been part of a ship like those described in Orkneyingasaga: "King Inge gave the earl (Ragnvald of Orkney) two longships. They were rather small, but unusually beautiful, built mainly for rowing, and then at great speed."

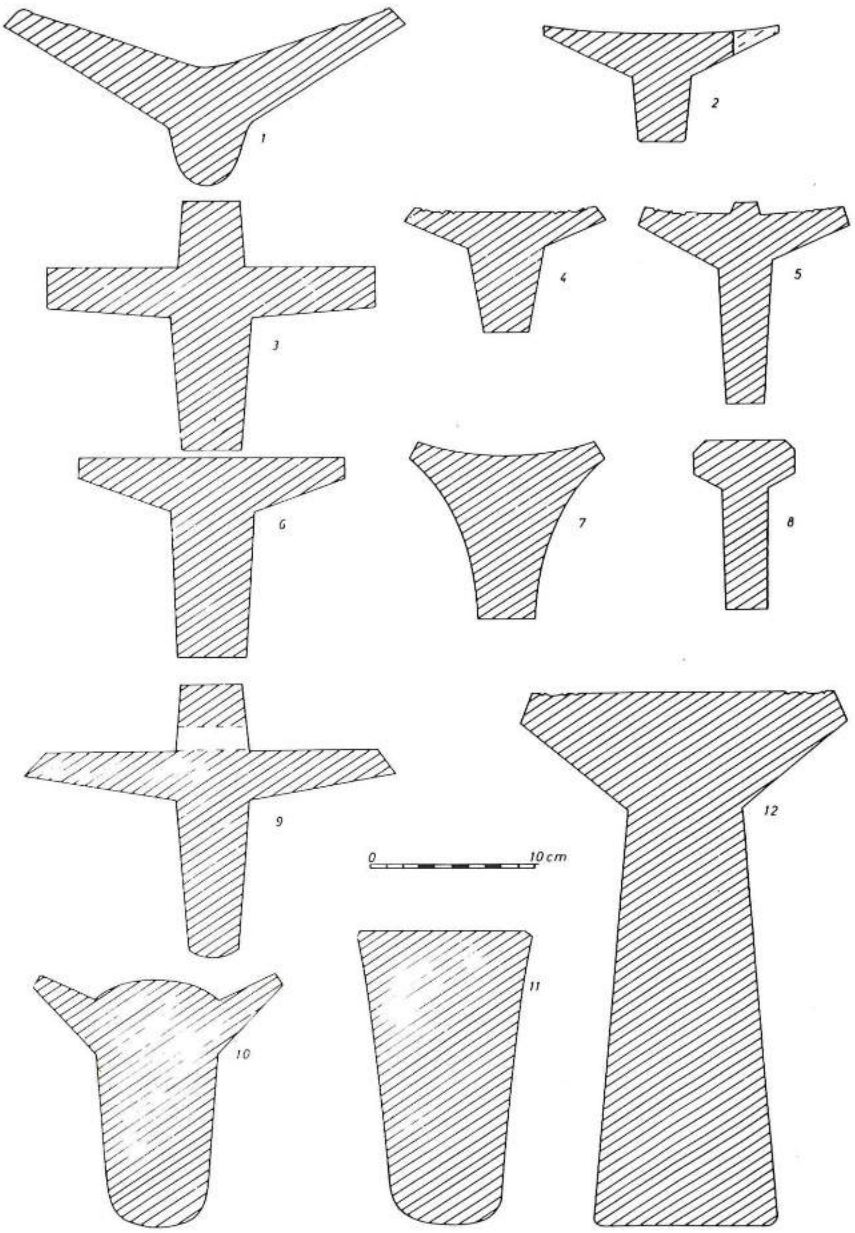


Fig 16-1 A collage of keels drawn to the same scale, in order to show the variations found

1 Bryggen
2 Bryggen
3 Kvalsund ship
4 Gokstad færing
5 Gokstad seksæring
6 Kvalsund færing
7 Modern Nordfjord færing
8 Modern Hardanger færing
9 Holmedal boat
10 Klåstad ship
11 Sjøvollen ship
12 Gokstad ship

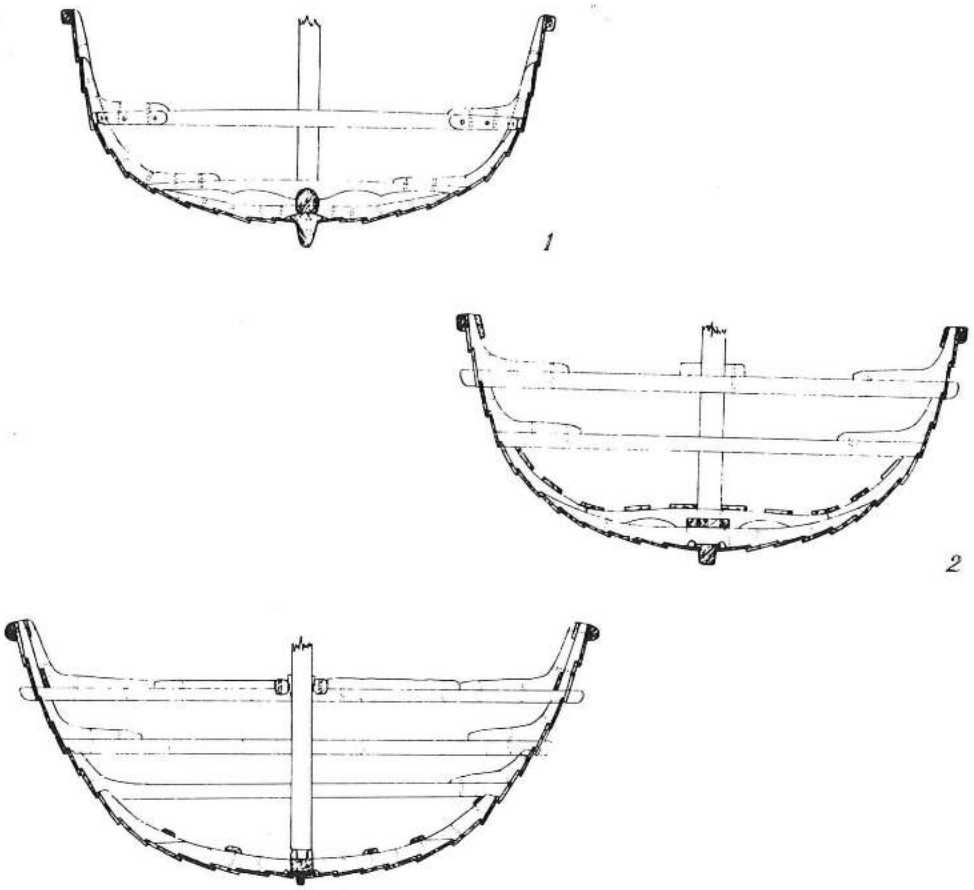


Fig 16-2 Cross-sections of the Elling Aa, Galtabäck and Kalmar I vessels (after Olsen and Crumlin-Pedersen 1958)

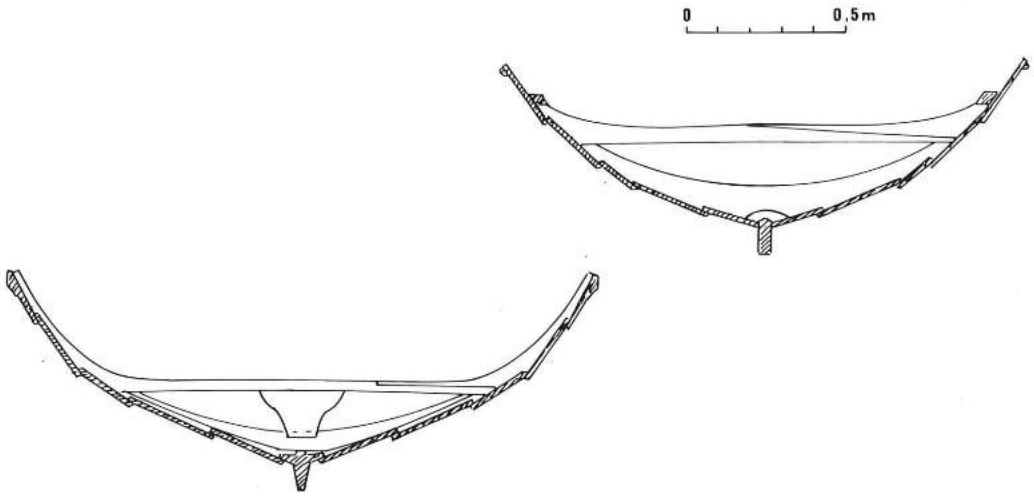


Fig 16-3 19th century Sunnmøre færing and Gokstad seksæring. Midship cross-sections to the same scale

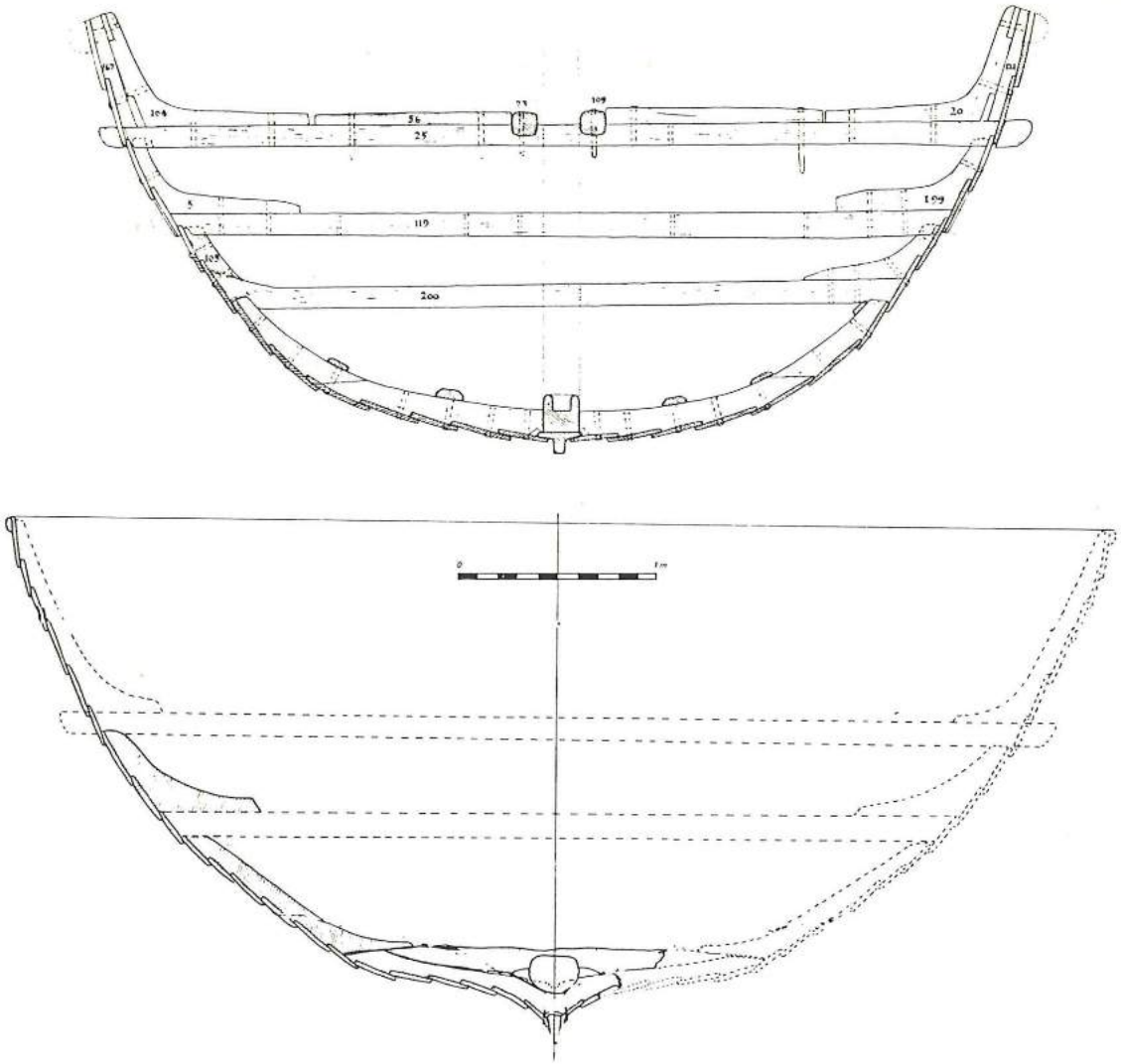


Fig 16-4 Midship cross sections of the Kalmar I and Sjøvollen ships to the same scale

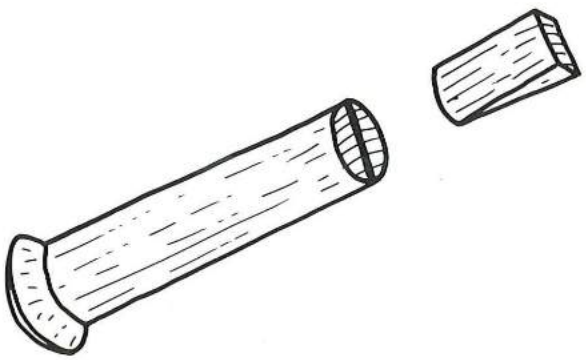


Fig 16-5 Sketch showing how year-rings run in typical treenail and wedge

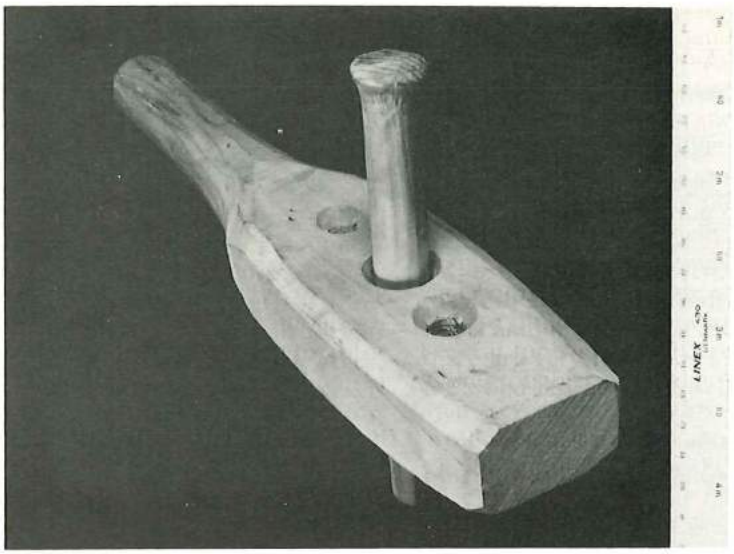


Fig 16-6 Tool for sizing treenails made by Sigurd Bjørkedal on Sunnmøre

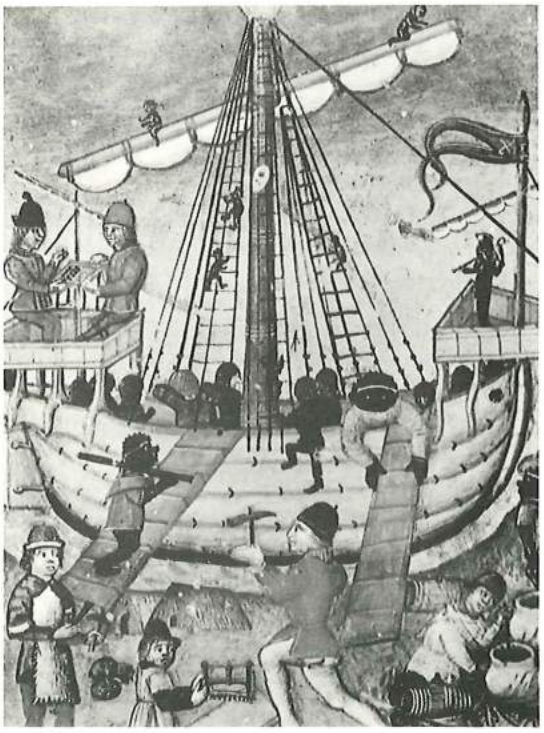


Fig 16-7 Smooth-skin ship with caulking laths over the seams. The laths are held by staples (after Asaert 1974)

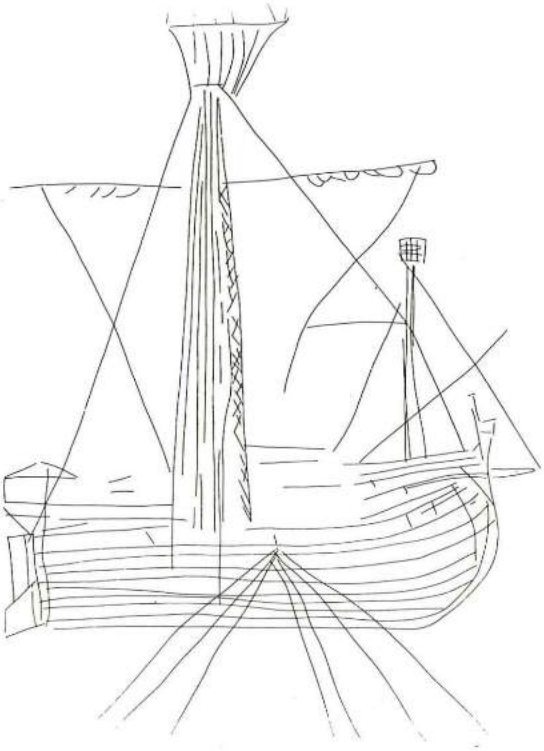


Fig 16-8 Two masted ship, probably of 15th century date, graffito, from Borgund Stave Church (after Blindheim 1977)

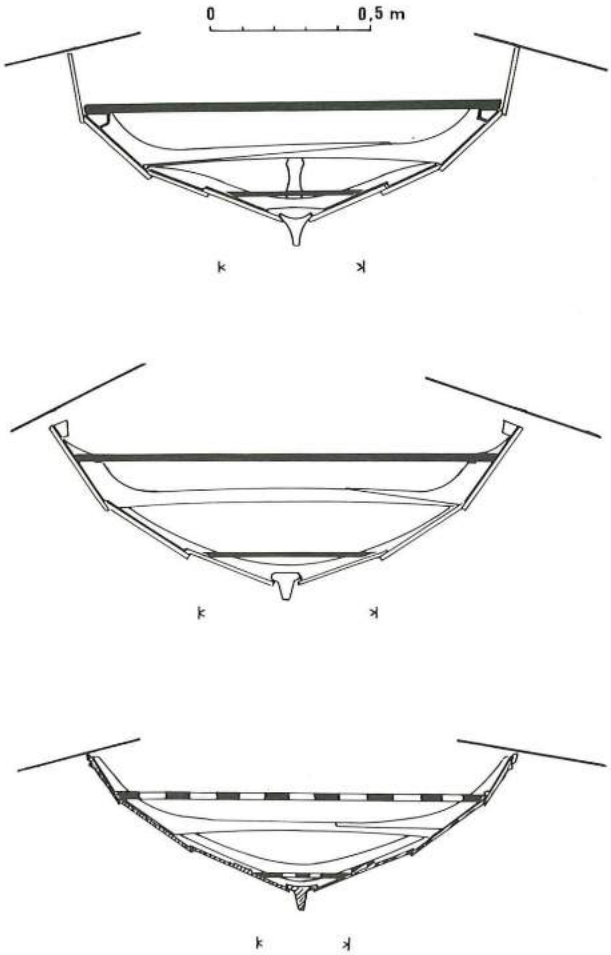


Fig 16-9 The position of oarlock, seat and floorboard in modern færing boats from Nordfjord (a) and Os (b) compared to the Gokstad færing (c)

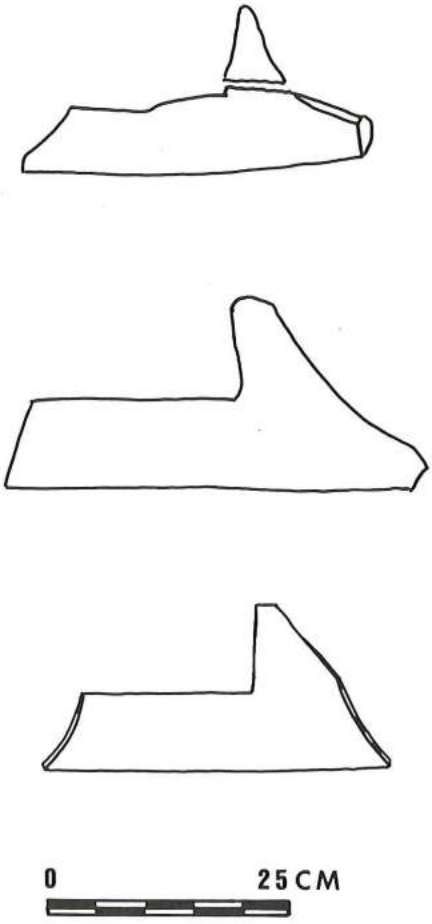


Fig 16-10 Rowlocks from bog find at Li, Hatlestrand, Hordaland, and modern Os-elver rowlock

