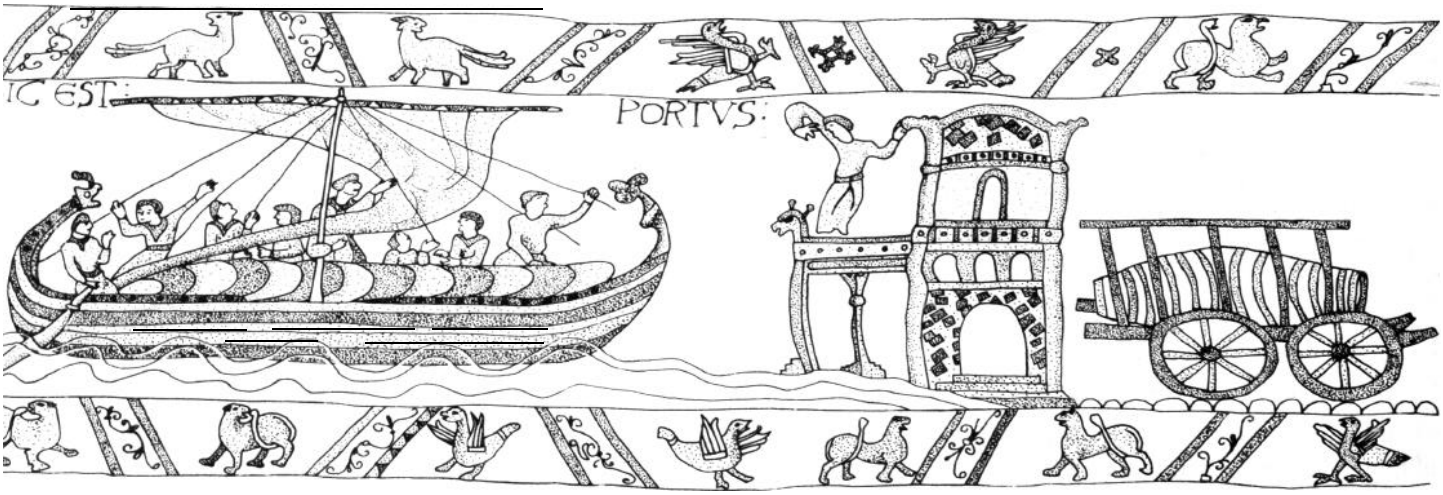
CBA
RESEARCH
REPORT

No 41

WATERFRONT ARCHAEOLOGY IN BRITAIN AND NORTHERN EUROPE

Edited by
Gustav Milne
and Brian Hobley



1981

Waterfront archaeology in Britain and northern Europe

A review of current research in waterfront archaeology in six European countries, based on the papers presented to the First International Conference on Waterfront Archaeology in North European Towns held at the Museum of London on 20-22 April 1979

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1981
Research Report No 41 The Council for British Archaeology

ISBN 0 906780 08 X

Designed by Allan Cooper FSIA and Henry Cleere

Published by
The Council for British Archaeology
112 Kennington Road
London SE 11 6RE

Printed at Tomes of Learnington

Cover drawing adapted from the
Bayeux Tapestry by Chrissie Milne

British Library Cataloguing in Publication Data
International Conference on Waterfront Archaeology in
North European Towns
(1st: 1979: London)
Waterfront archaeology in Britain and northern
Europe - (CB A research report, ISSN 0589-9036; no41)
1. Archaeology - Congresses
2. Anthropo-geography-Congresses
3. Maritime anthropology
I. Title II. Milne, Gustav
III. Hobley, Brian
940'.00946 CC51

ISBN 0-906780-08-X

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Introduction

Almost any definition of a town must refer to the importance of trade, but archaeologists have only recently attempted to study the development of riparian and coastal towns by examining the major trade outlet itself, the waterfront. Such a study can provide graphic evidence of and suggest reasons for a town's origins, growth, or decline. In order to stimulate interest in waterfront archaeology by reviewing its potential, by assessing the current state of knowledge, and by improving the contact between urban and nautical archaeologists in Britain and on the Continent, a conference was held in London on 20-22 April 1979. It was jointly organized by the Museum of London, the Council for British Archaeology, and the Nautical Archaeology Trust. Although it was the first conference devoted specifically to the problems and progress of waterfront archaeology, the multi-disciplinary approach which the subject demands had already been foreshadowed by such events as the 1977 Greenwich symposium on dendrochronology in Europe (Fletcher 1978), the conference on Roman shipping and trade held in Canterbury the following year (du Plat Taylor & Cleere 1978), and the Bremerhaven symposium on medieval ships and harbours (McGrail 1979).

Fourteen of the papers presented to the London conference are published in this volume, along with 21 other contributions. They are divided into three sections: waterfront archaeology in London; the Continental evidence; the British evidence.

In Part I, the main themes, approaches, and potential of waterfront archaeology are discussed with detailed reference to the recent work in London. The first five papers cover the development of the waterfront in the Roman, Saxon, and medieval periods, the use of-boats, and topographical topics such as buildings and reclamation. A discussion of the derivation and use of the terms 'hithes', 'quays', and 'wharves' is followed by a comparison of the results of the recent dendrochronological research on material from London and Hull. In contrast to the opening papers, the section concludes with an outline of the development of the waterfront at Southwark, the City's southern suburb, and a summary of the excavations at Runnymede Bridge, where the importance of the waterfront to a prehistoric proto-urban community was demonstrated.

In Part II, many of the themes introduced in Part I are developed in the light of the Continental evidence. The Polish contributions examine the evolution of ships in the southern Baltic and outline the contrasting development of Wolin and Gdansk. Summaries of Roman harbour construction at Velsen, the Carolingian waterfront at Dorestad, and the later medieval port of Dordrecht are followed by papers on medieval Bergen, on inland harbours, barges, and cranes on the Rhine, and on dendrochronological research relating to the 11th century port of Schleswig.

Current research in eighteen towns in Britain and Ireland is presented in the final section, usually in summary form but with extended treatment given to the important work in Dublin, Hull, and King's Lynn. The other papers outline the waterfront development of some major Roman and medieval ports, and include reports of the hitherto unpublished excavations in Exeter, Harwich, Kirkwall, Plymouth, and Portsmouth.

We hope that these papers will help to generate further discussion and research in waterfront archaeology, a crucial aspect of urban and nautical study.

Gustav Milne **Brian Hobley**

Acknowledgements

First and foremost, our thanks must go to the archaeologists of six European countries who kindly contributed papers to this publication. We also wish to express our gratitude to our colleagues in the Museum of London and the Council for British Archaeology who helped with the organization of the London conference, especially Jean Coleman, Wendy Rix, Chrissie Milne, and Henry Cleere, and to acknowledge that the generous hospitality of D A G Sarre and the staff of British Petroleum at Britannic House during the opening session was greatly appreciated.

The preparation of this volume benefited from the hard work of several members of the Museum's Department of Urban Archaeology, including typist Pamela White, photographers Trevor Hurst and Jon Bailey, and Alison Balfour-Lynn, who drew up Figs 1-6, 24-27, 61, 72, 76, 79, 90, 101, 104, 105, 106, 117, 124, 127, and 130 for publication. The advice and editorial skills of Valerie Horsler and Henry Cleere of the CBA were also invaluable. We should also like to thank Friedrike Hammer, who translated the paper by Dr Ellmers.

List of contributors

P V Addyman, York Archaeological Trust, 47 Aldwark, York YO1 2BX

B S Ayers, Field Officer, Norwich Castle Museum, Norwich

S R Bassett, Department of Medieval History, University of Birmingham, Edgbaston, Birmingham 15

J Barber & C Gaskell-Brown, Department of Archaeology, City Museum and Art Gallery, Drake Circus, Plymouth PL4 8AJ

A Carter, Norwich Survey, c/o Centre of East Anglian Studies, University of East Anglia, Earlham Hall, Norwich NR4 7TJ

H Clarke, Department of Medieval Archaeology, University College London, Gower Street, London WC1E 6BT

M G Dennis, Southwark and Lambeth Archaeological Excavation Committee, Port Medical Centre, English Grounds, Morgan's Lane, London SE1 2HT

B J Durham, Oxfordshire Archaeological Unit, 47 Hythe Bridge Street, Oxford OX1 2EP

A G Dyson, Museum of London, Department of Urban Archaeology, London Wall, London EC2Y 5HN

D Eckstein, Ordinariat fur Holzbiologie, Universität Hamburg, 205 Hamburg 80, Federal Republic of Germany

D Ellmers, Deutsches Schiffahrtsmuseum, 2850 Bremerhaven-M, Federal Republic of Germany

W A Van Es & W J H Verwers, Rijksdienst voor het Oudheidkundig Bodemonderzoek, Amersfoort, Kleine Haag 2, Netherlands

W Filipowiak, Museum Narodwe, ul Starmlynska 27, 70-561 Szczecin, Poland

R Fox, c/o City Museum and Art Gallery, Museum Road, Old Portsmouth, Portsmouth PO1 2LJ

J Hillam & R A Morgan, Department of Prehistory and Archaeology, University of Sheffield, Sheffield SI0 2TN

C G Henderson, Royal Albert Memorial Museum, Queen Street, Exeter EX4 3RX

C M Heighway & A P Garrod, City Excavation Unit, Barbican Road, Gloucester GL1 2JF

A E Herteig, Bryggens Museum, 5000 Bergen, Norway

B Hobley, Museum of London, Department of Urban Archaeology, London Wall, London ECZY 5HN

I P Horsey, Archaeological Unit, Museums Service, Guildhall, Market Street, Poole, Dorset BH 15 1NP

M J Jones & R H Jones, Lincoln Archaeological Trust, Sessions House, Lindum Road, Lincoln LN2 IPB

P Marsden, Museum of London, Department of Urban Archaeology, London Wall, London EC2Y 5HN

N McGavin, Urban Archaeology Unit, Society of Antiquaries of Scotland, 26 East Bridge Street, Falkirk FKI lYE, Scotland

S McGrail, Archaeological Research Centre, National Maritime Museum, Greenwich, London SE10 9NF

G Milne, Museum of London, Department of Urban Archaeology, London Wall, London EC2Y 5HN

J Morel & M D de Weerd, University of Amsterdam, Albert Egges van Giffen Instituut voor Prae en Protohistorie, Singe1 453, Amsterdam, Netherlands

S Needham, Department of Prehistoric and Roman Antiquities, British Museum, London WC1 3DG

B J Philp, CIB ARC Kent Rescue HQ, Dover Castle, Dover, Kent

M W Ponsford, City Museum, Queen's Road, Bristol BS8 1RL

H Sarfatij, Rijksdienst voor het Oudheidkundig Bodemonderzoek, Kleine Haag 2, Amersfoort, Netherlands

J A Schofield, Museum of London, Department of Urban Archaeology, London Wall, London EC2Y 5HN

P Smolarek, Centralne Muzeum Morskie, ul Szeroka 67/68, Gdansk, Poland

T J Strickland & S Ward, Archaeological Unit, Grosvenor Museum, 27 Grosvenor Street, Chester CH1 2DD

K J Wade, Archaeology Department, The Museum, High Street, Ipswich IP1 3QH

P F Wallace, National Museum of Ireland, Kildare Street, Dublin 2, Ireland

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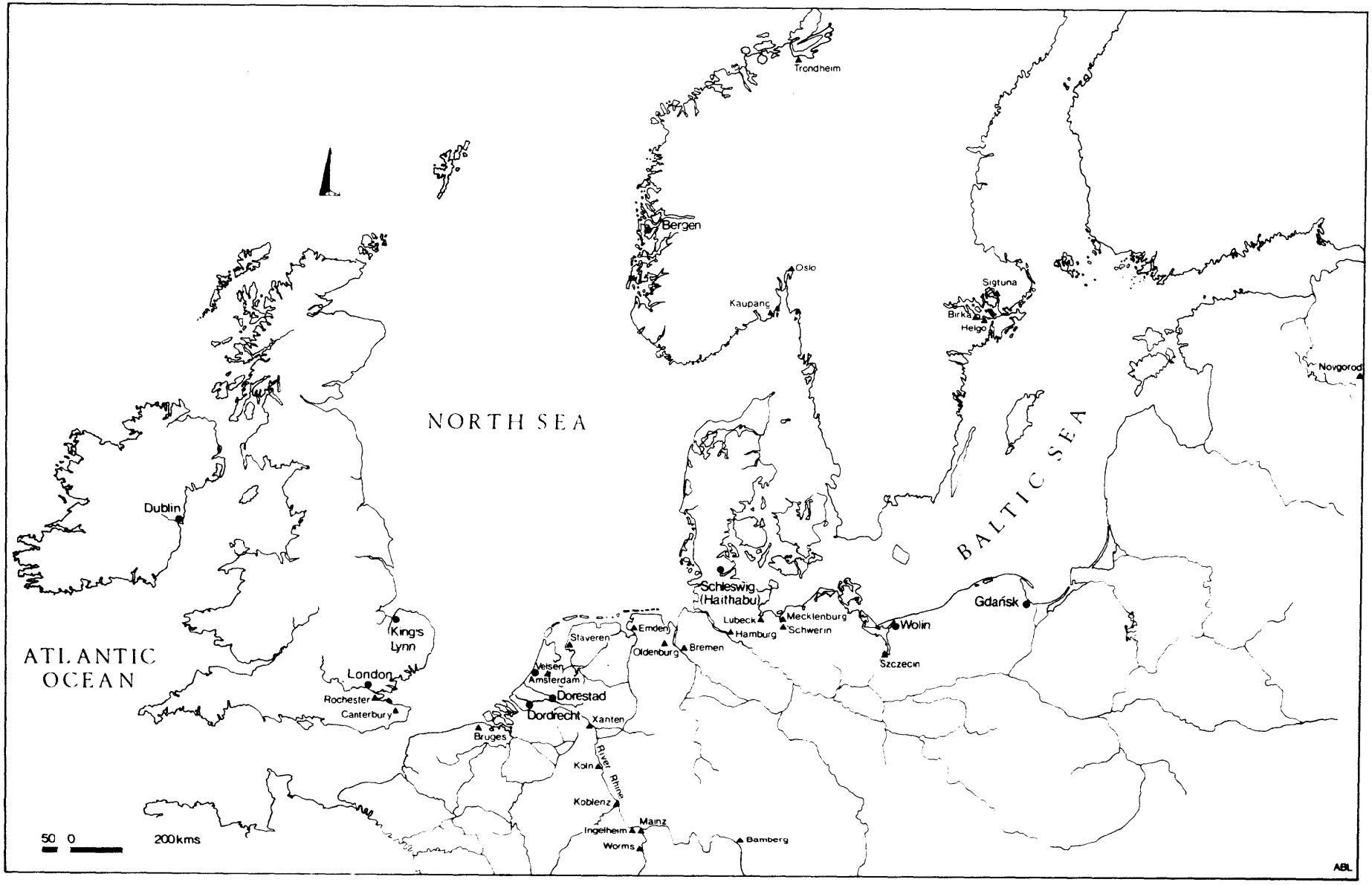


Fig 1 *Map of northern Europe to show principal sites mentioned in text: see also Fig 101*

Link to next section

The London waterfront-the exception or the rule?

B Hobley

Until recently waterfront archaeology has been one of the most neglected aspects of urban studies in northern Europe, although, as this paper will attempt to show, of high research value. However, outstanding pioneer work has been seen at Bryggen in Bergen (Herteig 1975, 65-89), Amsterdam (Baart 1977, 41-66), and King's Lynn (Clarke & Carter 1977), and since 1973 at London (Hobley & Schofield 1977; Milne & Milne 1978). All have demonstrated the need in the future for greater and better coordinated research programmes, including nautical archaeology, which is almost solely concerned with ancient shipwrecks as current research shows *(Int J Naut Archaeol Underwater Explor)*. Waterfront investigation is an integral part of urban research since so many early towns were also ports. It should therefore follow that the three main urban research areas of origins, continuity, and development will be better understood as a result of the combination of archaeological investigation and documentary studies on not just the mercantile shore but also the whole area which abuts on to the river or sea. Waterfront development is an economic indicator not only for the town itself but in many cases for the hinterland also. The well preserved survival of topographical elements can, as found in London, include streets, houses, churches, castles, defences, and sometimes palaces as well as wharves, quays, revetments, jetties, docks, bridges, and cranes. There is, however, an urgent need for an agreed terminology where many of these words are concerned (Dyson, below, 37), and a list of suggested definitions is set out in Appendix 1 to this paper (9). The discovery of ancient wrecks and reused ship timbers is also a feature of such excavations, while the study of the changing draught of ships is a consideration relevant to the siting of ports and the nature of harbour installations (Ellmers, below, 88; Vogel 1977, 21-8).

In addition, waterfront studies should examine the inter-relationship of natural features, such as landforms, sea-level changes, river regimes including course, level, width, tidal head, salinity, silting (Smolarek, below, 51; Wallace, below, 109), and navigable limits related to man's adaption of the shoreline.[1] The pattern of waterfront reclamation and the construction of mills, embankments, weirs, hards, and towpaths are also important.

The economic viability of ports has to be understood in the context of the changing suitability of their situation, for silting or flooding and changes in trade routes and ship design could all result in a port's decline or migration to a more favourable site.

From prehistoric times to the present day, the physical character of many waterfronts in Scandinavia, the Baltic shore, and northern Europe were affected by rises in land or sea levels. These have been due in part to eustatic change caused by glacial ice melting and isostatic recovery of the earth's crust following adjustment to the weight of the ice, resulting in a sinking at the rate of at least 2-3m for London since Roman times. The significance of flooding on the North Sea coasts is now known to be considerable and has been a recurring problem since the Saxon period, but particularly in medieval times (Greensmith & Tucker 1973, 193- 202; Willcox 1975, 285-92).

Finally, the excavation of waterfronts has a special value for artefact studies, because so often these offer well preserved waterlogged stratified deposits rich in both organic and inorganic finds[2] originating both from the town itself and from its external trade, and including most importantly ancient ship timbers (Wallace, below, 109; Marsden, below, 10). Dendrochronological analysis has been used to date timber structures and, by implication, the associated deposits, a process with wide-ranging inter-national applications. In sum, the study of waterfronts embraces many disciplines, with rewards which can be far-reaching for the economic and social history of Europe, as the results from London and other historic towns has begun to show.

Since 1973 the historic port of London has been extensively and fruitfully investigated in a continuing programme of excavations and documentary research (Figs 2 and 3) (Hobley & Schofield 1977; Milne & Milne 1979, 198-204). From Roman times to the present day a well preserved sequence of-deposits, stratified horizontally as well as vertically, has accumulated on the waterfront covering some 8ha: it is potentially 2km long (east-west) by (where excavated) c 125m wide and up to 10m deep (Fig 6c). The almost unbroken sequence of structures has shown London to have been a significant port of trade for most of its near-2000 years of history, with a remarkable continuity of site and a port well into the present century. Hence, it is considered worthwhile for this paper to compare London with parallel phenomena from elsewhere in northern Europe.

Inside the Roman empire and outside, the location of historic European towns shows a decided preference for river or shoreline sites. The Peutinger Map, which is thought to be of 3rd century date, reflects quite clearly the Roman awareness on the Continent of the economic and geographic benefits to trade and communications of the meeting place of land and water (Miller 1962). In Britain a similar picture is seen, and Strabo also recognized this in Gaul, where rivers allowed goods to be conveyed almost coast to coast with little difficulty.[3]

The outstanding continuity found in London reflects well on the Roman choice of site, though whether this was made for military or commercial needs (or both) has yet to be resolved absolutely. Although a military beginning in AD 43 cannot at present be totally discounted, even though there is a general lack of early military equipment, the growing evidence strongly suggests a foundation date for London of *c* AD 50 (Marsden 1978). It seems more likely that it was Roman mercantile enterprise, sanctioned imperially, which created London, and trade in this case did not follow the standard but preceded it. A site was chosen, it must be emphasized, whose excellent location in commercial terms has stood the test of time.

A high percentage of the earliest finds are recognizable as imports and Tacitus describes London within a few years of its foundation as 'an important centre of merchants and merchandise' (Tacitus, Ann, XIV, 33). However, the earliest revetments yet found are of late 1st century Trajanic date,

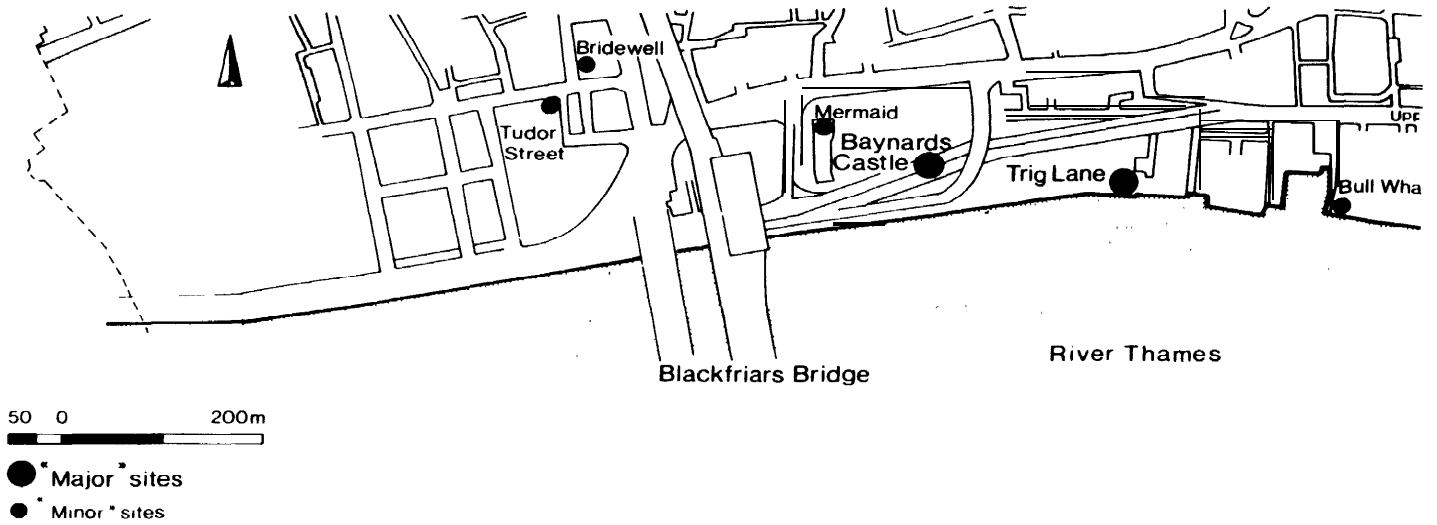


Fig 2 London location of water front excavations

so that the waterfront facilities of these critical development decades are not yet known. The only area of the Trajanic waterfront examined to date, at Billingsgate Buildings (Fig 2b), incorporated a crude timber-built revetment apparently without front or back braces and having domestic rubbish dumped on the landward side (Jones & Rhodes 1981). The 1st century waterfront cannot be judged by this small site and a larger area near the bridge at Miles Lane (Fig 2b) is shortly to be examined which should produce more meaningful structures.

The late 2nd century timber quay was found on several sites including Custom House and New Fresh Wharf (Fig 2b): if this was continuous, it must have stretched for over half of the 2km town frontage. The first recognized discovery was at the Custom House sire, where a series of timber boxes jointed at the front to the quay wall built of four or five tiers of horizontal oak beams was recorded (Tatton-Brown 1974, 122-8) (Fig 4). Later, at New Fresh Wharf, a similar large structure was revealed, 10m below pavement level, with one sill beam at least 8m (28ft) long (Schofield & Miller 1976, 390-5) (Fig 4). Such large engineering works would almost certainly have been the work of the army. The quay wall was braced internally with horizontal timbers jointed to all levels of the wall beams and running back *c* 3m to large square piles. No trace of flooring was found on either site. The discovery of merchandise such as pipeclay Venus figurines, recovered within the main structure below floor level, and pottery on the immediate foreshore, suggested that zoned wharfage was being operated, a theory supported by the absence of pottery from another site at Seal House just upstream of New Fresh Wharf and the bridge (Fig 2b). The quay was probably standing, albeit in a decayed condition, until

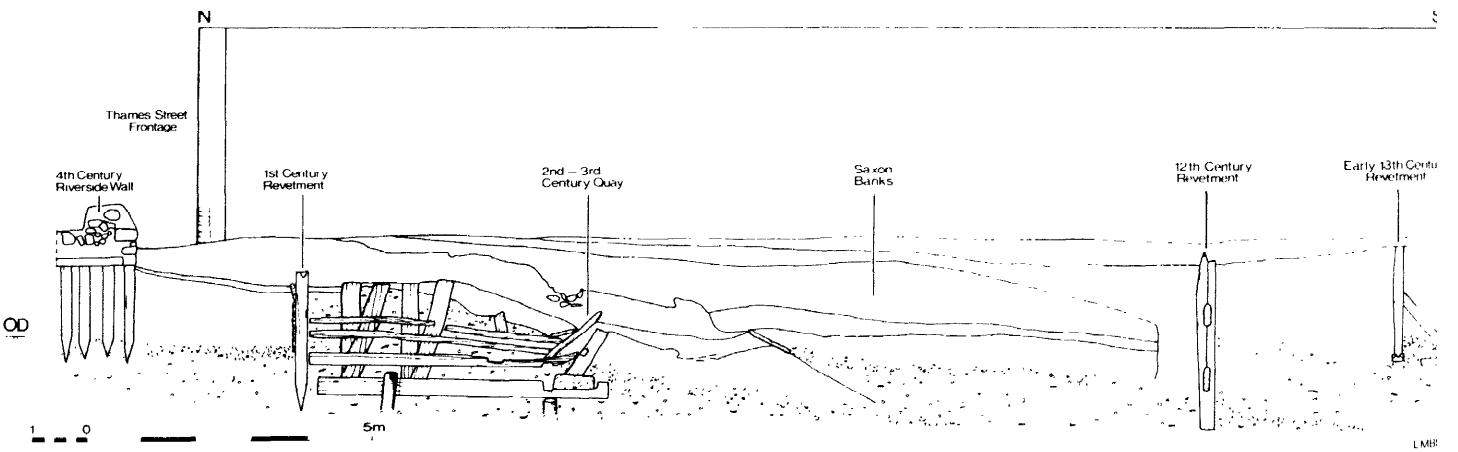
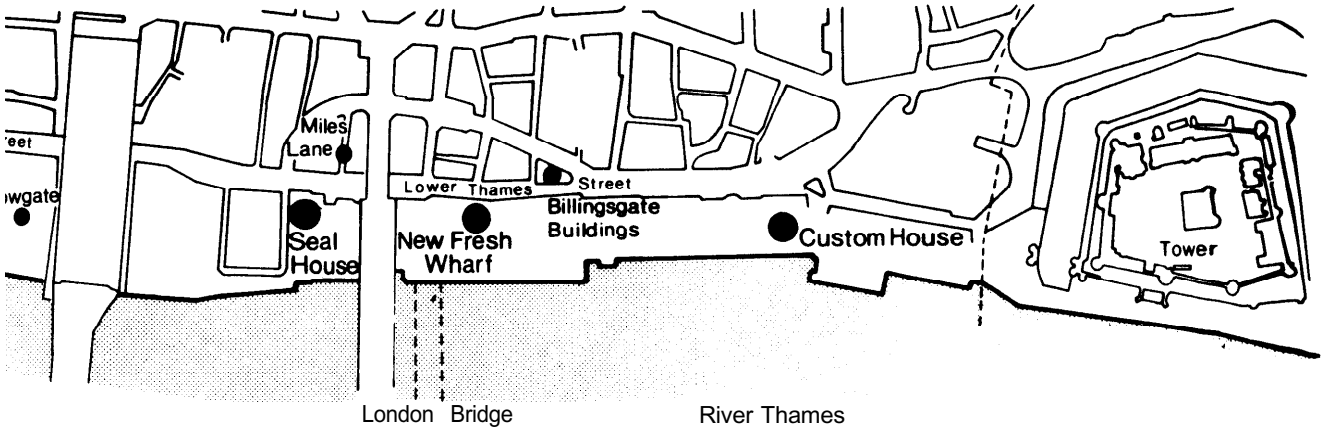


Fig 3 London: composite west-facing section across waterfront: (a) New Fresh Wharf, (b) Trig Lane

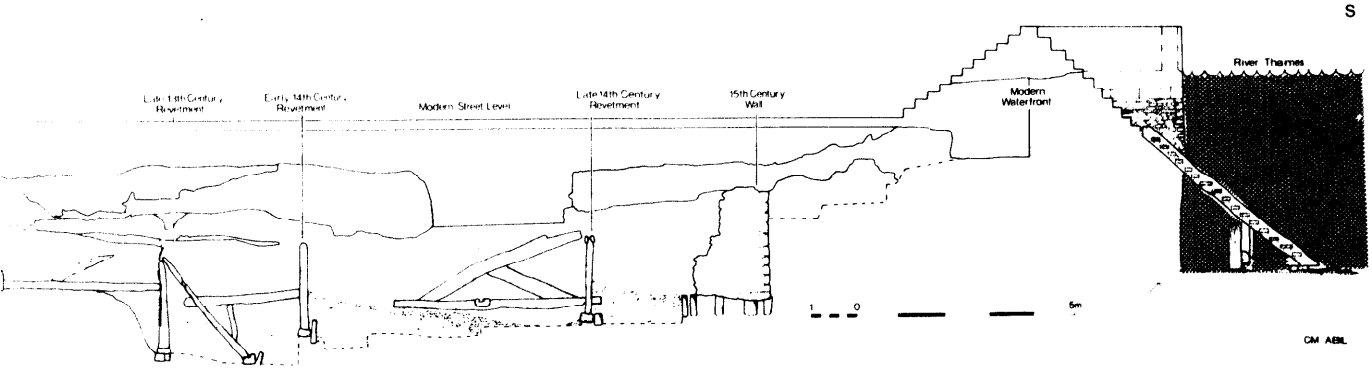


sometime in the 7th and 8th centuries, but excavations have shown nothing to suggest it was in regular use after the Roman period. Only at Xanten on the Rhine, at the legionary fortress of *Vetera,* have comparable timber quays been found (von Petrikovitz 1952, 145- 157) and during the 1978-9 excavations an additional 25m long quay was uncovered. [4] Unfortunately, in Britain, except for London, few Roman harbours have been examined in detail, though fragments of stone quays have been recorded on a number of civil and military sites including Dover (Rigold 1969, 78-100; Hurst 1974,8-52) and Caerleon (Boon 1978, 1-21). Fryer (1973,261-73)and Cleere (1978, 36-40) have recently both reviewed the evidence, and Cleere recognized the need to relate both civil and military harbours to the road network.

