Crossroads in Ancient Shipbuilding

Proceedings of the Sixth International Symposium on Boat and Ship Archaeology Roskilde 1991

ISBSA 6

Edited by Christer Westerdahl

Oxbow Monograph 40
1994

Published by
Oxbow Books, Park End Place, Oxford OX1 1HN

ISBN 0 946897 70 0

This book is available direct from
Oxbow Books, Park End Place, Oxford OX1 1HN
(Phone: 0-865-241249; Fax: 0-865-794449)

and

The David Brown Book Company
PO Box 5605, Bloomington, IN 47407, USA
(Phone: 812-331-0266; Fax: 812-331-0277)

Printed in Great Britain by
The Short Run Press, Exeter

8. Iron Nails in Iron Age and Medieval Shipbuilding

Jan Bill

Boat nails from clinker built vessels are known from hundreds of archaeological sites in Scandinavia and other parts of Northern Europe. If they are not regarded as especially important for the understanding of a specific phenomenon, they mostly remain quite anonymous to the archaeologists.

There are, in fact, several reasons to look at them as more than a useful source to illuminate the construction of an individual boat or the activities at a port of trade. First, the iron nails came to play a most important role in the seafaring of the North by their use in the clinker building technique; a technique which was not limited only to Scandinavian boat building. Second, the qualities of iron have made the nails survive under varying conditions; sometimes the nails are the only items preserved to demonstrate the maritime aspect of a site. Third, the finds containing boat nails are not only many in number, but also distributed over a large part of the northern hemisphere – from the River Volga in the east to Ellesmere Island in the west.

If the morphology of boat nails was subject to changes and local developments, those should appear as chronological and regional patterns in the distribution of different nail types; a classical example a little out of focus for this article is the predominance of wooden nails in Western Slav shipbuilding (Crumlin-Pedersen 1969: 24). If the nails do reflect a range of different clinker traditions, this gives us the possibility of learning more from "anonymous" finds. But even more important, it would give us a new tool for the examination of transport routes and transport organization.

Furthermore, a detailed knowledge of the development of an item, which has been produced and used in millions, may contribute a little to our economic and technological history.

This paper gives a preliminary report on a study on this subject. It has, so far, mainly been based on the published, and often very scarce, accounts of about 150 finds from Northern and Eastern Europe. First hand investigations have been carried out on parts of the English, Danish, Swedish, Estonian and Russian material, in total about 25 finds; further information has been collected through colleagues. These are not big numbers, compared to the thousands of finds, which most likely exist. Also, there are areas, for which the material studied is certainly not representative yet, especially on the southern coast of the North Sea. Although the project is still at the stage of collecting information, preliminary analyses seem to point towards the existence of such patterns, a number of which shall be presented here.

An understanding of the production and use of boat nails is essential to any study of this kind. Nails are in most cases strictly functional objects, and their morphology is therefore very much influenced by these factors. On the basis of archaeological evidence and experimental work (see e.g. Bill & Johansson 1987: 20–21), the processes can be reconstructed as shown in Fig. 1. It is important to notice that they are not unilinear – there may be no difference between e.g. a fully finished spike and the nail element of a rivet, which has not yet been put into use. This of course calls attention to the context of a find; a shipyard will show a different array of nail types than the ship built there. It also calls attention to the fact, that the apex of the nail is of special interest; for example, a rivet can only be identified by the rove, or by the deformed end of the shank, and a spike only by the pointed end of the shank.

In order to establish a typology for the nails each of the three structural elements – the head, the shaft and the apex – has been treated individually, as shown in Fig. 2. From this diagram, the morphology of known types of boat nails can be described as a code in three capital letters, each of them defining the character of one of these elements; the diagram can easily be extended to include additional types. Some variants of the basic elements will be shared by several types of nails, while others will be typologically significant on their own. When all, or a representative selection of nails in a find are analyzed in this way, the find can be described in terms of the percentage of nails of different types. Even in a closed find, as for example a wreck, one should expect to find different types of nails. This is partly caused by the differing function of the nails (e.g. spikes compared to rivets), and partly by the nature of the production process, which will allow a certain degree of variation before the product is rejected.

When a find is described as a combination of different nail types, it can easily be compared to other finds. "Closed" or pure finds, as wrecks or well-documented boat-graves, can be used to establish eventual distribution patterns in time or space. Ships are indeed very mobile structures, but the main bulk of vessels are most likely to

have operated locally during the period discussed here. Mixed or "open" finds, as e.g. ports of trade and boat cremation graves, have to be analyzed carefully and used with great circumspection, as the nails may come from different objects and different object types.

Examination of the finds is, as mentioned, at an initial stage, and the results presented here must therefore be regarded as preliminary. One of the most interesting characteristics found to be of typological importance so far is the cross-section of the shank; it might serve as an example of the potential of these studies.