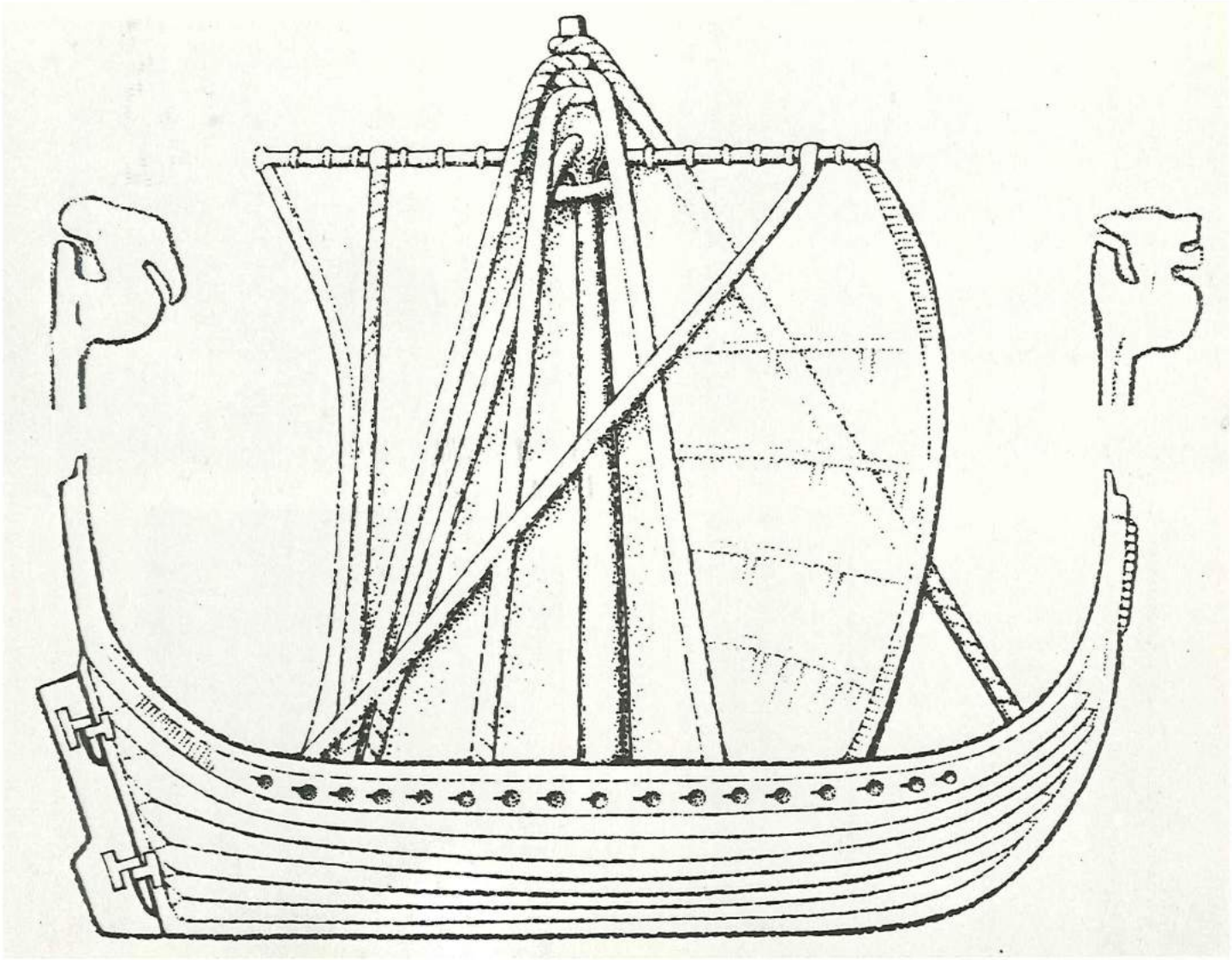


Fig 16-11 Ship from the tomb of Alexander McLeod, in St Clement's church, Rodil, Harris, Scotland

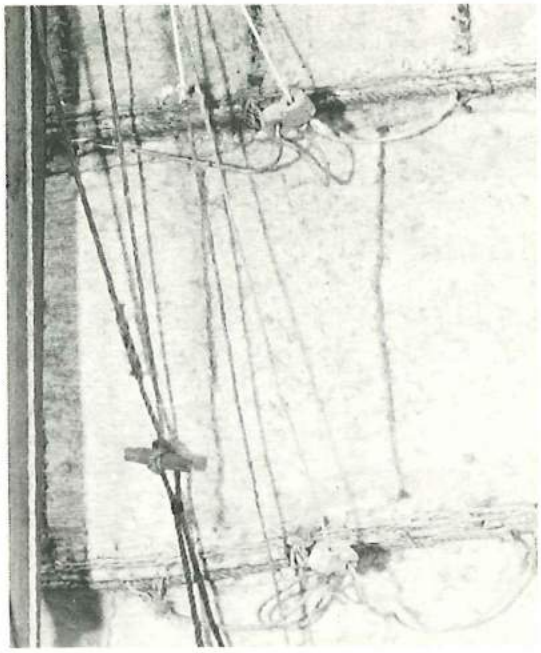


Fig 16-12a Rope-end toggle and fairlead in the rigging of a jekt model from Træna church, probably of late 18th century date

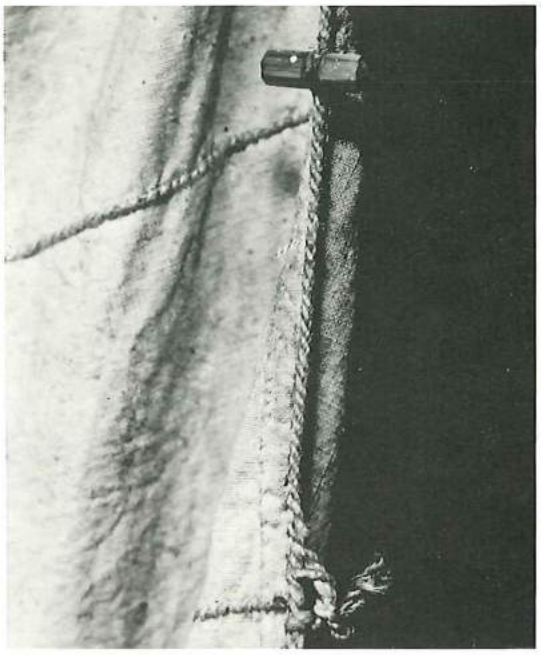


Fig 16-12b Rope-end toggle in the rigging of a 19th century jekt model, also in Tromsø Museum

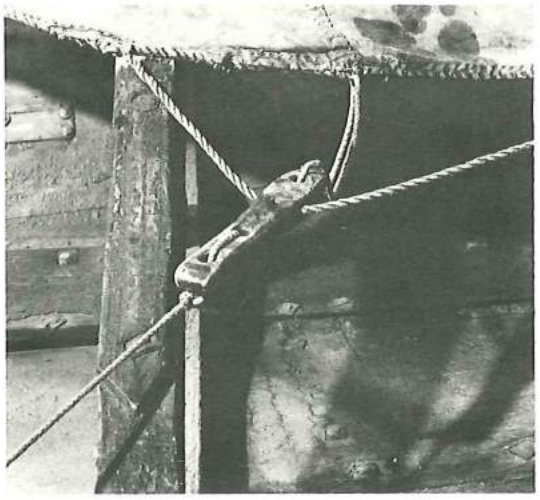


Fig 16-13 Fairlead-like detail on the middle sheet of a 12-oared boat from Nordfjord. Norsk Sjøfartsmuseum, Bygdøy, Oslo

Fig 16-14 Sheat cleat cut on the end of the inwale. 6-oared boat from Sunnmøre. Norsk Sjøfartsmuseum, Bygdøy, Oslo

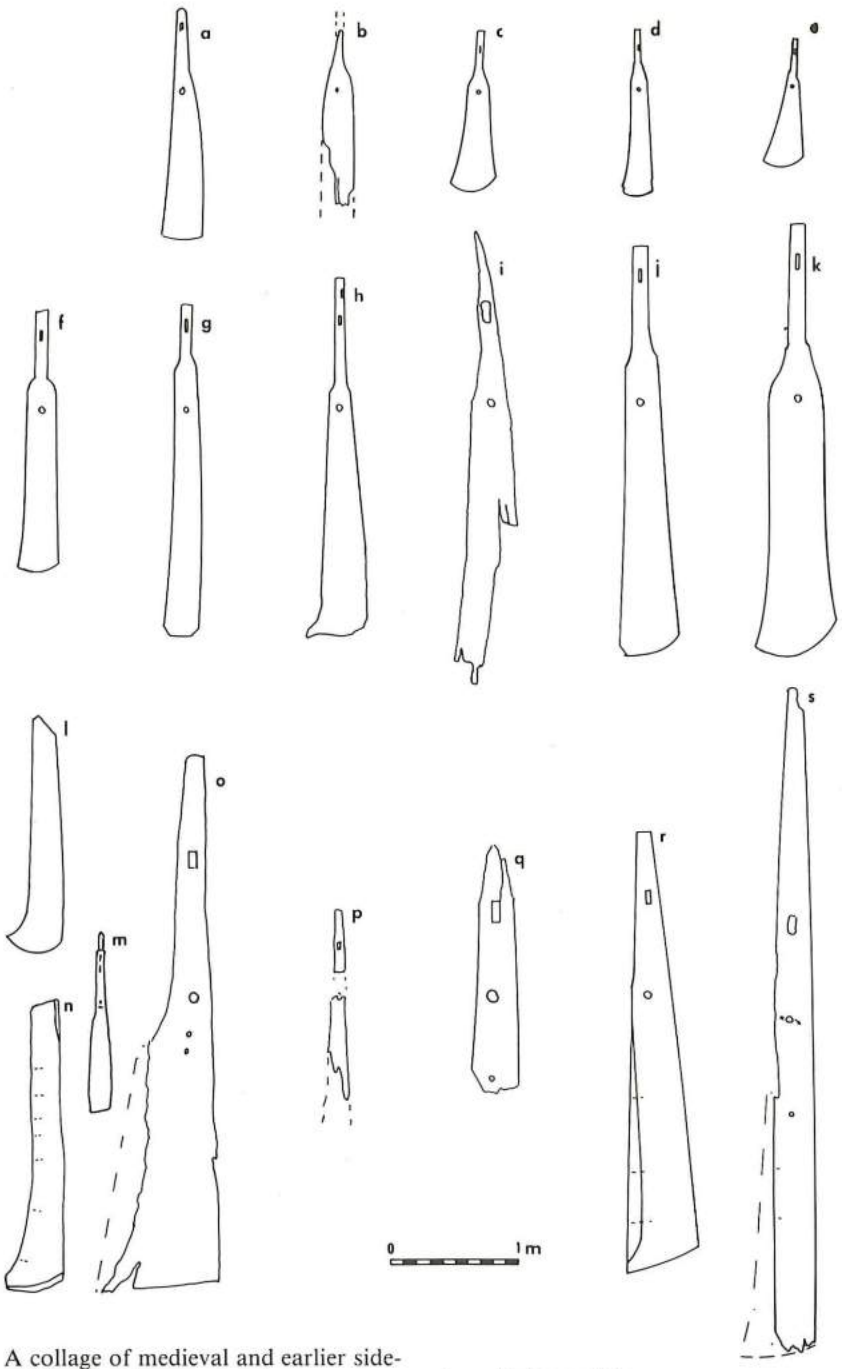


Fig 16-15 A collage of medieval and earlier side-rudders to the same scale

a Fjørtoft, large boat
b Bog find from Aukra
c Gokstad, largest boat
d Gokstad, third unrestored boat
e Gokstad, smallest boat
f Tune ship
g Kvalsund ship
h Vorså, Denmark
i Jongshoved, Denmark
j Oseberg ship
k Gokstad ship
l Medieval layers Trondheim
m Östra Aros, Sweden
n Bryggen nr 92741
o Rebek, Denmark
p Bryggen nr 90830
q Bryggen nr 92894
r Bryggen nr 91446
s Bryggen nr 92738

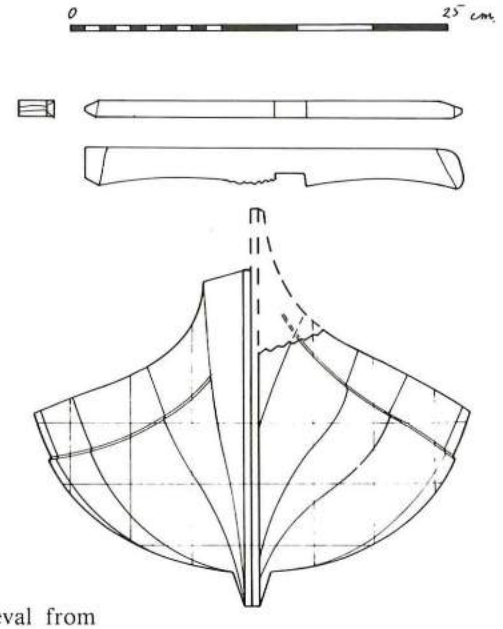


Fig 16-16

Boat model, possibly medieval from Båsmyr, Sandar, Vestfold. Reconstructed from fragments

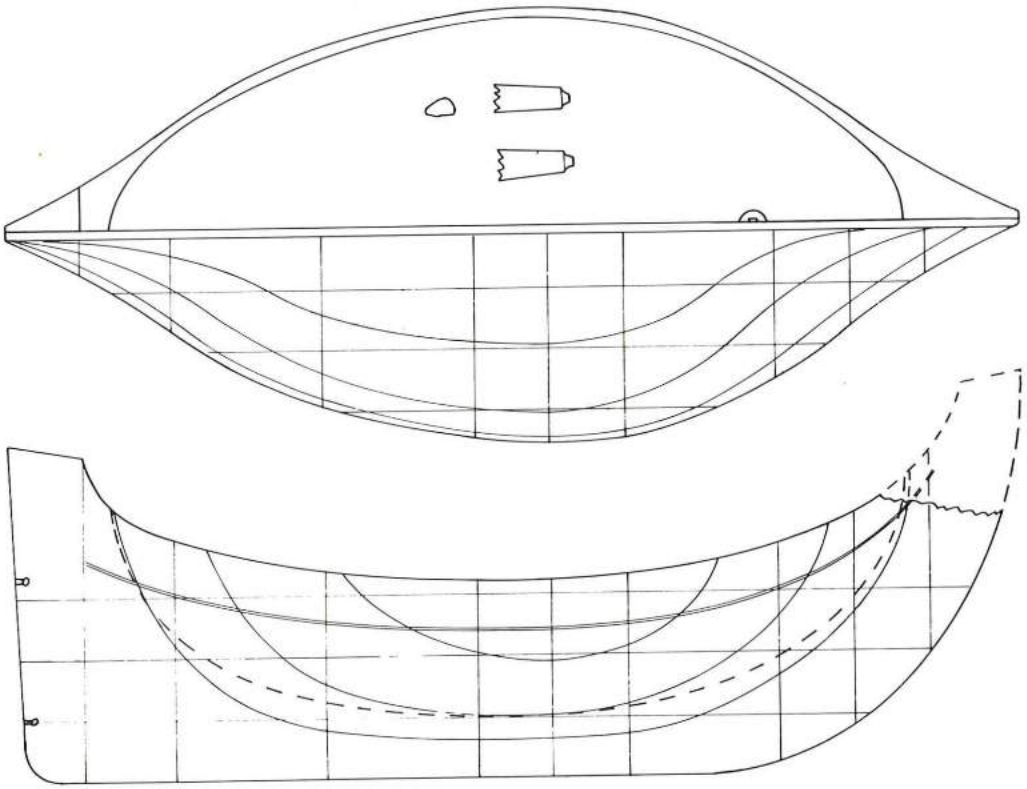


Fig 16-17 Boat model of uncertain date, from Trøndelag

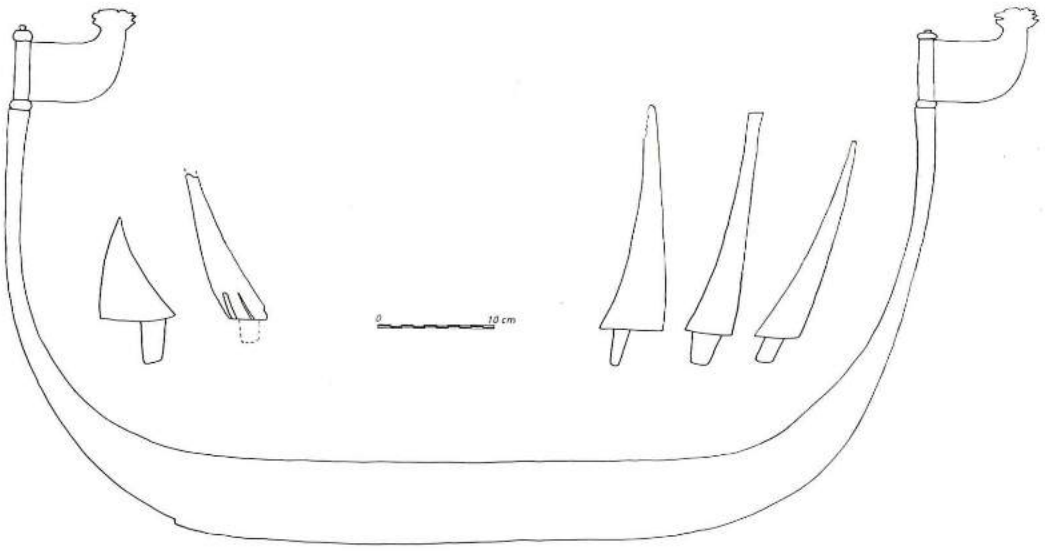


Fig 16-18 Iron candlestick from Dale Church, Sogn, and loose stemtops from Bryggen drawn to the same scale

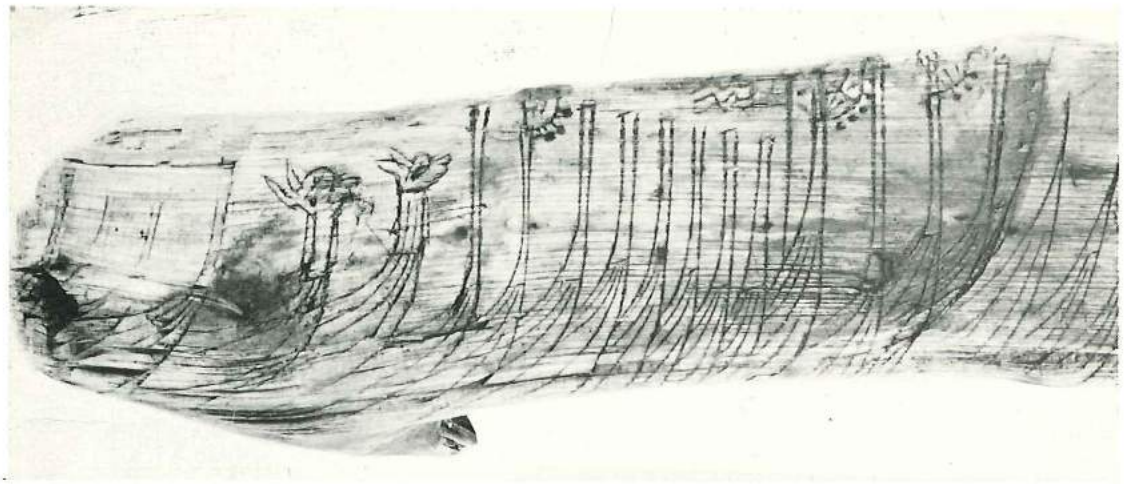


Fig 16-19 Detail of the carving from Bergen, showing loose stemtops on most of the ships

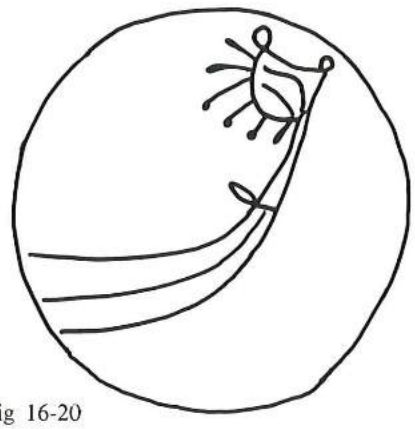
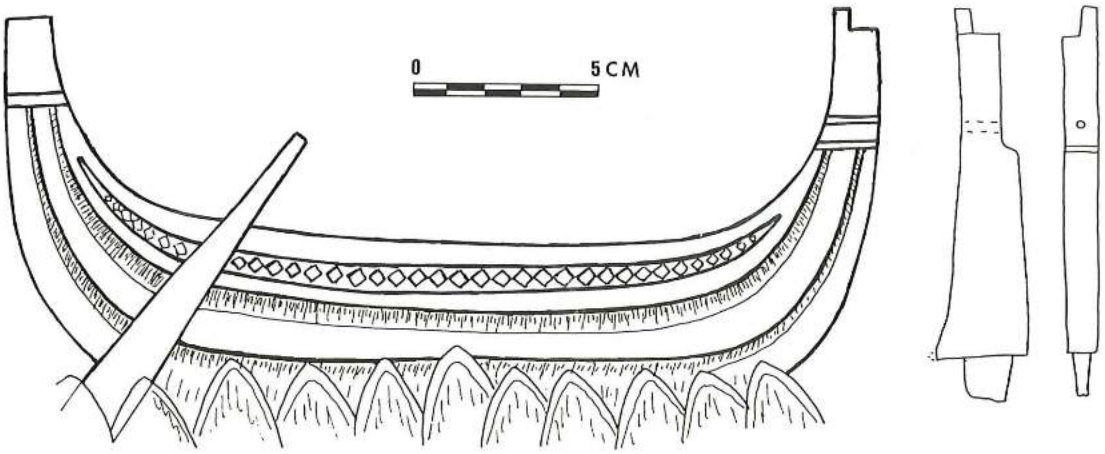


Fig 16-20

Gaming-piece from Gamla Lödöse, Sweden. Drawn from a photo in Riksantikvarieämbetets årsberettelse 1962. Diameter of piece c 6.8 cm

Fig 16-21 Folded out drawing of the ship carved on the portal from Nesland Stave Church, and the model stemtop 25547