In London the need to explain the absence of a riverside defence to match that of the early 3rd century landwall has been a challenge to London archaeologists for over 100 years; as late as 1975 a coherent defensive wall was widely regarded as a fiction (Brooke & Keir 1975, 114). However, during that year a 130m length of wall was uncovered immediately east of the Mermaid Theatre in the south-west corner of the city (Hill *et al* 1979). It was clear that the wall was built above the contemporary river level and therefore could not have been used as a waterfront. It was dated by combined calibrated radiocarbon and dendrochronological samples to the 370s, subsequently confirmed by the dating of further sections of the wall in the Tower of London and at New Fresh Wharf (Fig 3a).

In post-Roman times the pattern of urbanism is obviously one of survival, revival, or new foundations, and the general rule remains valid that the rivers and coastal harbours seem to have persisted as a stimulating economic force, allowing emporia to grow on long-distance trade routes though the date when they began is often obscure (Smolarek, below, 51).

In London at New Fresh Wharf a beach waterfront of Saxon date was discovered (Fig 5). Here the earliest Saxon embankment consisted of a rubble bank, laced by oak posts, which survived against the remains of the Roman defensive wall. The bank may have spread northwards over the foreshore that had formed from the river silts after the Roman quay fell out of use, and was found to have spread riverwards for at least 11m: it was traced for 18m east-west. It did not raise the foreshore significantly but reinforced it like a modern 'hard', and so was presumably used for boats to be drawn upon (Miller 1977,47-53). The closest continental parallel is perhaps the early Viking harbour of Kaupang in Norway, where a similar stone-built



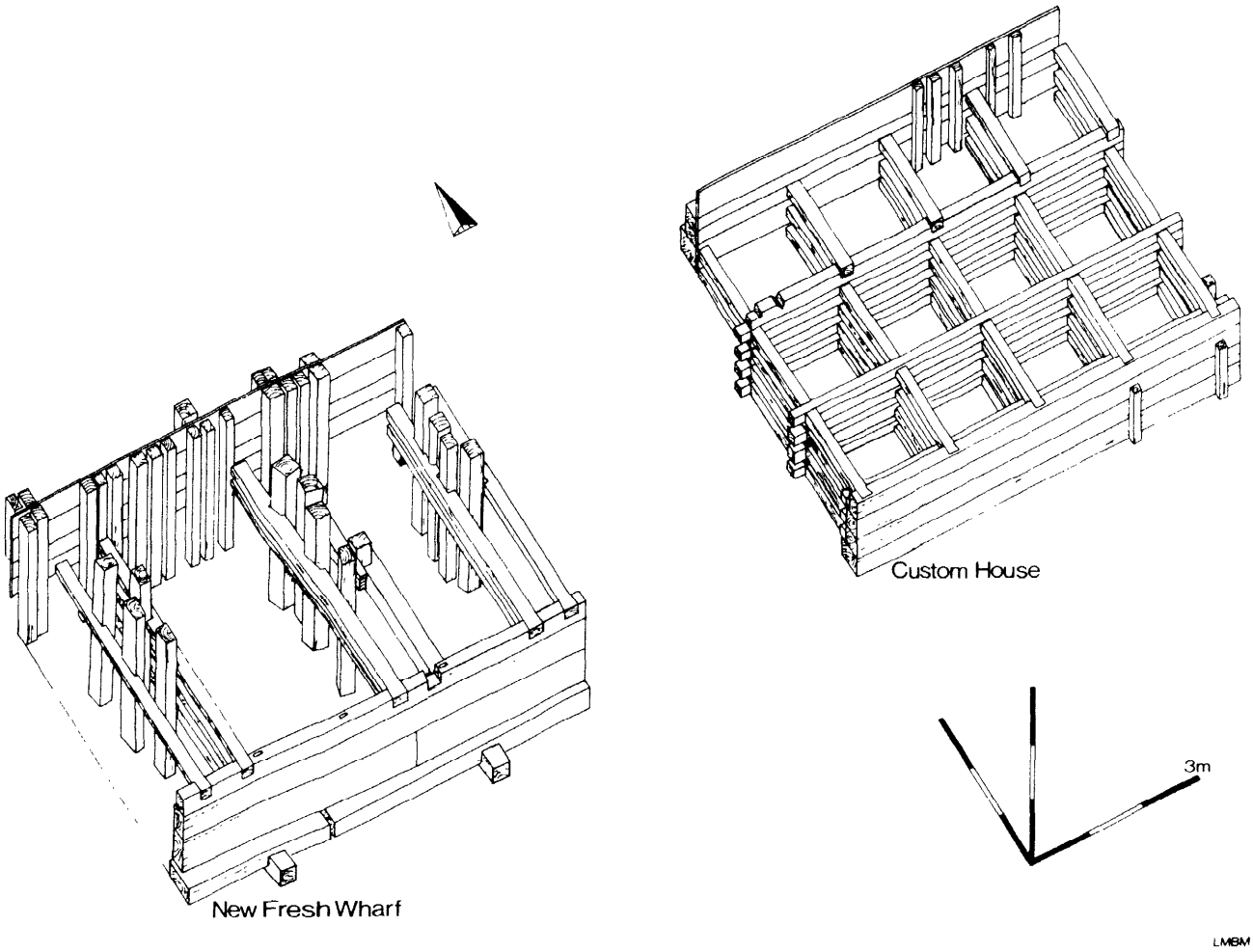


Fig 4 London: projection of Roman timber quay structures from New Fresh Wharf and Custom House

embankment incorporated brushwood and hori zontal logs in front of it (Blindheim 1960, 83-100).

Thus London, in common with other former Roman ports such as those on the Rhine (Ellmers, below, 88), saw its harbour installations decay as the town diminished. The small self-supporting community such as London is assumed to have had little need for waterfront installations such as the Roman quays, for small shallow-draught trading vessels could be landed by running them up on to a flat beach or hard. Thus, it is possible there was a link between the siting of early trading places with shelving beaches and ship design (Smolarek, below, 51; Ellmers, below, 88). Appropriately, the Saxon hard at New Fresh Wharf was built in part of reused boat timbers (Fig 5). The boat was obviously constructed earlier than the bank radiocarbon-dated to 760±100 (Birm 548).

In London a revival of trade by the late 7th century is suggested by coins inscribed *Londinium*. Documentary evidence records London as a port 'where ships come to land' in *c* 672 (Sawyer 1968, 1165) and by Bede, who described London in the 7th century as 'a mart of many nations'. The presence of tax collectors working in the harbour area is implied in a charter of c 745 (Sawyer 1968, 86).

Beyond the Rhine frontiers after the fall of Rome, towns originated from ports and harbours from the 7th century onwards (Ellmers, below, 88). Apparently trading colonies were beginning to grow during the early migration period (400-600) in Europe and as far north as the east coast of Sweden and the islands in the Baltic sea-Oland, Gotland, Bornholn, and Åland (Ellmers, below, 88). On the southern coast of the Baltic Sea the development of early towns took the same course-eg Oldenburg in Holstein, Mechlenburg, Stettin/Szczecin, Schwerin, Wolin, and Kolburg (Smolarek, below, 51), larger ports being situated on river estuaries and not immediately on the Baltic itself. Here political centres and local market settlements protected by a fort gradually developed into international trading towns through the late migration period (600-800) and the era of Viking activity up to 1000 (Smolarek, below, 51).

In France the dead and dying towns lie on the Roman roads and the growing points are to be identified on rivers,

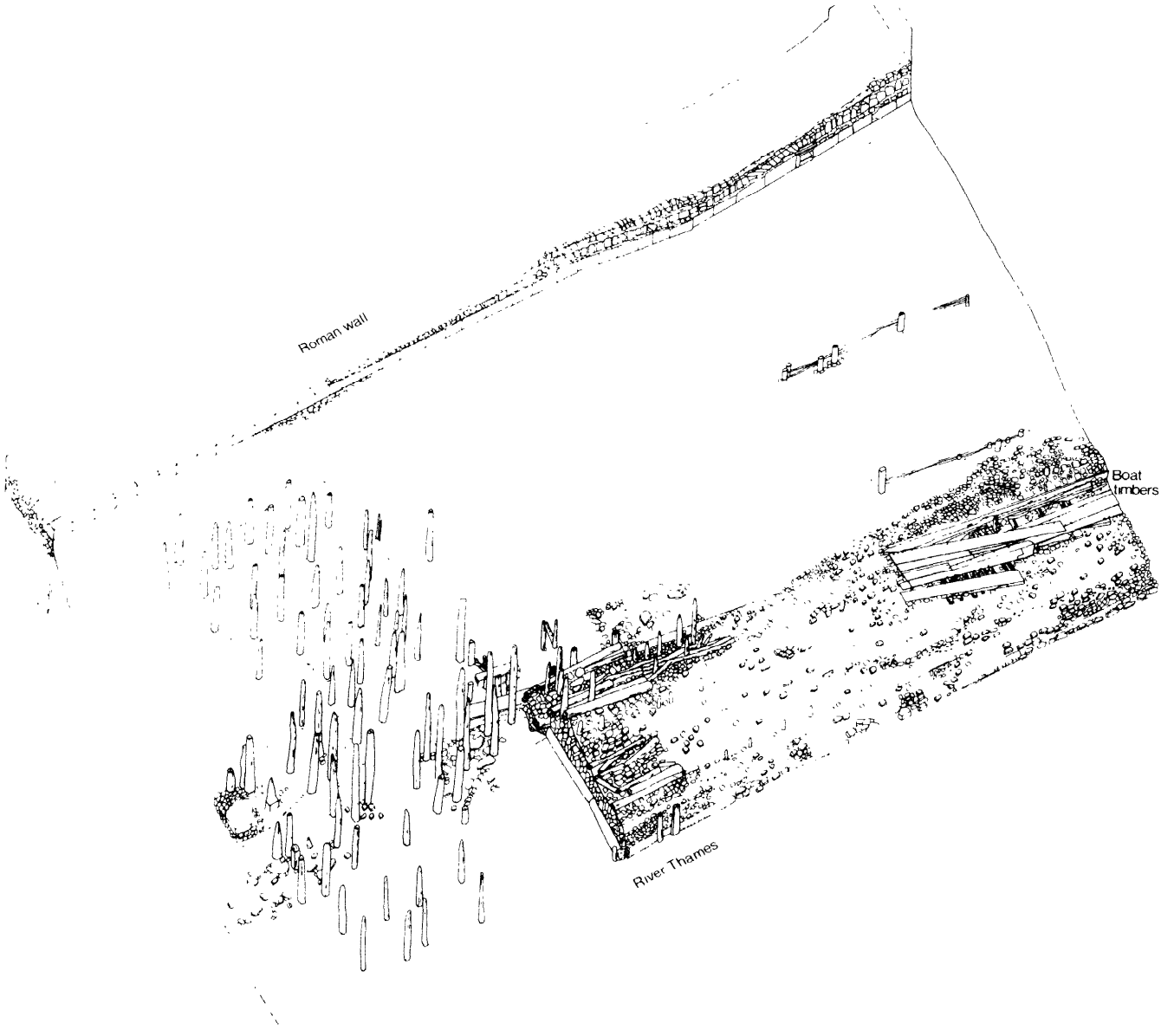
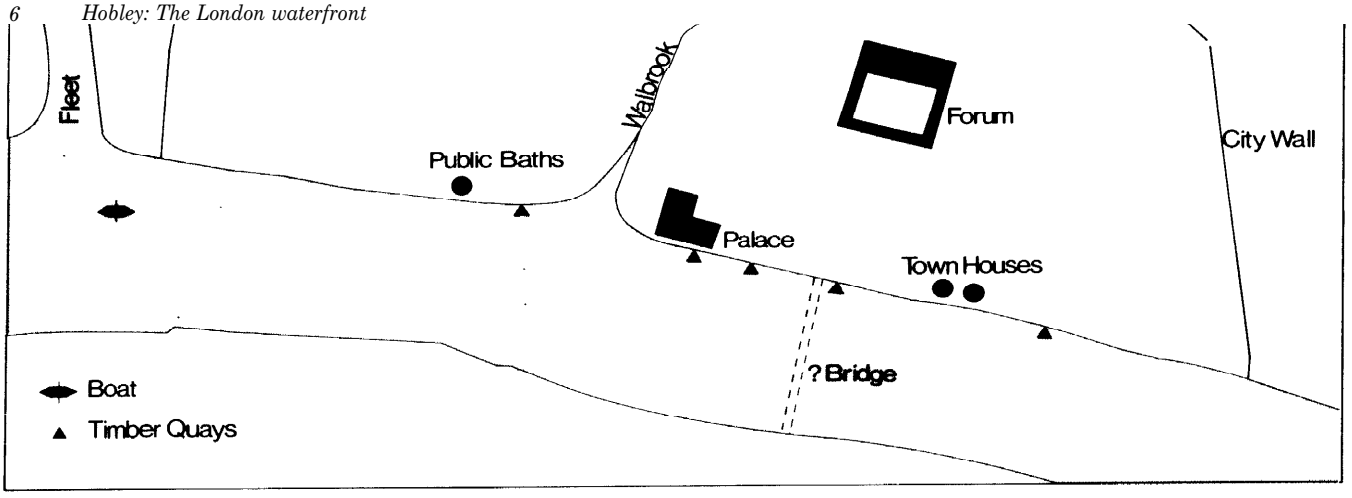
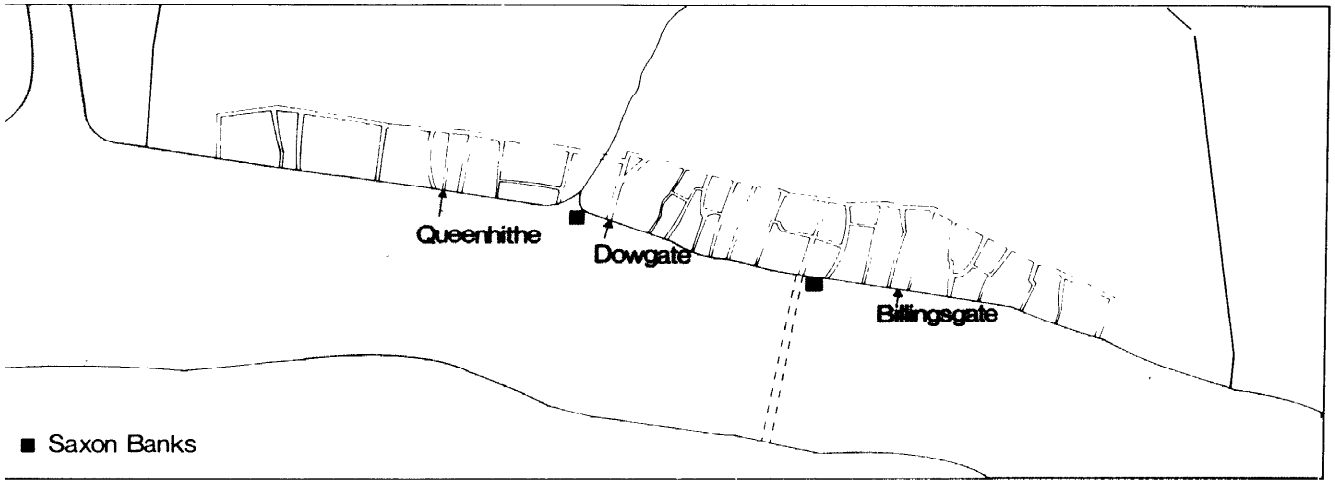


Fig 5 London: reconstruction of Saxon waterfront features at New Fresh Wharf

often at the junction of a land route with the river. In Britain the shift from Romano-British to Saxon centres (eg at Cambridge, Wroxeter to Shrewsbury, Caistor to Norwich, Coddenham to Ipswich, etc) is not observed in London. Significantly, Hill has emphasized there are only four sites in Britain–London, Canterbury, York, and Rochester–where the possibility of urban continuity can be accepted from archaeological evidence (Hill 1977, 293-302). However, this is still rather an open question because in London, as with other Romano-British towns, the archaeological evidence for continuity is mainly demonstrated by an enigmatic featureless 'dark (or 'black') earth' deposit averaging 1–2m in depth, which archaeologists are beginning to argue is better interpreted as evidence for discontinuity in any real urban sense.[5] In passing, it should be noted that many other European historic towns have similar deposits–eg the early trading centres of Birka and Sigtuna in eastern Sweden and Kaupang in Vestfold (Norway). Our knowledge of the physical appearance and even the existence of early Anglo-Saxon towns in Britain is therefore tenuous in the extreme. In London, where excavations in the town beyond the waterfront have failed to clarify the question, the evidence from the waterfront, as already indicated, was rather more positive.

In addition, a dyke-like embankment was built in late Saxon times at New Fresh Wharf which was higher and much more extensive than the earlier one, covering an area some





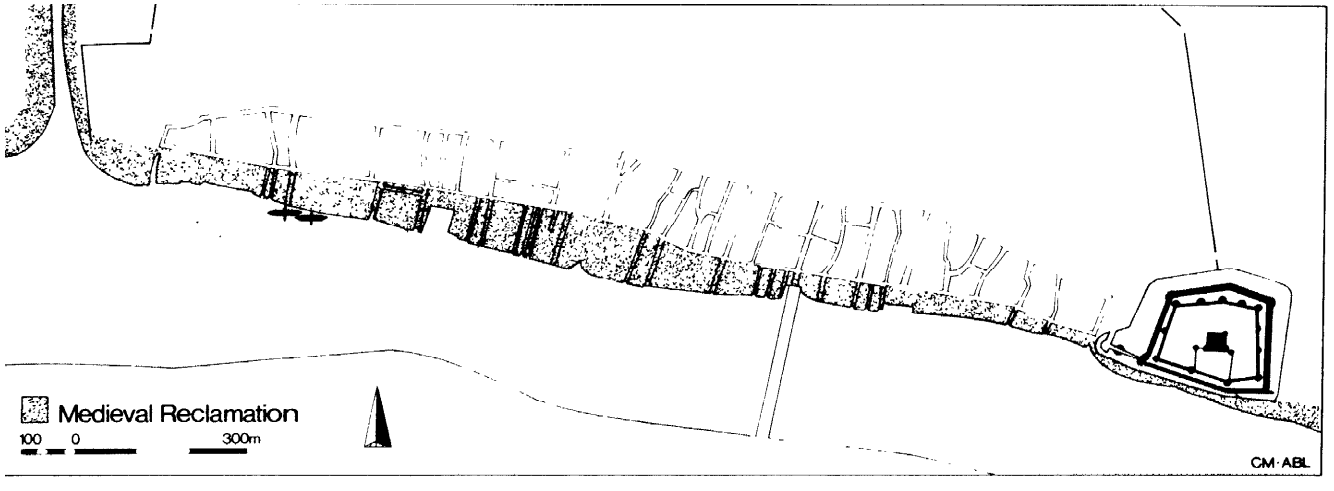


Fig 6 *London: development of the waterfront* in *the Roman, Saxon, and medieval periods*

42m by 21m. It consisted of a clay bank supported by timber to make a substantial raft platform for beaching boats. Furthermore, five frontage tenements were observed with boundaries consisting of rough fences and containing a crude grid of large timbers (Fig 5), carpenter's waste, bundles of faggots, and dumped peaty silt. A provisional radiocarbon date of AD 940±80 (Harwell 2542) allows parallels to be drawn with Dublin (Wallace, below, 000) and the 'Flood Dyke' found on the Fosse at York, where a clay bank was built on a raft of brushwood, dated to around the 10th century (Richardson 1959, 51-79). It is also similar to the 8th-9th century clay bank at Oxford (Hassall 1972, 144-8). London would thus seem to conform to the situation postulated in Europe at this time, where waterfronts were without exception of beach-type construction (Ellmers, below, 88).

In addition to providing landing facilities, these beaches could be used as markets, where goods could be sold either directly from vessels or just above highwater level. A beach market of this type existed at Dowgate (Fig 2b) in London in the 12th century and probably earlier in the 11th: here the shoreline was found to be littered with Germanic pottery, including a considerable quantity of Pingsdorf ware (P Marsden, pers comm). This haven lies adjacent to the later 'Steelyard', the headquarters in London of the Hanseatic merchants whose presence was first recorded c 1000, when Ethelred's law code also records Billingsgate as a centre of international trade. In fact, by the 10th century London was expanding and prosperous. At Queenhithe (Fig 6b), the earliest named centre of commerce on the river, first mentioned in 889, the market existed north of and distinct from the maritime shore to the south (Dyson 1978, 200-15).

Between 800 and 1000 the new factor of Viking power was one which was to keep Europe in a state ofsuspense which extended far beyond the North and Baltic Seas and was by 900 to cause the abandonment of exposed riverbank harbours in favour of those protected by town walls (Ellmers, below, 88). Moreover, as Viking ports and trade grew, so did the development of ships which required more cargo space and hence longer and deeper vessels were built. Eventually, Immediately after the Viking period, when this trend continued, more and more deep water for harbourage was needed, which led to the construction of quays at which ships could be moored from as early as the 11th century onwards in Norway (Ellmers 1972, 14). Ports were sited in relation to two main factors: the development of trade and the protection of trade routes against piracy. The town of Haithabu, near Sliaswick (Schleswig), whose origins date back to the 8th century, was crucially located for trade between Europe and Scandinavia, from whence goods could be transhipped between the North Sea and Baltic Sea (Vogel 1977, 21-8). A settlement which, as it grew, developed a striking similarity to Haithabu was the rich town of Birka situated on an island in the Mäler lake in eastern Sweden (Ambrosiani 1977, 109-14; Ambrosiani & Arrhenius, 1973). A third major port at this time was Dorestad near Nijrnegen, 'the Rotterdam of-the Middle Ages', as it was once called. From here the Frisians, with a strong maritime tradition, practically controlled the trade of northern Europe and set up colonies overseas, at, for example, York and London.

Before the 12th and 13th centuries riverside development in London is known at the two pre-Conquest wharves of Queenhithe and Billingsgate (Dyson 1978) (Fig 6b). Whatever the extent of the late Saxon riverside development beyond these two principal centres (eg Dowgate) may have been, it would have to respect the existence, in part, of the late Roman riverside wall, which was apparently still standing in the early 11th century, though the rising Thames may have reached its maximum width by the end of the Saxon period, not only covering the tops of the Roman wharves but advancing to erode the south face of' the riverside wall.[6]

The next stage in the development of the London waterfront was in marked contrast to the simple reinforcing of the natural riverbank by hards and banks. Now the land was reclaimed behind vertical timber revetments which rose 1.5m or more from the foreshore (Fig 3b).

From the 11th to the 16th century in London piecemeal but continuous reclamation at the expense of the Thames advanced the north bank of the river some 50-100m (Milne & Milne 1979) by a series of rubbish-backed revetments, as excavation has shown. Similar deep archaeological strata are known on many sites elsewhere in northern Europe (Fig 6c).

In London deposits in excess of 10m are known and in Hamburg some 6m. Deep stratification is also recorded at Amsterdam, Bergen, Dordrecht, Emden, Lübeck, Schleswig, and Staveren. The widespread archaeological resource that these deep waterfront deposits represent must surely now be seen as one of the greatest challenges of the future for European archaeology. The earliest post-Roman port waterfront and quay found to date which permitted vessels to be moored is at Gdañsk, Poland (Zbierski 1978; Smolarek, below, 5l), which was apparently built because of shallows that most likely resulted from isostatic recovery in the Baltic area. The next earliest examples of revetted waterfronts are from London at New Fresh Wharf, dated by pottery to the late 11th century and possibly early 12th century,[7] and at Schleswig, dated by dendrochronology to 1075 (Eckstein, below, 96). In London the three earliest successive revetments were found each lying l-2m riverwards of-the previous one, at a slightly higher level and with the area in between filled with mixed dumps of organic material, gravels, and soil. The earliest one was front-braced and had square posts with edge-set planks slotted into the sides (Fig 3a).

The phenomenon of this advancing revetted waterfront is known from Bergen (Herteig 1975) in the north to Dublin (Wallace 1979, 141-7) in the west and Amsterdam (Amsterdam Museum 1977) in the south. Bergen leads the 'advance' in the distance of reclamation zone with 150m from the natural riverbank. London and King's Lynn follow with l00m, Dordrecht 90m, Dublin 85m, Hull 80m, Lincoln an estimated 50m, and Amsterdam-Warmoestraat 32m.