The oldest clinker built boats with iron nails are the

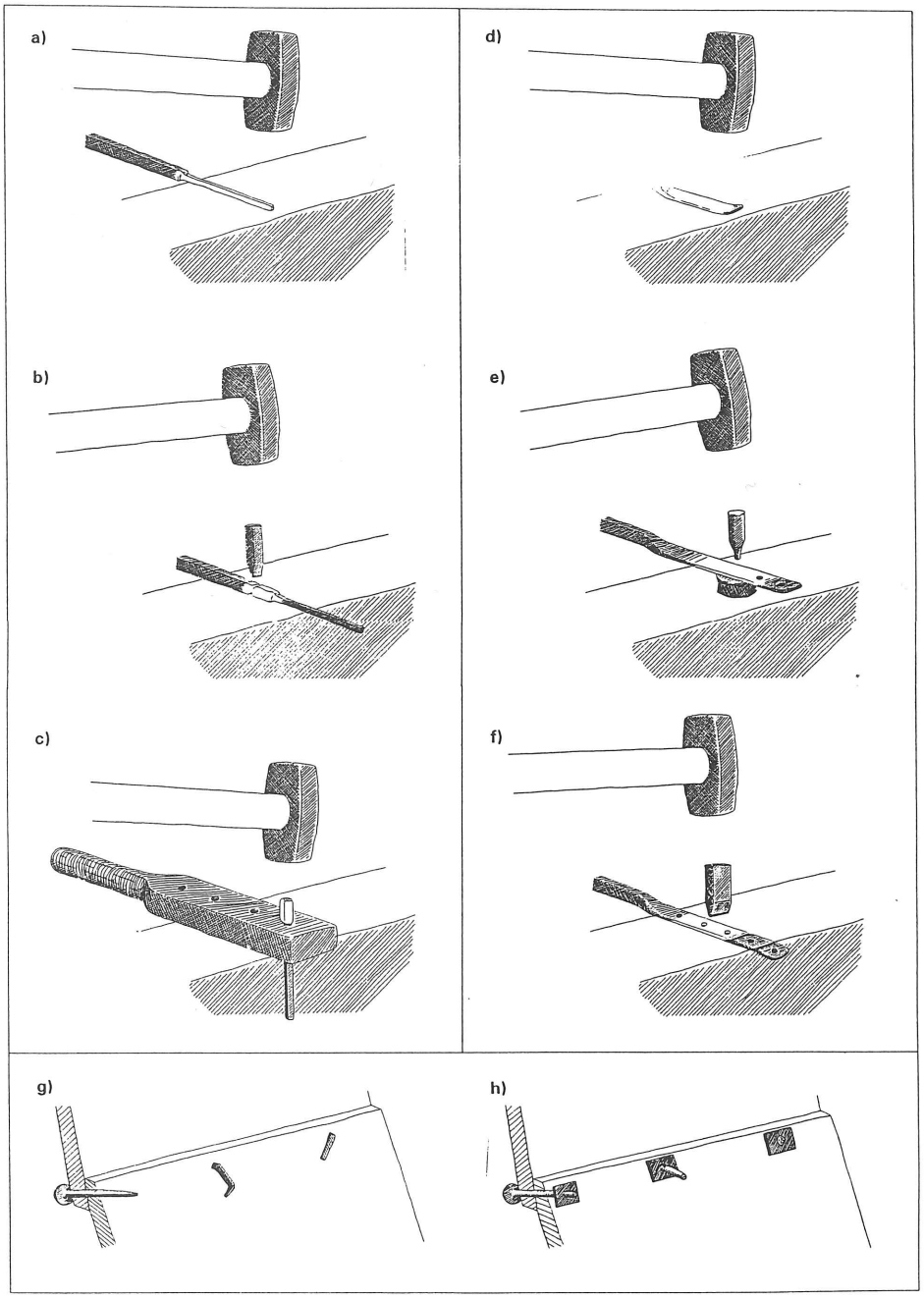

Fig. 1. The production and use of iron nails in the clinker-technique in North-European boatbuilding before AD 1400). The following processes are depicted: ***a)*** *The shank is hammered out from a red-hot iron rod or bar. At the initial stage, this produces a square cross-section, which subsequently can be worked into a multifaceted or round shape. At this stage the tip can be tapered too.* ***b)*** *The nail, including material for the head, is cut off from the rod by a chisel.* ***c)*** *In a specialised tool, a nail-making iron, the head is hammered out.* ***d)*** *The roves are made from a iron rod or bar, which is hammered out to form a strip.* ***e)*** *With a chisel holes are made at regular intervals.* ***f)*** *Finally, the individual roves are cut off from the rod with a chisel.* ***g)*** *Pointed nails can be used as a tack or a spike, or it can be bend to form a turned or hooked nail.* ***h)*** *Pointed and blunt nails can be inserted in pre-drilled holes and used together with roves to form rivets. Surplus length of shaft is cut of before clenching the rivet.*

vessels found in southern Jutland, at Nydam. Dating back to the 4th century AD, these finds show us a type of ship, which already had a long line of evolution behind it; perhaps back to the sewn Hjortspring boat of the 4th century BC found in the same region (for the connection between these finds, see the paper of F. Rieck in this volume). There are also several finds of rivets from maritime sites such as boat-houses (Rolfsen 1974: 92f) and beach-markets (Thomsen 1989). These finds date back to the 3rd and 4th centuries AD, showing that the clinker technique occurs in Denmark and perhaps Northern Germany from the 3rd century AD at the latest, in south-western Norway from about 350 AD, and in Sweden from about 400 AD. Probably all these dates will be moved further back in time by new finds in the future.