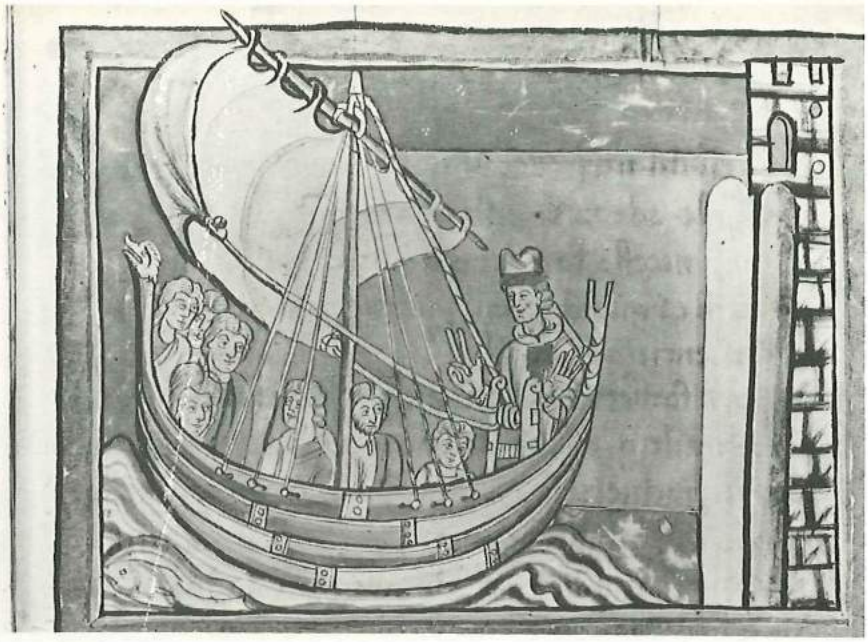


Fig 16-22 Ship with windlass aft (after Asaert 1974)

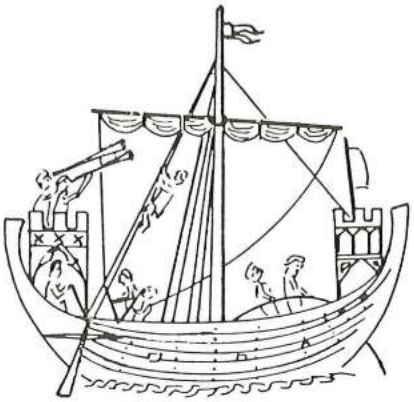


Fig 16-23

The town seal of Winchelsea, early 14th century. Two men aft are winding home the anchor cable with a horizontal windlass. The windlass is not seen but the handspikes are clear enough

Fig 16-24 Timber is cut and ships built for invading England, shipbuilding scene on the Bayeux tapestry (after Stenton)

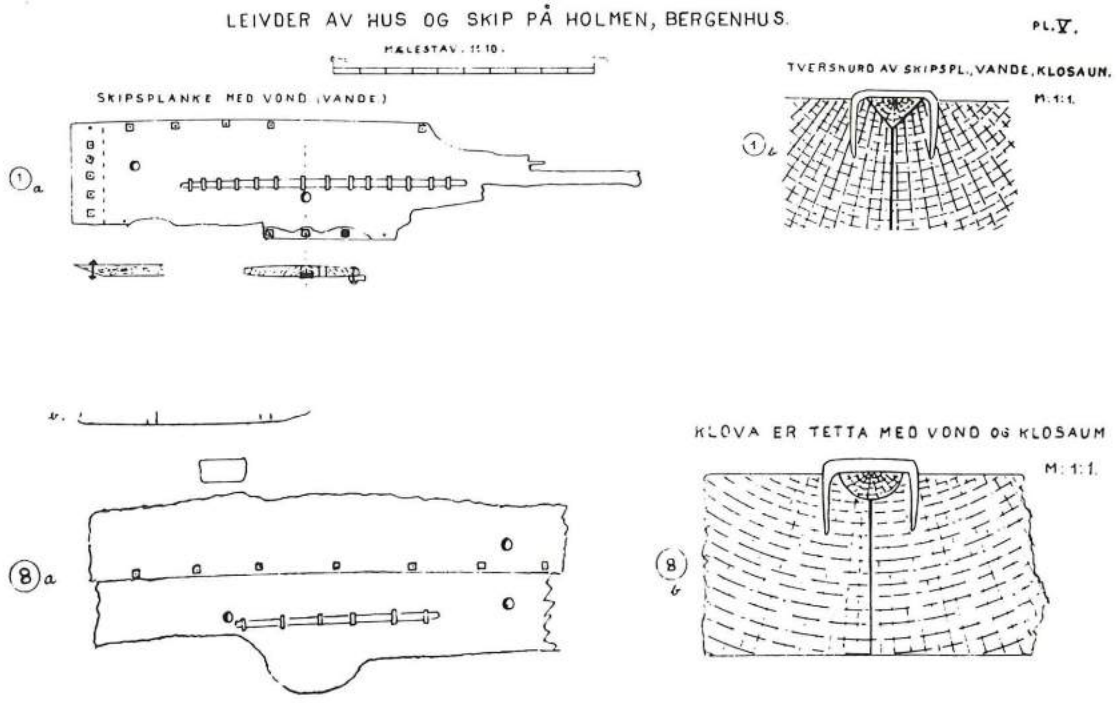


Fig 16-25a Repairs to cracked strakes by lath and staples. (a) ship from Bergenhus (after Færøyvik 1948-I). (b) repair lath with staple impressions from the Sjøvollen ship

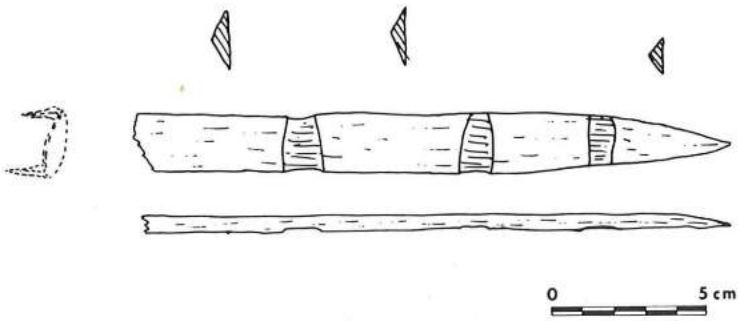


Fig 16-25b

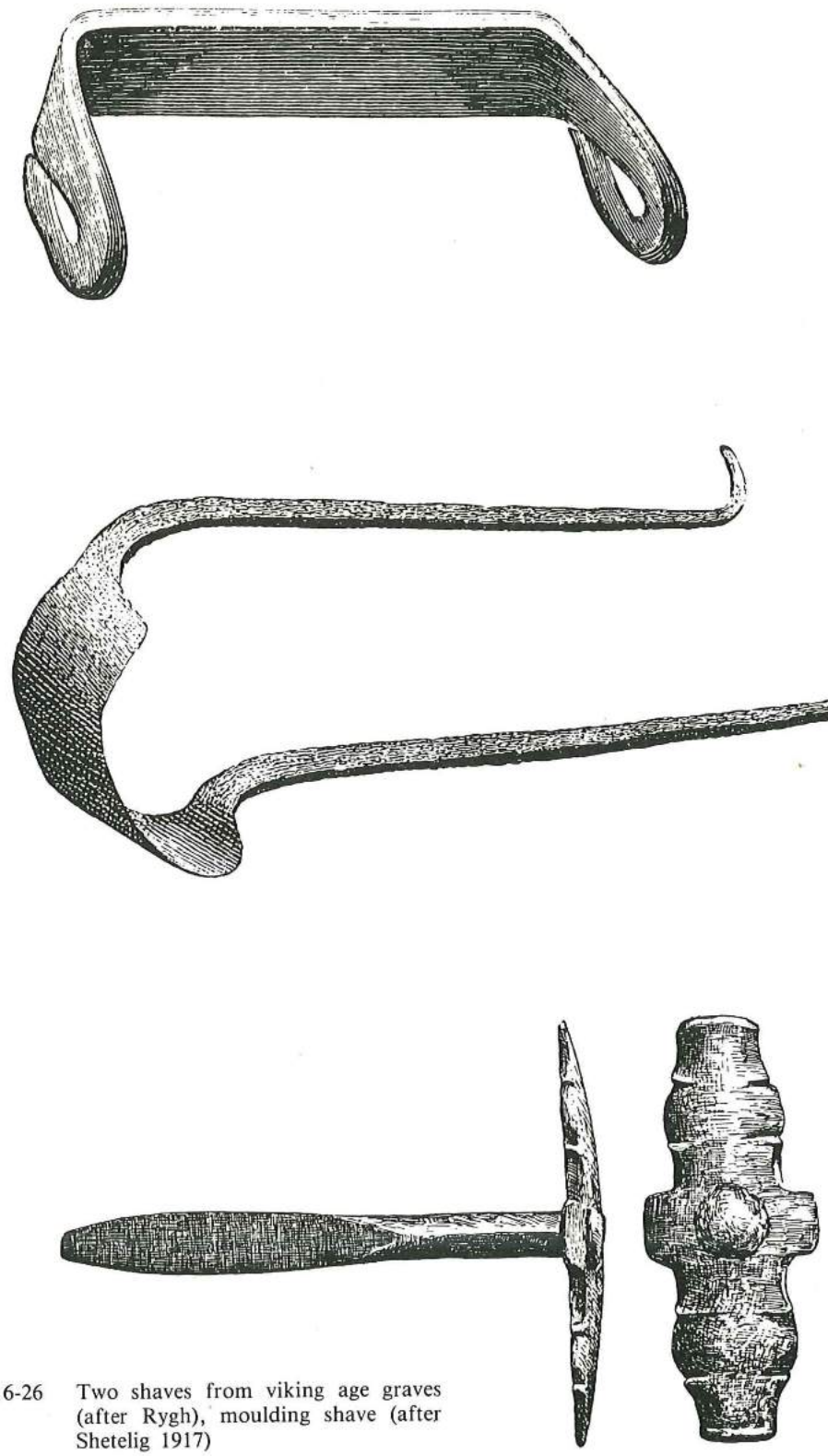


Fig 16-26 Two shaves from viking age graves (after Rygh), moulding shave (after Shetelig 1917)

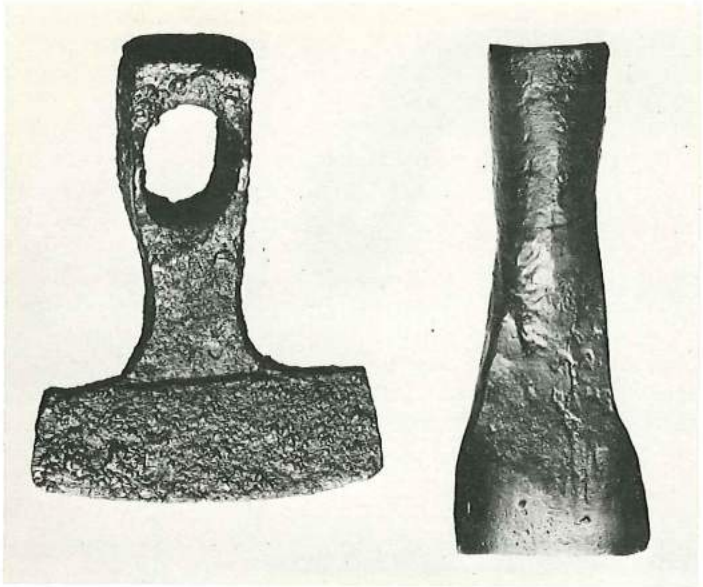


Fig 16-27

Broad adze, and socketed adze with hollow edge, C 26524

Fig 16-28

Spoon-bit auger found in the Gokstad ship

Fig 16-29

Wooden dolley for driving roves on to the nails. Used by Ingvald Sande, Nordfjord c 1980

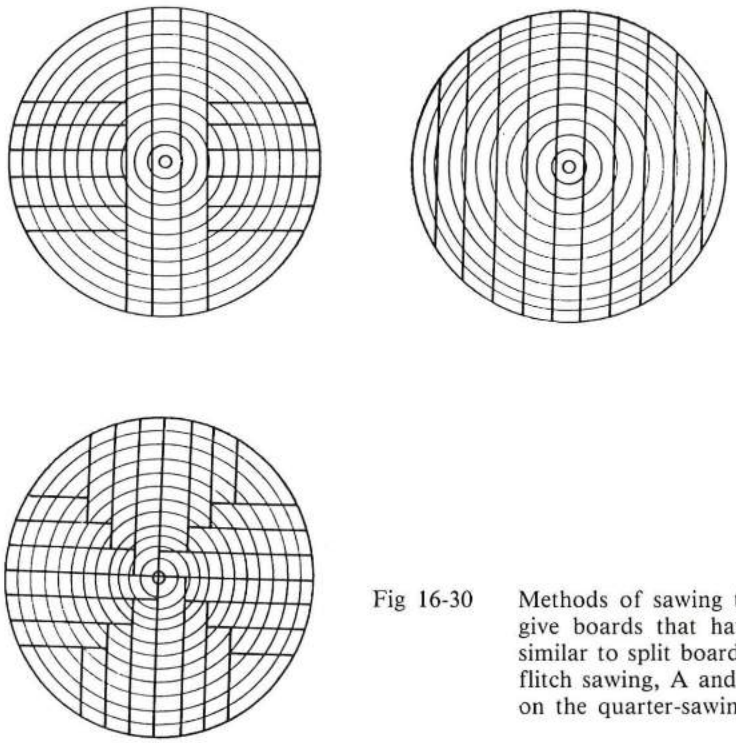


Fig 16-30 Methods of sawing timber. A and C give boards that have characteristics similar to split boards. B is known as flitch sawing, A and C are variations on the quarter-sawing technique

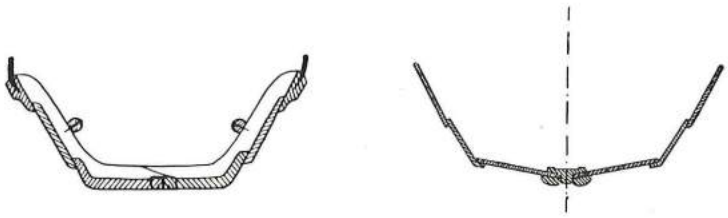


Fig 16-31

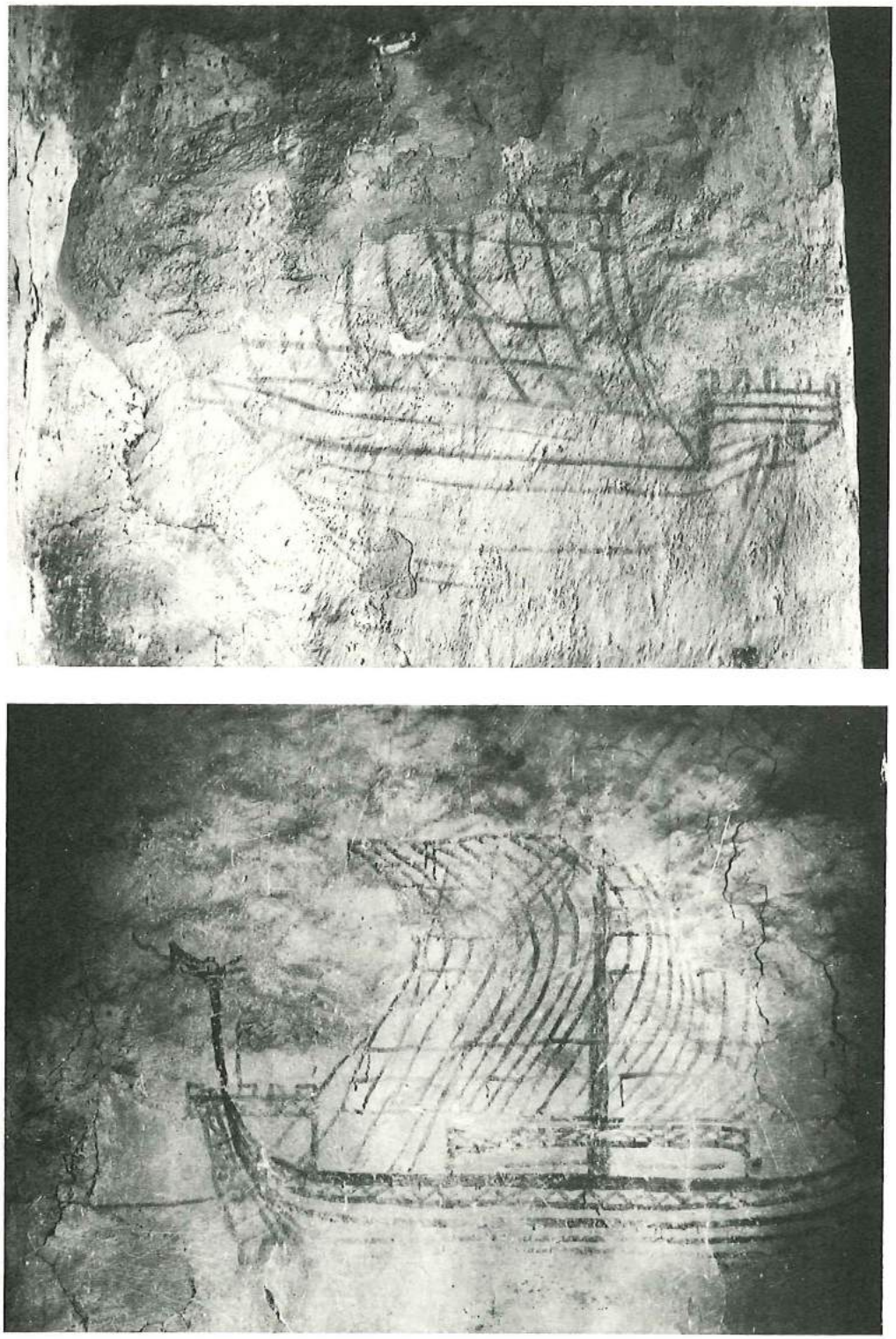
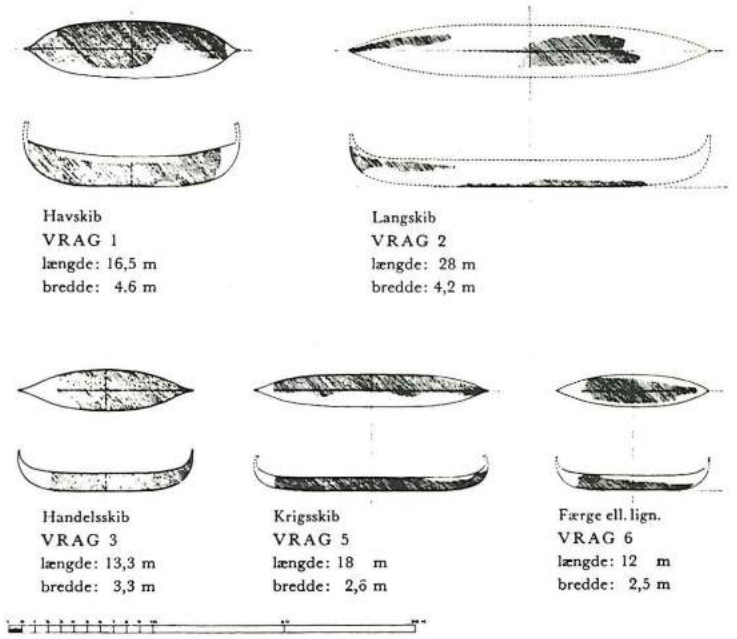


Fig 16-32 Two ships painted on the wall of Siljan Church, Telemark, one is a nordic keeled vessel, the other a cog

Fig 16-34

Even if this stone, from Trands church, Jutland, Denmark, shows the highly dramatic story of Thor fishing the Midgard serpent, it is still a good rendering of two men fishing from a small boat



Plan og opstalt af de fem Skuldelev-skibe. Skraveringen angiver de bevarede dele af skroget

Fig 16-33

The relative sizes of the 5 Skuldelev ship shown in diagrammatic form (after Olsen and Crumlin-Pedersen 1967)

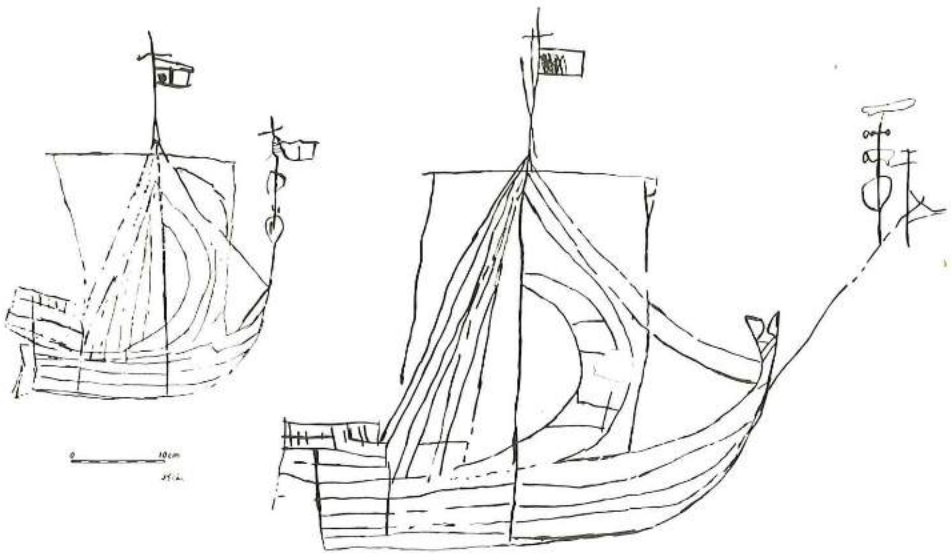


Fig 16-35 Sailing coasters of jekt-type painted on the wall of Trondenes Church, North-Norway