Other ports where extensive reclaimed foreshores are known include Bristol, Carrickfergus, Gloucester, Hamburg, Hull, Old Portsmouth, Poole, and York. Deposits behind the revetments range from domestic rubbish to sand, gravel, and turf sods. At Dordrecht it is reported that a waterfront feature 5m high was required to prevent flooding at high tide (Sarfatij 1977,211). Known constructions on waterfronts include streets, warehouses, and domestic dwellings, notably at Bergen, Dordrecht, and London, where in addition at New Fresh Wharf the two churches of St Magnus and St Botolph appear to belong to the earliest phases of reclamation. Later phases of reclamation have been detected on a number of sites, principally Custom House, Seal House, and Trig Lane (Fig 3b). Substantial remains of at least twelve timber

revetments have been recorded, as well as the more fragmentary remains of at least ten others dated from the 12th-15th centuries. Significantly, the revetment sequence has produced a relative chronology for which dendro-chronological analysis has allowed absolute dates to be suggested.

Although all the revetments constructed during the reclamation of the London waterfront were different, it was possible to classify them into two principal groups: front-braced and back-braced. The former (earlier) group were all of post-and-plank type, incorporating horizontal planking, while the later group included examples of vertically set timbers (Milne, below, 32).

Both groups clearly belong to the 'vertical' tradition of revetment construction known from other sites in England as well as from the Netherlands and elsewhere, and not to the 'horizontal' tradition exemplified at Bergen, Gdañsk, and other towns in the softwood zone.

Thus towns had to adapt not only to increasing high tides but also, and more importantly, to the continuously increasing draught of trading vessels. Open-shore harbours become obsolete: either extensive structural alterations were required to deepen moorings or the harbour shifted its site. Caution is, however, required, for the decisive factors in each shift were probably different. Nevertheless, they perhaps related more to the changing regime of rivers and draught of ships than to the often rather overstressed needs of defence. Ancient shoreline installations were built, and were changed, to serve the needs of-trade and shipping, just like those constructed today. Roman and medieval towns lived by trade, crafts, and markets; in urban studies the economic criteria, such as information about trade and crafts, can be illuminated by the archaeological sources, though documentary records before late medieval times throw light on certain aspects of trade, such as slavery, where archaeology fails. Consequently, more knowledge needs to be gained about how waterfronts were used (eg zoning) and about the ships that used them, either by direct mooring or by transshipment by lighter or barge. Ancient ships and their cargoes are therefore a vital aspect of waterfront studies. In this regard, no other port in Europe can match London in the number and wide range of ancient wrecks found, for six mainly whole vessels and six parts or fragments of vessels have been recovered, including a type of vessel of mid-Saxon date unique for British waters (Marsden, below, 10). This vessel makes an important contribution to research on ship architecture during the Dark Ages. Discoveries of this nature on waterfront archaeological excavations help in establishing more accurate evolutionary patterns and in interpreting local ship-building practice, whilst sea-going vessels found in this way give a guide to where they originated. Hence, patterns of long-distance trade can be gained with some certainty, though there are many problems that cannot be resolved, principally the fact that many goods can seldom, if ever, be part of the archaeological record. The scanty documentary records of this type for all periods up to post-medieval times record that only a small percentage were non-perishable items which might survive the archaeological record in the normal way (Fulford 1978). Clearly, because of waterlogging and the fact that the waterfront provides the first and most concentrated contact with the importing society it is here that greatest attention should be given. Pottery is certainly the best suited artefact to demonstrate trade and marketing patterns; from London mention has already been made of the early medieval Germanic pottery at Dowgate, whilst from New Fresh Wharf there is the outstanding large samian assemblage not seen elsewhere on the Roman waterfront, Both Roman and medieval pottery seldom appears as trade items in written or epigraphic evidence. In fact, in archaeological terms the volume of Roman trade in pottery is not large: for example, all the imported colour-coated vessels and glass found in Britain would fill a remarkably small number of packing cases (Greene & Price 1978, 57,77). When these quantities are set against the fact that a Roman cargo ship was capable of carrying 10 000 amphorae, the scale of potential pottery imports can be visualized. There is a scarcity in the archaeological record of many trade goods such as textiles, and here again waterfront discoveries could help to elucidate the problems. For the Viking period, where there is documentary evidence for such classes of goods as slaves, cloth, wine, and salt, the archaeological method all but fails again as it does for Strabo's list of pre-Roman exports from Britain, which included not only slaves and hunting dogs but also corn, cattle, and hides (Strabo 4, 199). Billingsgate in c 1000 was receiving cargoes of fish, blubberfish, wood, wool, cloth, vinegar, melted fat, pepper, and pigs. In sum, every fragment of archaeological evidence is vital when dealing with trade goods, and it is on the waterfronts that the survival and stratified recovery will be most valuable.

To sum up, the central purpose of this paper has been to reveal some of the potential of waterfront archaeology. It has also been demonstrated that the development, decay, and modification of the London waterfront (Fig 6), reflects the prosperity of the city as a whole and is related to similar phenomena elsewhere in northern Europe.

Research in London has shown that the crucial relationship between the Roman and medieval structures is a vital research need, where as yet no evidence of timber-planked revetments, so typical of the medieval period, has been found. Consequently, the Saxon deposits of the Billingsgate lorry park, shortly to become available, will make it an excavation of truly international importance, where total excavation must be ensured. Extensive investigation of the waterfronts at Hamwih (Southampton) and Ipswich, which do not have Roman precursors, should also be considered as the highest priority, while further work in many historic British ports is essential.

Finally, this paper must seek an answer to the question posed in the title of whether or not the London waterfront is the exception or the rule. Conformity to the general European pattern appears on the present evidence to be broadly the rule for all periods-Roman, Saxon, and medieval. The great uniformity in the Roman world would seem to be derived from military practice on such large engineering works as the waterfronts at Xanten and London. The universality of medieval waterfront reclamation which was required to improve trade, combat flooding, and to facilitate town refuse disposal is also well demonstrated by excavation.

However, London was exceptional in that it saw no dramatic shift of haven until the 19th century. The continuity of function therefore produced a connection between the cities of antiquity, the emergence in the Saxon period of an urbanized Europe, the flowering of trade and town life in the Middle Ages, and modern urban culture.

Appendix I: Waterfront terminology

WATERFRONT: land or buildings abutting on a river, a lake, the sea, etc: the frontage of a town on the waterfront.

PORT: a town (or place) possessing a harbase to which vessels resort to load or unload, from which they start or finish their voyages.

HARBOUR: a place of shelter for ships, especially where they may lie close to and sheltered by the shore or by works extended from it. A waterfront area in which goods and passengers were regularly transferred from ship to shore, and vice versa.

DOCK: an artificial inlet, to admit a boat, etc.

WET DOCK: a water-tight enclosure or basin in which the water level is maintained so that vessels remain constantly afloat in it.

DRY DOCK: a water-tight enclosure or basin from which the water may be excluded for the purpose of repairing an enclosed vessel.

Jetty pier, and mole are often considered as synonyms: the following definitions are therefore suggested to highlight three distinct functions of these features:

MOLE: a solid structure of-stone or earth faced with piles extending into the sea or tidal river primarily to protect or partially enclose a harbour.

JETTY: a projecting part of a wharf; a timber pier of slight construction usually incorporating a landing stage or stair on to the foreshore.

PIER: a projecting structure similar to a jetty, but usually larger, to facilitate the passage of persons directly on to the deck of a moored vessel.

REVETMENT: a 'facing of masonry, concrete, timber, sods, etc, supporting or protecting a bank or embankment.

For the historical meaning of-the terms *quay* and *wharf, see* Dyson, below, 37.

Notes

1 Dated estuarine sediments from archaeological sites in the City of London are being studied by Peter Boyd of the Department of Urban Archaeology, Museum of London, with a view to interpreting the subfossil biotic assemblages that they contain. The remains of a wide range of subfossil planktonic and benthic organisms have been recovered, including diatoms, dinoflagellates, tintinnids, ostracods, cladolerans, foraminifera, testaceans, bryocoans, charophytes, molluscs, seeds, and pollen. These are being used to identify changes in salinity due to climatic or sea-level changes and trace the development of pollution in the Thames and its tributaries. The preliminary results of this study are to be published in the proceedings of a conference on environmental archaeology of coasts and islands organized by the Association for Environmental Archaeology, held at Lancaster University in September 1979.

2 For example, see the report on Roman leather shoes from London in Jones, D, & Rhodes, M, *Excavations at Billingsgate Buildings (The Triangle), Lower Thames Street, London, 1974,* London Middlesex Archaeol Soc Special Paper **4,** 1981.

3 Strabo (IV, 1, 2): 'the courses of rivers are so excellently disposed in relation to one another that goods can be conveyed over the plains for a short distance and that without difficulty while for the most of the journey they travel by the rivers . . . .'

4 Information from Dr C B Rüger, Rheinisches Landesmuseum, Bonn.

5 Philip Taylor of the University of London Institute of Archaeology has carried out several grain-size analysis and other tests *in situ* and in the laboratory on samples from the dark earth in the City. No definite explanation can be given for its formation at present, but there is no evidence for it having been a true soil, as it shows none of the vertical differentiation one would expect in cultivated soil or one left fallow and has a low organic content, the dark colour apparently being due to disseminated carbon.

6 After describing the landward defences of London, William FitzStephen, biographer of Thomas Becket, writing in the 1170s, went on to say, 'On the south side, London was once walled and towered in like fashion, but the Thames . . . . has in the course of time washed away these bulwarks, undermined and cast them down'.

7 Information from Clive Orton, Department of Urban Archaeology.

Early shipping and the waterfronts of London

P Marsden

The interpretation of the significance of the early waterfronts and shipping of London is largely dependent on a study of the economic, political, and environmental history of the port. For at least half of the period of the history of London little is known about these factors, and so the significance of the quays and other structures could easily become lost in a study of a mass of constructional and stratigraphical detail.

A current study of groups of objects from the Roman city shows that its greatest trading period was from about AD 50 to about AD 130. Rubbish pits and occupation layers dating from this period contain objects from Italy, Greece, Palestine, Turkey, Syria, north Africa, southern Gaul, and Spain, as well as from Germany and northern Gaul. Indeed, as this was the period when Roman London apparently embraced trade with the whole Empire, it may be expected that its waterfront would be one of its most developed areas. But, in fact, little of the waterfront of this period and none of the ships have been excavated so far. A small portion of a waterfront revetment has been uncovered as far east as the Custom House site (Tatton-Brown 1974, 122), near the Tower of London, but this was not particularly substantial and is unlikely to have been a landing site for the large Roman merchant ships, such as those which carried amphorae from Spain. As in the later Middle Ages, the largest seagoing ships may be expected to have been moored downstream of London Bridge, whereas only the smaller and more local craft were generally offloaded upstream of the bridge. It was these local vessels that may have been moored at the six timber posts, each about 100mm in diameter, that were found driven into the early Roman river gravels of Dowgate, about 50m from the Roman river bank, on the Public Cleansing Depot site in 1959 (Fig 7).

A period of decline seems to have followed from about the middle of the 2nd century, and it was not until the end of that century and during the 3rd century that the city was to some extent restored, probably with a reduced population. The discovery of a major quay and three ships dating from this period of restoration indicates a resumption of trade, though a study of the objects from rubbish deposits in London shows that apparently trade was not generally restored with the Mediterranean region. Instead, trade was primarily concerned with central and northern Europe.

The three ships were different types of craft, and reflect the varying trading activities on the waterfront of London and elsewhere at that time (Fig 9). The County Hall ship, found in 1910, was of 3rd century date, and had a rounded hull form, a slightly projecting keel, and a construction that was characteristic of classical period shipping in the tideless Mediterranean (Marsden 1974). It is clear, therefore, that this sea-going ship was designed to moor at deep-water quays to be offloaded, and that it could have been one of the many vessels trading with Germany or Gaul, as was a ship carrying a cargo of samian ware, presumably bound for London, that was wrecked on Pudding Pan sand in the Thames estuary off Whitstable.

Such a deep-water quay, apparently dating from the late 2nd century, seems to have extended along about half-a-mile of the waterfront of Roman London, east of the Walbrook stream (Fig 7). Built out from the river bank so that it lay in deeper water, the quay had a frontage of squared baulks of oak, and no doubt supported a deck of planks on to which the cargoes were offloaded. There was probably about a 2m depth of water in front of the quay, which was deep enough both for the County Hall ship, and for the merchant ships importing goods from Gaul and Germany (Fig 8). Such goods were indeed found at New Fresh Wharf, just downstream from the Roman bridge, when in 1974 excavations beneath the Roman quay revealed a large quantity of unused but broken pottery. The assemblage presumably represents consignments damaged during transit and thrown away at the quay, and included samian ware cups, bowls and dishes from Gaul, while Rhenish wares included a large group of mortaria from Soller in Germany, together with a stamp of the late 2nd century potter Verecundus. (Schofield & Miller 1976; B R Hartley in Hobley & Schofield 1977, 62).

In contrast to the County Hall ship, which required a deep-water mooring, the Blackfriars ship had a flat bottom and no keel (Fig 9) and was therefore designed to operate in the tidal coastal waters off northern Europe (Marsden 1967), Indeed, the fact that its planking had been infested by the

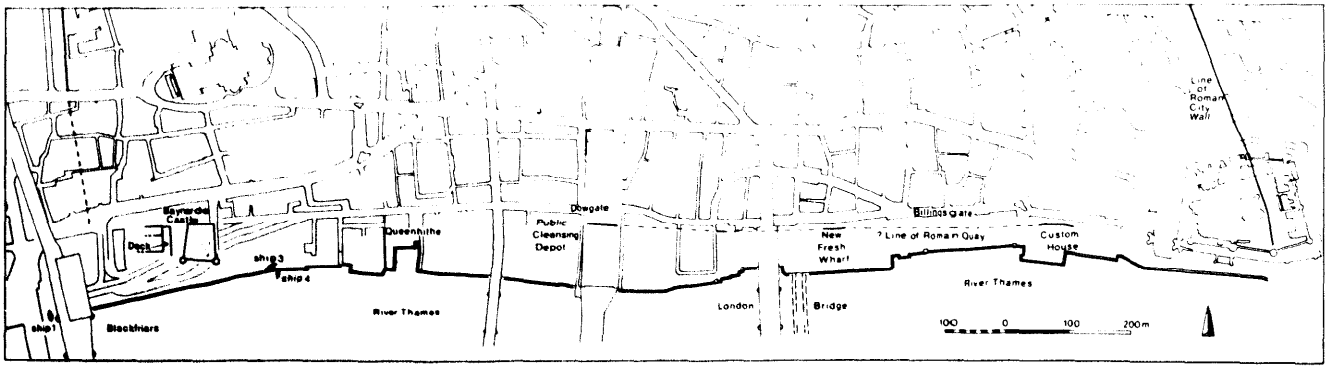


Fig 7 Plan of London waterfront, showing sites mentioned in the text

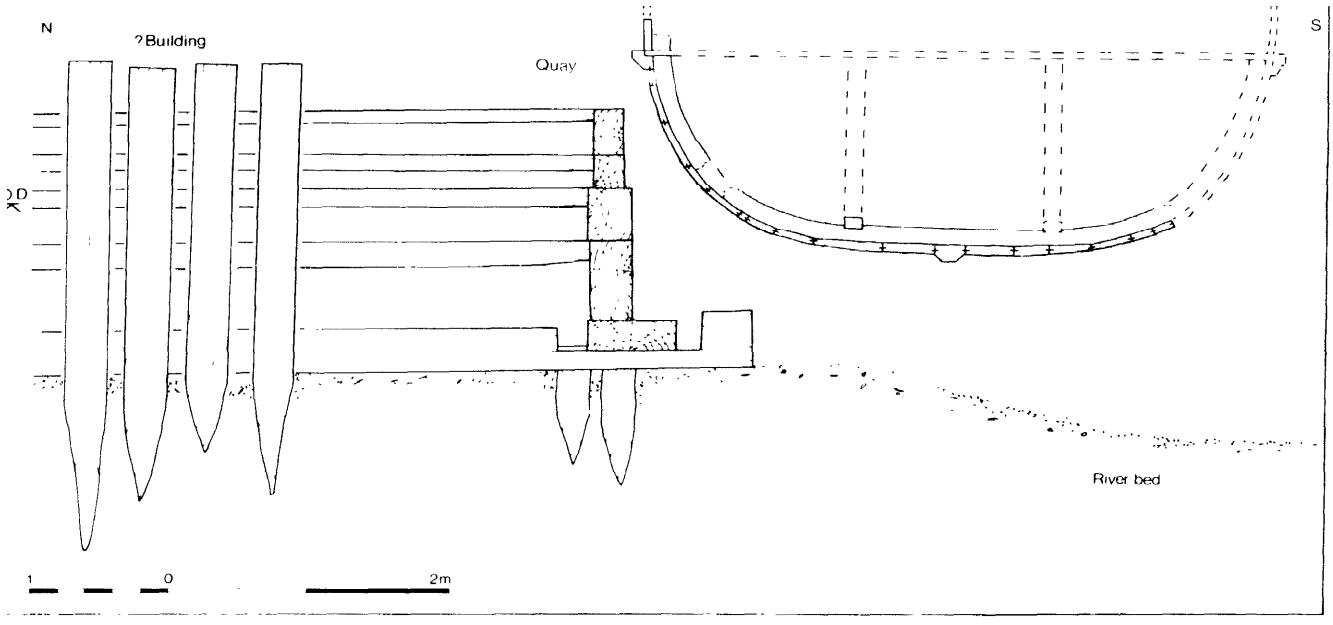


Fig 8 *London: partly reconstructed late 2nd or 3rd century quay at New Fresh Wharf, with approximate Roman river level, and cross-section of the County Hall ship (3rd century)*

marine wood-borers *Teredo* and *Limnoria* is proofenough that its usual environment was the sea. Its flat bottom enabled it to be loaded and offloaded from the foreshore of coastal settlements at low tide, and then to set sail when afloat at high ride. Its construction and design was the product of the Celtic peoples ofnorthern Europe, and is paralleled by a 2nd century boat found at Bruges in Nelgium in 1809 (Marsden 1976). Because the Thames at London was probably hardly tidal during the 2nd century when the Blackfriars ship sank, this large vessel had to be offloaded at a deep-water mooring at a quay or jetty, or even into a local river barge at a deep-water anchorage. Although, when wrecked, it was carrying a cargo of building stone from the Maidstone district on the river Medway in Kent, an unfinished millstone of Millstone Grit from Yorkshire suggests that, on a former voyage, it had been trading with the York region on the river Ouse.

The Blackfriars ship might have been offloaded into a river barge of the type that was found at New Guy's House in Southwark (Marsden 1965). This vessel had such a low freeboard, even though it had a beam of-over 4m, and such a broad flat bottom that it was clearly an inland craft designed to operate in a shallow river (Fig 9). It could float in less than 1 m of water and so did not require a deep-water quayside. Presumably the New Guy's House vessel carried such things as local agricultural produce up and down the Thames, particularly between the riverside rural settlements and the port of Londinium.

During the 4th century the trade of London declined owing to economic and political disturbances, as well as to Saxon raids (Merrifield 1965, 52-75). A possible watchtower was built downstream at Shadwell (Johnson 1975), and eventually a riverside defensive wall separated the Roman city from the river (Hill et al 1980). It is no wonder that at this stage its quay was silting up and eventually collapsed into the river (Tatton-Brown 1974, 127-8; Miller 1977,47-8).

By the time that there was a revival in trade during the latter half-of the Saxon period, much of the Roman riverside wall had been eroded away (Hill et al 1980,45) and much of what remained of the Roman quay had been buried under alluvium. It was at this stage that markets apparently developed on the waterfront, certainly at Queenhithe (Dyson 1978) and Billingsgate, while excavations have revealed traces of carefully prepared waterfront landing sites at Dowgate and just west of Billingsgate at New Fresh Wharf, suggesting that markets may have existed there too.

At New Fresh Wharf traces of a prepared beach and embankment included the reused broken pieces of a clinker-built ship or boat. Found in a deposit radiocarbon-dated to AD 760 ± 100, the pieces of planking apparently lay on the sloping surface of the shore, possibly to help facilitate boats being pulled ashore (Miller 1977,47-5 1). A similar late Saxon embankment was found in 1959 further west, just east of the mouth of the Walbrook, and in front of it a later foreshore line along which lay a large quantity of pottery sherds ranging in date from the 10th- 11th centuries to the mid- 13th century (Marsden, forthcoming). The surprising feature about this pottery group is that roughly three-quarters of it comprised imported pottery, much of it being spouted pitchers of Pingsdorf ware and related types, as well as blue-grey ware pots, also from the Pingsdorf region of Germany. This is especially interesting for immediately east of the site there lay the Steelyard, the London headquarters of the German Hanse merchants in

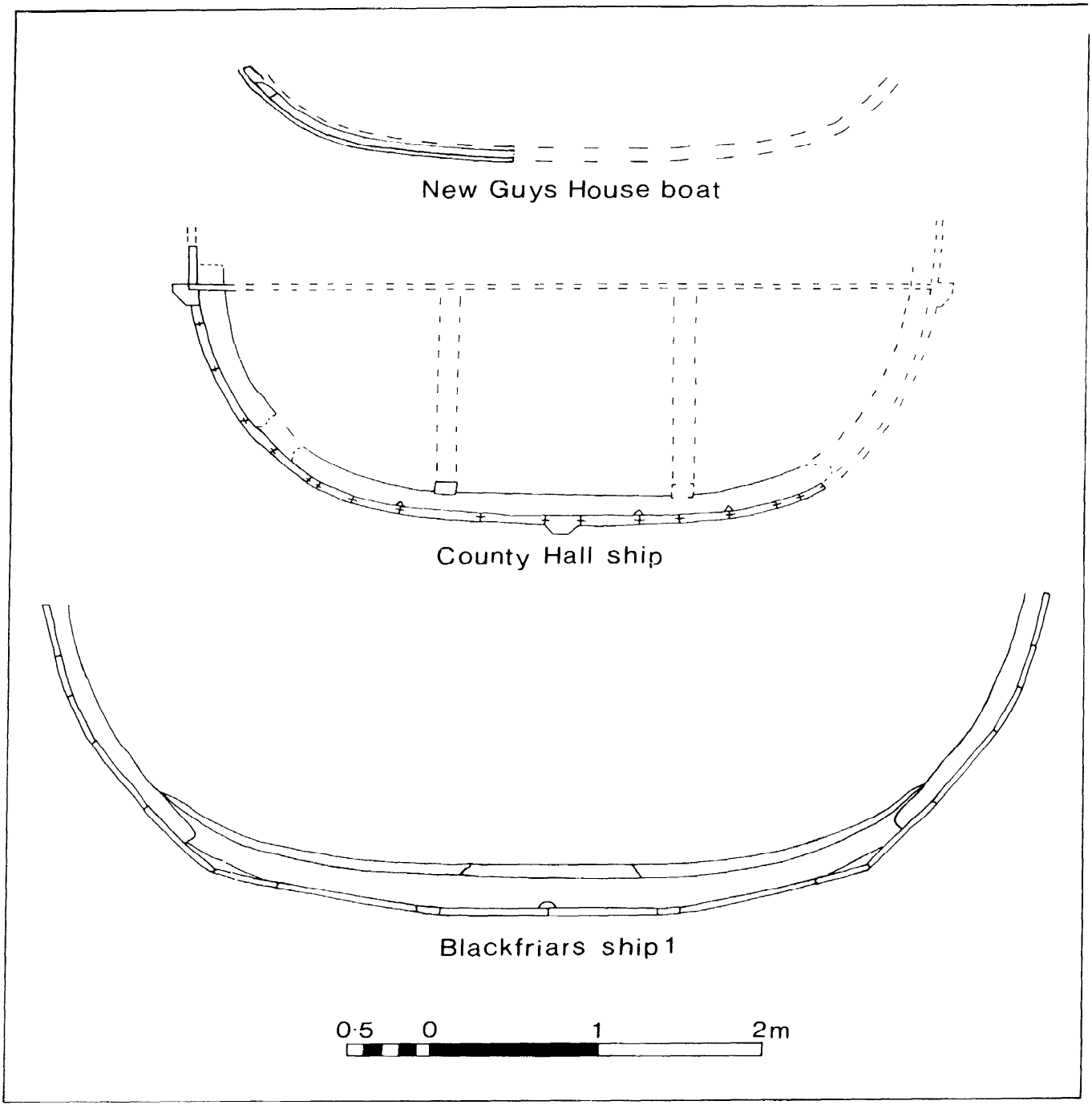
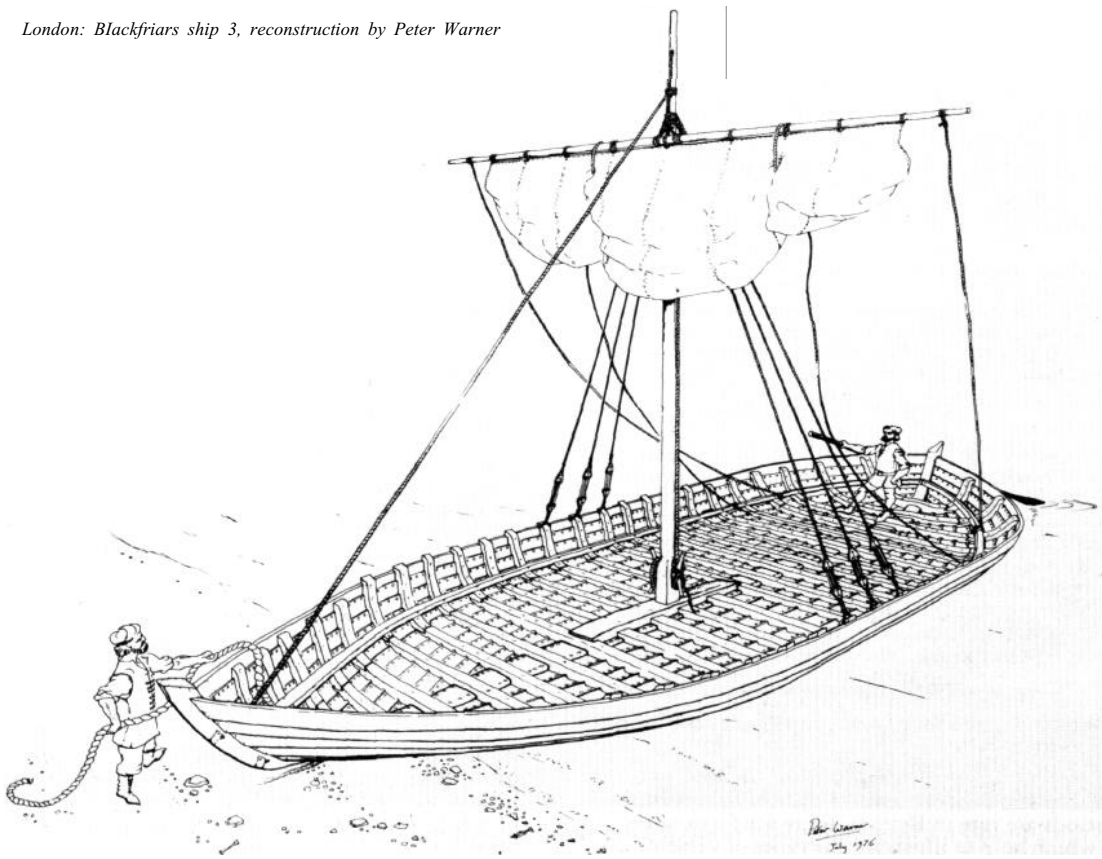


Fig 9 *London: partly reconstructed cross-sections of the three Roman ships found in London. The sides of the New Guy's House boat were probably more upright, but had been a little flattened owing to burial*

Fig 10 *London: Blackfriars ship 3, wrecked in the Thames during the late 15th century, was a broad sailing vessel with a shallow draught, for sailing on inland waters*

Fig 11 *London: BIackfriars ship 3, reconstruction by Peter Warner*



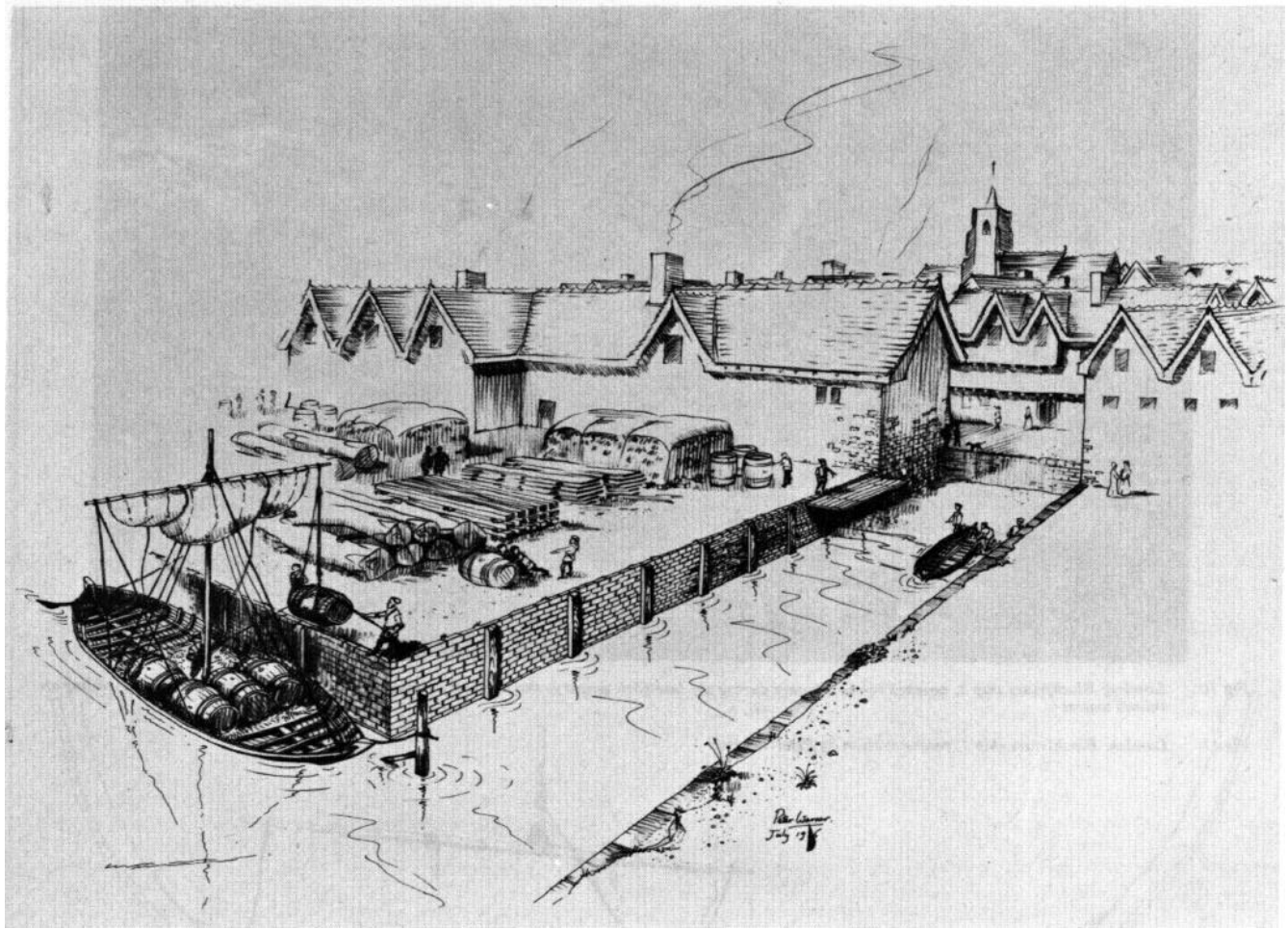


Fig 12 London: reconstruction by Peter Warner of the 15th century dock, situated west of Baynards Castle, excavated in 1972

the later Middle Ages. Although the Steelyard was acquired by the German merchants in 1475, it seems likely that the site was occupied by their *Gildhalla* at least as early as the 12th century (Harben 1918, 550), a view that is now supported by the archaeological evidence.