From the information collected about finds older than 500 AD there appears a rather mixed picture. The cross-section of the shanks vary greatly, from square to round

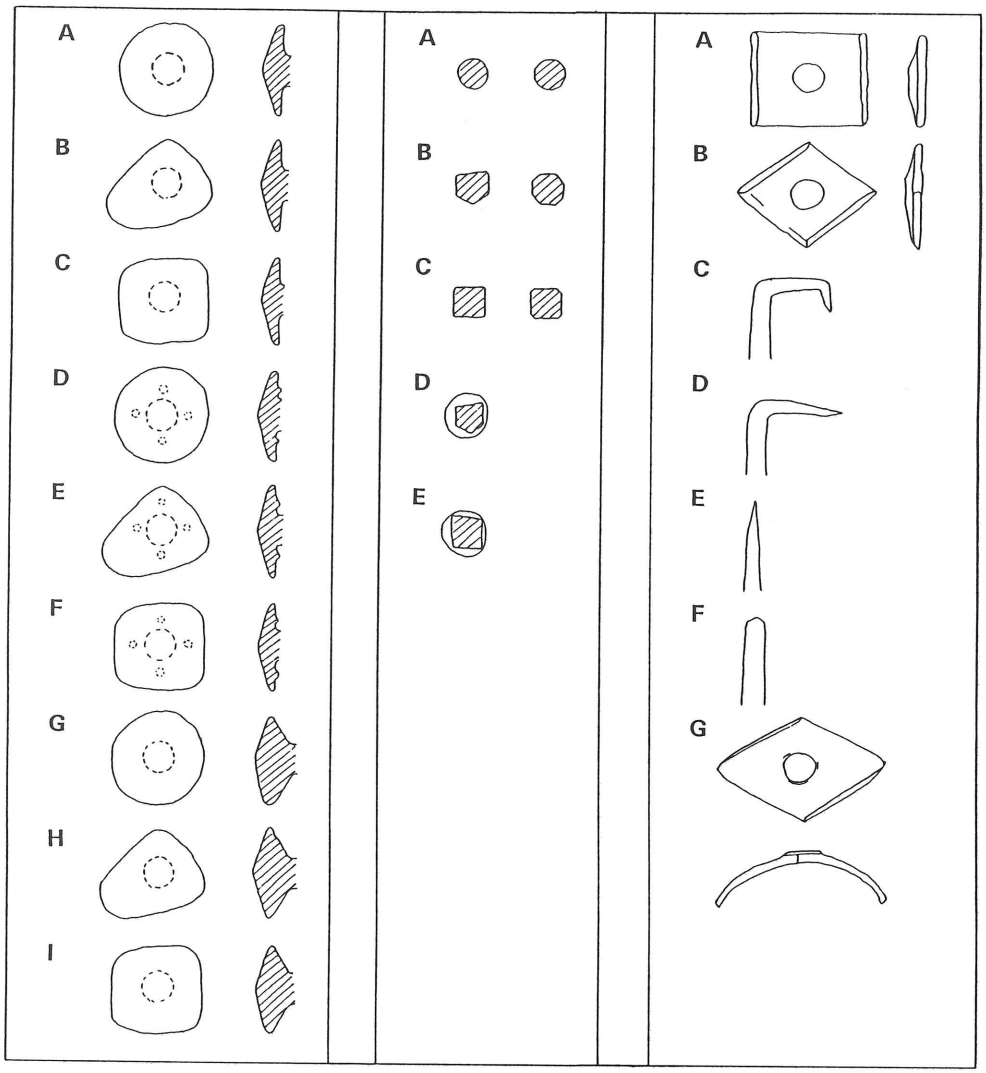

Fig. 2. Known variations of the three elements of a boat nail. A typical Scandinavian Viking period rivet would be an AAA or AAB nail, while the hooked nails found in e.g. the Kollerup cog, are D-, E- and FCC-nails. In the scheme, relevant terms are stated:

Head:

A: Round, low doomedA: Round
B: Unregular, low doomed
C: Square, low doomed
D: A+points under head
E: B+points under head
F: C+points under head
G: A+conical towards shaft
H: B+conical towards shaft
I: C+conical towards shaft

Shaft (cross-section):

A: Rectangular rove
B: Multifacetted
C: Square
D: B+plug
E: C+plug

Apex:

B: Rhomboid rove
C: Hooked
D: Turned
E: Pointed
F: Dull
G: Curved rove

in most groups of finds. Apart from this, most of these nails have round, low doomed heads and, when riveted, rhomboid or rectangular roves. In Fig. 3 the spatial distribution of these finds show a clear cluster in the Scandinavian part of Northern Europe. There are no signs in the material of other clinker-traditions at this early stage, but it must be taken into consideration that the number of finds from this period is still very limited.

When we turn to the following period, c. 500–1100 AD, the picture is much more complicated (Fig. 4). When we look at the Scandinavian area the nails are still the same, except for a clear development towards round shanks for the rivets; square-shanked rivets are rare in Scandinavian boat-finds from this period. The same type of nail is found at the 6th and 7th century East Anglian ship burials of Snape and Sutton Hoo 1 and 2. Another characteristic of the Snape and Sutton Hoo finds is that they have only rhomboid roves. In this they have parallels in a number of Scandinavian princely graves, such as the boat graves from Vendel and Valsgärde (mid-sixth to mid-eleventh century) and the ship burial at Hedeby, dating to c. AD 900. (See refs in Fig. 4.)

From the northern part of the British Isles there are several finds showing nail types similar to the contemporary Scandinavian material. These finds are all from a later period than the East Anglian ship burials, and they include boat graves as well as other types of find. The roves are of varying shape in this material; from two sites, IL 323 on Colonsay and Knoc Y Doonee on Isle of Man, there are finds of nails rivets with curved roves, in other finds these are used to fasten the upper end of a rib to the planking in smaller boats. In general, the nails from the northern part of the British Isles are very much like the Scandinavian ones, which is naturally not surprising.