Fig 16-36

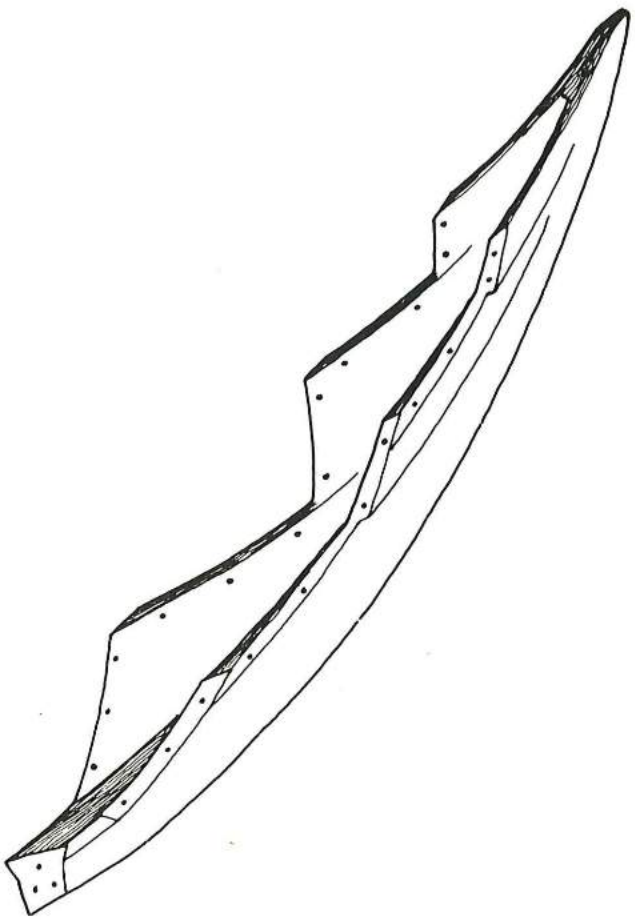


Fig 16-37

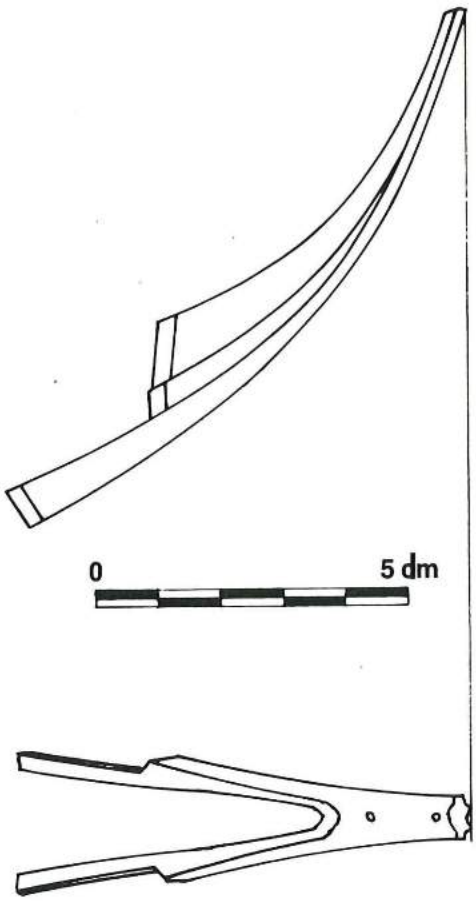


Fig 16-38

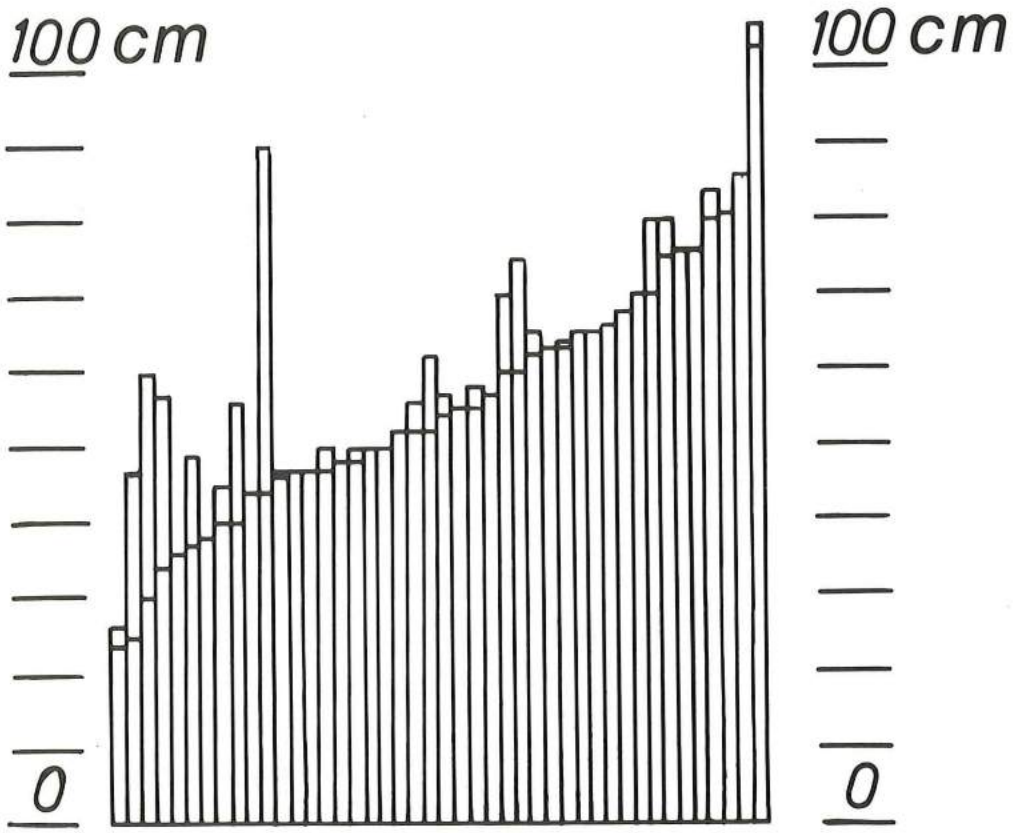


TABLE 16-I

SHIPS IN MEDIEVAL SOCIETY, THE WRITTEN SOURCES

It is a fact which has been stressed before that the Scandinavians of the Viking and the Middle Ages were maritime in orientation like few other societies have ever been. That statement would seem to be true, when we read their own literature, but no attempt has been made to define the degree of maritime interest, and very few scholars have ever discussed what it is that makes a community maritime: how does a society which is keen on maritime matters signal its interests?

In his book "Sailing from Lamu, a study of maritime culture in Islamic East Africa", A H J Prins discusses the character of a maritime culture and its expression. "Since this book deals with maritime culture, it is legitimate to ask how we know whether a culture is, or is to be considered maritime" (Prins 1965, 3). Prins finds the following points significant: the use of nautical similes in colloquial language, maritime proverbs being used, children playing with toy boats, men building models of ships in leisure hours, the integration of sea and ships into the make-up of functionally non-maritime institutions like votive offerings and mortuary ritual. The Middle Ages no longer used ships for burying people or as part of offerings in bogs, but the other points fit as well to what we know of medieval Western Norway as they do to 20th century Lamu. A final important detail is what other people think of the culture. For the rest of Europe, medieval Scandinavia still had some of the "Viking image"; the Scandinavians were definitely considered as maritime peoples (fig 17-1).

Two French examples show this. According to the monk Mattheus Parisiensis, who visited Bergen i 1248, the French king, Louis, suggested a joint crusade with King Håkon Håkonsson. King Håkon was offered the command over the entire French fleet. In 1295 King Phillipe of France paid the Norwegian ambassador Audun Hugleiksson 6000 marks of silver in advance for promised naval support against England. Norway was expected to muster 100 large ships and 200 "galeae", manned by 50000 able men.

It is remarkable how little this intense maritime preoccupation shows in written sources outside the sagas. The saga picture is one of warring kings and nobles, for whom the ship is a tool of power and prestige. It is here that we get our only glimpse of actual shipbuilding in the famous story of the "LONG SERPENT".

In his saga of the Norwegian kings, written around 1230, Snorri Sturlason describes the event which took place about 230 years before, probably in 999–1000. "That winter, when King Olaf had come from Hålogaland, he had a big ship built below the cliffs at Lade. It was larger than any other ship in the country at that time, and the stocks are still there, so the size can be estimated. Torberg Skavhogg was the stem-builder, and many others were at work. Some fitted the planks, some hewed to shape, some forged nails and some moved the timber. All materials were selected with care, the ship was long and beamy, high-sided and built of large timbers." "It was the best ship ever built in Norway, and the most expensive". (My translation from Snorri Sturlason, transl by Holtsmark and Seip, 190.) A few scraps of information can be snatched from the laws, but the huge mass of diplomas are nearly silent on maritime matters. There are glimpses, true enough, but the 21 volumes of Diplomatarium Norvegicum show clearly enough that what was conveyed to writing were sales of land, quarrels over land, fines to be paid for killing, quarrels between heirs. Ships were built and changed hands without written agreements – or at any rate none that has survived – trade by sea likewise. Only rarely are ships mentioned in other contexts.

What we can find points to great maritime activity. In some cases the activity seems to have been too great for the ruling classes. Some of the best sources deal with what is forbidden for the common man: building large ships, sailing with merchandise if one has not got considerable capital, selling ships to foreigners. If a decree has to be repeated it shows that things went on as before, regardless of what the lawmakers thought. By analysing the laws, we can get glimpses of a maritime society that did not leave written records like its agrarian counterpart. Nevertheless, the maritime occupations must have been what kept a great percentage of the population busy in medieval Norway.

The joy of fast sailing is vividly expressed in the sagas and scaldic poems, generally in connection with praising the king for his boldness, seamanship or both. Tjodolv, court poet to Harald Hardråde, likens the king's ship under

oars to an eagle spreading its wings (Snorri Sturlason, 553). When Ragnvald, earl of the Orkneys, planned his pilgrimage to Jerusalem, he had a ship built in Norway. A man called Jon Fot had it built for him: "and he should make it as fine as he could". After two years in Orkney, Ragnvald returned to Bergen to find the ship. "It had 35 rooms and was of exceptional beauty, decorated with carvings, and all was well made and gilded, both parts of the stem and the weather-vanes. Other parts of the ship were also decorated. Thus, the vessel was a very valuable piece of property" (Orkneyinga-saga). In the strife between King Håkon and Earl Skule on the one side and the band rallying around Sigurd Ribbung on the other, a campaign was launched where Skule marched from Trøndelag and Håkon from Oslo, against Sigurd, who had his followers around Hamar on Lake Mjøsa. For this campaign it was clearly unthinkable to be without ships, even though the fighting was planned to take place in the middle of the best arable land in Norway. The earl had forged a mass of ship's nails, which were carried by packhorse across the mountains from Trøndelag. He also had many shipbuilders with him. On Lake Mjøsa, the earl confiscated all ships he could get hold of, and had built five new ships, so large that their like had never been seen on Mjøsa before. "They were built with great haste." That the haste must have been too great in this case was seen when the ships were launched. "The earl had launched the ships, but they were so leaky that they could hardly float, bailing was no help, they were not at all fit for battle." The planned big battle did not come off, and as Skule marched north again, the ships were burned or broken up. The point in case is not the bad ships, but the fact that the military leaders included ships in their strategical planning whenever there was any chance of meeting the enemy near water.

In 1252, King Håkon had a new ship built in Bohuslän. Gunnar, a relative of the king, had organized the building on the king's order. It was one of the largest ships ever built in Norway. The king named it "THE CROSS" on launching. The sheerstrake was 9 ells above the waterline and level with the tent supports of other large ships. When the new ship dropped her anchor at Öckerö, the cable ran out so fast that the windlass caught fire. Some of the men tried to quench the fire with wet canvas, but Magnus, the king's son, quickly took a bucket of water and poured it over the windlass. Similar glimpses of life on board are not hard to find, but more practical information on how ships were built and handled is rare. Most of the information deal with dramatic and unusual situations. King Sverre had a big ship built in Trondheim in 1176. When he arrived in Trondheim, 9 strakes were already laid. The king said; "The ship is much smaller than I intended. Take it apart and add 12 ells to the keel." The shipbuilder opposed this, but it was done as the king wanted. When launched, some of the joints gave, as there were too many scarfs close together. "MARIASUDEN" was not a pretty ship. She was too small fore and aft when compared to the midship section because of the changes." "The king had three chests brought on board, and there were four men to carry each one. Many wondered what was in them." "When they sailed round Cape Stadt, the weather was heavy and some of the joints in "MARIASUDEN" sprang leaks. The chests were opened and were seen to contain nails, which were used to repair the ship."

If we look for the craftsmen in the written sources, we find but little. Only two boatbuilders are named in the sagas, one is Torberg Skavhogg, who took part in the building of the "LONG SERPENT". The way in which the other one is presented in the saga of King Olaf the Saint is clear proof of the pride boatbuilders took in their work. "One man was named Torstein Knarr-builder. He was a merchant and a good craftsman, a big and strong man who liked to be foremost in all matters, and a great fighter. He had come to be an enemy of the king, and the king had taken a large new merchant vessel that Torstein had built for himself. That was as a fine for violence and killing. Torstein was with the army. He went to Tore Hund in front of the men and said: 'I want to be here, Tore, in your company, for I want to be the first man to use arms on the king, if I get close enough. I want to pay him back for taking from me the best ship that ever went trading'."

Decrees concerning the defence-ships - *Leidangskip* - are found in the laws of both Gulating and Frostating, as well as in the common law given by Magnus in 1276. The regulations are most detailed in the Gulating laws. Here we find chapters on building new ships, building boathouses for the levy vessels (Norw *naust*), launching, beaching, storing the sail and judg-

ing whether the ship is seaworthy. The Frostating laws have nearly the same regulations about shipbuildings, launchings, and beaching and storing the sail, but with somewhat less detail. The following, partial translations from the Gulating laws are based on Robberstad's translation into modern Norwegian and the Old Norse texts in Norges Gamle Lover I.

"When the ship is decayed from age and they shall build a new one, they may build where they want, but without damage to grainfields or grassland. If the king owns land in the district, that land shall be used for the building, but if it is not sufficient, they may build where they like. But if they build more than one ship, they shall not damage the woods of one man only. They must then divide the timber among them. Those who are allotted keel or stem, strakes or hood-ends, shall be fined half a *mark* if it is lacking. For *saks* or *saks*-frames, for each tree that is lacking the fine is three *øre* and the tree must be delivered, even if it is later. Three *øre* is the fine for all frames that reach across the ship, one *øre* for the sharp frames fore and aft, and one *øre* even if only one claw (one side of the frame?) is lacking. Three *øre* is the fine for the mast, and for the yard and for all timbers, even if they are inboard. Now, they shall be fined one *øre* for each missing strake, one *øre* even if only an ell is lacking, and they must supply the strake even if it is later, one *øre* for each nail and rove, one *øre* for each bucket of tar, one *øre* for each luting-string, one *øre* even if only an ell is missing. One *øre* should be fined for each meal (for the workmen), one *øre* for each penny that should be wages for the workers.

Now, workers should be summoned, all that are within the district, until there are enough. Each stembuilder will be fined six *mark* if he does not report. Now when they have set up the keel and started building, if any one leaves the work, then that stembuilder or strakecutter shall be outlawed, for he ruins the defence for the king. Now, the craftsmen shall work for payment: the stembuilder two 'six-ell øre' on workdays, with Sundays in between, but the strake-cutter one *øre*. (A six-ell *øre* is presumably the value of six ells of wadmal.) Now, one shall not burn or break a ship until the stems of the new ship are riveted to the keel. But if they burn or break it before, it is *hamlefall*, and they shall be fined three *mark* for each *hamle* (rowlock). (*Hamlefall* means literally 'loss of rowlock' and the fine for burning the old ship before the building of the new one was under way was calculated on the basis of the number of rowlocks.) Now, the steersman will allot time for making the sail for the ship. If it is not ready in time, the fine is three *mark* for all those who should supply it. If some have done theirs, and some not, the fine is one *øre* for each ell, one *øre* for each boltrope, and one *øre* even if only one ell is lacking on the rope, one *øre* for each ball of twine, one *øre* for each thimble, one *øre* for each *klo* (literally claw). The ropes shall be measured by the hides that are necessary, one *øre* for each hide that is lacking, and they must supply the hide later. Now if anything is lacking, the *årmann* (king's steward) or *lendmann* (sheriff) shall get it, according to the income they have, and later get it back from those who did not supply what they should"(fig 17-2).

In connection with the sentences stating that the ship should be built on king's land if possible, and that the burden of supplying timber should be divided, it is relevant to point out the solution to this problem which E Bull (1917) found in Varaldsøy, Sunnhordland. On the island of Varaldsøy, there is a farm named Havn (Harbour), with the large ruin of a boat-house (*naust*) which may well have been for the levy-ship for the district (*skipreide*) corresponding to the present municipalities of Varaldsøy and Strandebarm. Near the ruin is a piece of forested land known as *skiprei(d)teigen*. This is jointly owned by the farms of Havn and Dysvik, but there is a local tradition, that the plot was formerly the common property of the *skipreide* (levy district), and that the necessary timber for building and maintaining the levy ship was taken here. In 1917, the plot had good oak and pine growth. This isolated example is no proof that this was a common way of solving the problem of supplying timber, but it is an interesting example of a solution which must date from the time when the levy system was still working as an active tool for the defence of the country, and not as a taxation instrument, as it was to become later.

"Now, the King sends his men around to survey the ships, and if they or the steersman judge a ship unseaworthy, while they (the men responsible for the ship) consider it seaworthy, they shall then call men from another ship district, who shall swear it seaworthy or not. But if they will not swear, they shall launch the ship and test it: let it lie in water for five nights, then bail. Now if one man can do the bailing

until the ship is in the main channel, then it is seaworthy. The anchor shall come with the ship, but if it is lacking, the men of the levy district shall be fined three *mark*. But the steersman shall supply the rudder and tiller."

After the Black Death of 1349, the maintenance and renewal of levy-ships evidently caused problems, and there is a handful of letters concerning this in the Diplomatarium Norvegicum. On 14/10 1365 King Magnus permitted the inhabitants of Sandir levy district to build a smaller ship (evidently, the population was smaller than before the Black Death of 1349, and they could no longer man a large ship). They had a ship 20 ells in the keel when they were "fully manned"; now they may build with a 16, 17 or 18 ell keel, but not less than 16 (DN II, 385). A letter from King Olaf, dated Tunsberg 20/4 1382 permitted the inhabitants of Slagen and Våle levy districts to build a new ship for the defence of the land within three years, 20 ells long in the keel, and they may burn the old ship in order to re-use the nails (DN I, 470). Several letters between 1394 and 1400 deal with a ship that the inhabitants of Eiker bought from Gudbrand Erlingsson, presumably instead of building a new levy-ship. The fact that the payment did not come forth as quickly as expected resulted in more documents than the original letter of agreement. The ship was expensive: 60 head of cattle and 50 pounds of malt (DN II, 530 and 562, DN III, 519). A document drawn up 12/3 1386 at Vinreid deals with the account given by Jon Holmssøn to two men from each *skipreide* of the expenses borne by the inhabitants for repairs to the longship of the *sysle*. The sysle in this case was evidently a larger district than a *skipreide*, and several *skipreider* must have been permitted to keep one larger ship together (DN III, 349 and 465).

It is evident from the sagas and poems that the ships of the king and nobles were expected to be well-built and of beautiful shape. Quality is not mentioned regarding the trading vessels, apart from Torstein Knarresmed's judgement, already mentioned, of his own merchant vessel which King Olaf had confiscated before the battle at Stiklestad. However, the quality of craftsmanship found in the Bryggen fragments and other medieval ship finds from Scandinavia is remarkably high. Both the sculptural beauty of the complete ship and its various elements and the surface finish go far beyond what is necessary for the use of a vessel (fig 17-3). The group of beams 90852f discussed on p 64f are a fine example of the workmanship and sculptural qualities achieved by medieval boatbuilders. Every line is shaped with an eye to beauty: smooth, even curves are evident all over. I have no doubt that the shape of the boat must have been exquisite, the work of a craftsman with artistic as well as technical skill, the prized property of an owner who must have had that love of the sea and pride in good ships which is often voiced in the sagas. A comparison with the late medieval and early post-medieval ships found in the Ijsselmeer polders show this clearly (Reinders 1978 and 1980). The Dutch vessels are sturdy, well built from good materials, but utilitarian and without the grace and careful finesse of workmanship seen on Norse vessels. A comparison between the Norwegian and Danish Viking ships and the Graveney boat (Fenwick et al 1978) gives the same picture. Scandinavian ships show that eye-sweet lines and a high standard of finish must have been desirable qualities in a ship besides strength and seaworthiness (figs 17-3 and 17-4).

Why are the maritime activities that were not related to "wars and kings" so seldom recorded in the written sources? In my opinion, the answer is that given by Olof Hasslöf in several of his works (eg Hasslöf 1972 and 1980). Written sources mirror only one part of society, those few people who were trained in using the written word and who, moreover, had an interest in recording the ownership of the most permanent of all valuables - land.

This is not restricted to the Middle Ages. As late as in the 19th century, when written sources are plentiful, they are often not reliable when dealing with maritime matters, as the archival system was geared too much to agrarian problems to be able to catch maritime matters properly (examples are given in Christensen 1971 and Hasslöf 1972).

Trade by sea, building and selling of ships, fishing and the sale of fish, all must have gone on with oral agreement as the only form of contract. The runic inscriptions found on pieces of wood on Bryggen (Liestøl 1964) show that the people who traded by sea were not illiterate, so the lack of written agreements must be by choice. A possible hypothesis is that maritime economic life was firmly based on native tradition, and the need for written agreement was not felt.