On both the New Fresh Wharf and Dowgate sites the later Saxon and Norman waterfronts were merely sloping beaches, indicating that the ships were expected to run aground to be offloaded. This was apparently the normal type of waterfront in northern Europe at that time, as far as can be judged, and it is likely that the usual types of ships using the port of London then were somewhat similar to the well-known Viking ships at Roskilde in Denmark (Olsen & Crumlin-Pedersen 1967), as well as to the ships illustrated on the Bayeux tapestry and on the 12th century town seals of Fordwich and Faversham in Kent (Fenwick 1978, 245). The vessels were therefore probably clinker-built craft pointed at both ends, and they were propelled either by oar or by a single square sail.

Although ship and boat remains of the late Saxon and Norman periods are rare in Britain, there are fortunately three finds which help to illustrate the types of vessels that were in use in south-eastern England. The most complete was found at Graveney in north Kent, at the mouth of the Thames. Dated to the 10th century, its form and construction were entirely consistent with what is believed to have been the general style of vessel commonly in use at that time, and it seems to have been abandoned on a muddy foreshore covered with traces of brushwood (Fenwick 1978, 183). Another boat apparently of similar form, but dating probably from the 13th century, was found, split down the keel-line and reused in slabs of still fastened planking, in a revetment on the Custom House site in London (Tatton-Brown 1974, 128-32). Both the Graveney and Custom House boats had iron rivets holding their overlapping planking, and had a luting of hair. This is very different from the fragments of the boat found at New Fresh Wharf, reused on the late Saxon waterfront. Although the boat was clinker-built, the overlapping planks were held to each other not by iron rivets but by wooden pegs, and the luting was of moss. A recent examination of the boat fragments by Miss Jane Squirrel1 shows that the planks were made from unusually straight-grained oak, that the wooden pegs holding the clinker planks together were of willow, and that they had been expanded by small wedges of oak. Unfortunately, there are insufficient fragments to show the form of the vessel.

Fig 13 *London: timber rubbing posts protected vessels moored in Baynards Castle dock from damage by the stone wall*

Fig 14 *London: timber mooring post situated at the mouth of the 15th century dock west of Baynards Castle, partly buried in a waterfront wall built at the end of the 15th century*

The development of trade during the Middle Ages led to the proliferation of specialized types of ships and boats that were adapted to their environment and use, and also to quays and docks. One of the medieval ships found in London particularly clearly illustrates this (Figs 10 and 11). Blackfriars ship 3 was a flat-bottomed beamy clinker-built, single-masted vessel with a low freeboard and a shallow draught (Marsden 1972). It had sunk during the 15th century close to the contemporary river wall recently excavated at Trig Lane (Milne & Milne 1978). It was clearly designed for use only in the Thames and was presumably engaged in the local trade of the river. Fortunately, it is possible to reconstruct its method of loading and unloading for the excavations just west of Baynards Castle, nearby, revealed the complete rectangular basin of a contemporary dock of the 14th and 15th centuries (Marsden, forthcoming). The dock was surrounded by stone walls (Fig 12), with the medieval castle close by on the east side and a large gravelled area for unloading on the west. Oak rubbing posts originally lined the dock to protect the boats from being damaged by the rough stonework (Fig 13), but those on the castle side had gradually decayed away and were not replaced, indicating that little use was made of that side of the dock. On the west side, however, the posts had been renewed several times before the dock was filled in at the end of the 15th century, to make the area available for an extension of the castle. An oak mooring post was found just outside the dock entrance (Fig 14), while towards the back of the dock were two rubbing posts with mortices cut in them, indicating that they once supported an unloading platform that had projected over the dock side. No trace of a crane was found at the edge of the dock, and it is possible that the yardarms of the ships were used for unloading (Fig 12). Inshore of the unloading area, and beside Upper Thames Street, there was a stone building, perhaps a warehouse, with an arcaded lower floor which fronted on to the unloading area. The south-west corner of London, therefore, provides an unusually clear picture of some contemporary waterfront activities during the later Middle Ages: a ship, a dock, an unloading area, and probably a warehouse. These represent the domestic activities of London's port, however, and not its international trade, which was mainly located downstream of London bridge, and which may be elucidated by future excavations in the Billingsgate area.

Types of water transport

Apart from personal flotation aids such as the inflated skins and sealed pots described by Hornell (1972, l-20), there appear to be nine basic types of ancient water transports, some of-them with hybrid forms. These types may be divided into two main groups:

Non-watertight rafts made of reed bundles, bark bundles, inflated skins, or logs/bamboos. They may be 'boat-shaped' or otherwise.

Watertight boats made of waterproofed reed, bark, skin or bitumen over a wooden skeleton, logs, or planks.

In the region of northern Europe considered at this conference, reed and bark boats and rafts made of bark or of skins have not been excavated and there are no surviving traditions which might indicate their earlier existence. Until a year or so ago a similar statement might have been made about reed rafts, but Breandán O Ríordáin recently drew my attention to such a craft in the ethnographic collection of the National Museum of Ireland (Fig 15). This raft *(cliath thulca)* was made for the National Museum after the design of-reed rafts known to have been used on the river Suck in southern Co. Roscommon in recent times (Delaney 1976, 24- 8). These earlier rafts were poled as well as rowed, and the superstructure was of wickerwork rather than the timber shown in Fig 15. Such craft could obviously be made wherever suitable reeds grew and so it is advisable to keep an open mind about the possible use of reed rafts in medieval Europe.

European log rafts have been published by Ellmers (1972, 106, 112-6), and by Eskeröd (1956, 59-61). Skin boats, represented in recent times by the currach and the coracle, have not yet been excavated, but there is documentary and iconographic evidence for their medieval use (Hornell 1972, 111-47; Severin 1978; Johnstone 1980). Until recently, logboats (= dugout canoes) were generally believed to be of prehistoric date, but there is now a considerable body of evidence for their medieval use (McGrail 1978, 251-3; McGrail & Switsur, 1979a). Of the 24 reliably dated British logboats, for example, fourteen are from the 3rd to the 14th centuries AD. Planked boats appear to have reached a dominant position in north-western Europe at an early date, and medieval examples have been excavated from many sites.

Urban archaeologists may find some or all of these types of water transport associated with their excavations of medieval waterfronts; planked boats and ships will undoubtedly be the most numerous.

Boat and ship archaeology

Boat and ship finds are almost always incomplete and therefore the archaeologist has to evolve conjectural reconstructions of the original vessel, so that he may attempt to answer questions about her performance. What could she have carried? What was her draft? Could she have come alongside this waterfront at high-water or low-water, or have to lie off? Could she have crossed the North Sea direct? How stable was she? To answer such questions the nautical specialist must evaluate the reconstruction(s) by eye, by calculation, by tank test, or by full-scale replica trials to deduce operational capabilities. In addition, a knowledge of the prevailing regional weather and the tidal regime in a particular harbour is required, and the strength and resilience of the ship's structure and her methods of propulsion and steering must be established. Waterline shape is an important factor in the assessment of a ship's performance, but what was the medieval waterline? The best solution here, perhaps, is to use several values for freeboard and draft in the calculations. For this and other reasons (not least that several reconstructed forms may be compatible with the surviving remains) the nautical archaeologist may be unable to give a precise answer to some of the foregoing questions, but rather several answers, each valid for different sets of assumptions.

In the past, boat and ship remains have seldom been well recorded or dated, and there are at present few regions and periods with a sufficient number of well documented finds to support the identification of specific local types, although broader classifications may be possible (see below). Furthermore, it is often impossible to equate excavated remains with type-names from documentary sources, as historians and others would wish. Attempts have sometimes been made to equate a particular feature of boat building (such as the use of moss caulking or of treenail plank fastenings) with a unique time and place. But this may be unwarranted because of widespread use. For example, moss caulking was used on the Bronze Age Ferriby boats (Wright 1976), on post-medieval Dutch boats (Reinders 1979), and in intermediate periods; treenail plank fastenings were used on two of the 10th/11th century Skuldelev ships (Olsen & Crumlin-Pedersen 1967, 100, 111) and on the 12th/13th century Norwegian Sjøvollen ship (Christensen 1968a, 140), as well as on 9th/10th century ships in the East Baltic (Crumlin-Pedersen 1969). Identification of a boat's origins and any link with a documented type-name is probably best pursued by systematic feature analysis and dating of the boat find, together with a similar analysis of the documentary references and iconographic representations. If successful, this investigation should reveal groups of characteristic features which may be tentatively identified with a named type, or, at a more detailed level, with particular regional or temporal variants (McGrail & Switsur 1979b). Diagnostic features, a sub-set of the characteristics, should then enable future finds to be allocated to these types.

Analysis of form and structure has proceeded sufficiently far in certain areas for some general boat and shipbuilding traditions to be identified. Thus, Crumlin-Yedersen (1978) has listed the common features of Viking warships and cargo ships, and the general characteristics of the Rhine barges of late Roman times are beginning to be understood (Marsden 1976; de Weerd 1978; de Boe 1978; Arnold 1978). Using this sort of evidence Crumlin-Pedersen (1978) has postulated that four types of indigenous planked boats were in use in north-western Europe from the beginning of the

Fig 15 *A reed raft* (cliath thulca) *being rowed by Patrick Gately, the builder, on the river Suck, Co Roscommon, Ireland, in 1962 (Photograph: National Museum of Ireland)*

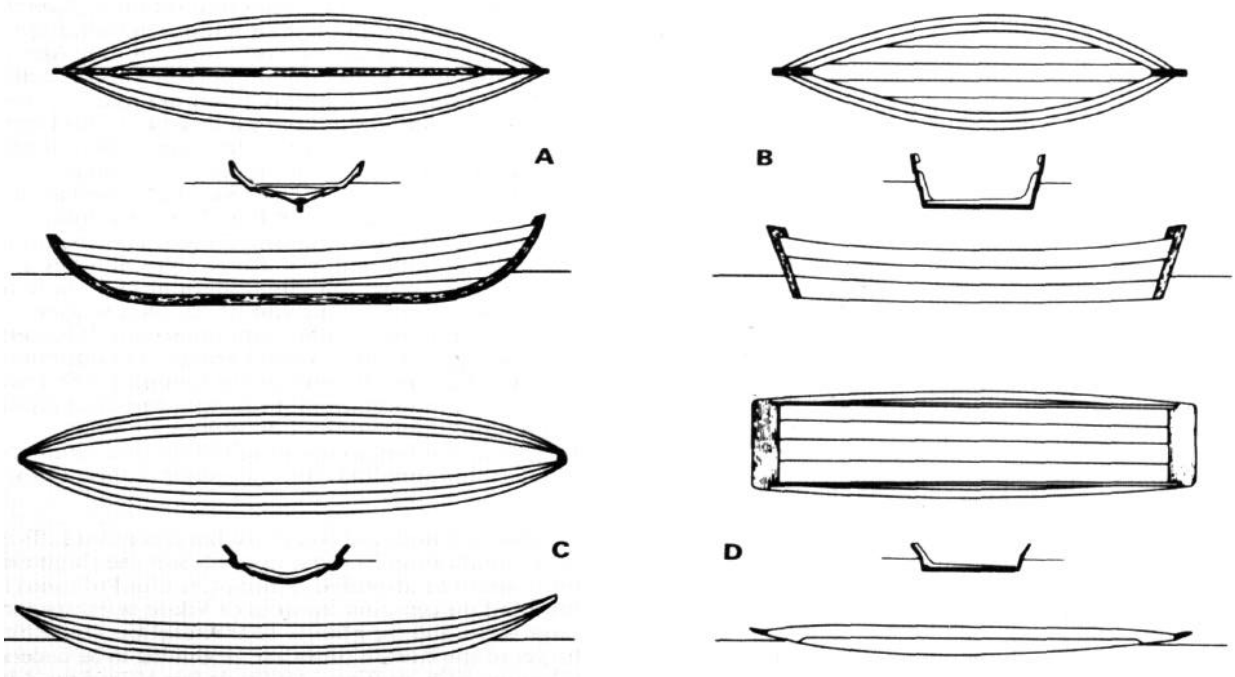


Fig 16 *Basic characteristics of four medieval boatbuilding traditions in north-west Europe: (A) Nordic or Viking (B) cog; (C) hulk; (D) punt or barge (Drawing after Crumlin-Pedersen)*

Fig 17 *The 13th century seal of Winchelsea, depicting a late form of the Viking tradition of shipbuilding*

(Photograph: National Maritime Museum)

Fig 18 *A seal of Elbing (Elblag), Poland dated c AD 1350: a late form of cog (Photograph: National Maritime Museum)*

medieval period (Fig 16). In response to changing economic and military requirements, first one and then another was developed in size to become the principal ship of the day.

Thus, the period c AD 800- 1200 was dominated by the Nordic or *Viking* shipbuilding tradition. For excavated examples, see Olsen & Crumlin-Pedersen (1967) and Christensen (1968b); representations of developed versions of this type can be seen (Fig 17) on 13th century town seals (Ewe 1972). The cog, a flat-bottomed, high-volume, cargo carrier (Fig 18), possibly originating in the Netherlands, became the most important sea-going ship in the 13th and 14th centuries (Crumlin-Pedersen 1965; Ellmers 1976,259; Ellmers 1979; Crumlin-Pedersen 1979). Documentary sources indicate that, subsequently, another tradition from the Frisian region came to dominate sea commerce in the 14th and 15th centuries. This was the *hulk,* whose characteristics are thought to be a banana shape with the planking not terminating at conventional stem and stern posts but on a horizontal line (Fig 19). No example has been excavated, but see Greenhill (1976, 283-5) for a summary of other evidence. Co-existent with these three sea-going types, Crumlin-Pedersen believes there was widespread use of a *punt* or barge type (Fig 20) on rivers and estuaries and in harbours.

Crumlin-Pedersen's thesis is a useful working hypothesis, though other traditions of boat and shipbuilding may remain to be identified. As the dominant ship type changed during the medieval period, so did the type of landing place required. In addition, as high-value, high-density goods gave way to low-density, mass-consumption goods, and with a general increase in the volume of trade, the sea-going ship was developed in size (Fig 21) with an increasing requirement for harbours with waterfronts. Defence requirements, the collection of custom dues, and warehouse methods of marketing probably reinforced this trend towards formal landing places.

Landing places

There is documentary and archaeological evidence that, at least until the 11th century, boats and ships-especially in tidal regions-did not need formal harbour facilities to discharge and take on cargo. For example, the marked wear on the keel and lower planking of Skuldelev ship 3 shows that

Fig 19 *An angel of henry VII doted to the late 15th century. This is considered to be a representation of a hulk*

(Photograph: National Maritime Museum)

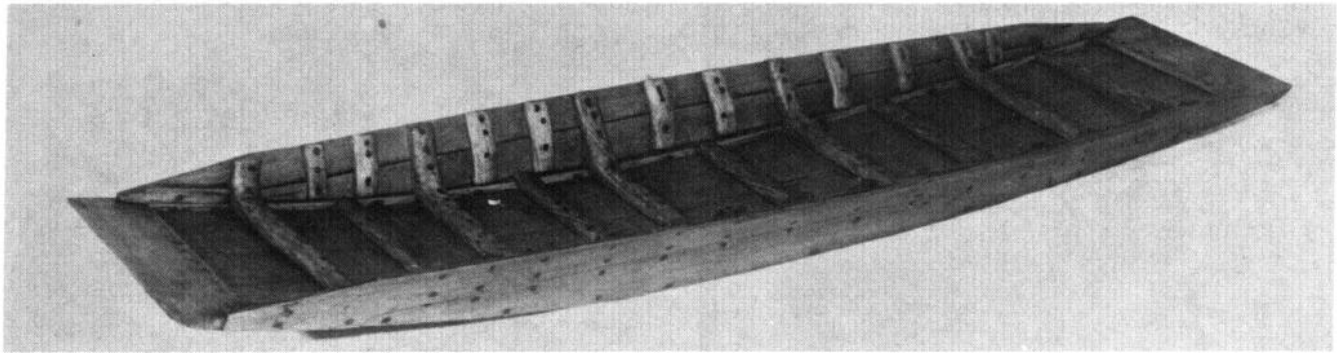


Fig 20 *A model of the conjectural reconstruction of the punt-type of boat from Egernsund on the Flensburg Fjord Denmark, dated to c AD 1090 (Photograph: O Crumlin-Pedrsen)*

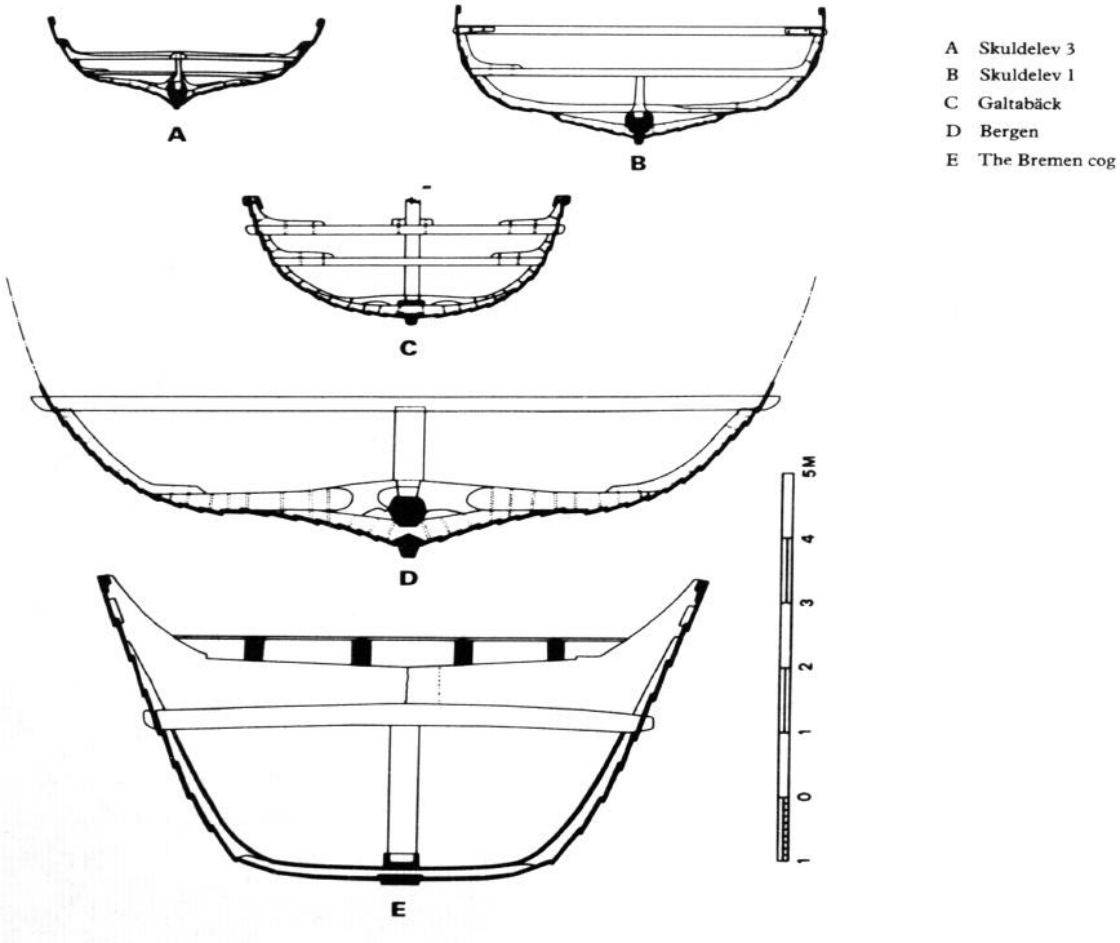


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Fig 21 *Transverse sections of four ships in the Viking tradition (Drawing after Crumlin-Pedersen)*

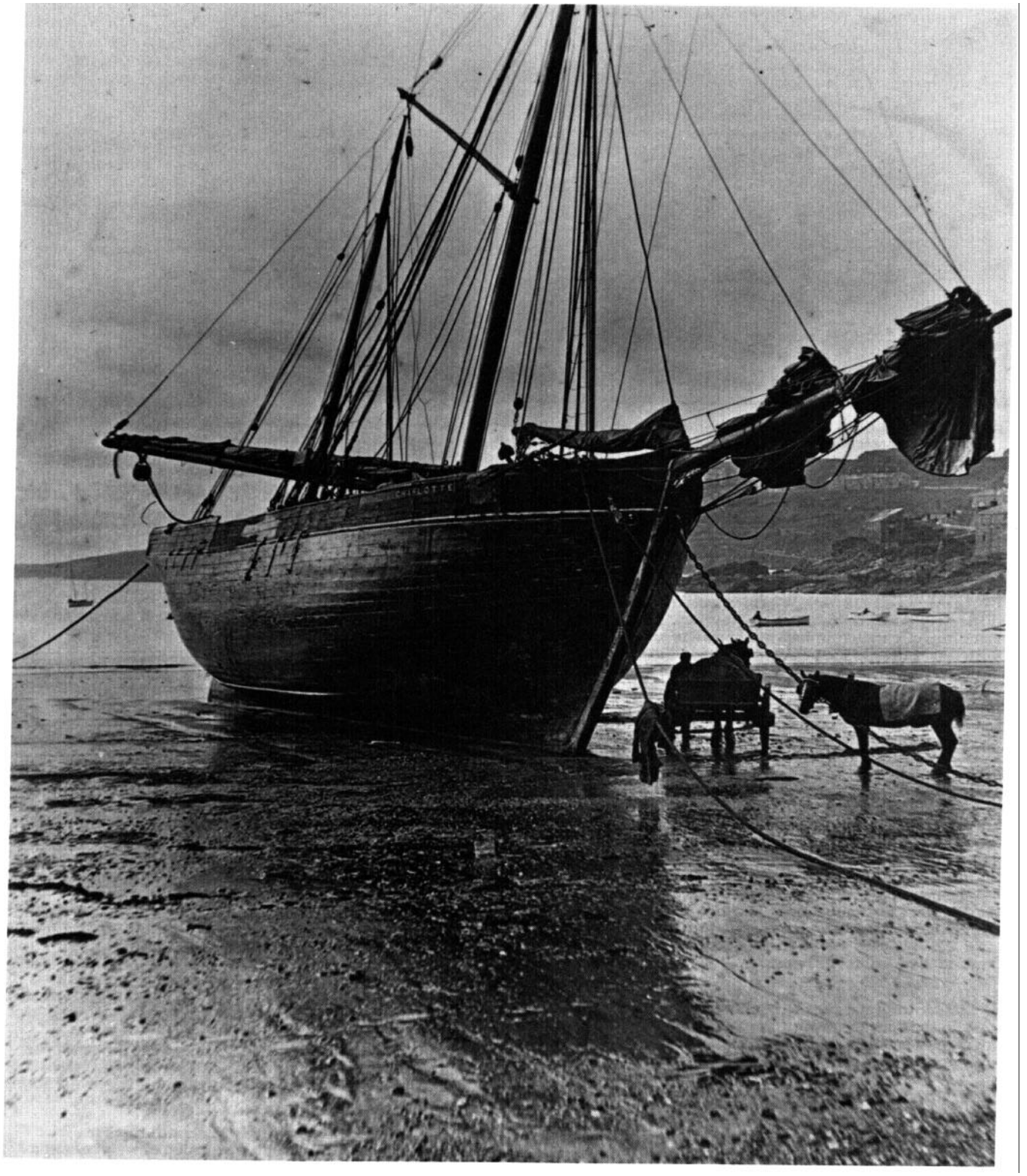


Fig 22 *The coasting ketch* Charlotte *discharging cargo on the beach at St Ives, Cornwall c 1908 (Photograph: Gillis Collection)*

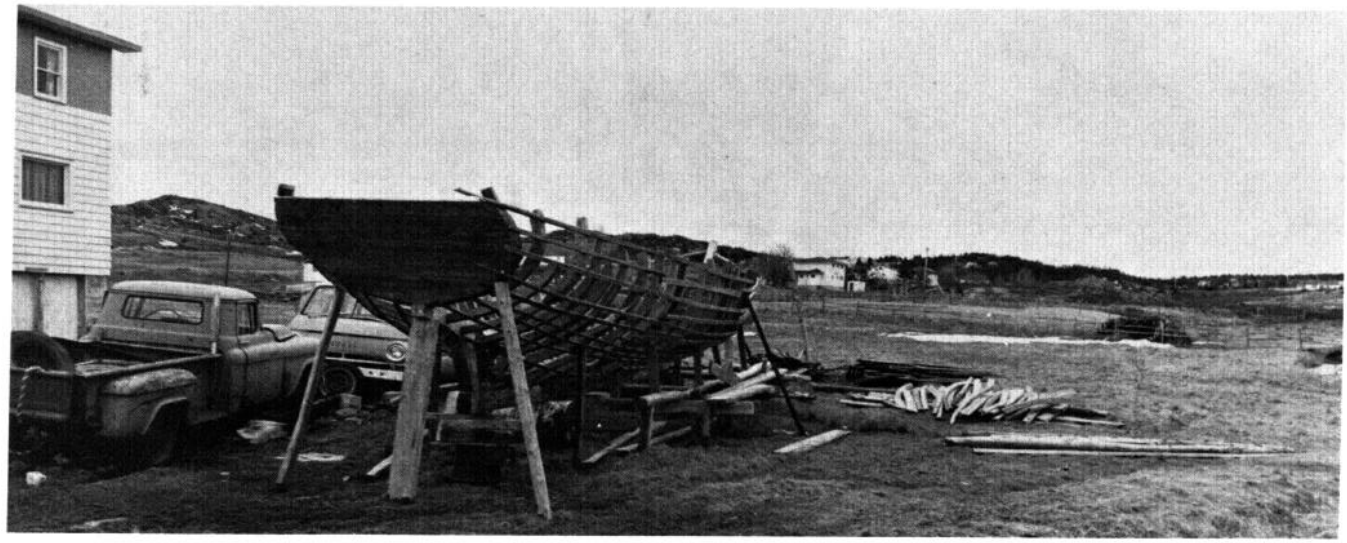


Fig 23 *A small schooner beinn built in 1877 at Brigus, Newfoundland Similar stocks and shores could have been used in medieval Europe, leaving little remains to be found by excavation (Photograph: Basil Greenhill)*

she was frequently run ashore on sand or shingle beaches, not just settling down with a falling tide (Olsen & Crumlin-Pedersen 1967, 130-2; Crumlin-Pedersen 1978,40). The 10th century Graveney boat's keel-plank is smooth underneath, apparently without significant wear from its original profile, but this is probably due to being berthed on mud banks (McKee 1978,94). Where vessels might experience difficulty getting off mud, as at Graveney, simple hard-standings of parallel timbers are known to have been used, with stakes to hold the vessels upright and to check them at high-water (Fenwick 1978b, 181-5). Suitable strands or beaches of mud, sand or shingle were available on rivers and estuaries near towns, and coastal sites could have been used where there was protection, natural or artificial, from the prevailing winds. In tidal conditions relatively light-draft vessels such as the Skuldelev ships, the Graveney boat, and other medieval barge types could be run well up the foreshore before grounding; for a longer stay they might then be dragged, or moved by tackle or beach capstan, clear of the water. Not all vessels can be beached, however, for the strains on taking the ground may be considerable. An alternative is to anchor off a landing place or moor to posts in shallow water, and this would often be the best course of action in non-tidal areas. From such berths ships could be unloaded and loaded by men wading through the water, or on to carts driven into the water (Fig 22). Vessels moored further offshore could be unloaded by lighter or barge.