A clinker tradition different from the Scandinavian one occurs in South-Eastern England in the mid- and late

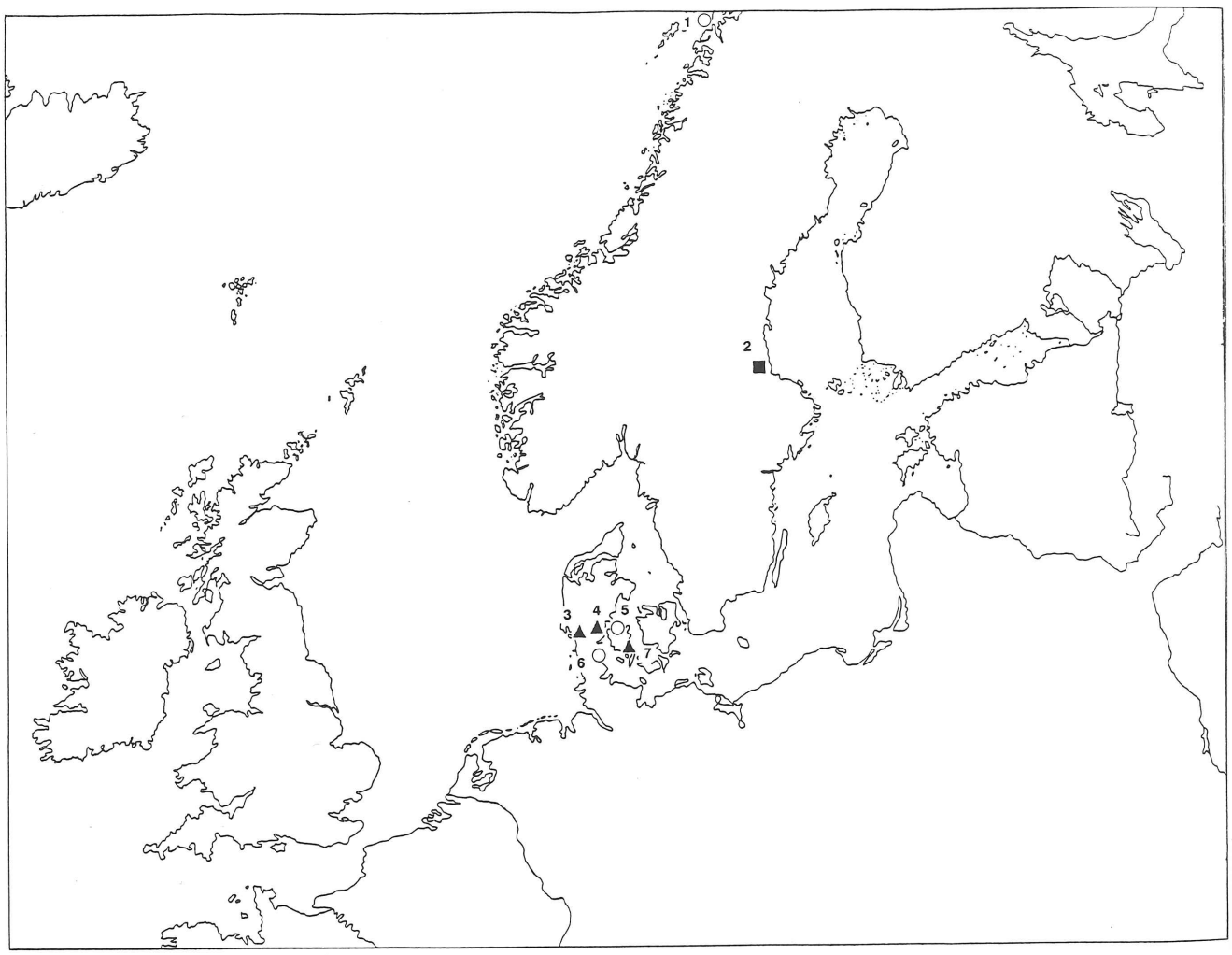

Fig. 3. Finds of boat rivets with known cross-section of shank, dated earlier than AD 500. Closed signatures are based on exactly described finds, open signatures on less reliable sources (photographs, x-rays photographs etc.). The numbers refers to the following sites: 1: Skarstad (Shetelig 1918a); 2: Björke (Humbla 1950); 3: Brokær (Thorvildsen 1957; all nails have been examined; dating is based on the type of nails and on the nearby Late Roman Period cemetery); 4:Ejsbøl (Ørsnes 1988); 5: Vimose (Engelhardt 1869); 6: Nydam B (Rieck and Crumlin-Pedersen 1988); 7: Lundeborg (Thomsen 1989 and examination of a small number of nails).

Saxon period (see also Goodburn in this volume). It is characterized by the use of wooden plugs, through which the nails are inserted; the shanks are either square or polyfacetted in cross-section. The Graveney boat (Fenwick 1978) is the best preserved example of this tradition, but it is seen also in finds of reused ship's planks from London and in a number of Anglo-Saxon graves from Caister-by-Yarmouth and Thorpe-by-Norwich. In the Caister-by-Yarmouth material there were graves with wooden-plugged rivets as well as graves with Scandinavian type rivets. (See refs in Fig. 4.)