The use of documents on paper or vellum as

proof of ownership of or rights to land originated with the church, based on Continental customs and Roman law. Clerics who had studied abroad came home with new knowledge of the power that could be exercised with the help of documents. The custom of establishing proof on paper caught on among farmers during the Middle Ages, but not for maritime matters.

The city law of King Magnus decrees that written agreements should be drawn up when goods worth more than 10 mark were sold. Most sales of ships would come into this category, but unlike documents concerning land, such sales contracts were of little interest once the ship was too old for service. Accordingly, there is less chance of finding such letters. Even so, the number is remarkably small, and there is reason to suspect that the law was not always obeyed on this point. Moreover, no such ruling existed concerning ships sold outside the cities. When warships were built, the wages of the shipwrights were regulated, and it is probable that these wages express the price level also for merchant ships. There is a repair account for a warship preserved (see p 246) but no contracts for building merchant ships have survived, if they were ever drawn up. If we look in the written sources for the humble and peaceful trading vessels, they are hard to find, as mentioned earlier. What an old and hardworked merchant ship might look like can be deduced from the stratagem used by Hårek from Tjøtta to get past the fleet of King Knut in Øresund (Heimskringla, Saga of Olaf the Saint). King Olaf decided to abandon his ships in Scania, and travel overland to Norway, in order to avoid the fleet of King Knut. "Hårek answered: It is easy to understand that I cannot walk to Norway. I am old, heavy and not used to walking. Besides, I do not want to part with my ship." When Hårek passed King Knut's fleet, he had lowered the mast, taken down the weather vane and clothed the ship in grey canvas above the waterline. A few men rowed fore and aft, while the rest of the men hid by sitting low in the ship. The lookouts of King Knut's fleet guessed that the old grey untarred vessel carried salt or herring, heavily laden, but with a small crew. Other sagas contain similar descriptions, but there is not much in other sources. On the following pages, I have assembled what I have found in the 21 volumes of Diplomatarium Norvegicum of documents concerning ships. I have excluded the fairly common documents on fresh water fishing, and restricted my selection to documents older than 1500. I have also excluded the English customs rolls. They do contain valuable information about the cargoes carried and the names of ships and skippers, but they give little information on technical matters.

A letter dated Stavanger 5/4 1322 informs us that 11 men bear witness that Canon Eirik, on behalf of the brethren, sells the ship they got from Bishop Håkon to Bård at Hauge for 70 old mark (DN IV, 142). (This is not Bishop Håkon of Bergen, whom we will meet later, as he was not yet bishop at that time.) In 1399, 12/5, another shipping transaction was put on paper in Skien. Greip Ivarsson, the King's representative (*sysleman*) on the Faeroe Islands, buys a ship for 200 mark and 24 parcels of Faeroese wadmal. Included in the sale is one anchor of 12 *lispund* and a cable weighing 16 *lispund* (DN II, 559). (The *lispund*, originally a Baltic unit of weight, differed in West and East Norway. In the east, it is believed to be equal to 9.26 kg. This gives us a weight for the anchor of c 110 kg, and for the cable 148 kg.)

Another transaction was written down in Tønsberg 15/12 1333, when 4 men bear witness that Sir Guttorm Kolbjørnson bought "a ferry" of 8 lasts from Orm Smørsvein with sail, oars, an anchor weighing 7 *lispund* and all other equipment. The payment was in land (7 lispund = c 65 kg) (DN I, 226). One of the clergy bought himself 1/3 of a ship for 56 mark and had the transaction put to paper on 15/4 1407 (DN XI, 112). These letters are in all probability a result of the ruling in the city law that transactions of more that 10 marks value should be recorded in writing. In one instance, a ship is recorded as payment for one half of a tenement (*gård*) in Bergen. The ship is said to be of 6 lasts, "and stands in the boathouse at Fosse with all equipment" (DN II, 638, Nesviken 11/7 1416). In a letter written in Sarpsborg 23/1 1434, Eindride makes public that he has built "a ship of 16 lasts, and not otherwise". This may indicate that ship sizes were regulated even before the 1490 ruling (see p 257) (DN IX, 260).

In his testament, drawn up 20/5 1385, Ogmund Ogmundssøn gives land and goods to the church, for masses to be sung for his own and his wife's souls. Among the objects named are "one new seine and a six-oared boat" (DN XII, 115). One of the canons of Nidaros, Arnfinn

Petersøn, bequests his ship to the church, as payment for his burial place. The ship is named the "MOSSEIMS FERRY" and it is given with all equipment, using the Old Norse nautical formula *med rá ok reida* (ie with yard and equipment) (DN II, 305, 17/10 1349). Another Nidaros canon, Ogmund Olafsson, bequests three vessels in his will, drawn up 18/2–1381. "Also I give Ogmund Einarson at Berg the boat he gave me, with yard and equipment, and particularly two cables. Also I give to Hadsel church my ship, the largest, with yard and all equipment belonging to it. Also to Helga Pålsdatter the merchant-ship (*karve*) with yard and all equipment" (DN II, 468). Archbishop Arne Vade, who as a canon supplied mast timber to the bishop of Bergen (see p 249) also gave away a boat in his testament, drawn up 23/9 1349. "Also we give to Nikulas Kamp, our relative, our *karve*, which came from By, with the equipment that is now in the ship." (DN V, 212). One of the canons in Oslo, Guttorm Håvardsson, in his will drawn up 13/4 1331, bequests his ship to Asle, his relative, and Alf, his servant, with yard and all equipment. The ship is called "DRAGSMORKEN", perhaps being named after the well-known monastery at Dragsmark in Bohuslän. Maybe this is where the ship was built (DN III, 160).

When Bishop Aslak Bolt moved from Bergen to Trondheim in 1429, to take over the archbishopric, an inventory was drawn up of the goods he brought with him. Two vessels are named, a *snekke* called the "MONASTERY RUNNER", new, of oak, with all equipment, one other, called "THE CAT"(?) also with all equipment (DN V, 586). In 1531/32, an inventory was drawn up at Tautra Abbey near Trondheim (Nidaros). Tautra is on an island, so boats must have been absolutely necessary for the monks. The inventory lists two boats, one ten-oared, the other six-oared, both with equipment. In addition, the inventory lists one herring net of 24 fathoms (DN XI, 582).

When ships are mentioned in connection with Iceland, we can be sure that they were merchant vessels, probably with some passengers on board, as warships were never sent to Iceland by the Norwegian kings, as far as we know.

A Norwegian ship which arrived in Iceland in 1253 had a crew of 60 or 70 men, while another ship in 1258 had 100 men on board (Sturlunga saga). In 1412 a ship visited Iceland, and is described in the annals as a large Norwegian ship. It had 140 men on board (Nyi Annall, 292). (My thanks are due to Helgi Thorlaksson of Reykjavik for information about these sources.)

These sources provide glimpses of ships in a general way, but they do not deal with such details as the building, handling or selling of ships, nor with the freighting of cargo, which was the purpose for which most of the vessels were built. Even the clergy, well-trained in the use of written records, seem to have adopted oral agreement for maritime matters. The English customs accounts show that bishops and abbots did indeed own ships to a much greater degree than the few surviving Norwegian documents indicate, and they used them to trade overseas (Nedkvitne 1977). In this context, it is very fortunate that Bishop Håkon of Bergen was such a keen letter-writer, and that a large number of his letters are preserved. They give us a vivid glimpse of the shipbuilding activities of a member of the upper level in Norwegian medieval society.

Håkon Erlingsson is mentioned as canon in Bergen in 1319, but the year and place of his birth are not known. He became bishop in Bergen in 1332. In his later years his health was failing, and he probably died shortly after his last known letters, which were written at the end of May 1342.

Among his letters, I have selected for partial translation those dealing with shipbuilding. The letters were originally published by P A Munch with a modern Norwegian translation in "Samlinger til det Norske Folks Sprog og Historie vol 5". The letters are also in the Diplomatarium Norvegicum vol VIII. My translations were checked by Aslak Liestøl, to whom I am very grateful. Several of the letters which contain material on shipbuilding are written to Arne Einarsson, a canon in Nidaros.

In a letter of January 1st, 1338, the bishop thanks Arne Einarsson for the mast timbers, but does not know "how to get them here, as none of our own ships sail north, and the other ships sailing from here to Trondheim are mostly small, and can not take them, even if they wanted to." (DN VIII 102). The masts are mentioned again in a letter of May 25th, 1338 (DN VIII, 110).

On October 14th, 1338, Bishop Håkon writes to the bishop of Stavanger on various topics, and "in our great need beg you to sell us one last of iron for full payment". The iron may, of

course, have been intended for many uses, but as we shall see from a later letter, it may well have been intended for ships' nails (DN IX, 118).

A letter of March 21st, 1339, probably to Arne Einarsson, mentions that the Icelandic bishop has arrived as a passenger in Bishop Håkon's *buza* (DN VII, 162). A letter to the noble Bjarne Erlingsson, April 11th, 1339 contains, among considerations on politics, the information that "the boat that we have promised you, lies ready in our boathouse" (DN VIII, 118). On April 21st, 1339, Arne Einarsson is again asked for help with mast timber. "As we are called east to the king, there is urgent need for a mast for our own ship, that must at least be 49 ells to the cheeks. If it is possible for you to arrange it so that the mast can be taken to Kråkvåg, it can be shipped in our own vessel which will arrive from the north. We then know for certain that those men will bring it to us. But if there is a possibility for more masts, as we have written about earlier, we will gladly send our *karve* and men to fetch them. The mast that we last had when we were in Viken, broke, and it really looked bad (for the ship)" (DN VIII, 119). (According to Knut Helle, the last sentence may also be translated, "the last mast, which I had from Viken, was of bad quality". This does not affect the overall meaning – a new mast is needed.) P A Munch was in some doubt about the meaning of the sentence referring to the length of the mast: *er at minsta vildum ver at væra halft fimtugt ok iiij alna i kinnum*. He suggested that this may refer to both the mast and the ship, and divided *half fimtugt og iiij* into two measurements. He also maintained that *kinnum* must refer to the strongly curved ends of the ship. The result is a rather meaningless translation. I interpret the wish of Bishop Håkon as a log long enough to shape a mast "half the fifth ten plus four" (ie 49) ells long from the heel to the swelling around the halyard hole which may well be called the "cheeks". In 19th century maritime terminology, the heavy knees supporting the trestle-trees of a mast were called the "cheeks of the mast" (Harboe 1828). This is a long mast, and the Bishop's ship must have been a huge one. If we use the ell of 47.4 cm the mast must have been c 23 m long to the halyard hole, while if the length is calculated on the basis of the longer ell of 55.3 cm, we get a mast of 27 m.

On September 1st, 1340, a letter to another nobleman, Paal Eirikssøn, speaks of problems in shipbuilding. "This spring you asked for a *karve*. There is no possibility for that at the moment, and we are quite dissatisfied about that. However, if you will tell us, how large a *karve* you need, we will try to have one made for you, as soon as that one is ready, which we are now building for our own use. There is some lack of materials, as iron is very hard to get" (DN VIII, 131). Finally, on March 22nd, 1341, masts from Trøndelag are again in demand from Arne. "About the mast, of which you speak in you letter, we will write you soon, by the messenger of the arch-bishop. The mast should be two less than forty ells (ie 38) and if we will let ships be built in the future, we gladly take more than one (mast), and we will write about it soon" (DN VIII, 140).

We do not know if the copy book reflects all the correspondence of the bishop, but what we have, shows considerable maritime activity. Within a span of less than four years, the bishop orders masts from Trøndelag three times, speaks of his *buza* (buss) and his *karve*, delivers a boat to Sir Bjarne, builds a new *karve* for himself and promises another to Sir Paal.

It is not possible to decide for certain where Bishop Håkon had his shipbuilding activities. The bishop's palace, at Holmen, seems to have had its boatsheds, *naust*, on the north side (Helle 1982, 284) but there was probably not room there for building larger ships. Ships were beached and sold on the open shore at *Strandsiden* across Vågen from Bryggen. This is also a likely place for shipbuilding. Another possibility is that the bishop's ships were built on one of the farms near Bergen that belonged to the bishopric. However this may be, Bishop Håkon stands out from the letters that we have as a person who was unusually active in maritime matters. I do not think that his activities were exceptional, but in other cases our sources for the maritime activities of the upper classes in society are less detailed.

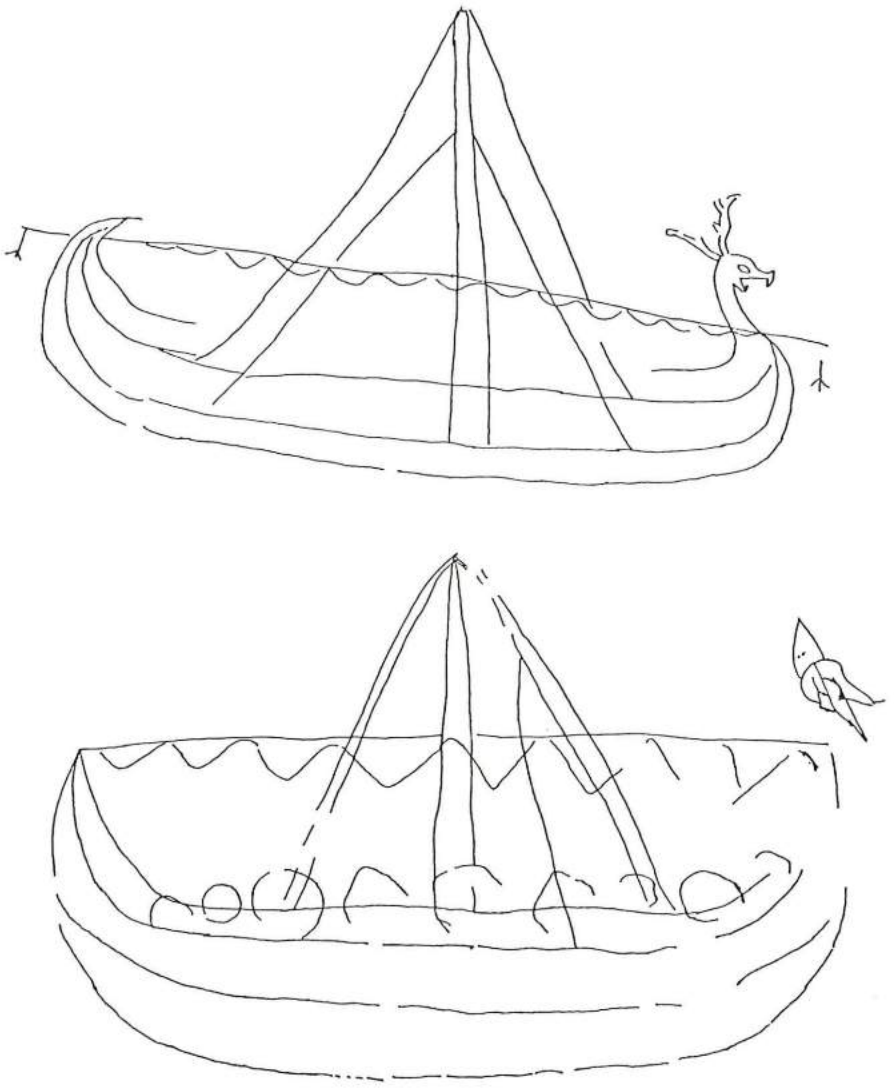


Fig 17-1 Even far inland, people carved ships, as on this stone from Gauldalen in Trøndelag. The ships are probably of early 11th century date. (After Stalsberg Alsvik 1973)

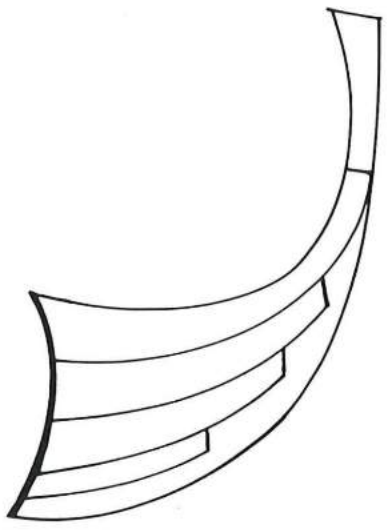


Fig 17-2 In Codex Regius, written in Iceland c 1270, the scribe has sketched a stem in the margin, clearly indicating the characteristic details of a winged or stepped stem. Enlarged sketch by A E Christensen

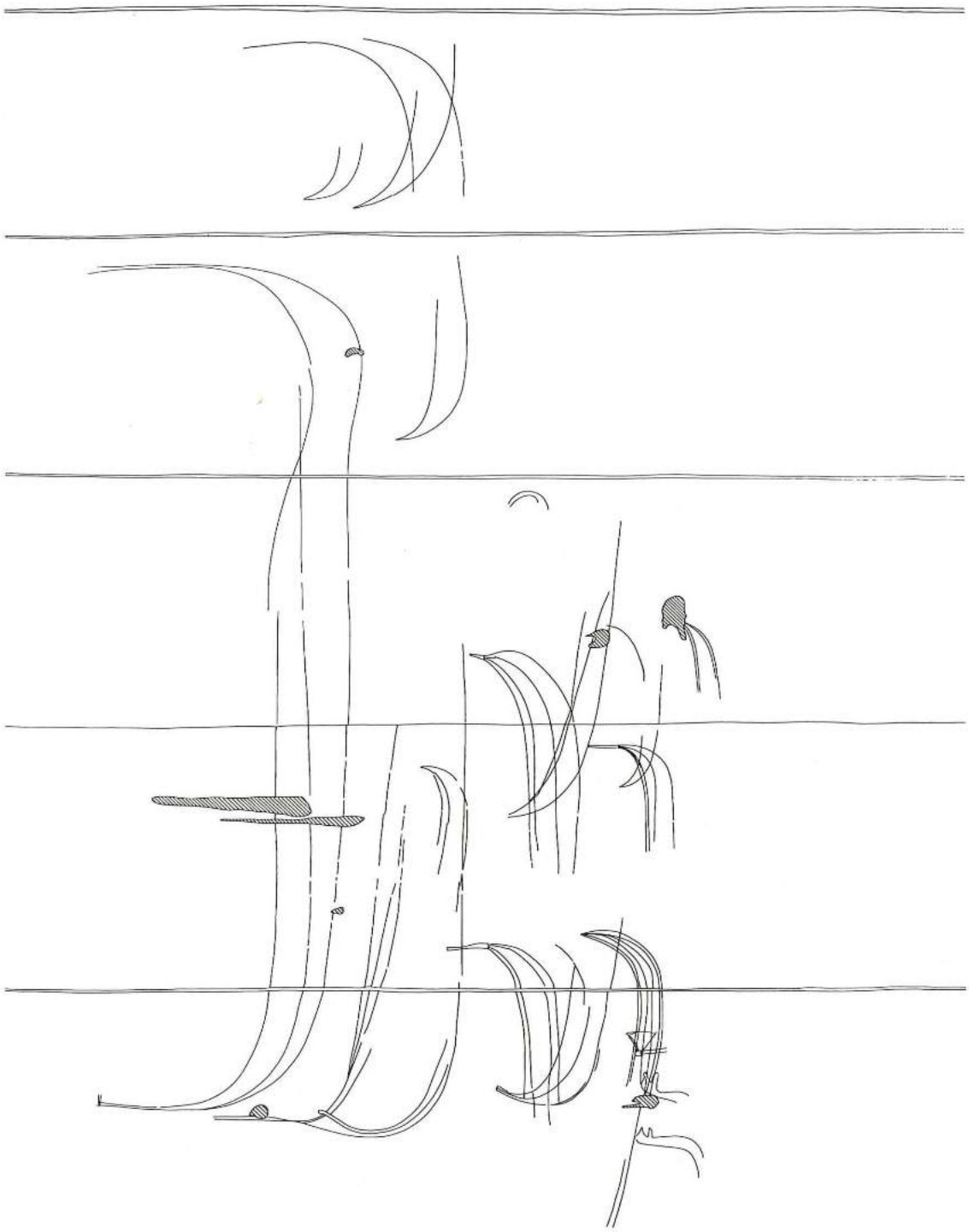


Fig 17-3 Among the motifs found in Stave Church carvings, ships are common, but generally only one stem is indicated. On the wall of Fantoft (Fortun) church we find this fine collection of ships