Similar informal sites were chosen for boat-building (Fig 23), in the open or under a simple shelter, with ready access to the water possibly via an elementary slipway. Such sites may leave insignificant structural remains to be excavated.

The 12th and 13th century ship of the Viking tradition (Fig 17) was probably beached only in unusual circumstances, and this was probably true of the cogs and hulks of the 13th century and later. Anchoring or mooring to posts would be possible, but coming alongside a waterfront with sufficient depth of water would save transshipment of goods and thus might be preferred. In favourable conditions sail may be used until close to a waterfront; otherwise the ship can be towed from a boat, or smaller ones may be manoeuvred by oar. When within range the vessel may be warped alongside the waterfront by manpower, or by ship or shore-based windlass. The precise action would often be determined by the state and relative strengths of wind and tide. A flat-bottomed ship such as the cog would settle on an even keel when alongside waterfronts which dried at low water.

When estimating how many ships could use a section of waterfront it should be noted that if any ships exceeded 30m overall length they were the exception until late in the medieval period. It is relevant that Drake's *Golden Hind,* which circumnavigated the world in 1577-80, is thought to have been only 60ft (18.3m) from stem to stern and 75ft (22.9m) overall (Laird Clowes 1932, 67). Viking merchant ship Skuldelev 1 is *c* 16.5m in overall length, with a maximum beam of c 4.6m, and her loaded draft is estimated at 1.5m (Olsen & Crumlin-Pedersen 1967, 109). If a similar length/breadth ratio is used, the 14th century Bergen ship (Fig 2ld) with a beam of *c* 9m would be *c* 30m overall. The cog excavated from the river Weser at Bremen in 1962 is *c* 23.5m by 7.5m (Crumlin-Pedersen 1978, 38): a significant difference from the Viking ships is her depth (Fig 21e), from midship sheerline to bottom of keel being almost 5m compared with *c* 1.9m for Skuldelev 1. Her operational draft remains to be calculated, but at full load it can scarcely have been less than 3m. The Roman Age barges so far excavated are estimated to have been 20-27m in length, with two (Zwammerdam 6 and Kapel Avezaath) possibly being 34-35m. Their maximum beams were generally 3m, and none can have drawn more than about lm. The medieval Egernsund boat (Fig 20), ofsimilar form, was about 7m by 2m with a draft of less than 0.5m.

The Viking tradition of ship had, until the late 12th century, a side rudder, which extended to well below the keel and was also a potential obstruction to starboard. However, this type of rudder can easily and quickly be rotated to a position level with the keel and still be used,

albeit not so effectively. Fenders could be used to protect vulnerable parts of the ship when going alongside a waterfront, or to allow ships to berth alongside waterfronts with front braces. Floating pontoons or rafts could be similarly used, with gangplanks spanning the gap.

But ships are not restricted to berthing parallel to a waterfront: they may berth bow or stern first, and this position could be compatible with a front-braced structure. Having the stern to a waterfront is well documented in medieval illustrations, with either anchor or mooring post to hold the bow.

Tides present special problems to waterfront operations, although inland river sites with fluctuating depths of water also experience them to a degree. Deeply laden ships may only be able to approach and come alongside at or near the times of high- water. In general terms, during a 12 hour period, a ship will move down relative to the quayside until low water and then back to high-water position again; this tidal range varies nowadays in Britain from 2m to 13m. Such vertical movement poses problems of how best a ship can be unloaded and loaded; however, near the times of high water and low water there are periods of 2-3 hours when height changes relatively slowly. In modern times intermediate stagings and stairs are sometimes used to facilitate cargo handling at low water. Such facilities may be detectable during excavation, as may steps at which small boats could berth at all states of the tide.

Changes in relative sea level have not been uniform throughout north-western Europe and therefore the precise state in antiquity at a particular port needs to be established before the problems of tides and depths of water can be turther investigated.

Co-operation between urban and nautical archaeologists

Medieval builders of waterfronts and boats worked with wood and used similar tools: their methods of-selecting and converting timber and the joints they used were also probably similar or related. Thus, much may be learned from an integrated study of the material surviving from these trades and from other woodworking crafts (McGrail 1979a). One possible outcome of this research could be the ability to date boats, ships, and other wooden structures by phases of technological change. It may also prove possible to determine the origin of'ships, should significant regional differences in woodworking techniques become evident.

A further area of joint study must be that of-sea levels and tidal ranges. Although the general trend of-change through the medieval period may be known, the precise effects at a particular waterfront are determined by local conditions, and there is much work to be done here.

Technical terms must also be agreed. The various forms of scarf joint are not always known by the same name, for example, and even such terms as *Jerry* and *dock* may need to be clarified.

The urban archaeologist needs to be aware of the range of' water transport (including exotic types) which may be found and of the possibility of finding boatbuilding sites and informal landing places on river strands and estuary beaches. The possibility of identifying beacons, leading marks, and transits, which may have guided medieval seamen to a harbour entrance, should not be overlooked. Nautical archaeologists, who may in the past have concentrated too much on the identification of shipbuilding methods, now need to investigate boat and ship operations in greater detail, including operations in harbours and at other landing places. If nautical and urban archaeologists are to exploit their own material to the full, they must explore the potential and understand the limitations of the other sub discipline. In this way the waterfronts will be peopled with shipwrights and seamen as well as carpenters and merchants, and from this co-operation should evolve a greater understanding of-medieval economic life and technology.

Medieval waterfront buildings in the City of London

J A Schofield

Early waterfront properties and buildings (c 1000-*c* 1250)

Development of the riverfront south of Thames Street probably radiated out from three late Saxon centres: Queenhithe (first documented 899) (Dyson 1978), Billingsgate (first mentioned *c* 1000, wharves nearby at New Fresh Wharf dated archaeologically to the 10th century), and the pre-Conquest foreign settlement at Dowgate (later the Steelyard). The Billingsgate and Dowgate areas included medieval, and possibly late Saxon, churches south of Thames Street, suggesting that these areas may have been involved in mercantile traffic to a greater degree than the intervening sections. The extreme east and west ends of the waterfront were evidently less densely developed until the later 13th century; it might be expected that at an earlier date the same was true of the other sections between the late Saxon centres (Dyson 1977).

The development across Thames Street, which coincided with the general edge of the riverbank in the earliest medieval period, in a southerly direction can also be traced in a tendency towards common ownership of properties facing each other across the street. This has been noticed at the east end, where four adjoining tenements south of the street, of which the middle two formed the site of the medieval Custom House, were associated with tenements north of the street, the arrangement continuing well into the second quarter of the 14th century. Although the main buildings were to the north of the road, other buildings were erected on the new quays, perhaps because of reclamation, by 1349 (Dyson 1975). Other deeds suggest this was a practice of the early period (eg Hodgett 1971, 223). Such extensions have been noted at King's Lynn (Clarke, below, 132-5) and at Hull (Horrox 1978, 134-5), where the development of the sinuous riverbank was also sporadic and intermittent in its early stages ***(ibid, 22).***

The earliest archaeological evidence for quays in London comes from the site of New Fresh Wharf between the bridge and Billingsgate (Fig 24, site 10; Miller 1977; Hobley & Schofield 1977, 37; Hobley, above, 1). Embankments were built out from the decayed late Roman riverside wall, stretching to what may have been a common line about 21-22m south of the wall, divided into plots by fences. These divisions can be dated by radiocarbon and ceramic evidence to the late 10th century, and fragmentary wooden buildings of uncertain plan were found on them. In the early 12th and 13th centuries a series of stone foundations were laid or cut into the reclamation deposit as the wharf edge moved southwards (Fig 25). One double wharf (buildings A, B) is known to have been granted by Holy Trinity Priory, Aldgate, to a certain Brounlocus in 1147/67 (Hodgett 1971, 257). On the two properties nearest to Billingsgate (buildings C and D), substantial ground-level undercrofts were built, one with a door to the quay. In 1286 this property was owned by Henry, son of Robert de Burgh, pepperer (Husting Roll 16(79)); a previous owner of 1269-71 was Wybert of Arras (Husting Roll 4(10)). In 1269-71 building D next door was described as once belonging to Lawrence the clerk (Husting Roll 4(57)).

Buildings were also recorded at Seal House, in the early medieval period a comparative backwater just above the bridge (Fig 24, site 8). The earliest buildings on this single property date from the 12th century, with the first medieval revetment (waterfront I) 21 m south of the street (Schofield 1977) (Fig 26). A second revetment of different design (waterfront II) extended the property by 6m without any perceptible accompanying alteration to the building. The revetments have been dated by dendrochronology to after 1140 and after c 1170 (Morgan & Schofield 1978), although associated pottery would suggest dates later by about a generation.

The construction of a third front-braced revetment (waterfront III), dated by dendrochronology to sometime after 1210 (Morgan & Schofield 1978,233) and by pottery to the mid 13th century, seems to have prompted a rebuilding of the whole tenement, with the addition to the back of building A of a second building (B). At its north end lay a series of small hearths, and from the south end a

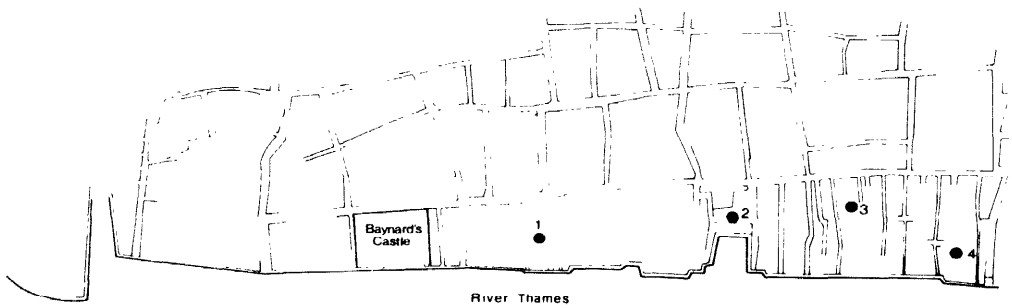


Fig 24 Medieval London waterfront: location of sites mentioned in text

1 *Trig Lane*
2 *Queenhithe*
3 *Vintners' Hall*
4 *Vintry*

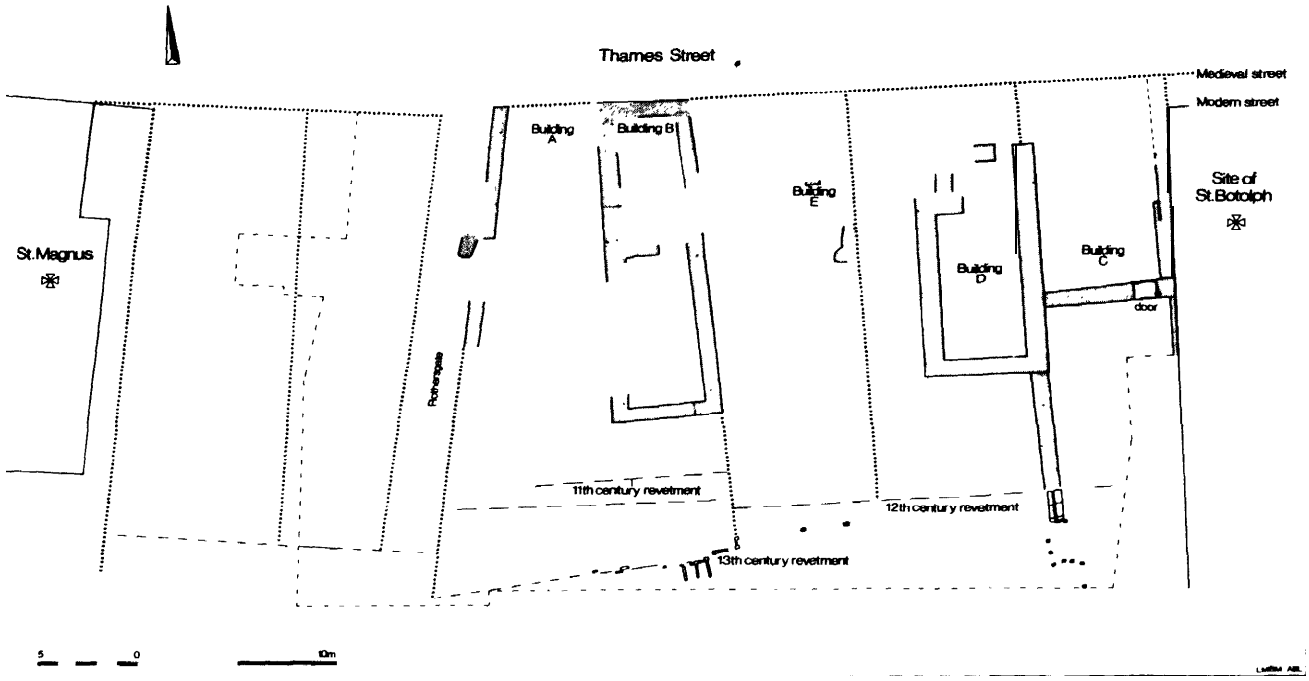
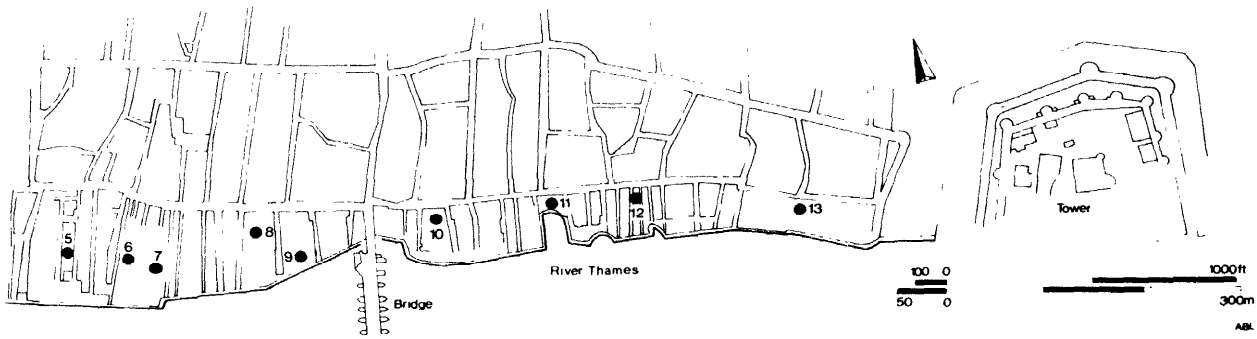


Fig 25 London: New Fresh Wharf; early medieval buildings

drain of oak and elm boards crossed the 8m of extended property to empty into the river. This was probably the work-place of William de Eure, an ironmonger who bequeathed the property in 1298 (Husting Roll 27 (34)).

One of the largest areas of growth south of Thames Street may have been the Vintry, just upstream of the foreign settlement at Dowgate (Fig 24, site 4). The Anglo-Norman wine trade may have developed seasonal storage facilities here in the 11th century, possibly even before the Conquest, and it prospered through royal encouragement in the 13th century. Here, probably by 1300, lay a large house with vaults for the storage of wine (Stow 1971 i, 239; Sharpe 1889, i, 128); there were at least ten vaults in 1376 *(Cal. Close Rolls* 1374-7,375-6). In the street, possibly between the house and the church of St Martin Vintry opposite, a row of cookshops servicing this mercantile area is known from Fitzstephen's account (1183: Stenton 1934, 28) and contemporary deeds (eg Hassal 1949, 241 (1214/22)).

Thus development south of Thames Street in this early period took the form of stone vaults or storage rooms, for the most part at or near ground level, with access from street to wharf either through these rooms or alongside. The nature of the houses above these cellars is not yet known. It is however clear that the street frontage included shops in many cases, and that similar shops and cellars lay



5 Steelyard
6 Coldharbour to 1400
7 Coldharbour after 1400
8 Seal House
9 Fishmongers' Hall
10 New Fresh Wharf
11 Billingsgate
12 Pakemann's Wharf
13 Custom House

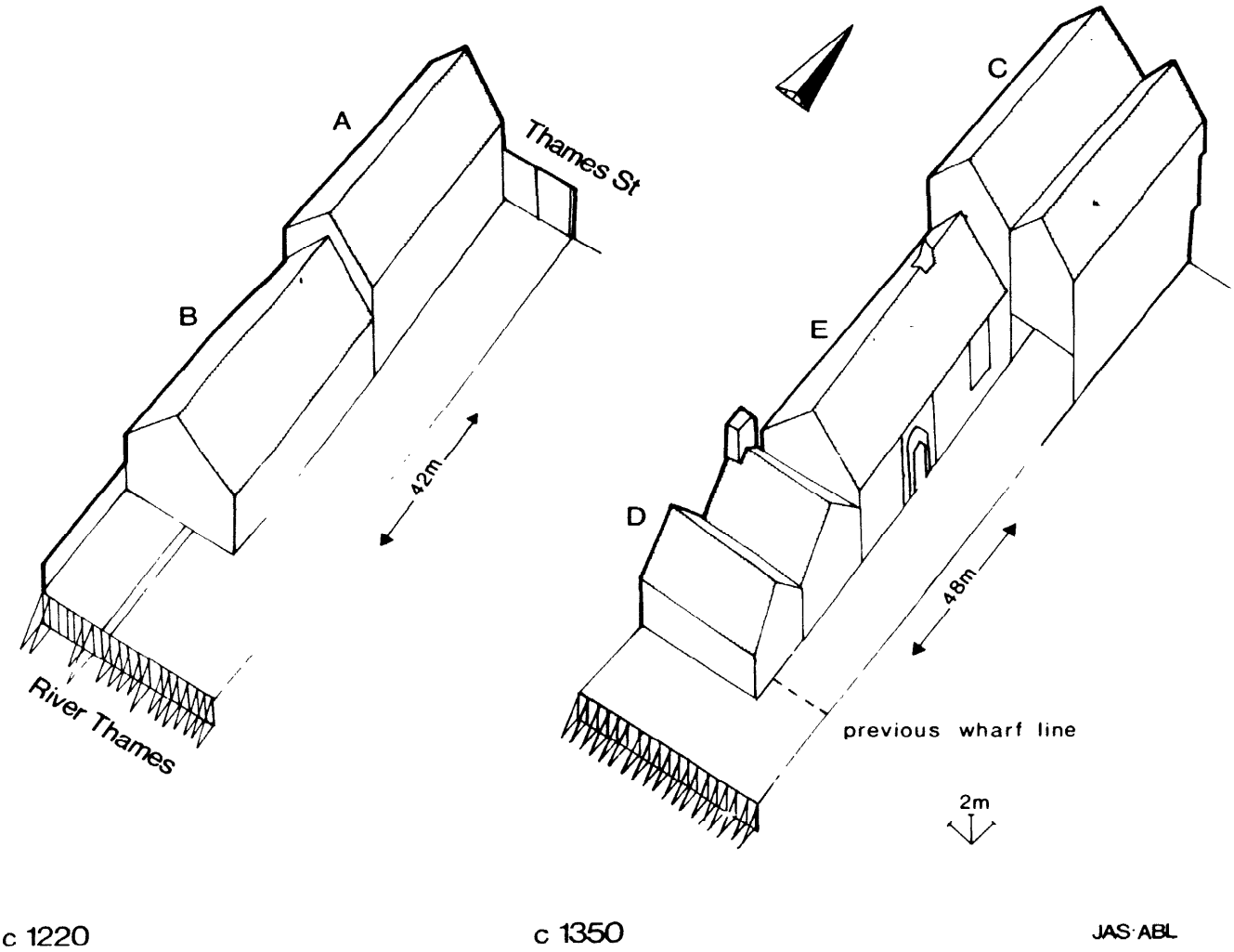


Fig 26 London: Seal House; 13th and 14th century buildings

to the north of Thames Street (eg Hodgett 1971, 430 (1236)). Perhaps the storage room of building D at New Fresh Wharf (Fig: 25) lay behind a timber-framed shop which faced on to the early medieval street.

Development of waterfront properties, *c* 1250- *c* 1500

The great majority of waterfront properties were between 3m and 11m wide. Many had an alley downone side, and in consequence buildings were usually arranged down the side of the plot behind a street-range placed across the head of the plot.-Such an arrangement can be inferred from a lease of 1384 for Pakemann's Wharf, downstream of Billingsgate (Fig 24, site 12) which specifies that the new tenants shall rebuild the property. A street range shall be three storeys high, the individual storeys measuring 12ft, 10ft, and 7ft in height; behind, a 'chef dwellynplace above stag', ie a hall, 40ft by 23ft, a parlour, kitchen, and buttery, all on cellars 7ft high expressly for merchandise. The wharf, which was to be enlarged, was to be faced with stone (Salzman 1952, 464).

The disposition of rooms in buildings comprising the street ranges cannot be fully explored in the waterfront excavations owing to the later widening of Thames Street. Shops with solars over are known at Dowgate by 1302 (Kerling 1973,911). A property to the west of Billingsgate was described in 1334 as having three shops *in fronte* of the tenement; in 1436-7 the same tenement, now called *le lyon on the hoop,* comprised two shops and a solar above on the street side, with two further solars lying above the gate which gave entrance to the tenement, and a hall and cellar behind (Husting Roll 62(52); 165 (25)). This arrangement is very similar to Pakemann's Wharf.