In the east the clinker technique is attested in the area

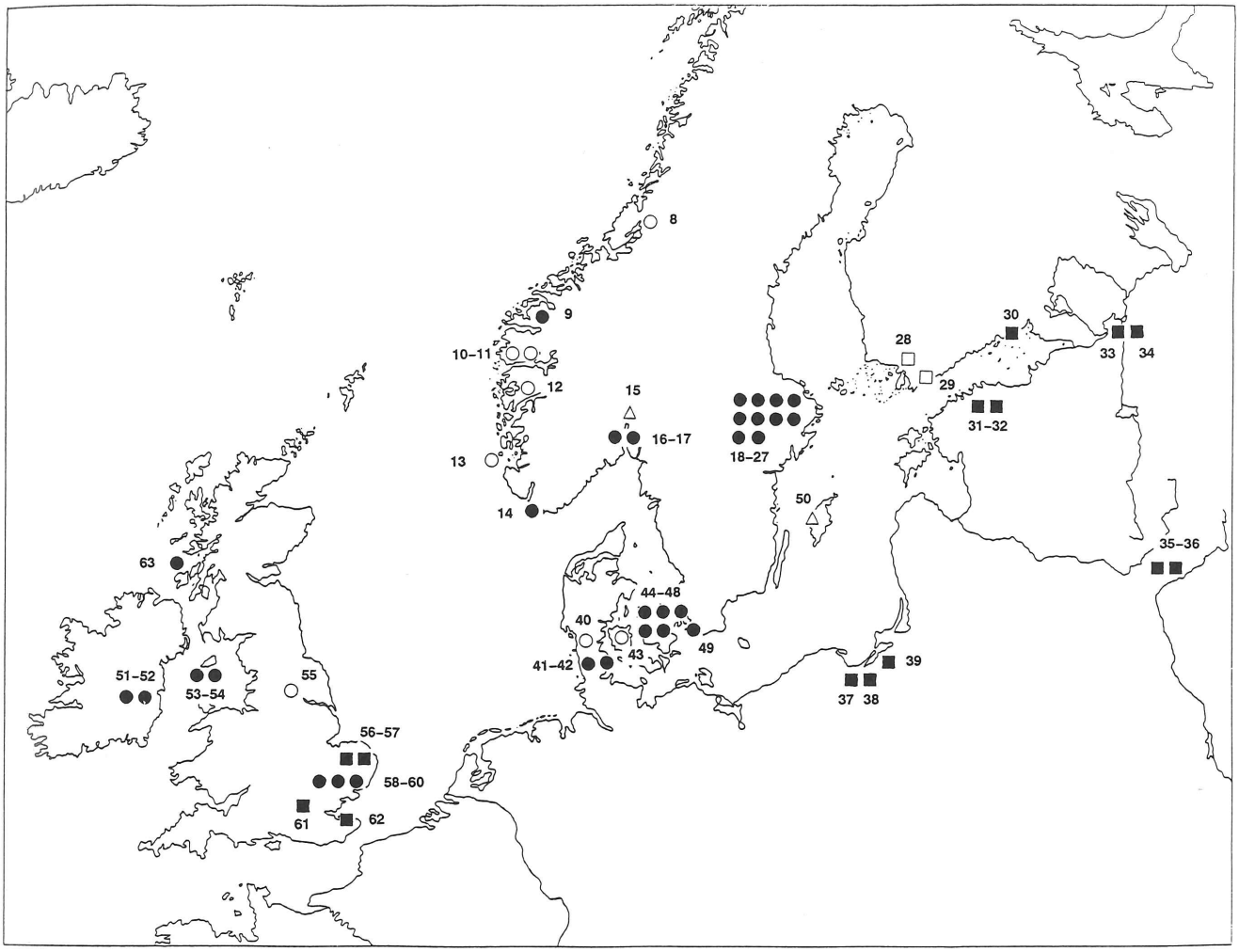

Fig. 4. Finds of boat rivets with known cross-section of shank, dated between AD 500–1100. Same legends as Fig. 3. The numbers refer to the following sites: 8: Lø (Farbregd 1984); 9: Setnes (Marstrander 1963); 10: Myklebostad, mound 2, grave I (ibid.); 11: Myklebostad mound 4 (ibid.); 12: Byrkje (Shetelig 1912); 13: Grønhaug (Shetelig 1902); 14: Østhassel (Univ. Olds. Aarbok 1941–44); 15: Gile (Herteig 1955); 16: Gokstad (Brøgger & Shetelig 1950; Rosenquist 1979); 17: Fossesholm (Rygh 1885); 18: Årby (Arbman 1940); 19: Valsgärde 1 (Fridell 1930); 20: Valsgärde 2 (Dyfverman 1929); 21: Valsgärde 4 (Odencrants 1933); 22: Valsgärde 6 (Arwidsson 1942); 23: Valsgärde 7 (Arwidsson 1977); 24: Valsgärde 8 (Arwidsson 1954); 25: Valsgärde 14 (Bill & Johansson 1987); 26: Ulltuna (Almgren 1904); 27: Alsike inv.nr.9404 (Arne 1934); 28: Yliskylä, (Appelgren 1897); 29: Ristimäki (Tallgren 1915); 30: Lapuri (Aleopaeus 1988 and personal communication from Aleopaeus); 31: Proosa (Deemant 1975, 1976, 1977); 32: Rebala (examination of nails); 33: Staraja Ladoga (Kirpichnikov 1985 and examination of nails from excavations in 1910–11, 1947–48, 1950, 1958–59); 34: Plakun (Nazarenko 1985 and examinations of nails from mounds no. 5, 7, 8 and 13, excavated in 1952); 35–36: Gnezdovo (Mühle 1988 and examination of nails from mounds no. 23 and 24, excavated in 1905); 37: Danzig-Ohra I (Lineau 1934); 38: Bagart/Baumgarth (Conwentz 1924); 39: Frauenburg (Heydeck 1900); 41: Haddeby (Müller-Wille 1976); 42: Hedeby 1 (Crumlin-Pedersen 1969); 43: Ladby (Thorvildsen 1957); 44–48: Skuldelev (Olsen & Crumlin-Pedersen 1967); 49: Falsterbo 1 (Crumlin-Pedersen 1984); 50: Paviken (Lundström 1981); 51–52: Dublin TG7 and TG10 (McGrail 1993); 53: Balladoole (Bersu & Wilson 1966); 54: Knoc Y Doonee (Kermode 1930 and examination of nails); 55: York Minster (Kjølbye-Biddle in press); 56: Thorpe (examination of nails); 57: Caister-by-Yarmouth (examination of nails from 9 graves); 58: Snape (Meaney 1964); 59–60: Sutton Hoo (Bruce-Mitford 1968, examination of small numbers of nails); 61: London (several sites, see Goodburn in this volume). 62: Graveney (Fenwick 1978); 63: Kiloran Bay (Crawford 1987 and examination of nails); 82: Dorestad (van Es and Verwers 1980).