Fig 17-4 Ship carved on a piece of waste wood, from medieval layers in Tønsberg

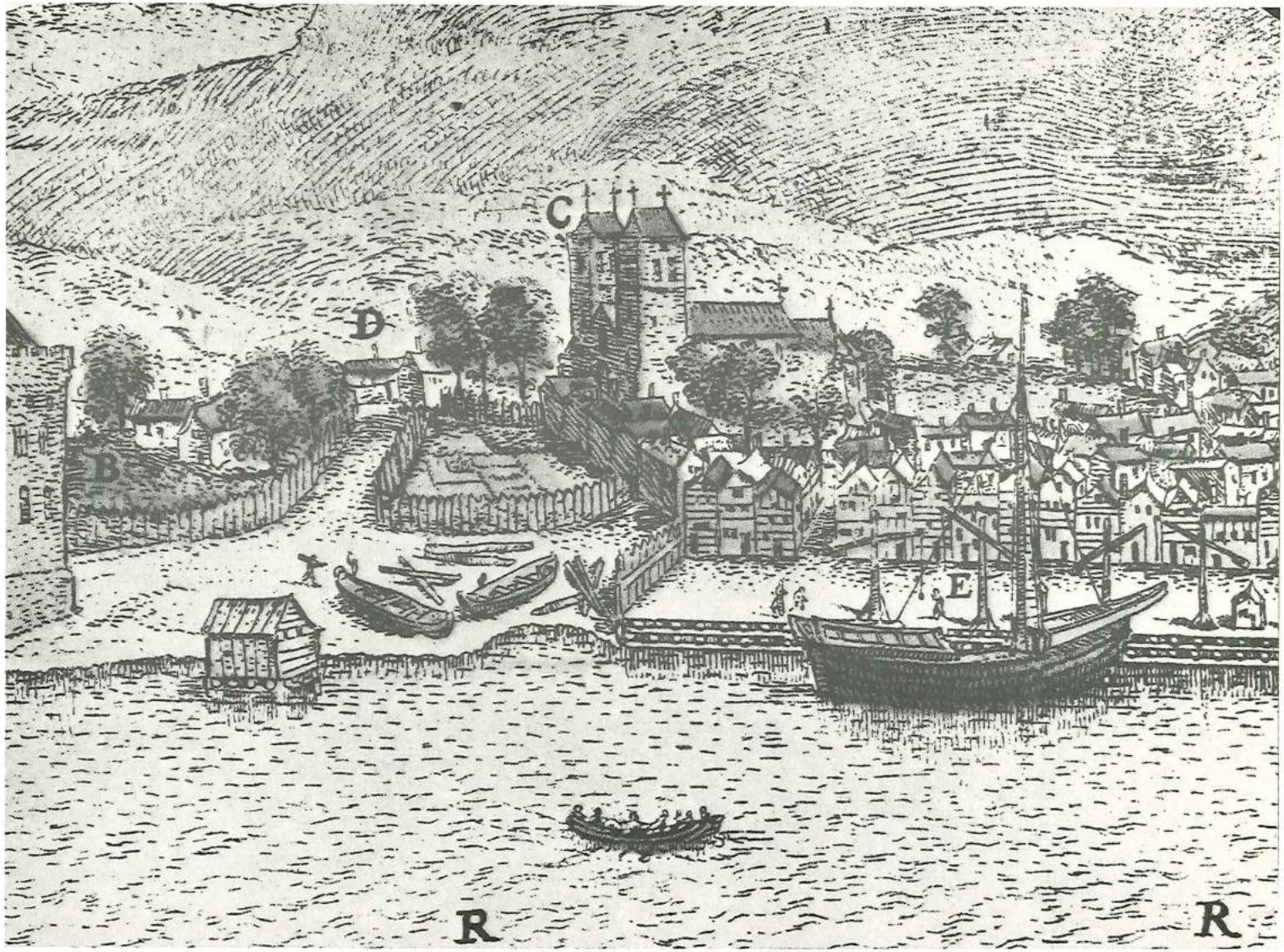


Fig 17-5 Detail of Scholaeus' print of Bergen, showing boats being built or repaired at "Brabenken"

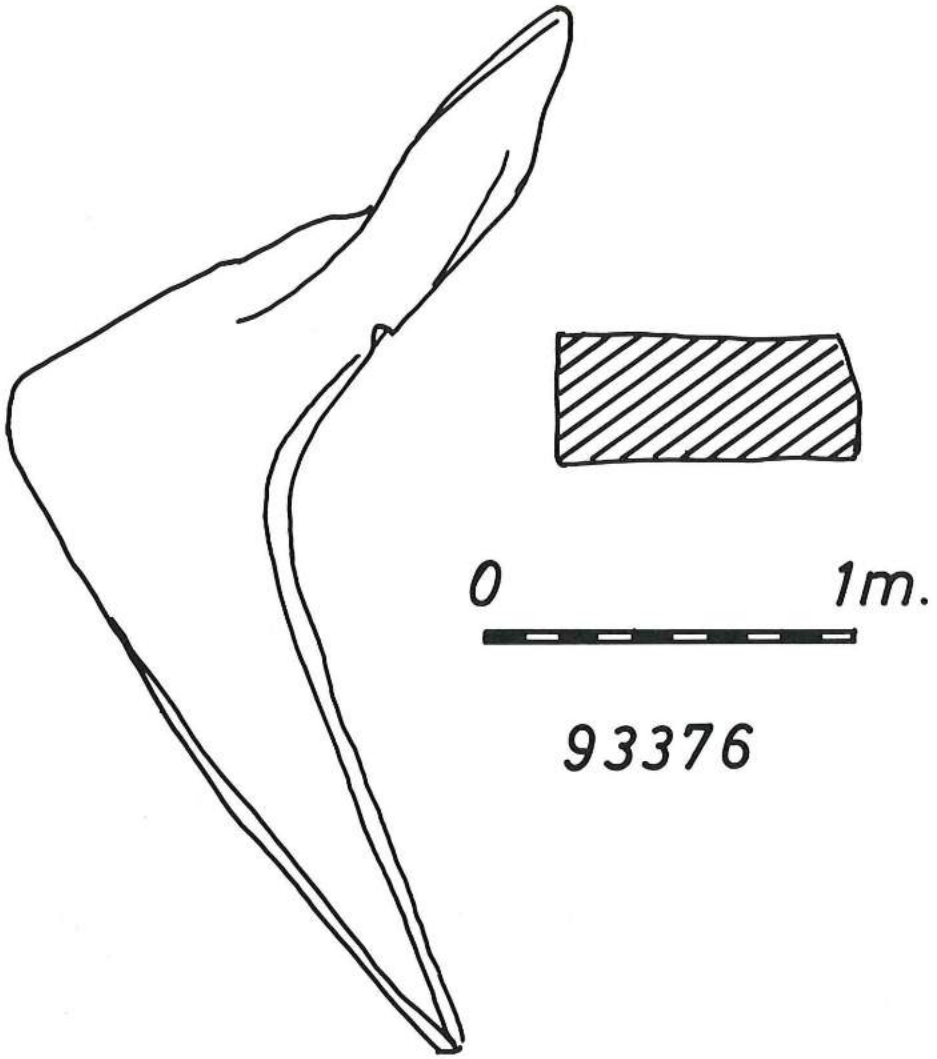


Fig 17-6 Large unused knee from Bryggen, probably intended for shipbuilding or repair

WHO BUILT, OWNED AND USED THE SHIPS OF WHICH FRAGMENTS WERE FOUND AT BRYGGEN?

In 1864, C F Diriks, Director of the Department for Lighthouses, wrote the first survey of the various boat types in use in Norway. He marvels at the number of boats which were necessary along the long Norwegian coast, for fishing, travel and transport in a practically roadless country. In Diriks' days, 6000 boats took part in the spring herring fisheries alone. "There are various reasons why we find such an enormous number of different boats. The real number, if it was possible to give it accurately, would appear impossible. Even the poor man on the coast has his boat - he cannot sustain himself without it. In some parts of South America there is such an abundance of horses that you might meet a beggar on horseback - in Norway you might find him in his boat". (My translation.) The population of Norway in the mid 19th century was larger than that of the Middle Ages, and the large herring fisheries belong to a more developed economy than was found in the medieval period, but there can be no doubt that the need for boats on the coast was as acute in earlier times as in the 19th century. Any dweller on the coast, fisherman or farmer alike, had to have a boat. In Bergen city, it must have been possible to survive without a boat, but it is highly probable that many of the city dwellers owned boats, just as they did in later centuries. The ownership of the small and medium-sized freighters is less easy to establish. They must have been numerous, and were distributed all over coastal Norway. The local trade to Bergen in the Middle Ages, as later, must be divided in two. Firstly, there was the North Norwegian fleet which brought the stockfish, once or twice in summer, and took back salt, grain, hemp, iron, cloth and a few luxuries to the fishing districts. Secondly, we have the coasters from Western Norway, which also carried fish, but their cargo to Bergen was mainly what the city itself needed in the way of timber, firewood, tar, birch bark, meat, butter, tallow and other produce of farm and forest. Their return cargo consisted of the same necessary items that went to Northern Norway.

Medieval literature has provided us with a vivid glimpse of the harbour of Bergen shortly before 1200 in the story of "The journey of the Danes to Jerusalem" (author unknown, modern Norwegian transl A Salvesen). "Many people live there, and the town is rich and has an abundance of many things. Of dried cod, which they call *skrei*, there is so much that it cannot be counted or measured. Ships and men come there from all directions, Icelanders, Greenlanders, Englishmen, Germans, Danes, Swedes, Gotlanders and other nations that we cannot name here, all can be found if one takes the time to look. There is plenty of wine, honey, wheat, good clothes, silver and other merchandise, and a lively trade with all kinds of goods". In this milieu of local and international exchange we must place our small coasters, among people who were probably farmers, fishermen, sailors or merchants as the occasion demanded. Their vessels had probably been in good use for a long time before ending at their final resting place as part of the foundations at Bryggen. Medieval laws indicate that some shipowners used their vessels too long; "A ship which requires bailing three times in the course of 24 hours will be declared seaworthy for all kinds of traffic; but if they so wish, the crew can entrust themselves to a ship which requires more frequent bailing. But if the steersman lets the ship be bailed at night, concealing this from the crew, such action shall amount to treason towards the crew, and the steersman shall be responsible for any damage or injury resulting from that, regardless of whether it affects men or cargo or both, for every man must pay for his own dishonesty" (from the city law of King Magnus "the lawmaker" 1276). There was even a "plimsoll mark" of a kind. In the Icelandic lawbook known as Greygoose, chapter 166 states: "A ship is loaded according to Merchant Law when it is divided into five parts, three below and two above the sea amidships". Many of the small coasters, probably most of them, would have been owned outside the city, and their main purpose would have been to serve the trade between Bergen and the rural districts.

The few large ships represented in the material may, of course, also have been used in the stockfish trade from Northern Norway, or for bringing large mast timbers from Trøndelag, but it seems more probable that they were mainly used for more long-distance voyages. Who owned these ships? Who handled the trade abroad? It is well known that the king, the

archbishop and members of the secular and spiritual nobility got their dues and taxes in all kinds of goods, and that the surplus was converted to cash by active trade. A look at the English customs rolls shows that ships with names like "THE BISHOP'S BUSS" traded regularly between Norway and England. Out of the 47 named Norwegian ships which visited Lynn in the early 14th century, at least 10 were owned by the Church. Two belonged to high noblemen and at least one to the Crown. The information about cargo indicates that some of the ships were of considerable size (Helle 1982, 398, Nedkvitne 1977 and 1978).

Men other than the bishops and nobles may also have traded with big ships, forming temporary companies, *felag*, for each trip. This trade was based on a system that is older than the development of towns in Scandinavia, a system that has lived on to this day for small-scale trade. The Old Norse name for a merchant, *farmann*, means literally travelling man, implying that the aspect of travel must have been important for all early trade. That this is not a Scandinavian speciality has been shown by Ellmers (1972), who uses the phrase *Wanderhandler* for the travelling merchants, and stresses that they could live in the cities as well as in rural districts.

The system is not well documented in the sources, and is best known from the decrees given to abolish it. (For a general survey, see Hasslöf 1966 and 1980.) In medieval society, this kind of trade seems to have been organized in the following way: One or more men, who owned a ship, made public their intention to make a voyage of trade, probably to a well-known marketplace at home or abroad. Other men, with goods to sell, joined in, and were allotted part of the cargo space in return for serving as crew members on the voyage. In the phrasing of the Frostating laws: "Now, when a man makes a merchant vessel ready in his own *herad* and people take freight with him, he should make it so, that there is room for all who have taken freight. Now, if the ship is too heavily laden, the steersman (presumably the ship-owner) should take his goods ashore first, while those who have hired freight-space shall keep it. But if they think that the ship is still too heavily laden, then those who took freight last shall take their goods ashore, until the ship is seaworthy. Then he shall pay those who took goods ashore as he has broken the agreement." (Frostatingslov, kjøpebolken, kap 24, translated from Taranger's modern rendering.) Alternatively, the shipowner or his appointed "steersman" might act as an agent for people who could not themselves take part in the trading voyage. The shipowner would then find a crew and pay for their services. I believe that the runic "labels" found in great number at Bryggen (Liestøl 1964) reflect such commissions. Of the about 80 labels, most give the name only, but two state that "Ragnar owns this yarn" and "Solveig(?) owns these threads, weighing 4 1/2 mark". If many different people sent their goods to Bergen to be sold without travelling themselves, it must have been a great help for the steersman that the goods were labelled. When the large *jekts* from Nordfjord took a cargo of firewood to Bergen around 1900, pine branches or bast ropes were used to divide the wood belonging to different people (Henden 1971, 28, Aaland 1926).

Helle is of the opinion that Bergen in the Middle Ages had a group of professional sailors, who skippered and crewed ships which sailed with the cargoes of merchants who did not operate on the *felag* principle at sea (Helle 1982, 403). In some cases the English customs rolls indicate that one of the clergy skippered a vessel for his church or monastery, in other cases, a professional skipper was entrusted. When Øyvind Bonde hired the ship of Bishop Håkon in 1341 we do not know whether he intended to sail himself as a skipper, but he evidently had so much freight that he intended to fill the cargo space, either alone or with his *felager*. We know this, as Bishop Håkon had to excuse himself to the high noble Erling Vidkunnson, who could get no room for his wares in the ship. The end of the long line of development, today's shipowner who does not travel himself and handles the goods of merchants who also stay on shore, probably did not exist in the Middle Ages, but there must have been some companies with both active and sleeping partners. The common law of Magnus rules that one man may run a ship for the *felag* if the others will not participate actively, and the parts cannot be sold to others (NGL II, 161).

The great landholders, the Church and the nobility, would rather have tenants who obediently tilled the land and paid their dues, than independent travelling merchants, who were more difficult to control. The system of shipping and trade which they tried to abolish, was

based on free individuals joining forces in an egalitarian company, contrary to the hierarchic structure favoured by those who were already on the top of medieval society. The first attack on free trade from the upper levels of society is found in the introduction to the Frostating Laws, in a "law-amendment" by Håkon Håkonsson from 1260: "Now, as labourers are very hard to get in the country and all want to go trading, we will totally forbid that any man travels as a merchant if he owns less than three marks of silver. This ruling is in force from Easter to Michaelsmas each year. But from Michaelsmas and all winter he may travel as he wants with what God has lent him, be it more or less. But steersmen who take on board men with less goods than stated, will be fined two *øre* silver to the king for each, and also for each who makes company with them" (NGL I, 125, translated with support in Taranger's modern rendering).

This contrasts sharply with an insert in the older Gulating Laws, said to have been given by King Magnus the Good (1035–47) and renewed by Håkon Toresfostre (1093). "Any man shall use his own ship in full peace, and travel wherever he wants." This may be a ruling counteracting a royal decree restricting shipping in wartime, but it shows that at that time, there were no restrictions to maritime trade in the laws. When the restrictive line was adopted in 1260, there was no question of loosening the ties again. The ruling is repeated in the general law of Magnus the Lawmaker of 1276, and the city law of the same year. It is again repeated in a "law amendment" of 8/3 1364. A new law amendment, in 26/8 1383 stipulates the necessary money for merchants as 15 *forngilde mark* and adds that "no one shall build any merchant ship and sail north in the country or to the 'taxlands' (ie Isle of Man, Hebrides, Orkneys, Shetland, Faroe Islands, Iceland, and Greenland which were not part of Norway, but paid taxes to the king) unless he has this amount of money".

The letter given by King Erik on August 29th, 1421 repeats the decree, without stating the necessary sum in detail.

On 4/12 1490 the king's counsellors were assembled in Oslo for a meeting and discussed, among other problems, "the common and deplorable custom, that peasants sail abroad with their own large ships, freighting timber and boards, salt and other merchandise, against law and privileges." As a result, the nobles maintained, farmland lay waste and dues were not paid. A decree was issued, that no peasant should own and use large ships, but only boats of three to four lasts, for coastal traffic (Hasslöf 1980, 28ff).

When the town privileges of Skien were renewed in 1548 by King Frederik II, it is said that "the farmers resident around the City practise shipping and trade and even have larger ships built than the law book permits." Part of the privileges were that "No farmer shall build or keep larger ships than the law book permits, nor practise any kind of trade that is found to be contrary to these privileges".

The ruling about the size of ships does not apply to the period covered by the Bryggen finds, but the letter of 23/1 1434 (DN IX, 266) which gives public notice of the size of a new ship, may indicate that there were some size restrictions in force also before 1490. However, the expense of building such large ships, coupled with the regulations about merchants' property, are strong indicators that the large ships found at Bryggen would have been owned by rich and powerful members of society. They may have been merchants resident in Bergen, or nobles who divided their time between a house in the city and a country manor.

Centres of Shipbuilding

When we come to the question of where ships were built, and whether the owners were from the city or the rural districts, we have few definite sources.

The crosspieces from boatbuilders' clamps do, however, indicate that boats were built or repaired in Bergen, close enough to Bryggen for discarded tool fragments to end up in the debris used as fill in the new quays. The huge, unused knee 93376 (fig 17-6) is another indication, this time of plans to build or repair a large ship, where this knee was never used, even though it was shipped to Bergen and roughed out. The large ship which Håkon Håkonsson used as his flagship on the trip to Scotland in 1263 was "built in Bergen" according to the saga. This was also the case with "MARIASUDEN", a dragonship of 30 rooms which was given as a present to the Danish king. Between Bryggen and Bergenhus Castle, there has been an open stretch of beach, known in later centuries as *Brabenken*. The name is probably derived from

bre or *breie* in the meaning "to smear with tar". Here, ships and boats have been repaired and built for centuries. On the well-known 16th century print by Scholaeus (fig 17-5), beached boats and men at work can be seen in this part of the town. As seen earlier, it is also probable that the open stretches of beach on *Strandsiden* were used for shipbuilding as well as for beaching ships for maintenance and repairs, or for winter storage. These sources, archaeological, iconographic and written, shows that shipbuilding was practised in Bergen, the medieval capital of Norway, or just outside the city limits. In spite of this I would postulate that the building of ships and boats in clinker technique has mainly been a rural craft, both in the Middle Ages and later. Even when practised in cities, boatbuilding as a craft was rural in character. It is never said directly in the royal decrees, that ships shall be built in allotted places, and the royal decree of 1282 on craftsmens' wages in Bergen does not mention shipbuilders, even though both house carpenters and tarrers have their wages regulated. In later centuries, boatbuilders have either been itinerant craftsmen, who had the customer as unskilled help and expected him to supply the timber, or else resident in a "craftsman community" specialising in boatbuilding (The phrase "craftsman community" was coined by Robert Kloster in order to describe a district where a large number of the households manufactured objects for sale to augment the income from smallholdings. The goods differed widely and might include barrels, boats, wooden spoons, blacksmiths' goods and household tinkerwork. The common factors are the skills shared by many people living close together and, in most cases, a good local supply of the raw material needed, ie wood.) Well known boatbuilding communities in Western and Northern Norway in later centuries were Hardanger and Sunnhordland, Gloppen in Nordfjord, Bjørkedalen in Sunnmøre, Åfjorden in Trøndelag and Rana in Nordland. Some of them are known as boatbuilding centres at an earlier date, because they happen to be mentioned in written sources. A boat from Sunnmøre is mentioned in a letter from Esge Bilde, commander of Bergenhus Castle, to the archbishop in 1536 (DN XII, 566). The trade in boats between Sunnhordland and the Scottish Islands is well known (Thowsen 1970). Both in the case of the itinerant boatbuilder and the "boatbuilding community", the key word is wood. Even in the 19th century, when carvel shipbuilding had long been established for large ships, and most of the coastal towns had shipyards, a large amount of the ships making up the Norwegian merchant fleet were built outside the cities, as were nearly all small boats. For building ships like the brigs and barques for the trade to Britain in the late 18th century, the main requirements were a piece of ground sloping towards to sea, and plenty of timber nearby. Many such "yards" built only one ship, and even where several vessels were built in the same place, the only permanent structure was the hearth for the pitch kettle. Medieval shipbuilding had even less need for permanent structures. Some sleepers for the keel (ON *bakkastokkr*) were all that would be left of a shipyard after launching. It is significant that when the sagas talk of ships being built in the cities, they are unusual vessels, built for special purposes, under the eyes of the king or nobleman who ordered them, probably by a famous shipwright called in to do the job. The huge vessel of Håkon Håkonsson has already been mentioned. Another case are the three ships built in Tønsberg in 1206, a time of war and busy shipbuilders. These were experimental vessels, with two banks of oars. The sagas never mention them again, so they were probably not successful. The sources show that shipbuilding did occur in the medieval cities, including Bergen. The king frequently used Bergen as his town of residence. This, in combination with the great demand for tonnage for overseas travel, may have given shipwrights in Bergen more experience than others in building large ships. There must have been a steady demand for repair work on both small and large vessels. In spite of this we should still, I think, place most of the shipbuilding activity outside the cities, spread out along the coast. The finds of unfinished oaken stems and keels on islands outside Bergen show that parts of the coast that are today practically treeless, must have had boatbuilding timber in the Middle Ages. Nevertheless, it is tempting to postulate that boatbuilding centres were in existence, based on well-forested districts in the inner fiords, then as later. I would suggest that most of the fragments of vessels found at Bryggen are remains of boats and ships built in the rural districts, by boatbuilders who had customers in the city as well as among fishermen and *far-*

menn. It is also possible that famous shipbuilders were called to Bergen to build special ships, like the stem-cutter of "THE LONG SERPENT" Thorberg, who according to Snorre had to leave the work for some time to go home to his farm. Evidently, he was not a city dweller.

We have followed the fragments of ships and boats from Bryggen through description and discussion, related them to written and iconographic sources, and have reached some conclusions. The final conclusion must be that the fragments reflect a very active maritime life in Bergen and the surrounding districts. Few pieces seem foreign. Most of them correspond with our picture of West Norwegian shipbuilding through the ages. The most common material used is pine, but some oak is found. The technical solutions are paralleled in other West Norwegian finds, the same elegant mouldings and good workmanship is represented in medieval houses, both those found in the Bryggen excavation, and the few still standing in the districts around Bergen.