At New Fresh Wharf, five of the six excavated tenements displayed signs of rebuilding in the late 13th and first half of 14th centuries. This suggests that the area between Billingsgate and the Bridge was changing in character: presumably the old vaults were no longer sufficient. The new type of building, which would have functioned with

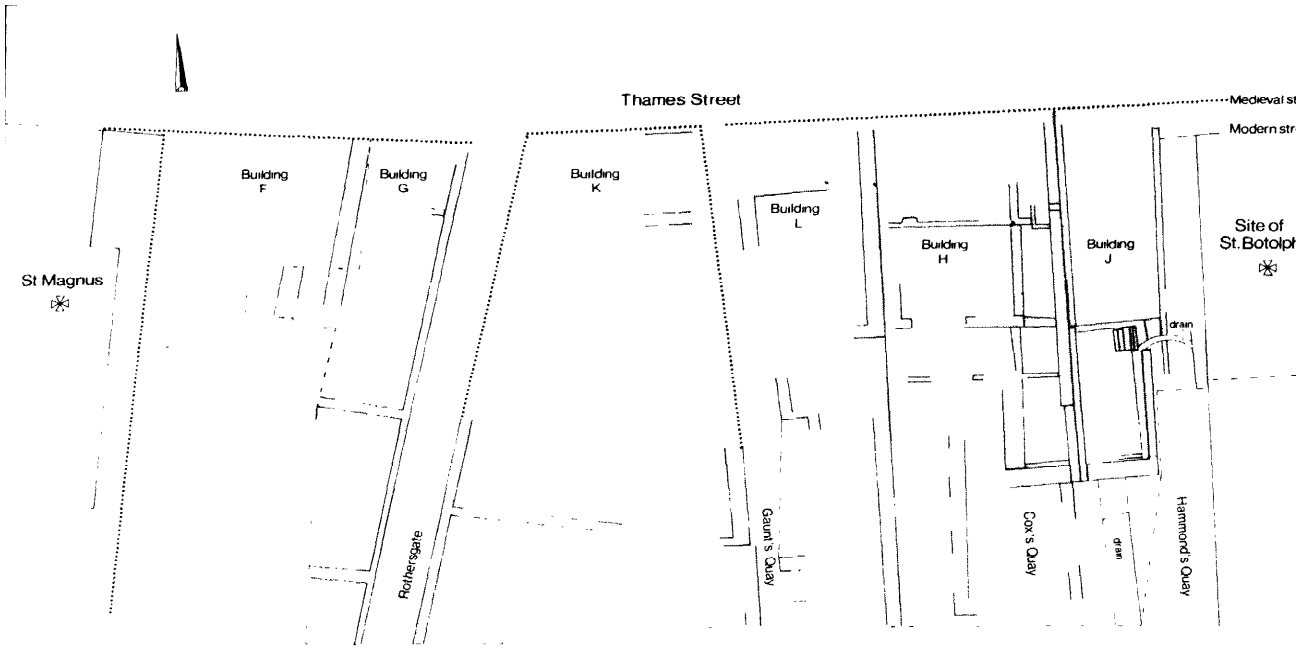


Fig 27 London: New Fresh Wharf; late medieval buildings

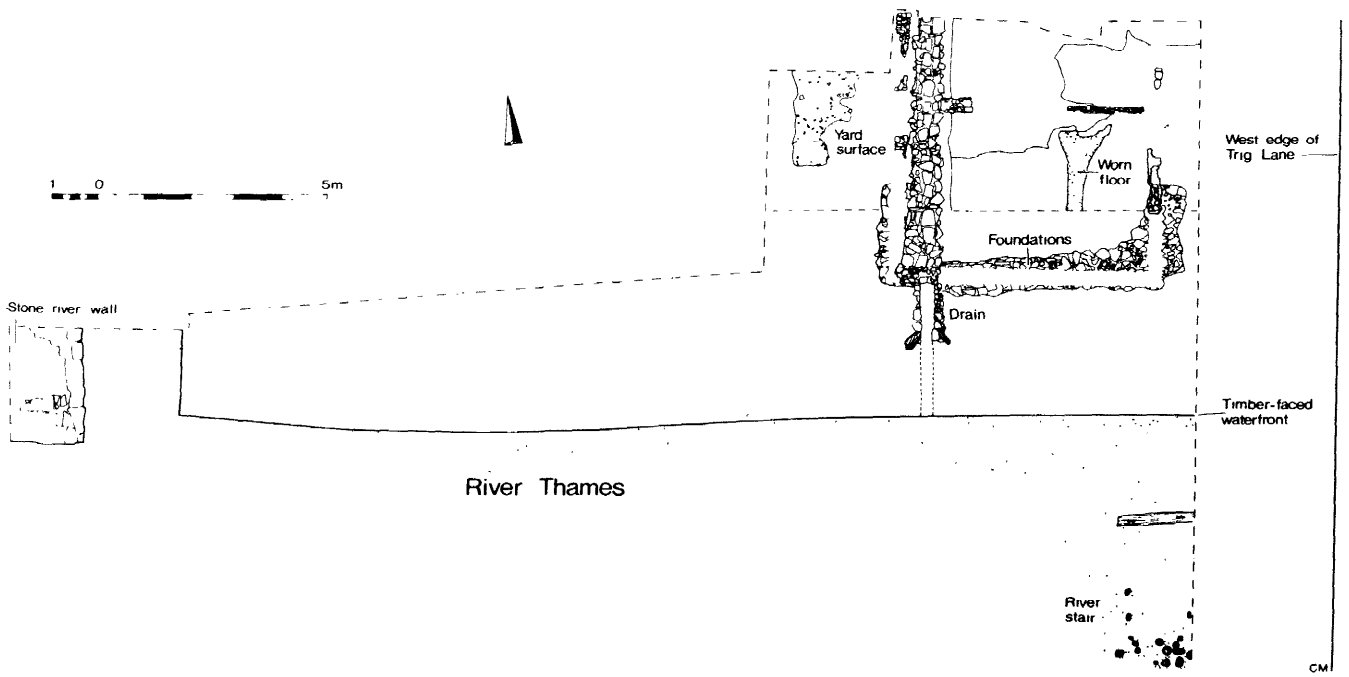


Fig 28 London: Trig Lane; Building C

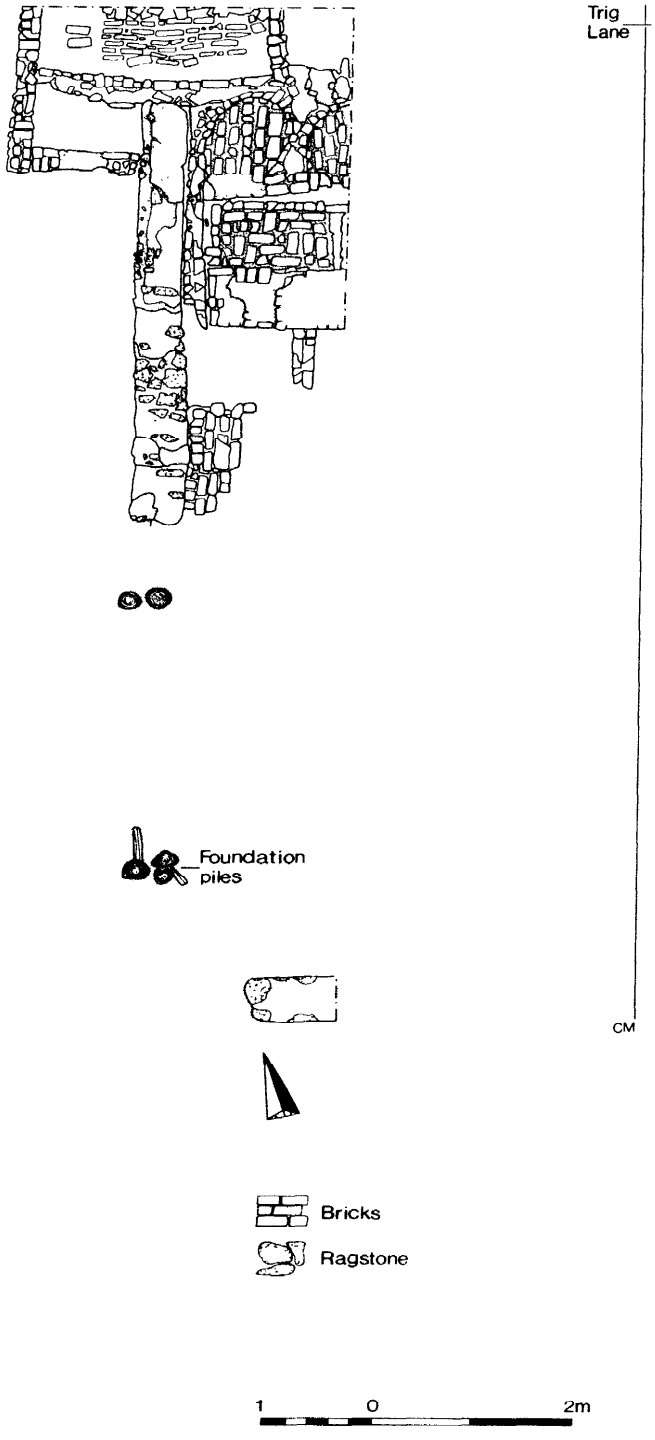


Fig 29 London Trig Lane,- Building E

further reclamation into the river, was of two rooms, at the head of the plot and at right-angles to the street, with an alley down one side; the excavated cellars were 0.5 – 1m below contemporary street level. The building would probably be roofed with gable to the street and would oversail the alley on first and upper floors; the alley would come out into the open air at the back of the house to act as a lightwell and access to buildings behind and the wharf (Schofield 1977: Fig 7). All the buildings were cellared to give maximum storage space. During the 14th and 15th centuries these tenements were held by a variety of professions, including a woolmonger and a chandler, but predominantly by fishmongers. It is likely, from analogues elsewhere in the City known from documentary evidence, that the street ranges of these newer buildings were of three storeys, or two storeys and a. garret, on cellars.

Stockfishmongers, purveyors of dried fish, moved into the part of Thames Street immediately above the bridge during the second quarter of the 14th century, and one of them took over the Seal House property in 1343 (Husting Roll 70 (46)). A substantial rebuilding seems to have followed (Fig 26). A new street range (C), mostly inferred, led to a hall with cross-passage and service rooms on the site of building B; in a slightly later phase the hall received a decorated tile floor. To the south lay a kitchen with successive stacked-tile hearths, and a further building with a new revetment.

It is probable that, at least in the 14th century, the hall of a riverside tenement, the social centre of the household, lay immediately behind the street range as in the Seal House and Pakemann's Wharf examples. This might also be the case in the properties excavated at New Fresh Wharf, but convincing evidence is lacking. Elsewhere in the City, on more compressed properties where expansion of the ground area was not possible, halls were to be found on the first floor of the building next to the street from at least 1410 (Salzman 1952, 483-5). It may be that the medieval form of open hall, on a cellar, persisted on the waterfront longer than elsewhere in the City as a result of the capacity, at least in the 13th and 14th centuries, for accommodating the pressure for additional occupation and storage by expansion of the property into the river.

The further development of the Seal House and New Fresh Wharf properties during the 15th and 16th centuries is shown by the provision of garderobes to houses on both sites. The subsequent infilling of properties has been studied at a third site, Trig Lane (Fig 24, site 1; Milne, below, 32-6). Here the southern third of three. medieval properties has been examined. In the first quarter of the 14th century the waterfront was extended and redesigned, and with it a building of stone (C) reused the former late 13th century revetment in its foundations (Fig 28). In a secondary phase a chalk drain ran through the building an emptied over the revetment, and the building was destroyed by fire and subsequently rebuilt before 1380. The property was owned by the fishmonger Trig family between 1367/90 and 1420, and it is possible that modifications to the revetments and buildings may be attributed to them. Later occupants of the properties comprised dyers, armourers, carpenters, coopers, and 'gentlemen'. An excavated building (E) of the 15th/16th century running alongside Trig Lane, behind the mid 15th century river wall, included at least two small ovens or vats at its north end (Fig 29).

Along, usually at the side of, most waterfront properties ran the access alley from street to wharf. This originated

Fig 30 *London: the second Coldharbour (arrowed) and its surroundings, c 1550 (Wyngaerde)*

for the most part as a private thoroughfare, in some cases becoming public through time and custom. In 1343 several major alleys were regarded as public, and the fact that some of them were suffixed *gate* by the 11th and 12th centuries may suggest a public origin. One of the properties excavated at New Fresh Wharf (Fig 27, building L) was known as *le Brodegate* by 1349, and the alley was just over 2m wide. The surfaces within the street-range were of mortar and oyster shells, but cobbled to the south where the alley was exposed. The lanes were the occasion of some litigation between neighbours (Sharpe 1885, 109; Chew & Kellaway 1973, 577), and in 1346 William Trig was accused of blocking the lane, then called Fissyngwharf Lane, to the west of his tenement with wooden stalls, wood, and other things so that access, formerly allowed 'to all citizens conveying their goods and merchandise to and from the river by horse and cart', was denied. In this case the defendant could prove that the lane, though common, had never been wide enough for use by carts, which could not turn in it (Chew & Kellaway 1973, 396).

Larger houses, of which there were several on the London waterfront, were usually the result of the amalgamation of two or more properties, and thus a greater freedom of planning was possible. Two larger houses were bequeathed to livery companies to become their halls: Vintners' Hall (Fig 24, site 3; Crawford 1977) and Fishmongers' Hall (Fig 24, site 9; Metcalf 1977). The riverside mansion of Coldharbour has recently been studied by Harding (forthcoming), who demonstrates that the name was borne successively by two adjacent large properties (Fig 24, sites 6-7). The eastern included by 1366 a group of shops, perhaps along the lane which bisected the property; by 1430 some of it has been turned into a brewhouse, and a plan of the property in 1612 survives. The second Coldharbour, to which the name had transferred by the early 15th century, was of some opulence as it was used for minor royal purposes (Kingsford, 192l), and can be seen in Wyngaerde's panorama of *c* 1550 (Fig 30). This drawing vividly illustrates the density of occupation on the waterfront by the mid 16th century.

Buildings of private and public corporations

The Steelyard (site 5)

The house of the Cologne merchants was established in London by 1170, and by 1235 their Guildhall stood in

Fig 31 *London: the Steelyard (awowed), c 1544 (Wyngaerde)*

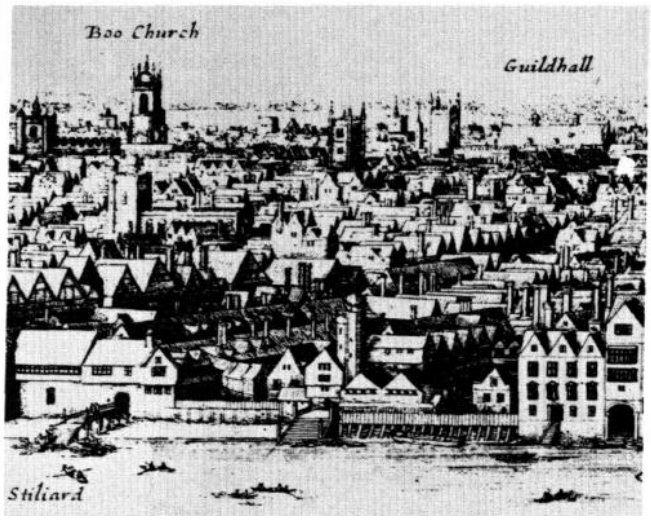


Fig 32 London: the Steelyard 1647 (Hollar)

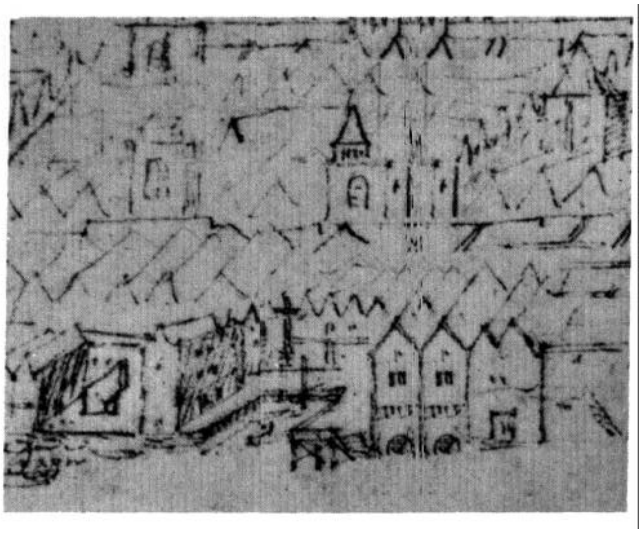


Fig 34 London: Queenhithe, 4 (Wyngaerde)

Windgoose Lane. In 1266/7 the establishments of the Hamburg and Lübeck merchants were also begun. The elements of the Steelyard can be seen in a plan of 1667, said to be by Hollar, which shows the arrangement of the property before the Great Fire of 1666 (Werner 1974). It comprised three blocks from Thames Street to the river, trisected by Windgoose and Steelyard Lanes. At the north-west corner stood the hall, gable to the street (?the original nucleus) with a tower at its southern end, shown by Wyngaerde in *c* 1544 (Fig 31). The complex also included a council chamber, a wine tavern at the street, houses for the merchants, and rows of warehouses running to a quay on which was a crane. The buildings are also shown (the crane misdrawn) in Hollar's panorama of 1647 (Fig 32). On certain panoramas (Norden *c* 1600; Visscher, 1616) the western warehouse range is shown with an open arcade on the ground floor. The most distinctive building lay at the south-west corner, the Hanse Master's house (Fig 32), under which Windgoose or Alley reached a 'bridge' or river stairs on the foreshore. In many characteristics the London Steelyard resembled its surviving companion at King's Lynn (Parker 1971, 115-8).

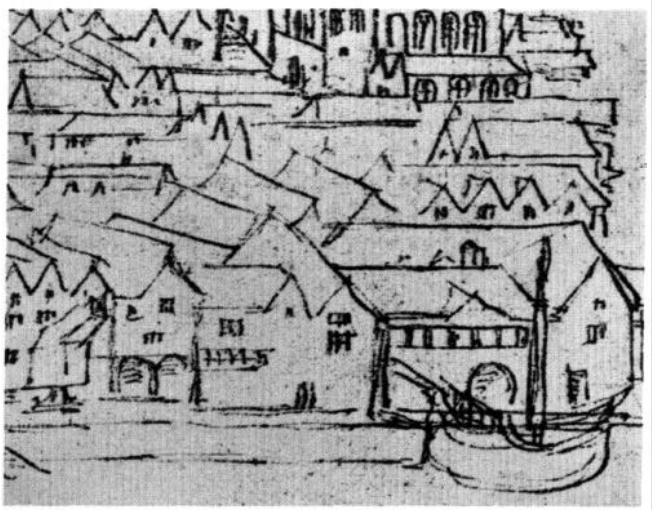


Fig33 London: the Custom House c 1544 (Wyngaerde)

The Custom House (site 13)

The first known Custom House of John Churchman in 1382-3 has been excavate by Tatton-Brown (1974; 1975); the original building lay parallel to the river. The eastern part had an open arcaded front to the waterside, and this may have set a fashion for other such ranges at major waterfront establishments. A western wing at right-angles was added by 1544, when south end of this colonnaded building, with a width of two bays, is shown by Wyngaerde (Fig 33).

Queenhithe (site 2)

Little is known of the medieval development of the Queenhithe buildings. The custom of 1302 shows that bakers, brewers, and others bought corn there, and rates for porterage were worked out (Stow 1971, ii, 8-9). In 1307 granaries and a brewhouse are recorded in the north-east corner, and two granaries with garrets in 1310 (Sharpe 1889, i, 212). The dock is Shown Wyngaerde (Fig 34). An open wharf surrounds the dock three sides, with stairs down to the water at the south-east corner. To the north, close-set buildings fill up the space to Thames Street, although an open space on the north side as at Billingsgate, was known as the *Romeland* (***CLRO*** *Journal of Aldermen* 15, f.256b (1545)). The view of London by Visscher (1616, derived from earlier drawings) shows that the building on the west of the dock had an open colonnade on the ground floor. The ground floor of the eastern building is not visible on any of the panorama.

Billingsgate (site 11)

Billingsgate is also shown in Wingaerde's drawing of 1544 (Fig 35). Despite the apparently close-set buildings there

was also a *Romeland* to the north of the inlet. On the west side is a colonnade building, three bays wide, with stairs down to the river. This is likely to be the range shown in the background of an illuminated manuscript illustration of *c* 1500 of the Tower (BM Royal ms, 16, F11, f73), though it has also been suggested to be the west range of the Custom HouseTatton-Brown 1975). The illustration shows a range of timber and possibly stone of two or three stone on a stone (?) vault, probably three bays wide. The Custom House range was only two bays wide, and the natural prominence of the larger building at Billingsgate would make it a more notable landmark in the background of the Tower, even though the Custom House was closer.

A common features of these four establishments, if the panoramas are to be believed, was open arcading on the ground floor of the western upstream ranges. Presumably this arrangement bore some relation to the way large ships docked and loaded or unloaded their goods. These arcaded ranges must have served the same functions as open-sided market halls elsewhere in medieval towns: temporary storage of bales or crates, and space for examination of goods and bartering

Fig 35 Billingsgate, c 1544 (Wyngaerde)

Towers

The existence of a tower at the Steelyard by 1544 (Fig 31, shown in the wrong place by Hollar; Fig 32) and the survival of the bricker at Clifton House, King's Lynn (Parker 1971, 90), had to the supposition that towers might have been bui originally to watch for incoming shipping. Indeed, to have been noted at other ports such as Hull (Horrox 1978) and Bristol. But in London they were occasionally built on inland properties during the medieval period, several were built as a stylistic affectation of the 16th century (Stow 1971, i, 133; i, 151), also in inland properties. They do not appear to have been an exclusive feature of the waterfront.

Discussion

Such organic development of buildings on waterfront plots has been demonstrated other ports, notably King's Lynn (Clarke, below, 132-5). Similarities with East Anglian ports are to be expected of the 33 fishmongers who served on the city council been 1285 and 1307, twenty at least owned property in Lynn, Ipswich, Boston, and in particular Yarmouth (Williams 1963, 163). Less similarity is found at Bergen, where the long plots had by the 13th century filled out with log-built buildings with jetties and longitudinal galleries, a feature not yet found in the major British ports (Reimers, per comm).

Clearly many of the buildings on waterfront properties in London were cellared for merchandise. At present little is known about special types of cellar for individual kinds of merchandise, except for the early storing of wine in vaults on the riverbank Medieval warehouses, although clearly existing around Queenhithe and Billingsgate, have not yet been identified in archaeological excavations. There may have been little difference in appearance between two-storey warehouses and shops with solars over, as at King's Lynn (Parker 1971, 117). Cranes are known on private and public wharves in l4th and 15th centuries, and cranes of both medieval types-see-saw and 'Hanseatic' or enclosed-are shown in the 16th and 17th century panoramas (Figs 31 -35), but their interaction with quayside buildings has not yet been researched. It seems likely that most imported merchandise came through the accredited hythes and controlled points of entry (Queenhithe, Billingsgate, the Steelsted, and the Custom House) so that specially built warehorehs of any great size were generally to be found only in these central places, the private cellars acting as secondary disy cbution points.

More also needs to be known about the localization of medieval trades along the waterfront area and modifications each trade may have made to the quayside buildings. There was an apparent mix between two kinds of trades: those which functioned here because it was the riverfront, such as shipbuilders and fishmongers, and those who were partly here for the water supply and partly because they produced noise or stench, such as brewers and dyers, and were thus relegated to what amounted to a long, narrow suburb of the city. These latter trades had taken over from the former group as this predominant residents by the end of the 16th century

Medieval riverfront reclamation in London

G Milne

Archaeological evidence of urban waterfront reclamation in the medieval period has been recovered in several European countries. The extensive excavations at the Bryggen in Bergen (Norway) began in 1955, and were one of the earliest archaeological investigations of reclaimed land (Herteig 1975, 65-89). By 1970, when the work was completed, the waterfronts at Staveren, Amsterdam, and Dordrecht in the Netherlands had also been studied in detail (Sarfatij 1973). In England urban reclamation was examined at King's Lynn and Plymouth from 1963, and in Portsmouth from 1969 to 1971 (*Post Med Archaeol* **5**, 1971, 204; 216- 17). Of this early English work, only that in King's Lynn has been fully published (Clarke & Carter 1977). Dr Clarke had also written an important article on the modification of the Lynn waterfront in 1973 (Clarke 1973b), but the possibility that other English medieval towns may have had a similar development seems to have been completely overlooked by recent students of urban topography: the subject was not even mentioned at the CBA's Leamington conference the following year, for example (Barley 1976). By 1979 further evidence for reclamation had been recovered archaeologically from Bristol, Cambridge, Durham, Harwich, Hull, Lincoln, London, Oxford, Poole, and York (below, 103-49). The phenomenon was therefore widespread and, as in London alone it accounted for a 10% increase in the size of the town, it must be considered as a topic of considerable topographical importance. This paper will examine medieval riverfront reclamation in the City of London presenting and discussing the evidence for its extent, chronology, mechanics, and possible motivation.

Extent and chronology

Sir William Tire stated 130 years ago that:

> '. . . there is abundant evidence of the care and skill anciently employed for the substantial support of the haven, and even for the gaining of ground from the river in the construction of quays; thus strengthening the view already expressed, that the commercial convenience of the City as a port was always regarded as an object of the first importance' (Tite 1848, xxiii)

This astute assessment was based on evidence derived from the observation of non-archaeological excavations on the London waterfront. The insertion of new sewers was a particularly profitable source of information, from which he deduced 'that nearly the whole south side of the road [Upper and Lower Thames Street, see Fig 21 has been gained from the river by a series of strong embankments' (Tite 1848, xxiv). For example, work on the Custom House site between 1813 and 1817 revealed 'three distinct lines of wooden embankment' as well as a river wall 'faced with Purbeck stone' (Laing 1818, 5-6). In 1849 the insertion of another sewer, this time in Water Lane to the west of the City, exposed a post-and-plank revetment which was thought at the time to be of Roman date (RCHM 1928, 148). During clearance associated with the construction of the new London Bridge and its approach road in the 1830s, three embankments were found. The first, to the south of Thames Street, was built of oak and fir and was considered to be 'a comparatively modern work'. The second was an oak and chestnut post-and-plank revetment 'of the most ponderous and substantial character' *(Gentlemen's Magazine,* 1831, 387), while the third lay some 21m to the north. This was presumably the same feature as the 'elm piles 8 to 10ft long [*c* 2.40-3m] closely driven together in the ground' quoted by Lambert (1921, 68-9). Later work in the same area north of Thames Street produced detailed evidence of Roman waterfront structures near Miles Lane (Fig 2), presumably associated with a major reclamation or embanking project (Lambert 1921, 62-72; *J Roman Stud,* **19**, 1929, 200; *ibid,* **21**, 1931, 239).

The discovery of Roman river gravels at Dowgate in 1960 (GMER, 6, 51), the location of the natural river bank at the foot of Lambeth Hill in 1962, and evidence from boreholes (Grimes 1968, 57 -64) confirmed that the Thames once flowed much further north than it does today. It was not known at this stage when the encroachment took place, although early river walls of-presumed medieval date had been observed during contractors' excavations. F G Hilton Price, for example, recorded a feature which was 'probably in late Norman times, the riverwall' situated 'midway between the backs of the Thames Street houses and the actual riverfront', although the position of the site itself is unknown. No Roman antiquities were found south of-the wall, and very few north of it, while the lack of finds of a date later than the end of the 16th century suggested that the site must have been built over by that time *(Proc Soc Antiq,* **20**, 1905, 229-30). The evidence from Dowgate suggested that encroachment had begun there by the 13th century, as the first front-braced horizontally planked revetment recorded by the Guildhall Museum appeared to have 13th century pottery dumped behind it and on the foreshore to the south (GMER, 6, 31). The first open-area excavation on the waterfront, at Baynards Castle in 1972, showed that the castle had been built on land entirely reclaimed before the late 13th century *(Medieval Archaeol,* **17**, 1973, 162). The following year excavation at the Custom House site demonstrated that reclamation here at the other end of the waterfront commenced somewhat later, in *c* 1300 (Tatton-Brown 1974; 1975).

Building on this important work, the Department of Urban Archaeology excavated three major waterfront sites in 1974 at New Fresh Wharf, Seal House, and Trig Lane (Fig 000). The first two excavations, sited on either side of the land abutment of the medieval bridge, produced evidence of reclamation incorporating timber revetments no earlier than the 11th or 12th centuries. The results of the work at Trig Lane, and at several other sites, suggests that, at the other end of the scale, the majority of the land to the south of Thames Street had been won by the 16th century. Although the full extent of riverfront modifications of Roman date has yet to be established, it seems that London's waterfront was advanced principally between the 11th and 16th centuries, a period of 500-600 years. This statement is also borne out by the position of the medieval bridge. Ogilby and Morgan's map of 1676 (see Fig 24) shows that the most northerly arch was built on the land *c* 10m to the south of Thames Street, marking the

line of the waterfront in 1176-1209. By the time the map was drawn some five centuries later, the land to the east and west had advanced to the line of the third cutwater.

Mechanics

Reclamation was usually effected by erecting a timber revetment upon the foreshore to the south of the contemporary frontage and infilling the intervening area with dumps of refuse, sealed with a gravel or stone surface (Milne & Milne 1978; Milne 1979). Although stone river walls are known from at least *c* 1220 in Westminster (Green 1976), the earliest archaeological evidence for a stone-faced frontage in the City is in the early 14th century at Trig Lane. By the end of the 15th century stone had become a more common facing (Fig 36).

The excavation of the Trig Lane site examined the development of private wharves on three adjacent properties from *c* 1270 onwards. The piecemeal nature of the development, a reflection of the sub-division of the property, was recorded in detail (Milne & Milne 1978; Milne & Milne, forthcoming), and showed that the extension and maintenance of the frontage was the work of the occupier of each separate property.

The role of the occupier (who need not necessarily be the owner of the property) in shaping the London waterfront is also illustrated by a document dated to 1384, which records that a lessee of a site (Fig 24, 12) in the parish of St Dunstan's was to undertake a comprehensive rebuilding programme which included extending the wharf into the river: 'enlarg' strecchyng in the Themesward the seyde wharfe . . . at his owne proper costes' (Salzman 1952, 464).