of the eastern Baltic at least as far back as late 6th/early 7th century AD in a cremation grave at Yliskylä, Perniö (Müller-Wille 1970: 151). More than 800 rivets and some special mountings, parallelled in the boat graves in Central Sweden, indicate strongly, that a boat was burned during the ceremony. As plenty of evidence exists for earlier contacts between Scandinavia and the Eastern Baltic, the clinker-tradition may have entered the area at a much earlier date. The cemetery at Proosa near Tallinn in Estonia has revealed rich Scandinavian finds from 5th and 6th century AD; rivets were found in the same cemetery, although in an undated context and in context from the 11th and 12th centuries (Deemant 1975; 1976; 1977). From the nearby pagan cemetery at Rebala, there are finds of rivets as well.

When we look at the nail types identified in this material it is striking that the square-shanked rivets are consistently represented; in the two Estonian finds mentioned above, they are actually dominant. A similar feature is found along the southern shore of the Baltic, both in the territories of the Balts and of the Slavs, although wooden pegs were much more common as fastenings than iron nails in Slavic boat building. Thus it seems as if the square-shanked rivets are characteristic of a Baltic clinker tradition, which in this manner differs from that of contemporary Scandinavia.

Further east along the river systems of Russia finds demonstrate the presence of the clinker-technique from the mid-eight century onwards. At the important port of trade Staraja Ladogá at the Volchov River rivets were found in the oldest and the following occupation layers dating back to c. AD 760 (Vierck 1983: 12f). At the nearby pagan cemetery Plakun several mounds, revealing cremation graves with rivets and spikes, have been excavated (for a description of the site and excavations, see Nazarenko 1985). Analyses made on material excavated in 1952 by N.N. Gurina and in 1968 by G.F. Korsuchina show the square cross-section to be a clearly dominant feature. Where the cross-section could be identified, 60–75% of all nails showed this characteristic, which was also found among the rivets excavated from the occupation layers at Staraja Ladoga. A similar picture is seen in the material from Gnezdovo near Smolensk, where nails from two cremation graves (kurgans 23 and 24, mid- and late 10th century AD) excavated by Abramov in 1905 have been examined. It must be taken into consideration that the cemeteries at Gnezdovo include a large number of mounds with presumed boat graves (Mühle 1988: especially 371f, 384ff), so the kurgans 23 and 24 might not be representative after all. But at this initial stage, the evidence from both Staraja Ladoga, Plakun and Gnezdovo points towards a Baltic, rather than a Scandinavian boat building tradition in western Russia at the time of the Vikings. This is not surprising, as the use of local craft would be natural under conditions so different from those in Scandinavian waters; furthermore, it is possible that the high-ranked persons in the Gnezdovo graves did not build the boats themselves. The burials at Plakun on the other hand may be those of local boat builders and boatmen.

Turning to the last period dealt with in this paper (AD 1100–1400, see Fig. 5), we see that a pronounced change took place. Apart from a group of 12th century finds in Southern Scandinavia, and perhaps in Dublin as well, the round-shanked nails now disappear completely. From the end of the 12th century, the material is dominated by finds purely consisting of square-shanked nails. It is most likely, that this development was caused by a change in the production process and/or in the organisation of the production. It is tempting to see it as a result of the contemporary political and economical developments taking place in Northern Europe with the implementation of feudal state structures in Britain and Scandinavia. Specialization of craft,turning the nail production over from the boatbuilder to the blacksmith with a permanent workshop would be a reasonable explanation for the choice of a more effective production process; and the change to a square cross-section from a round one is a rationalization (see production processes above). However, a find like the 15th century Aber-Wrach vessel (see L'Hour & Veyrat in this volume) with round-shanked rivets demonstrates that the studies are far from completed yet.