LIST OF FINDS

The following list of finds includes all the boat timbers from Bryggen that have been identified during the excavation, mainly by Egill Reimers, and checked by me, and the small fragments identified by me in the storerooms. A few timbers are uncertain as ships' timbers, but most of the identifications are secure. The list is based on the running list of finds kept during the excavation. This has been computerised, so that it is possible to get a computer list of all boat finds with more detailed information on find spot and stratigraphic situation. A list with all information included would be very heavy reading, and the present list is simplified considerably. Nevertheless, I have found it to be of value to publish this list for the following reasons. It gives an overall view of the material, makes it easier to see how groups of timbers were found together, and contains find-spot information which then could be excluded from the systematic tables presenting each group of material. The following information is included:

Find-number
Identification of object
Grid-square
Find-spot within the grid-square

The tenement (Norw *gård*) is given in abbreviated form. The Southern or Northern row of buildings within each tenement is given as S or N Bug = Bugården, Eng = Engelgården, Søsg = Søstergården, Gsk = Gullskoen, Bredsg = Bredsgården. Within the tenements, the object may be found in filler layers of earth and debris, in foundations, within a building, or in the streets separating the buildings. In addition to streets which include the passage ("passasje") separating the two rows of houses within the tenement and the wider public throughfare ("almenning"), we have the so called eaves ("veit") between the different tenements.

Date
This is given relative to the fires, based on the official chronology of the excavation. AF = after fire BF = before fire IF = in fire or contemporary with the fire level as numbered

Number	Object	Square	Find situation	Date
1115	Rowlock	G12	Bug S	BF 2
1357	Belaying cleat	L12	Bug in "veit"	AF 3/AF 2 ?
1801	Tholepin	G12	Bug S foundations	BF 4
1840	Rowlock	G12	Bug S foundations	AF 4
2823	Tholepin	H12	Bug S foundations	
3836	Rowlock	K12	Bug S foundations	BF 4
4124	Floorboard lath	I12	Bug S in house	AF 5
4127	Model mast	I12	Bug S in house	AF 5
4665	Rudder boss	I12	Bug S in fill	BF 5
4826	Knee	I12	Bug S in fill	BF 5
4903	Rowlock horn	I12	Bug S in fill	BF 5
4976	Knee	G11	Bug/Eng "veit"	BF 1
5042	Parrel	L12	Bug S	IF 5
5066	Model stem	L12	Bug S	BF 4
5442	Rowlock	I12	Bug N	BF 3
5719	Rib fr	F11	Bug N	BF 2
5753	Belaying cleat	H11	Bug N	IF 4
5968	Floorboard	K11	Bug N in foundations	AF 4
6850	Rowlock	F11	Bug N in "veit"	AF 4
6866	Rowlock	K11	Bug N	BF 4
6989	Rowlock	H11	Bug N passage	AF 4
7272	Rowlock	G11	Bug N	BF 3
7278	Rowlock	G11	Bug N	BF 3

Number	Object	Square	Find situation	Date
7501	Model bailer	K11	Bug N in foundations	IF 4
7771	Knee	F11	Bug N	
8035	Ribfr	F11	Bug N	AF 3
8256	Model stem-top	K11	Bug N	IF 4
8618	Model stem-top	F11	Bug N	BF 3
8697	Parrel	I11	Bug N	
8705	Knee fr	K11	Bug N in house	AF 5
8779	Model stem-top	G11	Bug N	BF 3
8905	Floorboard	I11	Bug N	BF 4
8929	Clamp crosspiece	H11	Bug N foundations	BF 4
9260	Floorboard	I11	Bug N foundations	BF 4
9277	Model stem	I11	Bug N foundations	BF 4
9279	Parrel	I11	Bug N foundations	BF 4
9829	Fairlead	K11	Bug N in fill	c 1170/1200
10082	Model boat fr	K11	Bug N foundations	BF 5
10257	Floorboard	I11	Bug N foundations	BF 5
11654	Rowlock	I11	Bug N	BF 6 ?
11722	Rope-end toggle	G11	Bug N	
12085	Fairlead	G11	Bug N in fill	BF 4
12368	Rowlock fr	H11	Bug N foundations	BF 4
12574	Parrel	G11	Bug N foundations	BF 4
12820	Rowlock	G11	Bug N foundations	BF 4
14065	Mast step?	K10	Eng S	BF 4
14261	Bailer	L10	Eng S in passage	BF 4
15298	Fairlead	K09	Eng N	BF 3
15810	Rowlock	K&I10	Eng S in fill	AF 5
16473	Parrel	L10	Eng S in fill	BF 5
16560	Fairlead	K10	Eng S	BF 5
17307	Rowlock	F11	Bug N	?
17436	Parrel	K09	Eng N	BF 5
17545	Model boat	L09	Eng N in house	BF 5
17536	Two fairleads	K10	Eng S in foundations	BF 5
17748	Rowlock	L12	Bug S	BF 5
18013	Bailer	L10	Eng S	BF 6
18067	Floorboard fr	L12	Bug S	AF 6
18417	Rope cleat	L10	Eng S	BF 5
19049	Rib fr	K10	Eng S in foundations	BF 5
19118	Rowlock	K09	Eng N	AF 5 ?
19133	Rib fr	K10	Eng S	BF 5
19372	Model mast	K09	Eng N	BF 5
19377	Rope-end toggle	K10	Eng S	BF 6 ?
19707	Floorboard	L08	Søsg S in foundations	AF 4
19732	Model stem-top	K&I09	Eng N in quay	BF 5
19733	Rib fr	K09	Eng N in quay	BF 5
20661	Model mast	L10	Eng S	BF 6
23086	Model mast	K09	Eng N in fill	BF 6
25547	Model stem	K05	Gsk passage	AF 3
25959	Parrel	K08	Søsg S	?
26836	Rope-end toggle	K06	Gsk S	BF 3
26924	Mould for vane	K07	Søsg N in foundations	BF 3
27250	Strake fr	L06	Gsk "almenning"	BF 3
27588	Rope cleat	K06	Gsk S	AF 4
28140	Rib fr	K07	Søsg N in foundations	AF 4
28450	Bailer	H04	Gsk N	BF 3
28569	Floorboard	K07	Gsk "almenning"	BF 4
29243	Parrel	K06&07	Gsk "almenning"	AF 3
29587	Floorboard	L05	Gsk passage	BF 4
29621	Floorboard	L07	Søsg in fill	BF 5
29629	Rowlock	K06	Gsk "almenning"	AF 5
29663	Knee fr	K07	Gsk "almenning"	AF 6
29674	Model stem	K06	Gsk "almenning"	BF 4

Number	Object	Square	Find situation	Date
30005	Fairlead	L05&06	Gsk S in fill	BF 4
30166	Strake	K06	Gsk S	AF 6
30341	Knee fr	K07	Søsg N in fill	AF 4
30518	Rowlock	K07	Søsg N in fill	AF 4
30828	Rope-end toggle	K07	Søsg N in fill	AF 4
30891	Model bollard	K06	Gsk "almenning"	AF 4
31091	Floorboard	L07	Søsg N	BF 5
31234	Boat model	K04	Gsk in "veit"	BF 4
31351	Rowlock	K05	Gsk passage	AF 5
31475	Strake fr	K04	Gsk N	
31397	Floorboard	L05&06	Gsk S	BF 5
31619	Rowlock	L07	Søsg N	BF 5
31699	Rib fr	L06	Gsk "almenning"	IF 6
32115	Floorboard	L06	Gsk "almenning"	BF 4
32246	Floorboard	L05	Gsk S	BF 5
32778	Parrel	K05	Gsk passage in fill	AF 5
33062	Strake fr	K&L06	Gsk "almenning"	IF 6 ?
33775	Rowlock	K&L08	Søsg S	IF 6 ?
33813	Knee fr	K&L08	Søsg S	IF 6 ?
35411	Rope-end toggle	L08	Søsg S	AF 5
35793	Rowlock fr	L08	Søsg S	BF 6
35884	Fairlead	K05	Gsk passage	
36344	Rib fr	K04	Gsk "veit"	BF 4
36365	Rib fr	K04	Gsk "veit"	BF 4
36429	Rib fr	K05	Gsk in fill	BF 4
36558	Block sheave	N06	Gsk "almenning" in drain	BF 2 ?
37029	Headbeam fr	I05	Gsk in foundations	BF 3
37109	Clamp crosspiece	I05	Gsk in foundations	BF 3
37690	Rib fr	H05	Gsk "veit"	BF 4
37787	Strake	I05	Gsk in foundations	BF 3
39606	Model stem-top	O05	Gsk in fill	BF 2
39900	Boat model	N05	Gsk	BF 3
40029	Oar	N05	Gsk	BF 3
40048	Strake fr	N05	Gsk	AF 3
40230	Rib fr	N06	Gsk "almenning"	BF 3
42309	Rowlock	M05	Gsk in fill	BF 5
42665	Rib fr	O05	Gsk in fill	BF 5 ?
42666	Rib fr	O05	Gsk in fill	BF 5
43043	Floorboard	M05	Gsk	AF 7 ?
43049	Rowlock	M06	Gsk in fill	BF 5
43433	Strake	O06	Gsk "almenning" in fill	BF 6
43563	Model stem	N05	Gsk "almenning" in fill	AF 6
43681	Rowlock	M05	Gsk in foundations	BF 6
43952	Rib fr	M05	Gsk in foundations	BF 5
44136	Clamp crosspiece	M05	Gsk in foundations	AF 4
44145	Fairlead	M05	Gsk in foundations	BF 5
44353	Clamp crosspiece	M05	Gsk	AF 6 ?
44618	Rope cleat	O05	Gsk in fill	AF 6
44727	Rope cleat?	N05	Gsk	AF 6
44760	Model stem	N05	Gsk	AF 6
45382	Rib fr	N06	Gsk in fill	AF 6
45510	Rope-end toggle	M06	Gsk in foundations	BF 5
46184	Rowlock	N05	Gsk in fill	BF 6
46730	Rowlock	M05	Gsk in fill	BF 6
46763	Rib fr	N06	Gsk in fill	BF 6
46821	Rib fr	N06	Gsk in fill	BF 6
49846	Strake fr	L04	Gsk in foundations	BF 2
49955	Rope-end toggle	N03	Gsk	IF 3
50131	Mast rib	O04	Gsk	AF 4
51628	Model parrel	O04	Gsk in building	BF 3
51681	Fairlead	M04	Gsk in building	BF 3

Number	Object	Square	Find situation	Date
52491	Knee fr	N03	Gsk in building	BF 5
52670	Strake fr	L05	Gsk in foundations	AF 5
52751	Rowlock	M04	Gsk in foundations	BF 6
53232	Rowlock	L04	Gsk	AF 5
53392	Rowlock	L04	Gsk	BF 4
53416	Rowlock	N03	Gsk in fill	BF 5
53582	Parrel roller?	N03	Gsk in fill	BF 5
53932	Rowlock	M04	Gsk in fill	BF 5
53960	Strake	M05	Gsk in fill	BF 5
54083	Bailer	K04	Gsk in foundations	BF 4
54401	Strake	K05	Gsk in fill	BF 4
54420	Model stem top	M04	Gsk in fill	BF 6
54503	Rowlock	N04	Gsk in fill	BF 6
54550	Fairlead	M03	Gsk in fill	BF 5
54563	Rowlock	M03	Gsk in fill	BF 5
54673	Parrel	L05	Gsk in fill	BF 5
54768	Model boat	N02	Gsk in fill	BF 5
54773	Rudder boss	M03	Gsk in foundations	BF 5
55107	Strake	N03	Gsk fill in house	BF 6
55221	Floorboard	N03	Part of square mrk L fill	BF 6
55519	Bailer	L04	"mrk" E	BF 5
55630	Rowlock	M05	Gsk fill in quay	BF 5
56159	Strake	M05	Gsk fill in quay	BF 6
59021	Block sheave?	O04	Gsk in "almenning"	c 1415–20
59923	Floorboard	P04	Gsk in fill	AF 3
61057	Parrel	P03	Gsk in fill	AF 4
61164	Knee	P04	Gsk in fill	BF 4
61820	Floorboard	O03	Gsk fill in building	AF 5
61906	Bailer	P02	Gsk fill below building	BF 4
62791	Rowlock	P03	Gsk	BF 5
62800	Floorboard	P03	Gsk	BF 5
62915	Floorboard	O02	Gsk in fill	BF 4
63307	Floorboard	O02	Gsk	IF 4
63473	Knee	O04	Gsk in fill	BF 5
63583	Clamp crosspiece	P04	Gsk in fill	AF 6
64308	Boat model?	P04	Gsk in fill	AF 6
64497	Strake?	N02	Gsk	BF 6 ?
64647	Floorboard	O03	Gsk in house	BF 6
64823	Knee	P03	Gsk loose find	BF 6
64924	Floorboard	P03	Gsk in building	BF 5
64925	Floorboard	P03	Gsk in building	BF 5
68342	Parrel	Q03	Gsk in fill	BF 2
70401	Bailer	Q03	Gsk in foundations	AF 4
70643	Strake	Q02	Gsk	BF 3
72062	Strake	Q02	Gsk	AF 4
72063	Strake	Q02	Gsk	AF 4
72064	Strake	Q02	Gsk	AF 4
72760	Model boat	R02	Gsk	IF 5 ?
73218	Strake fr	P02	Gsk	BF 3
77565	Rowlock?	N02	Gsk in fill	BF 6
78104	Rowlock	M04	Gsk in fill	BF 5
78105	Rowlock	M04	Gsk in fill	BF 5
78190	Rope cleat	L03	Gsk in fill	BF 3
78280	Knee	M04	Gsk in quay	BF 5
78330	Rowlock	L03	Gsk in fill	BF 5
78429	Rope cleat	L04	Gsk	?
78458	Floorboard	M08	Søsg S in fill	AF 3
78459	Floorboard	M08	Søsg S in fill	AF 3
78756	Rope-end toggle	N07	Søsg N	AF 4 ?
79876	Rope cleat	M08	Søsg S in quay	BF 4
79982	Rope-end toggle	M08	Søsg S in fill	BF 5

Number	Object	Square	Find situation	Date
80190	Floorboard	M07	Søsg N in fill	BF 5
80220	Stem knee	N06	Gsk "almenning" in fill	BF 5
80329	Rowlock	N07	Søsg N in fill	BF 5
80674	Rowlock	O07	Søsg N in fill	BF 5
80675	Floorboard	O07	Søsg N in fill	BF 5
80949	Parrel	O08	Søsg S	AF 4 ?
81062	Model stem	M06	Gsk "almenning" in fill	BF 5
81065	Model boat	M06	Gsk "almenning" in foundations	BF 5
81442	Keelson	M08	Søsg S in foundations	BF 5 ?
83491	Knee	N09	Eng N in building	AF 5
84207	Strake	M10	Eng S passage	BF 6
85455	Bailer	O10	Eng S	?
85579	Rope-end toggle	M10	Eng S in quay	BF 6
87658	Strake	N12	Bug S passage	AF 5
87661	Strake	N12	Bug S passage	AF 5
87663	Strake	N12	Bug S passage	AF 5
87888	Keel	M10	Eng S	AF 5
90017	Crossbeam	K12	Bug passage	1250–1300
90018	Rib fr	L12	Bug passage	BF 4
90019	Crossbeam	L12	Bug passage	BF 4
90020	Keelson	L11	Bug N	AF 4
90022	Strake	K11&12	Bug passage	BF 4
90023	Strake	K11&12	Bug passage	BF 4
90024	Strake	K11&12	Bug passage	BF 4
90025	Strake	K11&12	Bug passage	BF 4
90026	Crossbeam	K11&12	Bug passage	c 1300
90027	2 strake fr	K11&12	Bug passage	BF 4
90028	Strake	K11&12	Bug passage	BF 4
90029	Strake	K11&12	Bug passage	BF 4
90043	Strake	K&L12	Bug passage in drain	BF 4
90044	Strake	K&L12	Bug passage in drain	BF 4
90045	Strake	K&L12	Bug passage in drain	BF 4
90046	Strake	K&L12	Bug passage in drain	BF 4
90119	Rib	L09	Eng N in house	c 1450
90124	Bollard	K11	Bug N	c 1300
90125	Keelson	K11	Bug N	c 1350
90136	Keelson	H11	Bug N	AF 4
90149	Strake	I11	Bug N	AF 4
90150	Strake	I11	Bug N	AF 4
90151	Strake	I11	Bug N	AF 4
90152	Strake	I11	Bug N	AF 4
90153	Bollard	I11	Bug N	AF 4
90154	Knee	K11	Bug N	AF 4
90160	Anchor stock	H11	Bug N	AF 4
90164	Floorboard	F11	Bug N	BF 4
90208	Strake	L12	Section against Bredsgd	AF 6
90217	Strake	K10	Eng S	BF 4
90218	Strake	K12	Bug S	BF 4
90219	Strake	K10	Eng S	BF 4
90220	Breasthook	L09	Eng N	BF 3
90222	Large knee	K09	Eng N	AF 4 c 1350
90273	Strake	L08	Søsg in "veit"	AF 4
90286	Strake	K08	Søsg S	IF 4
90301	Mast	L08	Søsg S	BF 3
90306	Strake	L08	Søsg S	BF 4
90312	Ship beam?	K08	Søsg S	AF 5
90326	Strake	L06	Gsk S	AF 2
90333	Crossbeam	L05	Gsk "almenning"	AF 4 1350–1400
90337	Keelson	K06	Gsk "almenning"	BF 3 ?
90351	Spar fr?	L08	Søsg S	AF 4
90353	Ship beam?	L06	Gsk "almenning"	IF 4

Number	Object	Square	Find situation	Date
90355	Headbeam	L07	Søsg N	IF 2 ?
90356	Headbeam	L07	Søsg N	AF 4
90357	Headbeam	L07	Søsg N	AF 4
90359	Headbeam	L07	Søsg N	AF 4
90360	2 strake fr	K06	Gsk "almenning"	BF 4
90361	Strake	L07	Søsg N	AF 4
90368	Crossbeam	K07	Gsk "almenning"	BF 4
90369	Crossbeam	K07	Gsk "almenning"	BF 4
90370	Knee from 90369	K07	Gsk "almenning"	BF 4
90372	Strake	L07	Gsk "almenning"	IF 4
90373	Strake	L07	Gsk "almenning"	IF 4
90377	Strake	K07	Gsk "almenning"	AF 4
90378	Strake	K07	Gsk "almenning"	BF 4
90379	Strake	L07	Gsk "almenning"	IF 4
90381	Crossbeam	K07	Gsk "almenning"	AF 5
90382	Crossbeam	K07	Gsk "almenning"	AF 5
90387	Crossbeam	K07	Gsk "almenning"	BF 4
90388	Ship beam	K07	Gsk "almenning"	BF 5
90389	part of 90388	K07	Gsk "almenning"	BF 5
90390	Crossbeam?	K07	Gsk "almenning"	BF 5
90391	Crossbeam?	K07	Gsk "almenning"	BF 5
90392	Inwale	K06	Gsk "almenning"	BF 4 ?
90393	Rib	K06	Gsk "almenning"	BF 4
90395	Crossbeam	K06	Gsk "almenning"	AF 5
90396	Strake	L06	Gsk "almenning"	IF 4
90397	Part of 90396	L06	Gsk "almenning"	IF 4
90401	Strake?	L06	Gsk "almenning"	IF 4
90402	Strake?	L06	Gsk "almenning"	IF 4
90403	Headbeam	K07	Gsk "almenning"	AF 5
90404	Strake	L06	Gsk "almenning"	AF 5
90405	Crossbeam, mast support	K07	Gsk "almenning"	AF 5
90406	Part of 90405	K07	Gsk "almenning"	AF 5
90416	Rib fr	L05	Gsk "almenning"	AF 5
90418	Strake	K07	Gsk "almenning"	AF 5
90425	Crossbeam	K05	Gsk	BF 4
90438	Headbeam	L07	Søsg N	AF 4
90460	Strake	L07	Søsg N in fill	AF 4
90464	Crossbeam?	K07		
90474	Keel	N06	Gsk "almenning" in drain	BF 1
90477	Knee	K05	Gsk	BF 4
90484	Strake	I04	GskN in fill	BF 4
90498	Strakes	M05	Gsk passage	BF 2
90499	Strakes	P05	Gsk "almenning"	BF 2
90500	Strakes	P05	Gsk "almenning"	BF 2
90511	Seat from ship?	I05	Gsk	IF 4 ?
90513	Strake	O05	Gsk "almenning"	BF 2
90521	Strakes	P05	Gsk "almenning"	BF 2
90522	Strake	P05	Gsk "almenning" as paving	BF 2
90523	Strake	P05	Gsk "almenning" as paving	BF 2
90525	Ship beam?	P05	Gsk "almenning"	BF 2
90528	Breasthook	L07	Søsg N	IF 5
90535	Breasthook	L07	Søsg N	IF 5
90572	Yard	O06	Gsk "almenning"	BF 2
90573	Ship beam	O05	Gsk	BF 3
90576	Spar fr?	L08	Søsg S	BF 3
90586	Strake	M05	Gsk	IF 3
90587	Strake	M05	Gsk	IF 3
90588	Strake	O06	Gsk	BF 3
90591	Strake	P05	Gsk	IF 3
90593	Strake	M05	Gsk	BF 3
90594	Crossbeam	P05	Gsk	IF 3