Motivation

Medieval land reclamation on, for example, the east coast of England is well known: sea walls such as the so-called 'Roman Bank' were constructed to keep the sea out of salt marsh which in time would dry out to form valuable pasture (Hoskins 1955, 95-101). The marsh on the west bank of the Fleet just outside the City wall was reclaimed by a similar process: after canalization and embankment of the river, the area behind the bank was drained, as the excavation at Bridewell Place in 1978 has shown (supervised by D Gadd for the DUA). However, the gradual reclamation of land on the urban waterfront (perhaps more accurately described as extension rather than reclamation) is a rather different phenomenon, but is now known to be a feature of medieval ports. Several reasons for this extensive reclamation have been suggested:

A to win land
B to provide a deep water berth
C to overcome the problems of silting
D to maintain a sound frontage

Fig 36 *London: Trig Lane excavations looking south-west, river to south, showing back-braced riverfront revetments behind 15th century river wall*

A The need to win land for its own sake is the simplest and most obvious solution, and is the most significant reason advocated by Dr Helen Clarke to explain the 100m wide reclamation at King's Lynn (Clarke & Carter 1977, 423-4). The 1192 Dublin Charter admitted that its citizens were free to '. . . improve themselves . . . in making buildings . . . upon the water' (Wallace 1979, 144). There is also explicit support for this in London, where in 1345, for example, it is recorded that Gilbert de la Brewere, Dean of St Paul's, built a quay into the Thames specifically '. . . to enlarge and improve his property . . . ' (Chew & Kellaway 1973,392).

Archaeologically these developments could reasonably be expected to be extensive, with a riverwards extension of 4m at the very least. A ground-level building programme would accompany such work, utilizing the newly won land.

B Other scholars have argued that some extensions were directly associated with the need to create or maintain a harbour capable of accommodating deep-draught shipping at ports such as Bergen (Herteig 1959, 179), Schleswig (Vogel 1977, 22-3), and Amsterdam (Sarfatij 1977, 211). The gradual increase in size of seagoing merchantmen from the 11th and 12th centuries onwards is usually cited as the initial impetus for these harbour works, which were essential if a town was to attract seaborne trade. In 1358 the merchants of Dublin complained that 'for want of deep water in the harbour of that city, there never has been anchorage for large ships from abroad' (Wallace 1979, 146). The citizens of Bristol were prepared to pay some £5000 in the 1240s to canalize the Frome and construct the new quay so 'ships coming to our port of Bristol may enter and leave more freely and without impediment' (Sherborne 1965, 5). The contemporary London Eyre of 1244 suggests that the quays which the Londoners had built out into the current of the River Thames were for the benefit of '. . . the great ships fully loaded coming towards the City. . . ' as they were unable to reach the City '. . . before the wharves were made. . .' (Chew & Weinbaum 1970,343). However, the building of a stone wharf out into the river at Baynard's Castle in 1356 was clearly not to provide a deep-water berth, as its construction was considered to be 'to the nuisance of ships, shouts, and boats' (Chew & Kellaway 1973,453).

In fact, the cargoes of the majority of the seagoing vessels reaching London were initially destined only for the public quays such as Billingsgate (Riley 1859,208) and Queenhithe (Riley 1859,209). If reclamation in London was primarily a response to the need for deep-water berths, then these two areas would have developed as promontories. However on the earliest available maps of the 16th and 17th centuries, they appear as pronounced indentations where least extension has taken place (Fig 24).

Archaeologically a deep water berth could involve an extension over a shelving beach to produce a frontage at

Fig 37 London: Trig Lane excavations looking south-east, river to south, showing late 13th century front-braced revetment (left) superseded by back-braced 14th century revetments (centre) and 15th century river wall (right). Note remains of jetty on foreshore

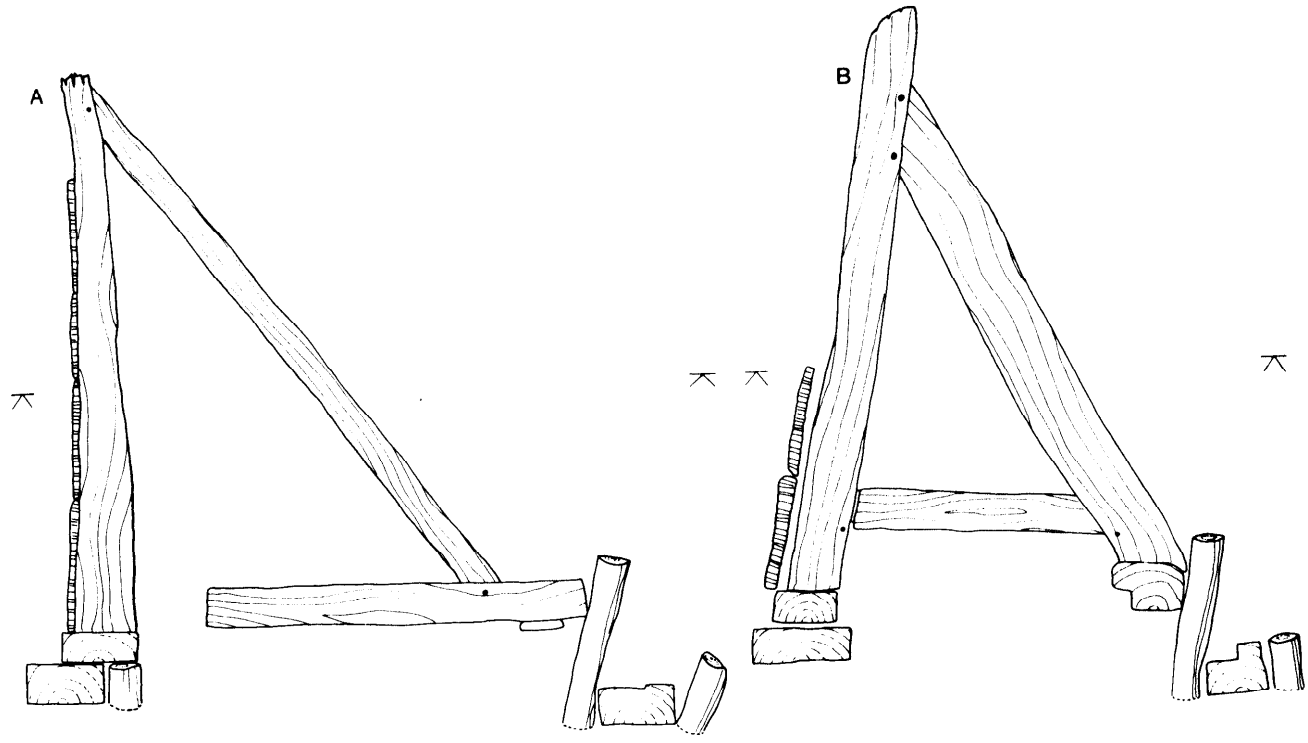
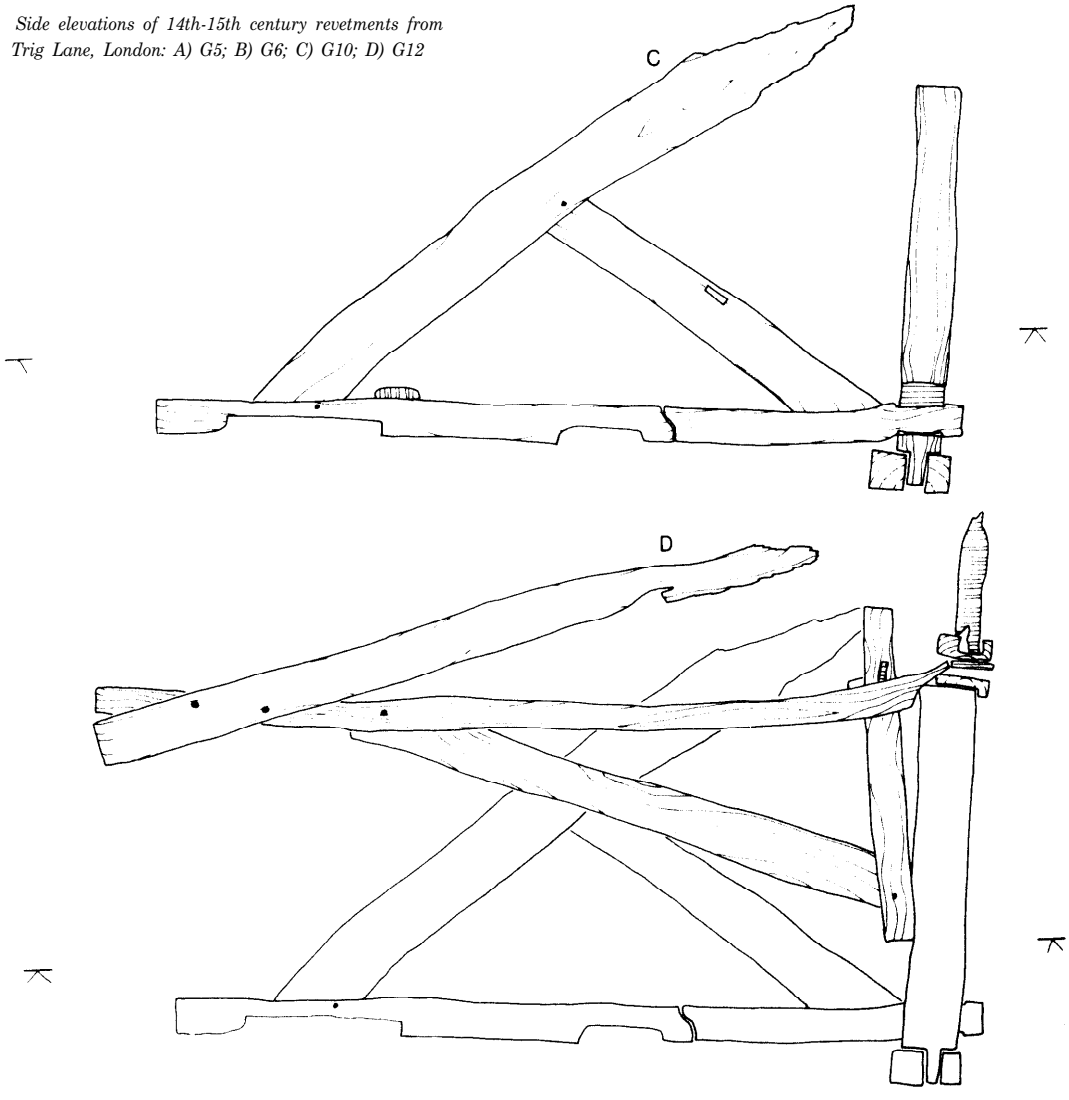


Fig38 *Side elevations of 14th-15th century revetments from Trig Lane, London: A) G5; B) G6; C) G10; D) G12*



least 2.5-3m high. If the facing was of stone, closely spaced rubbing posts may be anticipated (cf Marsden, above, Fig 13). Surface features could include warehouses, crane bases (cf Harwich: Bassett, below, 125) and open areas directly behind the frontage to facilitate the loading and offloading of merchandise.

C Many ports failed because their harbours became choked with silt. For example, between the 1lth and 13th centuries Sandwich (Kent) was the second most important port in Britain, but by the end of the 16th century the haven could no longer be used by the largest ships of the day. In 1307 the freedom to dig slime from Dunster harbour (Somerset) was granted, but the port was subsequently eclipsed with the development of Minehead (Aston & Leech 1977, 45). Before the advent of adequate dredging facilities, the principal method of overcoming the problem (apart from resiting the quays) was to build out over the shelving foreshore into the deeper water.

Archaeologically the accumulation should be readily identifiable, as it was at Trig Lane, where it is suggested that it built up against the faces of the excavated revetments at a rate of l–2cm *per annum* (Fig 36). However, silting does not seem to have been a primary factor in any of the extensions on the site as there was no direct relationship between extensions and accumulations. Revetments were constructed after as little as 0.20m or as much as 1.60m of foreshore had built up against them.

D The need to maintain a sound frontage is a factor mentioned in the London Eyre of 1246, in which it is claimed that waterfront encroachment *(Kayos elongauerunt vel extendurunt versus cursum aque)* by the citizens was customary to protect the land and tenements from the erosive action of the river *(ut sic terras et tenementa sua tueri possunt versus mare ascendens et descendens die et nocte)* (Chew & Weinbaum 1970, 343).

The excavated sequence at Trig Lane shows how front-braced revetments (eg Fig 38, G5 & G6) were superseded by the development of the back-braced revetment (Fig 38), which was itself further refined by the construction of revetments built in two distinct levels, separated by a horizontal plate (Fig 38; Gl0 & G12). The reasons for this development are important, and relate to the unfortunate facility with which waterfront timberwork decayed at the level of the contemporary Mean High Water Neap tides. Timber immediately above this zone is permanently exposed above the fluctuating waterline, while timber below it is subjected to submergence twice daily. The wood in the intervening area is thus subjected to regular swelling and shrinking immediately below the zone, but not above it. The physical breakdown of the wood on this boundary is an inevitable result. Once the heads of the earlier front-braced type of revetment at Trig Lane began to deteriorate, the associated structure would have to be replaced completely sooner or later. However, when the upper level of the bipartite revetments began to decay, it was only necessary to replace the timberwork of the upper section, as the lower half remained sound.

The Trig Lane sequence thus shows considerable evidence of repairs and complete replacements of riverfront revetments (Fig 38a, b), sometimes without any physical extension of the property. Where there is an advance, it is often only sufficient to allow for the erection of the new structures (Fig 37). The group 10 revetment illustrates this point admirably, as it superseded a much repaired and presumably unstable facing comprising sections of the group 3, group 4, and group 6 revetments by advancing the frontage 3m, the length of its back-braces (Milne & Milne 1978, 92). Parallels for refacing a decayed frontage by reclaiming land on the foreshore to the south of the dilapidated revetment have been found on other sites in the City (eg Tatton-Brown 1974, 132- 3) and elsewhere. At Wood Quay in Dublin, for example, three successive timber revetments were erected during the 13th century. Subsequently, a stone wall built in the early 14th century brought medieval reclamation and Dublin's quayside almost to the line of the modern quays (see Wallace, below, 109). The stone wall was obviously not susceptible to the decay which affected the timberwork and so did not need to be continually maintained or replaced. As at Trig Lane, the construction of the stone wall marked a hiatus in the reclamation process.

Archaeologically, such reclamation might be typified by a number of closely spaced revetments (cf **A** above), often decayed, repaired, or robbed out completely, as at Trig Lane.

Conclusion

For the private wharves in London, it seems that the accommodation of boats was not a major consideration in revetment design, as the small craft which would have operated from the frontage must have tied up at the foot of the projecting stairs rather than directly against the revetments. In the early 15th century the City considered that the Thames (ie river traffic) was '. . . greatly impeded . . .' rather than enhanced by the encroachment of quays into the water, and demanded that future encroachments '. . . upon the water of Thames . . .' would only be allowed if it was thought that '. . . no peril or damage . . .' would ensure (Riley 1859, 409).

It is suggested that the maintenance of a sound frontage was the principal concern of waterfront property owners or occupiers and that the piecemeal reclamation of land at the expense of the river was primarily (though not solely) a by-product of this need. Nevertheless, the value of the extension of the property which sometimes accompanied such work must have been appreciated by its perpetrators, and could have acted as a secondary source of motivation. There is evidence, however, that at least some extensions were primarily designed to win land for its own sake. The very real problem of silting was probably the third most important factor, but where it was associated with the need to accommodate the larger ships (particularly below the Bridge) this particular problem may well have been a more crucial consideration.

Riverfront reclamation was certainly a prominent feature of the topographical development of London, as it was in most medieval ports. It is important that archaeologists studying this development should distinguish an extension primarily designed to win land from one designed to create a deep-water berth, to overcome silting, or to consolidate the frontage. Only then would it be possible to make a correct assessment of the development of the area and of' the port as a whole.

The terms 'quay' and 'wharf' and the early medieval London waterfront

A G Dyson

Though far from complete, the current collection of references to the early medieval waterfront of the City of London, in the first instance up to the mid 14th century, has already drawn attention to a number of general issues which may be more fully resolved as both this work and archaeological investigation continue. One of these is whether, when medieval deeds relating to riverside properties very frequently refer to tenements with 'quays' or 'wharves', these terms necessarily bore the same primary connotation of docking facilities which they bear for us. In purely archaeological terms, too, a parallel consideration arises from the recent waterfront excavations: should the succession of vertical timber (occasionally stone) structures encountered to the south of Thames Street and parallel with the street and with the river best be regarded (as has often been the tendency) as a means of providing deeper-water berthing places for shipping or, more modestly, as a means of containing and protecting the land to the north from the river to the south? Or, which is hardly incompatible with either function, should they be seen as marking phases of land reclamation? The purpose of this provisional note is to show that 'quay' and 'wharf', which (at least from the 13th century) appear to be synonymous, were variously used to denote each of these functions, and that it is consequently of some importance to our conception of the nature and role of waterfront tenements in medieval London, as doubtless elsewhere, not to be misled by their modern, almost exclusive, association with only one of them.

The matter is conveniently broached by the articles of the special London inquest of 1246. Asked by the justices about purprestures (or encroachments on the public highway), the citizens replied that quays *(kayos)* had been lengthened and extended towards the river *(versus cursum aque)* as was permissible by custom because land and tenements could thus be protected from the ebb and flow of the tide, but that no quay had been placed in the Thames *(in Thamisia autem et cursu Thamisie nullum kayum assederunt)* except to the advantage of the king and of the City and of the great, fully laden, ships approaching London (Chew & Weinbaum 1970, no 343). Thus quays installed 'towards the current' as anti-erosion devices were one thing, and those actually erected 'in the current' were clearly quite another. The one was a matter of course, custom, and common convenience; the other, except when to the advantage of commerce and the authorities, was liable to be regarded as an obstruction. Of the former variety, presumably because it was customary, little is heard, but one case occurred in 1330 when the mayor licensed the widow of Hamo Godchep to construct a quay *(kayum)* in Southwark between the quay of St Augustine's Canterbury to the east and that of St Olave's churchyard to the west, in order to keep the water of the Thames from the houses of her late husband (Sharpe 1903, 243).[1]

The sort of quay with which the justices of 1246 were concerned was, to judge from an ordinance recorded in the early 15th century, to remain a source of civic anxiety: 'because the course of the water of Thames, which belongs entirely to the city, has been severely impaired by the purpresture of quays and other easements made in the said water to the great damage and peril of the whole city . . . no purpresture is to be made by the building of quays . . . in the water of Thames without inspection by the mayor, aldermen and commons' (Riley 1859, 476). Now this undefined 'great damage and peril' can hardly have arisen from the customary, anti-erosion, quays which were designed only to contain the highest tides and without which London could well have been overcome by the hazards to which Hamo Godchep's Southwark property had been exposed. As in 1246, the concern here is more likely to have been with the effects of the excessive canalization of the body of the Thames by the extension of properties into the river for the purpose of reclamation. There is, in fact, a definite sense in which 'quay' came also to mean 'reclamation'. In 1273 Holy Trinity Aldgate received a quitrent from a *cayo* and houses and shops built thereon in St Dunstan in the East (Hodgett 1971, no 197), while there is a reference in 1237 to the *kayum domorum* of the bishop of Norwich (*Close Rolls*, 1234–37, 488). In this usage a quay was regarded as a foundation which could be built upon, which looks uncommonly like reclamation.

Neither the articles of 1246 nor the early 15th century ordinance, it will be noticed, have anything to say about berthing, except incidentally in the earlier case, and it is also clear that the Godchep quay in Southwark had nothing to do with shipping or cargoes. Neither, it may reasonably be supposed—as this was the Thames and not the Styx—had the churchyard quay next door. But in so far as it brought London into more direct contact with deep water, reclamation doubtless aggravated a further abiding concern, amply reflected in the surviving records, on the part of the civic authorities and of the king. This was, simply, to ensure that goods coming into London from outside should be unloaded at specified places, notably the 'common' quays of Queenhithe, Billingsgate, and St Botolph's Wharf, where the collection of customs to which they were liable was undertaken. The fact that there was, especially in the 13th century, considerable dispute as to which of these places was appropriate to particular commodities[2] only emphasizes the importance of these restrictions and the rigour with which they were enforced. This was not, at least in the first instance, simply a matter of clerical convenience, as becomes obvious from the incidence of the legal right of *applicatio* (mooring and, by implication, unloading) which is recorded in a handful of cases up to the late 13th century. As early as the end of the 9th century, grants of market and mooring facilities by Alfred referred to the 'commercial shore' *(ripa emtoralis)* as if it was a limited and well defined portion of the waterfront at large, and the mooring facilities bestowed were carefully described and restricted to the frontage of the property with which they were associated (Dyson 1978, 200–15, esp 206). Another pre-Conquest grant, of Aethelred II to Chertsey, though probably spurious, confirms that mooring facilities, the conduct of trade, and the remission of customs were a matter of royal discretion (Kemble 1846, no 771). After the Conquest, the crown remained the ultimate source of the privileges of the city's common quays which

were gradually to devolve upon local government during the medieval period. But private landing rights still persisted: in 1275 Robert fitz Walter's port and *applicatio* at Baynard's Castle were said to belong to his barony *(Patent Rolls* 1272-81,98). At Broken Wharf in the parish of St Mary Somerset inquisitions held in, or shortly before, 1258-9, revealed that, though shops and boats still came ashore at that date, there was neither 'quay' nor rightful *applicatio,* except by default of the abbots of Chertsey and Ham who, some forty years earlier, had quarrelled over which of them should repair the quay which was common to them both, and had subsequently abandoned it *(Cal Charter Rolls,* 1257-1300, 16: *Cal Misc Inquisitions,* i, no 246). A quay, in the sense of a landing place, was not simply a three-dimensional amenity. Like a ferry, it was also a legal right to which, by definition, by no means everyone was automatically entitled.

These conditions are corroborated by the evidence of the occupations of the inhabitants of the riverfront tenements which, while yet by no means fully amassed or quantified, strongly suggests that, apart from the many fishmongers who could hardly operate elsewhere, the most conspicuous practitioners were dyers, tilers, and metalworkers. For none of these callings was a waterfront location vital in the sense that the supply of-raw material or the marketing of finished products depended upon immediate access to the waterfront. It is rather more likely indeed that they were obliged to operate there by the unpleasant conditions and by-products of their work; within certain restraints, the river was always an officially approved repository for filth generated throughout the city at large. This is not, of course, to say that no river traffic tied up at private quays-there is ample evidence that it did-but, except in the limited cases of special privileges, it is safer, at least at the moment, to assume that this catered for passengers or for loads which were small, local, or casual or which for some other reason did not incur customs. Even of this, much could no doubt have been accommodated by the 'bridges' *(pontes)* which extended into the river from the ends of several, perhaps all, of the public thoroughfares which led from Thames Street (Riley 1860, ii, 444-54), and which were also used for such miscellaneous purposes as water drawing, waste disposal, and laundering.

There is therefore good reason for questioning any too ready assumption that in the early medieval period the London waterfront, though largely composed of private properties possessing 'quays' and 'wharves', constituted an unbroken line of berthing and handling facilities. These terms were freely applied to reclamations and revetments also and there is little doubt that they denoted nothing more than the simple characteristic common to all of them: that they marked the point where land and water met. The word 'quay' is, of course, the French equivalent of the more uncouth English 'wharf', and was first used in connexion with the London waterfront in a deed dating from 1108 x 1147-67 (Hodgett 1971, nos 231-2). By the 13th century it had become by far the more common expression, and while 'wharf' still persisted, especially in proper names, it is clear that from this period at least the two were synonyms. Wharf (OE *hwearf,* related to *hwearfan* 'to oppose') was anciently used, like *quai,* in contexts which denote 'embankment' or 'bank', the poetical compound *merehwearf* apparently suggesting 'sea-shore'. In the 1030s, when a more specific context is first available, it denoted a bank built as a protection against flooding (Toller 1921 579; OED, (ii) 4-5)-precisely the primary meaning given to 'quay' by the justices of 1246, 'Wharf' has not so far been traced in connexion with London before *c* 1100, before which date the rare references to the waterfront confine themselves to 'hithe', *portus, statio navium,* and *ripa.* In the 12th century, however, it appears fifteen times (as against 'quay' only thrice), of which six cases clearly refer to landing places. It is remarkable that a composite, and probably spurious, Westminster charter, purportedly of Edward the Confessor but most likely dating from the 1140s, twice contains the formula *hwearfo quad est applicationem navium (Cal Charter Rolls,* iv, 330-6)-the only occasion on which either 'quay' or 'wharf' is found to define specifically, and apparently exclusively, a landing place. This is the more interesting in that so many of the ancient landing places of the city which can be traced back, or nearly back, to the 12th century-St Paul's Wharf, Haywharf (All Hallows the Great), Broken Wharf, Fish Wharf, Wood Wharf, Fresh Wharf, St Botolph's Wharf--all have 'wharf' fossilized in their proper names. Does this mean that 'wharf' had some early connexion with berthing which was not shared by 'quay', or that either term first came into currency with this association in the 12th century, a period when landing places, public or private, began to proliferate in sufficient numbers to acquire a more technical definition? If so, that particular sense was soon lost. What does seem certain is that by the 13th century 'wharf' had no more specialized connotation of docking than did 'quay', and that as synonyms neither term on its own can be taken to denote more than 'waterfront'.

Notes

1 Although Sharpe's calendar prints 'wharf', the original MS (City of London Record Office) f. 199r has *kayum.* This, and the converse, is a surprisingly common practice on the part of the editors of texts. Presumably it is done in the interests of consistency, but it rests upon the assumption that these words have only one meaning—whatever the context.

2 Eg, *Rot Litt Claus,* i, 397, ii, 119 (1220; 1226); *Curia Regis Rolls,* xiv, no 1518 (1231), *London Eyre 1244,* nos 248, 261 (1243-4); *Cal Letter Book G,* 225 (1368).

What value is dendrochronology to waterfront archaeology?

Jennifer Hillam and Ruth A Morgan

Introduction

The extensive rescue excavations along riverside sites in several major cities in England have provided a wealth of material for tree-ring analysis. The often almost complete state of the revetments and other waterfront structures, due to their inaccessible positions and the perhaps unattractive condition of the timbers for robbing, leads to a wide range of timber types being available for examination: boards, upright posts, sill beams, etc. This paper is a review of the type of information that can be extracted from these timbers, and discusses how it can aid the archaeologist in the interpretation of the local environment as well as in dating.

The obvious attraction of dendrochronology is the very accurate results which it can produce. Even if absolute dating is not obtained, relative dating may still be an immense help, particularly when the archaeologist is dealing with a complex site. There is, however, a further aspect of tree-ring analysis which has so far been much neglected. Examination of the timbers yields information about the age, size, and origin of the wood, as well as indicating how timber was used by man.

In the British Isles and much of north-west Europe, oak *(Quercus)* was preferred for waterfront structures because of its strength, durability, and resistance to water. Other species like elm *(Ulmus)* (eg Seal House, below), also highly suitable for use under water, and ash *(Fraxinus) (see* Wallace, below, 109) have been found, but this paper is confined to oak structures. The following description is based on tree-ring work on timbers from London (Fig 2) and Hull (Ayers, below, 128), (Fig 118). Whilst Hull was a relatively small site which produced only medieval timbers, the various sites in London are multi-period and dendrochronologically much more complex.

This paper is based on a relatively small amount of material compared with that which is likely to become available for study in the next few years, and so it is offered in the form of an interim report which will be extended by future research.