As mentioned earlier finds of boat nails may reflect not only the spread of different traditions, but even aspects concerning more general, technical relations between ship and tradition. In Fig. 6 the relation between size of vessel and size of nails is examined. The measurement used to describe the size of nails is the average area of the shank's cross-section. This dimension is chosen because the rivets within each find usually seems to be quite homogeneous in this respect. In contrast, the thickness of the planking (normally regarded as half the inside length of the rivets) may vary considerably depending on location in hull and on the actual, often lens-shaped cross-section of planks; this is clearly demonstrated by, for example, the five Skuldelev ships (see Olsen and Crumlin-Pedersen 1967). When we look at Fig. 6 there seems to be a clear increase in thickness of shafts related to the growing size of vessels. In the left side of the diagram, measurements made on the rivets from two clinker built waggon bodies are included; such waggon bodies have been found in a number of Viking Period burials in southern Scandinavia, probably representing a burial tradition comparable to the boat grave tradition. The rivets used in the waggons are comparable to those used in small clinker built vessels.

Of course the need of stronger connections between the planks, caused by increasing size of vessel, can be met in ways other than by increasing the size of the rivet; the most obvious one being to reduce the distance between each rivet. Thus the size of the rivets might give us some indication of vessel's minimum size, but only in vague terms as "small" or "boat-size", "medium-size" and "large".

From the material presented above it seems possible to distinguish clear chronological and regional patterns alone

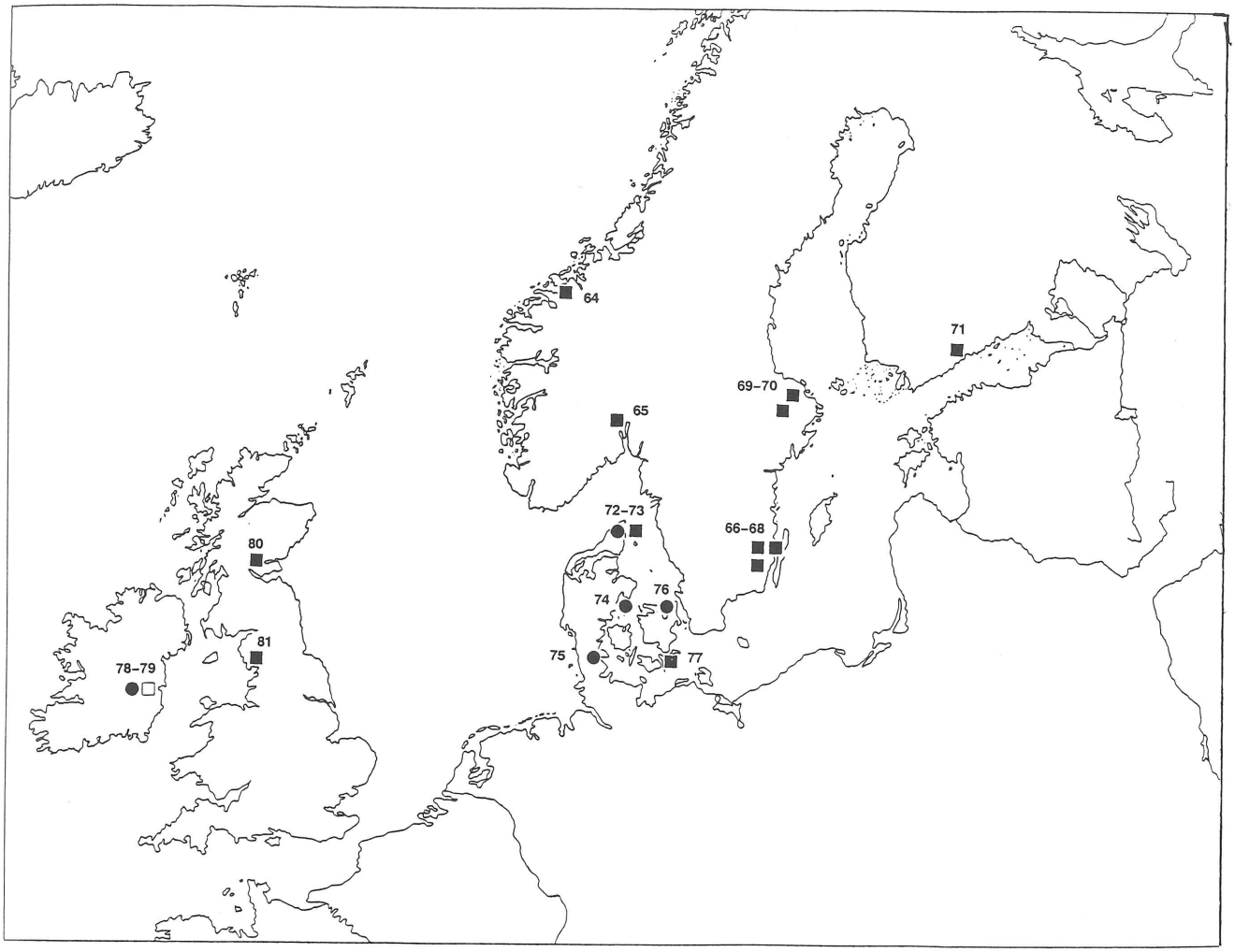

*Fig. 5. Finds of boat rivets with known cross-section of shank, dated between AD 1100–1400. Same legends as Fig. 3. The numbers refer to the following sites: 64: Bolsøya (Bostwick Bjerck 1991); 65: Sjøvollen (Christensen 1968); 66: Kalmar 1 (Åkerlund 1951); 67: Kalmar 2 (*ibid.*); 68: ..; 69: Helgeandsholmen V (Varenius 1983); 70: Vik (Larsson 1986 and information from Larsson); 71: Åbo Slotsholm (Forssel 1982); 72: Ellingå (information from Crumlin-Pedersen); 73: Nordstrand (information from J. Dencker); 74: Kyholm (information from Crumlin-Pedersen); 75: Schleswig, S51–53 (imprints, Crumlin-Petersen forthcoming); 76: Lynæs (from imprints in planks); 77: Gedesby (Crumlin-Pedersen 1988, Bill 1991 and examination of imprints); 78: Dublin TG 1–2 & 4–6 (McGrail 1993); 79: Dublin TG 3, 9 (*ibid.*); 80: Perth, King Edward Street (information from Michael King and examination of nails); 81: Kentmere (Wilson 1966).*