Number	Object	Square	Find situation	Date
90595	Part of 90594	P05	Gsk	IF 3
90596	Part of 90594	P05	Gsk	IF 3
90598	Strake	O06	Gsk "almenning"	BF 3
90603	Crossbeam	M05	Gsk	IF 3
90604	Part of 90603	M05	Gsk	IF 3
90605	Part of 90603	M05	Gsk	IF 3
90606	Part of 90603	M05	Gsk	IF 3
90613	Mast	P05	Gsk	IF 3
90614	Part of 90613	P05	Gsk	IF 3
90615	Part of 90603	M05	Gsk	IF 3
90648	Breasthook	O05	Gsk	IF 6
90659	Headbeam	G12	Bug S	AF 4 1350–1400
90703	Breasthook	N04	Gsk	AF 3
90716	Strake	N04	Gsk	AF 4
90726	Crossbeam, mast support	K04	Gsk	BF 4
90727	Crossbeam, mast support	K05	Gsk	BF 4
90728	Keelson	K04	Gsk	BF 4
90733	Floorboard	M03	Gsk	BF 5
90734	Floorboard	M03	Gsk	BF 5
90743	Knee	O03?	Gsk	?
90768	Strake	P04	Gsk	IF 2
90773	Headbeam	P03	Gsk	IF 4
90784	Strakes	O04	Gsk	AF 3
90787	Strake	P03	Gsk	BF 3
90788	Crossbeam	P03	Gsk	BF 4
90789	Headbeam	P02	Gsk	IF 3
90791	Rib	P03	Gsk	AF 4
90792	Rib	P03	Gsk	AF 4
90793	Stringer	P03	Gsk	AF 4
90794	Rib	P03	Gsk	AF 4
90795	Strake	P03	Gsk	AF 4
90796	Strake	P03	Gsk	AF 4
90797	Ship beam	P03	Gsk	AF 4
90800	Strake	P03	Gsk	AF 4
90801	Rib fr	P03	Gsk	AF 4
90803	Strake	P03	Gsk	AF 4
90804	Strake	P03	Gsk	AF 4
90805	Strake	P03	Gsk	AF 4
90806	Strake	P03	Gsk	AF 4
90814	Strake	P04	Gsk	BF 3
90818	Rib	P04	Gsk	AF 4
90819	Ship beam?	P03	Gsk	AF 4
90821	Strake	P04	Gsk	BF 3
90822	Strake	P04	Gsk	BF 3
90830	Side rudder	P02	Gsk	BF 3
90842	Strake?	P02	Gsk	BF 3
90843	Part of 90842	P02	Gsk	BF 3
90844	Part of 90842	P02	Gsk	BF 3
90847	Strake	O04	Gsk	IF 4
90851	Strake	O02	Gsk "almenning"	BF 3
90852	Rib	O03	Gsk	?
90853	Crossbeam	O03	Gsk	BF 4
90854	Crossbeam	O03	Gsk	AF 4
90861	Floorboard	O02	Gsk	BF 4
90863	Crossbeam		Gsk	IF 5
90864	Crossbeam	O03	Gsk	IF 5
90865	Part of 90864	O03	Gsk	IF 5
90867	Crossbeam	O04	Gsk	IF 5
90868	Crossbeam	O04	Gsk	IF 5
90884	Part of 90842	O02	Gsk	BF 3
90886	Ship beam?	O03	Gsk	IF 5

Number	Object	Square	Find situation	Date
90887	Strake	O03	Gsk	IF 5
90899	Knee	O03	Gsk	?
90900	Rib	O03	Gsk	IF 5
90901	Rib	O03	Gsk	IF 5
90902	Knee	O03	Gsk	BF 5
90903	Rib fr	O03	Gsk	IF 5
90907	Rib?	O04	Gsk	BF 5
90910	Strakes	O03	Gsk	IF 5
90928	Breasthook	O03	Gsk	AF 6
90929	Knee	O03	Gsk	AF 6
90984	Strake	O03	Gsk	IF 5
91024	Strake	N03	Gsk	BF 6
91034	Part of 90788	P03	Gsk	BF 3
91102	Strake	P02	Gsk	IF 2 ?
91220	Rib	O04	Gsk	AF 4
91279	Crossbeam	O06	Gsk "almenning"	BF 5
91357	Strake	N04	Gsk	AF 4
91358	Strake	N04	Gsk	AF 4
91359	Stringer?	N04	Gsk	AF 4
91360	Stringer?	N04	Gsk	?
91361	Stringer?	N04	Gsk	?
91362	Stringer?	N04	Gsk	?
91363	Crossbeam	N04	Gsk	AF 4
91364	Crossbeam	N04	Gsk	IF 4
91365	Crossbeam	N04	Gsk	AF 4
91366	Crossbeam	N04	Gsk	AF 4
91367	Crossbeam	N04	Gsk	IF 4
91368	Knee	L04	Gsk in building	AF 5
91428	Strake	O04	Gsk	AF 4
91431	Strake	N04	Gsk	?
91433	Strake	N04	Gsk	IF 4
91434	Strake	N04	Gsk	AF 4
91435	Ship beam?	N04	Gsk	AF 4
91436	Strake	N04	Gsk	IF 5
91437	Strake	N04	Gsk	IF 5
91438	Strake	N04	Gsk	IF 5
91439	Strake	N04	Gsk	IF 5
91440	Strake	N04	Gsk	IF 5
91441	Strake	N04	Gsk	IF 5
91442	Strake	N04	Gsk	IF 5
91446	Side rudder	N06	Gsk "almenning"	BF 4 ?
91449	Strake	M02	Gsk	BF 4
91459	Strake	M03	Gsk	AF 5
91488	Strake	N04	Gsk	AF 3
91500	Crossbeam	M04	Gsk	IF 4
91503	Part of 91500	M04	Gsk	IF 4
91504	Part of 91500	M04	Gsk	IF 4
91505	Part of 91500	M04	Gsk	IF 4
91506	Part of 91500	M04	Gsk	IF 4
91513	Strake	M04	Gsk	AF 4
91514	Strake	M04	Gsk	AF 4
91516	Strake	M04	Gsk	AF 4
91521	Strake	M04	Gsk in foundations	AF 5
91629	Strake	N04	Gsk	AF 4
91630	Strake	N04	Gsk	AF 4
91631	Strake	M04	Gsk	AF 4
91632	Strake	M04	Gsk	AF 4
91635	Strake	M04	Gsk	BF 3
91639	Strake	N04	Gsk	AF 4
91640	Strake	M04	Gsk	AF 4
91641	Ship beam?	N04	Gsk	AF 4

Number	Object	Square	Find situation	Date
91642	Strake	N04	Gsk	AF 4
91651	Strake	O04	Gsk	AF 4
91652	Strake	O04	Gsk	AF 4
91653	Strake	N04	Gsk	IF 5
91676	Crossbeam	L04	Gsk	IF 4
91680	Rib	L04	Gsk	IF 5
91682	Ship beam	L04	Gsk	IF 5
91693	Strake	L04	Gsk	AF 4
91694	Strake	L04	Gsk	IF 4
91696	Strake	O04	Gsk	AF 3
91720	Rib	L05	Gsk	BF 4
91725	Strake	L05	Gsk	AF 4
91727	Crossbeam	L05	Gsk	AF 4
91748	Strake	L05	Gsk in foundations	AF 4
91763	Strake	M04	Gsk	AF 4
91764	Strake	M04	Gsk	AF 4
91766	Strake	M04	Gsk	AF 4
91767	Strake?	?	?	?
91792	Stringer	L06	Gsk	AF 5
91860	Rib	L07	Søsg N	IF 4
91910	Crossbeam	K04	Gsk	?
91911	Crossbeam	I04	Gsk	BF 4
91912	Keelson	K04	Gsk	BF 4
91913	Rib	K04	Gsk	BF 4
91914	Part of 91913	K04	Gsk	BF 4
91915	Crossbeam	I04	Gsk	BF 4
91918	Crossbeam	I04	Gsk	BF 4
91919	Rib	K04	Gsk	BF 4
91920	Rib	K04	Gsk	BF 4
91945	Crossbeam	K05	Gsk	BF 4
91946	Crossbeam	K05	Gsk	BF 4
91956	Part of 90393	K07	Søsg N	BF 5
91988	Crossbeam	K07	Gsk	BF 4
92374	Floorboard	Q03	Gsk	AF 3
92380	Strake	Q02	Gsk	BF 3
92381	Strake	Q02	Gsk	BF 3
92382	Strake	Q02	Gsk	BF 3
92384	Stem	Q03	Gsk	AF 3
92410	Crossbeam	Q03	Gsk	?
92420	Stringer?	Q03	Gsk	?
92440	Strake	Q03	Gsk	BF 3
92444	Strake	Q03	Gsk	BF 3
92464	Crossbeam	Q03	Gsk	BF 3
92489	Strake	Q03	Gsk	BF 3
92499	Stringer	R03	Gsk	BF 3
92502	Strake	Q02	Gsk	IF 3
92504	Strake	P02	Gsk	IF 4
92529	Strake	R03	Gsk	BF 4 1400–1450
92530	Strake	R03	Gsk	BF 4 1400–1450
92733	Strake	N07	Søsg N	?
92734	Strake	N07	Gsk	BF 3
92735	Strake	N07	Gsk	BF 3
92736	Floorboard	N07	Gsk	BF 3
92737	Strake	N07	Gsk	BF 3
92738	Side rudder	M08	Søsg S	?
92741	Side rudder?	N08	Søsg S	1200–1250?
92894	Side rudder	L02	Gsk	1200–1250?
92993	Knee	P06	Gsk "almenning"	1150–1200?
93154	Headbeam	K11	Bug N	?
93156	Windlass	K04	Gsk	BF 4
93157	Part of 93156	K04	Gsk	BF 4

Number	Object	Square	Find situation	Date
93176	Crossbeam	I05	Gsk	BF 4
93177	Crossbeam	I05	Gsk	BF 4
93178	Crossbeam	I05	Gsk	BF 4
93179	Crossbeam	I05	Gsk	BF 4
93198	Strake	I05	Gsk	BF 4
93199	Deckbeam	I05	Gsk	BF 4
93213	Deckbeam	K07	Søsg N	AF 4
93220	Strake	I04	Gsk	BF 4
93221	Strake	I05	Gsk	BF 4
93222	Ship beam	I05	Gsk	BF 4
93225	Knee fr?	I05	Gsk	BF 4
93327	Knee	K11	Bug N	1350–1450
93362	Strake	P09	Eng N	1150–1200?
93376	Knee	K06	Gsk "almenning"	AF 5
93381	Strake	M04	Gsk	AF 4
93382	Strake	M04	Gsk	AF 4

The following pieces have been renumbered after the loss of original number or for other reasons. Information about the find spot is unfortunately lost with the original number.

93384	Crossbeam		
93385	Crossbeam		
93386	Floorboard	L08	Søsg S
93387	Floorboard	L08	Søsg S
93388	Oar	L07	Søsg N
93389	Rib		
93390	Rib		
93391	Rowlock		
93392	Oar blade		
93394	Model boat		
93395	Model bailer		
93396	Mast rib		
93397	Stem fr		

Aft — The back half of a ship or boat, as opposed to forward.

Assembly-plank — A strake to which several other strakes are scarfed, used near the stems.

Backbone — The assembled keel and stems of a boat.

Beam — 1 A structural timber, for instance a crossbeam.
2 The greatest width across a vessel's hull.

Bollard — Sturdy timber bolted to the ship's side and reaching above the sheerstrake. Used for fastening mooring-ropes etc. (See fig A).

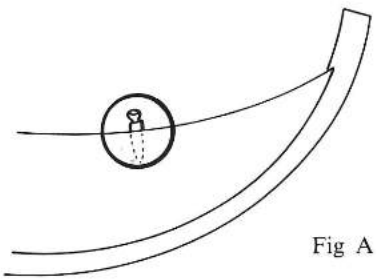


Fig A

Bowline — Line from the forward edge of a square sail, used to stretch the sail when tacking.

Breasthook — Rib set obliquely near the stem or stern of a vessel.

Buss — Type-name for a medieval merchant ship, presumably a large type of vessel.

Canthook — Breasthook (q v).

Carvel — Method of ship construction where planks laid side by side are bolted to a sturdy skeleton of keel, stems and ribs.

Caulking — Hemp or other fibrous material which is hammered into the seams between the planks of a carvel vessel to make the hull watertight.

Clinker — Method of ship construction where slightly overlapping planks are fastened together with lashings or nails of iron or wood. Ribs are inserted after the planking shell is completed.

Cog — Type name for a medieval ship, built with a smooth, flat bottom, straight stems and clinker-built sides.

Crossbeam — Timber spanning the hull from side to side.

Dovetail — A joint consisting of a tenon shaped like a dove's tail, fitting into a corresponding mortise. (See fig B.)

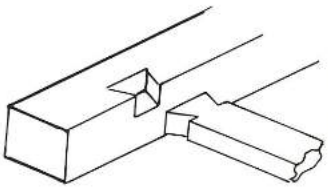


Fig B

Fairlead — A piece of wood with a hole for a rope. Used to change the direction of the rope.

Frame — Synonymous with rib.

Futtock — The middle section of a composite rib (q v).

Garboard — The strake next to the keel or bottom plank.

Girth — The circumference of the hull at its widest point.

Halyard — The rope used to hoist a sail.

Hanging knee — A knee standing vertically between beam and planking, either above or below the beam. In clinker building the knee usually stands on the upper surface of the beam.

Head-earing — A line used to lash the upper corner of a square-sail to the yard-arm.

Hood-end — That part of a strake which reaches the stem or sternpost.

Horn — See rowlock-horn.

Hull — The "body " of a ship, excluding mast, rigging and loose fittings.

Inwale — A strengthening timber or fillet running along a plank or strake, usually the sheerstrake.

Jekt (Norw) — Open clinker-built coaster rigged with one square-sail on a mast amidships.

Keel feathers — The protuding horizontal edges of a T-shaped keel. (See fig C.)

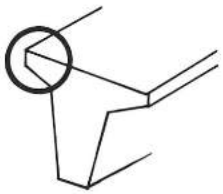


Fig C

Keip (Norw) — A rowlock consisting of a "saddle" and a "horn" at right angles to one another, generally made from a piece of a tree-trunk with part of a branch.

Knee — A naturally grown, angular piece of wood. Used to connect and strengthen joints on ships.

Last — A nautical measurement. The last has differed over the centuries, but the medieval one was probably about three cubic meters in volume or c 1800 kg when used to measure grain.

Lath — A thin strip of wood, nailed on to another piece for strength or in order to support another constructional member.

Limber-hole — A hole or recess cut in the underside of a rib etc in order to permit the passage of water.

Luting cove — A shallow groove scraped or planed along the edge of a strake to hold a string or wad of waterproofing material. This is inserted during the building process, as opposed to caulking, which is inserted after the mounting of the strakes.

Lodging knee — Knee (q v) connecting beam and strakes, where the part resting against the strake is horizontal or nearly so.

Parrel — Detail holding the yard to the mast. May be made of a single curved piece of wood, or composite, consisting of rollers and spacers.

Pram (mod Norw) — A round-bottomed boat, built with a bottom plank and transoms fore and aft instead of keel and stems.

Rabbet (also: rebate) — A groove cut into the stem or keel for a strake to fit into.

Rib — Curved timber inside the hull, supporting the strakes. May be in one piece, or composite, consisting of a floortimber, two futtocks and two top timbers.

Rope-end toggle — Piece of wood, spliced or knotted to the end of a rope.

Rowlock — Any contraption used for holding the oar in place when rowing.

Rudder boss — A specially shaped piece of wood on the ship's side, on which a side rudder is mounted.

Scarf — A joint between two pieces of wood (also used as a verb).

Scantlings — Dimensions of timbers in cross-section.

Sheerstrake — The uppermost strake in the hull.

Stanchion — Vertical support from floortimber to beam or between beams placed vertically above one another.

Stealer — A short piece of strake which does not run the full length of the hull, used in order to increase or lessen the width of a strake. In this work used synonymously with assembly-plank. (See fig D.)

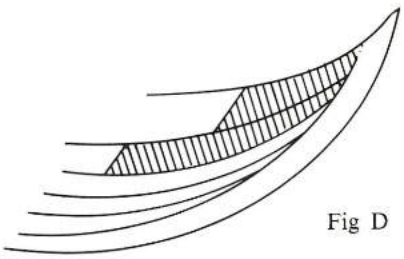


Fig D

Stem — 1 The sturdy, generally curved timber which closes the hull of a vessel at one or both ends.
2 The front end of a vessel, as opposed to the stern.

Strake — One plank in the hull of a vessel, from stem to stern. It may be in one piece, or scarfed from several lengths.

Stringer	A longitudinal timber set on the inside or outside of a strake for added strength.
Sweep	A large oar. Generally used with both hands in a large boat or ship which would generally not be rowed.
Tiller	The handle used to control a rudder or steering oar.
Tholepin	Vertical hardwood pin, generally one of a pair, set in the inwale to support the oar when rowing.
Thwart	Seat for the rowers or passengers in a boat. Usually, a plank running across the vessel, its ends resting on the strakes and a rib.
Transom	A flat termination of a vessel aft, above a short sternpost, or instead of a sternpost.
Yard	The spar spreading the head of a square sail.
Yard-arm	The outer ends of the yard.

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ABBREVIATIONS

Ab	Foreningen til Norske Fortidsminnesmerkers bevaring, Årsberetning
DN	Diplomatarium Norvegicum I-XXI, Kristiania (Oslo) 1849-1972
IJNA	International Journal of Nautical Archaeology and Underwater Exploration
KLNM	Kulturhistorisk Leksikon for Nordisk Middelalder
NGL	Norges gamle love indtil 1387. I-V. Kristiania (Oslo) 1846-1895
NGL II	Norges gamle love II rekke, 1388-1604. I-III. Kristiania (Oslo) 1912-1976
UO	Universitetets Oldsaksamling

Christensen: BOAT FINDS FROM BRYGGEN

Errata

page 62 2.column line 39, for 25b read 35

page 116 note 28, for 59924 read 59923

page 134 Table 9 - II, for 3 of read 2 of

page 134 Table 9 - III, in "date" column add BF6 for nr. 85795

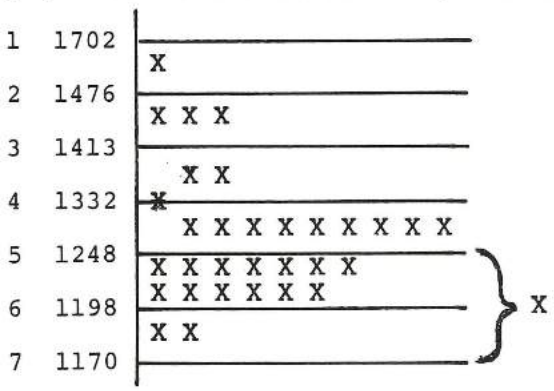
page 149 Table 10 - I, in "date" column add BF4 for nr. 14261

page 149 " , concerning nr. 61906, in "date" column for BF5 read BF4

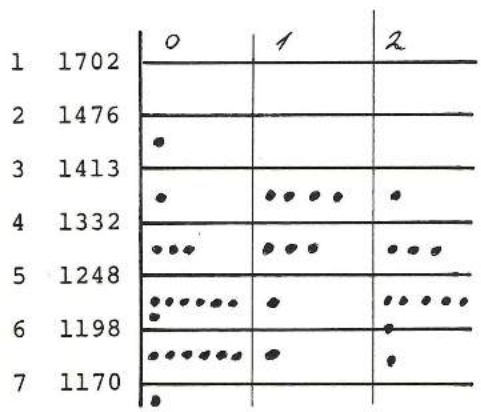
page 149 " , concerning nr. 70401, in "date" column for BF5 read BF4

page 151 fig. 10 - 7. The scale shown is 5 cm.

page 117 for Table 7 - II, substitute



page 123 for Table 8 - II, substitute



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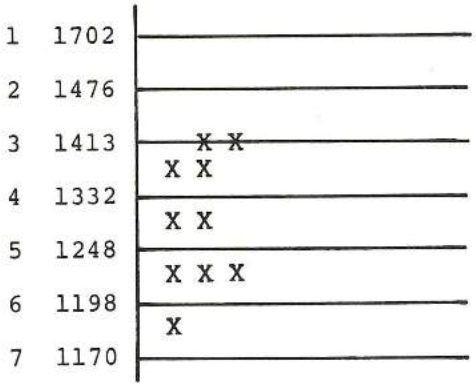
page 135 for Table 9 - IV, substitute



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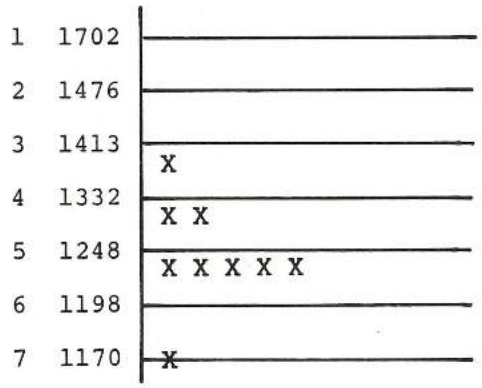

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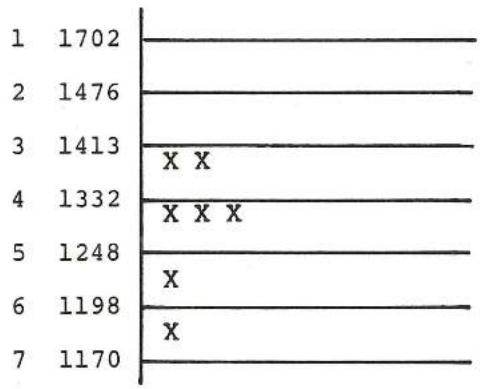

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