from a single feature as the cross-section of the shank. The blossoming of the clinker technique in an area not very far from the Roman border and from Roman influence is thought-provoking; an important key to the origin of the clinker-technique may be buried somewhere at the Saxon or Frisian North Sea coast. On the other hand, the seeming absence of finds from this area may indicate the technique to be Scandinavian in origin. The Scandinavian change from square-shanked to round-shanked nails points towards a local specialization and optimization, which indeed characterize the whole concept of the Viking ship. And the change back to cheap, square-shanked nails is almost emblematic of the acceptance of the European reality, which marked the beginning of the Middle Ages in Scandinavia.

ACKNOWLEDGEMENTS

This project would never have been carried so far without the assistance from a number of institutions and colleagues from different countries, and I would like to thank these for all the help offered. Especially I want to thank the Hermitage Museum in St Petersburg for permission to study and publish parts of their material, and Olga Davidan for her help and translations.

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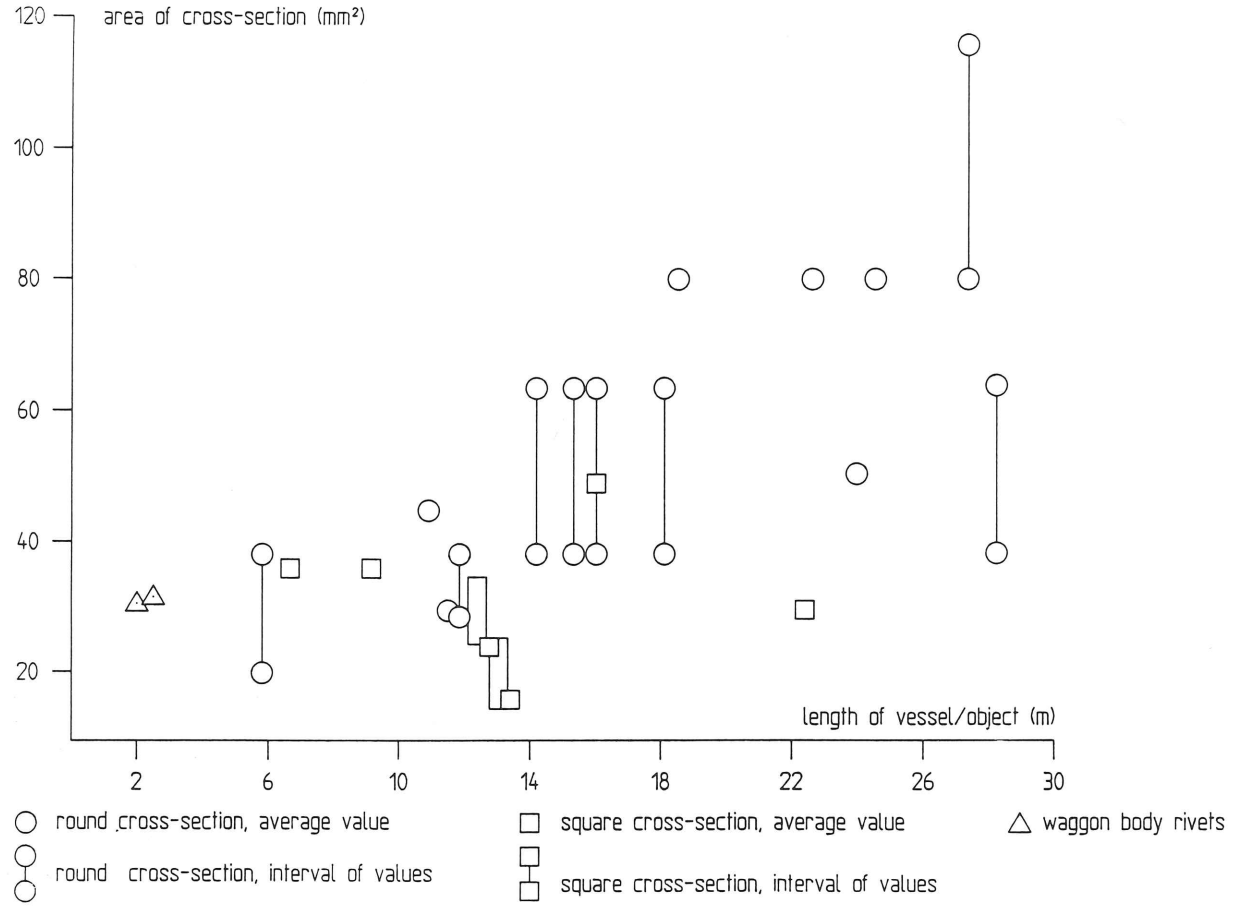

Fig. 6. Relation between area of shank's cross-section and length of vessel. Triangles represent waggon bodies.

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