The sites and their timber

Evidence as to the origins of the timber comes from observing the ring patterns: similar ring sequences may testify to the exploitation of the same woodland source, whilst estimations of the age and size of the trees extend our knowledge of the structure of the woodland. The widths of the rings suggest whether the woodland was dense or of a more open nature. It is sometimes possible to discover in which season the trees were felled, and the method of timber conversion signifies something of the current carpentry techniques. These were some of the points considered during the examination of the London and Hull material.

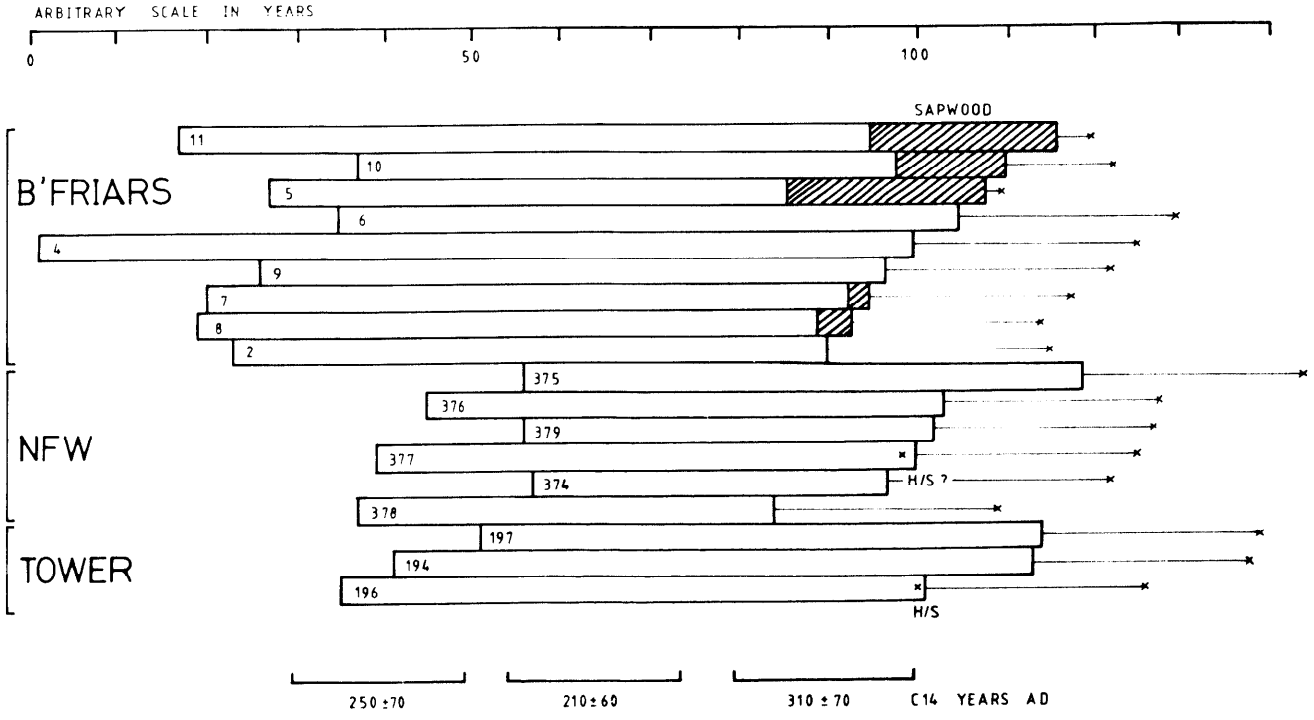
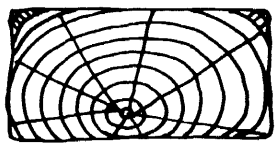
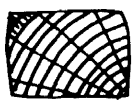


Fig 39 *Block diagram indicating the relative positions of the individual timbers from Blackjriars, New fresh Wharf, and the Tower, all of whick cumc from the foundations of the London Roman riverside wall. Crosses show the earliest estimated felling dates: H/S=heartwood/sapwood transition*

TABLE I Examples of the methods of timber conversion employed in waterfront structures

Rough sketch	Description	Example	Typical dimensions
	Large squared timber	Roman sill beam from New Fresh Wharf	30 x 56cm
	Small roughly hewn timber	Foundation pile from Roman riverside wall eg the Tower	18 x 25cm
	Double-centred trunk, roughly worked	Saxon embankment timber, New Fresh Wharf	16 x 20cm
	Quartered timber	Medieval brace from Seal House	6 x 15cm
	Tangentially sawn plank	Shuttering from Hull	2 x 27cm
	Radially split plank	Medieval revetment at Seal House	5 x 25cm

The Roman timber quays at Seal House and New Fresh Wharf (Schofield & Miller 1976) were formed of up to six horizontal rows of beams, supported by piles and braces. Almost all the timber came from the same woodland, which contained trees with a varied age range. Oaks of 60-80 years old were selected for piles and braces, whilst mature trees of well over 100 years of age were chosen and split for the horizontal members. There was no suggestion of reuse from archaeological or tree-ring results. It appears that the timber was felled as required for immediate use in the quay.

The defensive Roman riverside wall was built on a firm foundation of oak piles surrounded and covered by a hard packed layer of chalk. Oak piles have been examined from Baynard's Castle (Hill et al 1980), the Tower of London (Parnell 1978: DoE excavation) and New Fresh Wharf at positions just inland from the quays already mentioned. They were all from young trees which had been roughly hewn into a square or rectangular shape. The similarities between the ring patterns from New Fresh Wharf and Blackfriars imply that the timber came from the same woodland, but the Tower wood may have come from a second source. It was estimated that 750 piles were needed to construct c 40m of river wall at Blackfriars (Hill et al 1980). The total number required for the mile-long stretch from Blackfriars to the Tower must have thus involved the exploitation of a large area of woodland. The variations in the felling years at all three sites (Fig 39) indicate that the trees were not felled at the same time but may have been collected over a period of years. This storage of timber or the reuse of older timber is in contrast to the practice of immediate use employed with the quay structures.

A watching brief at New Fresh Wharf in 1978 produced wood samples of various periods. The Saxon timbers were mostly whole trunks, some of which had been very roughly worked into square section. They were of similar size to the riverside wall piles and had approximately the same average ring widths, suggesting that they derived from the same type of woodland as that exploited in the mid 4th century. Three out of the eight samples had double centres (Table I); this feature is most unusual, the only other examples so far coming from four medieval timbers at Coppergate, York (Hillam, unpublished). The significance of the double centres is so far unexplained.

The wood used in the three 12th and 13th century revetments at Seal House (Schofield 1975) was extremely varied. The latest revetment (ie that closest to the river) was the most complete and therefore the most extensively examined. It consisted of sill beams laid on elm piles, with horizontal planks pegged to front-braced vertical posts (Fig 40). The timber showed a great variety of conversion methods, even among beams which served the same

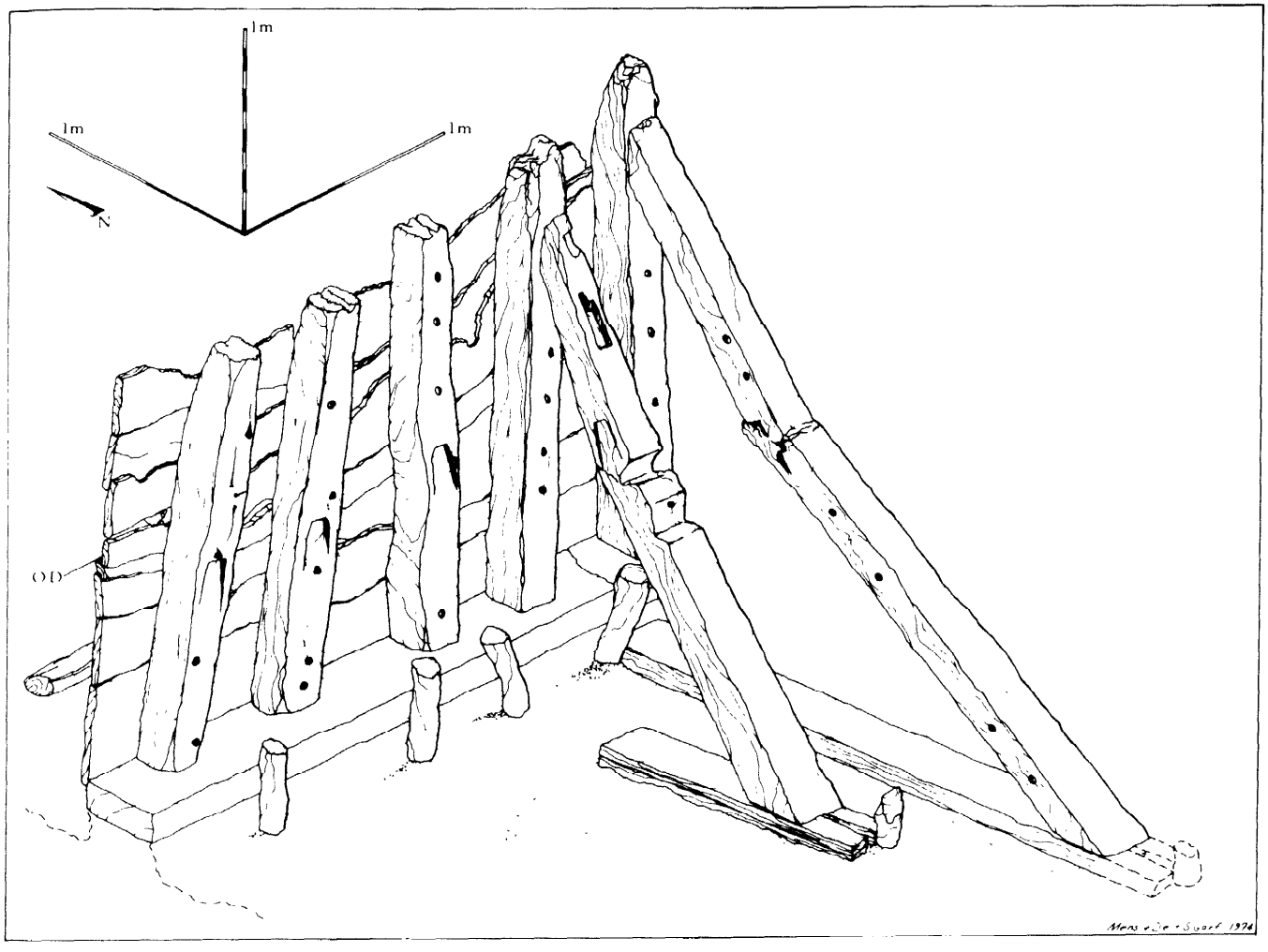


Fig 40 Isometric diagram of 'waterfront' I I I at Seal House, London. This medieval revetment is slightly older than the revetment excavated at Chapel Lane, Hull (see 128 below)

function. The average ring widths were not constant, implying that heterogeneous woodland sources were exploited. Archaeological evidence indicated a certain amount of reuse (see brace in Fig 40); this was not detected by tree-ring dating, since such short-term variations require detailed information from the full sapwood complement.

At Chapel Lane in Hull, the excavated section of revetment consisted of vertical posts with timber shuttering on the landward side (Ayers, below, 128, Fig 118). The timber was of lower quality than that used in the Seal House revetments. The planks at the latter were from slow-grown oaks often reaching more than 200 years of age, whilst those from Hull were of medium growth and well under 200 years old. To compensate for this lack of size, the Hull planks had been tangentially sawn as opposed to the radially split Seal House planks (Table I). Radially split wood gives stronger, more durable timber since it is split along the grain rather than sawn across it. Thus the tangential planks are less stable, being subject to cracks, distortion, and fungal attack. It seems that the Hull trees were selected as required, with little attention given to quality, from a younger woodland. The Seal House timber on the other hand was very variable, suggesting different localities and possibly the stockpiling of timber. The latter would account for the wide variations and would not be unexpected in 12th- 13th century London.

Although inferior timber was used at Hull-possibly the scarcity of oak timber, which was to become severe in later centuries, was already being felt-the carpentry indicated the very superior work of a skilled craftsman. Presumably the poor quality of the material would not be critical since revetments did not usually have very long life spans, but good craftsmanship would be vital.

The present state of dendrochronology

The success of the tree-ring method for absolute dating depends on several factors, but primarily upon the availability of dated reference chronologies, which have

TABLE II Summary of the tree-ring dating of the waterfront timbers examined at Sheffield

SITE	PERIOD	DATING	CHRONOLOGY	FELLING DATE
HULL				
Chapel Lane	medieval	absolute dendro	AD 1126-1297	1323 ± 9
LONDON				
Seal House	medieval	absolute dendro	AD861-1193	I *c* 1140 II *c* 1170 III after 1210
New Fresh Wharf	late Saxon	relative dendro, archaeol.	149 years	I year 117 ± 9 (*c* 870) II year 181 ± 9 (*c* 940)
New Fresh Wharf Seal House revetment	Roman	relative dendro, C14	282 years	year *c* 282 (3rd–4th c)
Riverside wall: Blackfriars, New Fresh Wharf, Tower	Roman	relative dendro, C14	*c* 120 years	*c* year 144 (4th century)

been constructed from successively older tree-ring patterns starting with modern samples. The present situation varies: there are published chronologies extending back to *c* AD 800 from Ireland and Scotland (Baillie 1977b,c) and from different regions of Germany (eg Hollstein 1965). In England, there are many shorter sequences of 200-400 years in length (eg Fletcher 1977; Hillam 1979a; Morgan 1977). Prior to AD 800, absolute dating by dendrochronology is not possible in Britain, although relative dating is proving useful.

The quality of the timber will also influence the prospects of dating (Hillam 1979b). Samples of good quality which came from slow-grown oaks of 200-300 years of age, such as the Roman sill beams from New Fresh Wharf, are better suited than the young trees with less than 100 rings which were uncovered in the foundations of the defensive riverside wall. The quantity of samples is similarly important: a site mean curve, based on the growth patterns of many timbers, is easier to cross-match with a reference chronology than a curve based on a single timber. For this reason, extensive sampling of all available timbers is necessary if the best results are required (see also Eckstein, below, 96).

Unfortunately, even if all these conditions are met, there will still be a proportion of samples that can never be dated. This is due to complex local conditions of habitat and climate which affect the growth of an individual tree and which cannot as yet be understood or interpreted. These timbers, however, may still provide information about the type of timber used in the waterfront structure.

Interpretation of tree-ring dating

The accuracy of the date depends upon the presence or absence of sapwood. The ideal situation occurs when the sapwood is completely preserved up to the bark edge so that an exact felling date for the timber can be determined. This is rare because the sapwood is usually removed during construction or has not been preserved. If, however, the transition from heart wood to sapwood is distinguishable, The felling date can be calculated with some accuracy by estimating the number of sapwood rings. The number is relatively constant for a mature oak tree and several results have been published, although further work is still needed in England based on a large number of samples. The values vary with tree age and ring width but are generally around 25-30 years, the Irish estimate being 32 ± 9 years (Baillie 1974) and the German 20+6 (Hollstein 1965). An immature wide-ringed tree might only have 12–15 rings, while an aged slow-grown oak might have over 40; the range seems to be quite large, but nevertheless the estimate is accurate to within a decade or two. If no trace of sapwood can be found , it is only possible to give a *terminus post quem* for the felling date of the timber.

The construction date is that which most closely concerns the archaeologist. In the case of revetments and other waterfront structures, the construction date is usually equivalent to the felling date since seasoning of the timber would be unnecessary.

The dating of the waterfront timbers

The following examples give a brief survey of waterfront structures from different periods showing how their dating, both relative and absolute, has been achieved (Table II).

Medieval period

Although timbers from the 13th and 14th century were discovered at Chapel Lane, Hull, only those from the early 14th century revetment were suitable for tree-ring dating. It was possible to construct a mean curve of 172 years using samples taken from the shuttering (Fig 41). This was compared with several reference chronologies using the Belfast computer program (Baillie & Pilcher 1973) to assess objectively the degree of similarity between the respective curves. The resulting t -value is statistically significant at the $P<0.001$ level when equal to

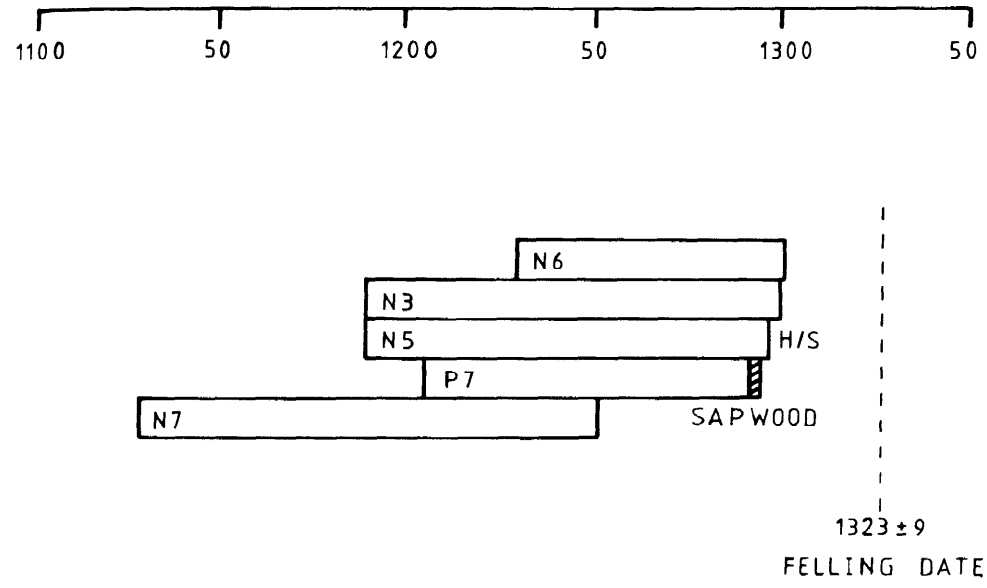


Fig 41 Block diagram of sample from the Hull planking H/S = heartwood/sapwood transition

3.5, but all results are checked visually before a match can be accepted. The latter process takes into account the general trends of the respective curves as well as the agreement between individual signature years. The comparisons indicated that the Hull curve spanned the years 1126–1297, good matches being obtained with sequences as far away as Dublin (Baillie 1977a) and southern Germany (Huber & Giertz-Siebenlist 1969). The *t* -values were not exceptionally high (eg 4.82 with York, 3.21 with Dublin, or 3.93 with southern Germany (Fig 43)) but together they make the dating indisputable (Hillam 1979c).

Some of the samples retained a little sapwood so that the felling date could be estimated as 1323 ± 9, where ± 9 is one standard deviation from the mean. This date for the revetment's construction agreed well with the date suggested by the archaeological evidence (Ayers 1979).

It must be stressed here that tree-ring dating, obtained in the above manner, is completely reliable; it must override any contradictory evidence such as that from pottery or documents. Such a conflict arose with the dating of the three Seal House revetments in London. Examination of the medieval timbers resulted in a mean curve produced from 20 samples (Fig 42). The 333 year curve covered AD 861–1193 (Morgan & Schofield 1978) and was dated with reference to western (Hollstein 1965) and southern Germany (Fig 43), and southern England (Fletcher 1977: ref 6); the *t* -values were 5.9, 7.8, and 8.5 respectively.

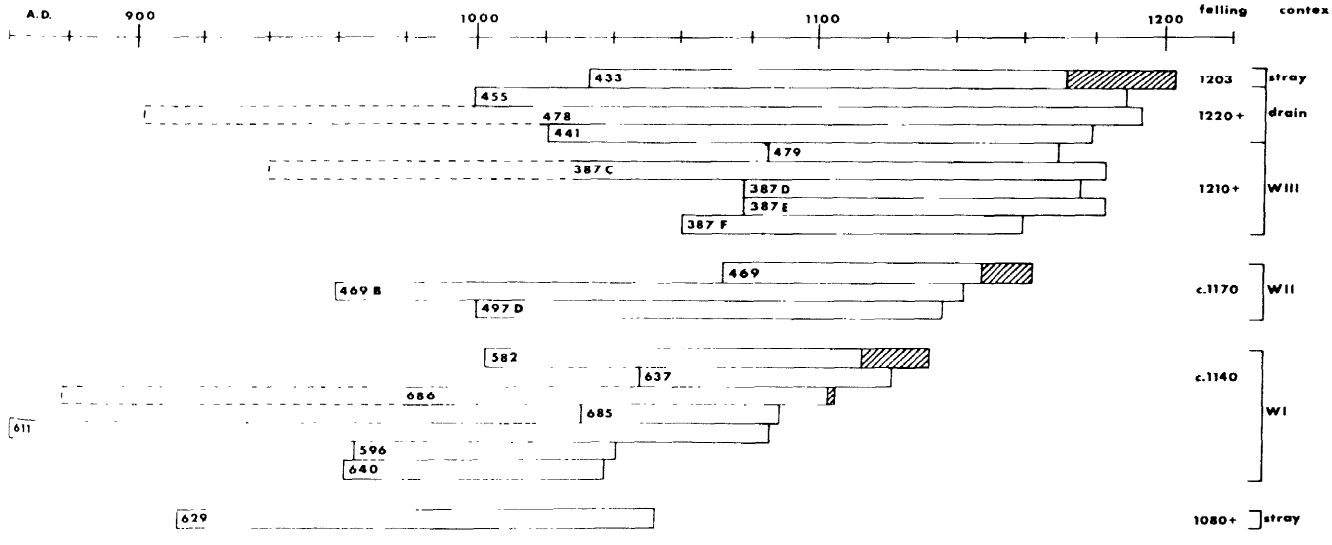


Fig 42 The relative positions of individual from three revetments from Seal House, London. The estimated felling dates of each revetment and associated features are given

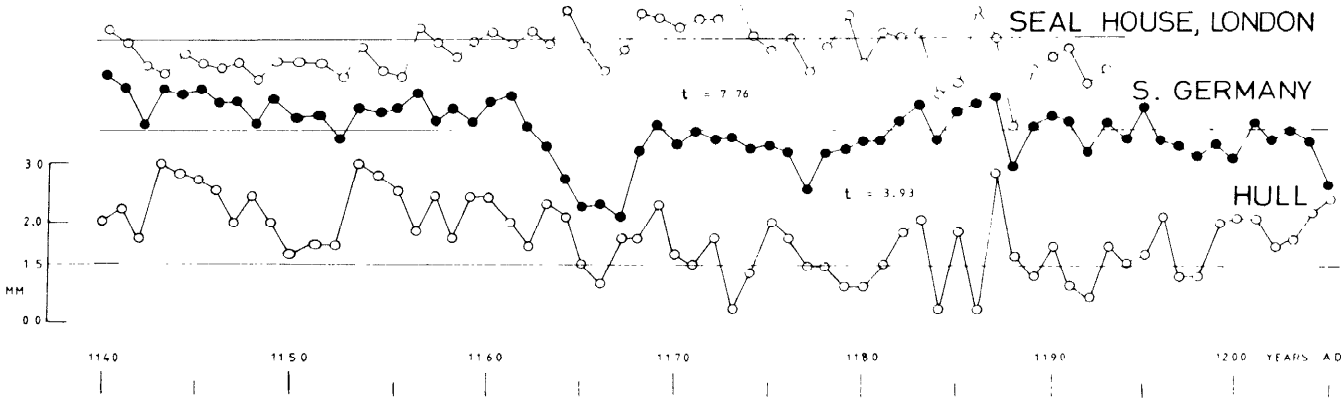


Fig 43 Cross-matching of the mean curves from Chapel Lane, Hull, and Seal House, London, with the south German oak chronology

Interpretation of the dating of-each revetment proved far from simple. At the top of Fig 42 are the blocks representing the years spanned by timbers from 'waterfront' III and its associated features. The only timber with its full sapwood complement was the stray find 433; thus its felling date of 1203 cannot aid in dating the revetment. The three drain timbers (441, 478, and 455) indicate a date of 1220 or later, whilst the five timbers integral to the revetment suggest a date sometime after 1210. It is impossible to say whether the drain is contemporary with the revetment or later than it.

The earlier revetments I and II each contained timbers which retained some of their sapwood. Hence II is dated to *c* 1170 and I to *c* 1140. This illustrates the earlier point about sapwood widths: the young timber 582 is likely to contain fewer rings of sapwood than the very old 686, thus explaining the discrepancy in the transition years.

The dates for the three revetments are consistently older than those expected from the pottery evidence by 40-50 years. Because of the absolute reliability of tree-ring dating as an indication of-when trees were felled, either the dating of-the pottery styles will need revising or some mechanism such as clearance of earlier material must be sought.

Saxon period

Of the eight Saxon timbers examined from New Fresh Wharf, five were crossmatched to form a short mean curve of 149 years (Fig 44). 4001 was from the first Saxon embankment whilst the remainder came from the second. Work on the dating of-these timbers is still in progress, but already the relative dating indicates that the timbers of the second embankment were felled 64 ± 9 years after those of the first. This precision is possible because of the remains of sapwood on 4001 and the sapwood transition on 3004.

Roman period

Studies on the Roman revetment timbers from Seal House and New Fresh Wharf (Schofield & Miller 1976) showed

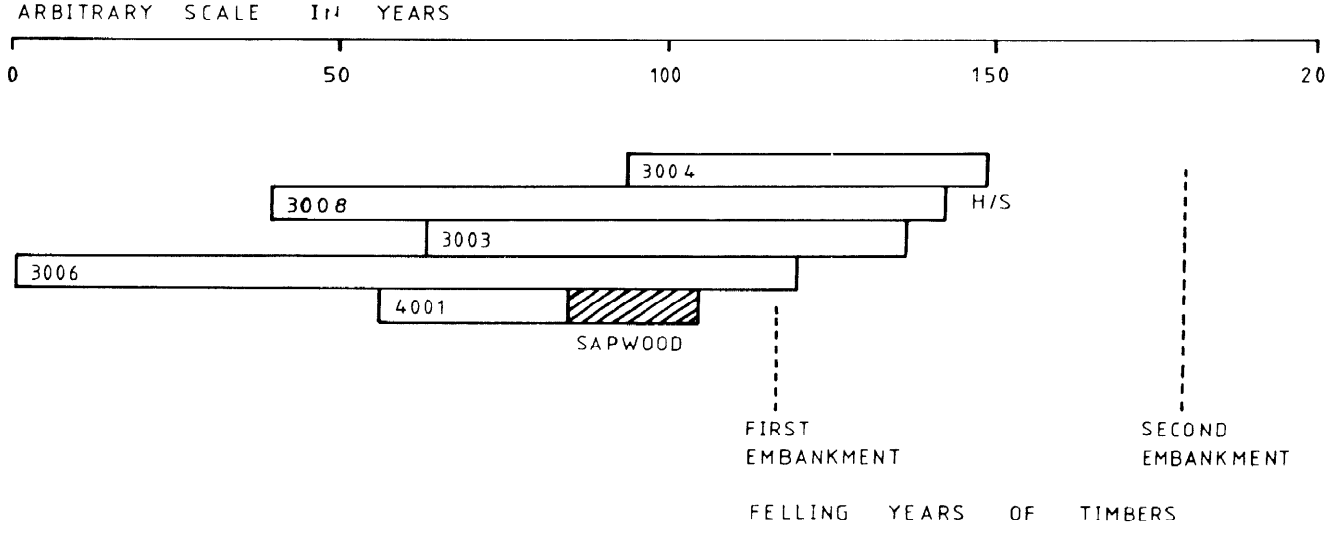


Fig 44 Block diagram of timbers from the late Saxon period at New Fresh Wharf, London. 4001 is from the first embankment, whilst the remainder derive from the second; the time interval between the two is 64 ± 9 years

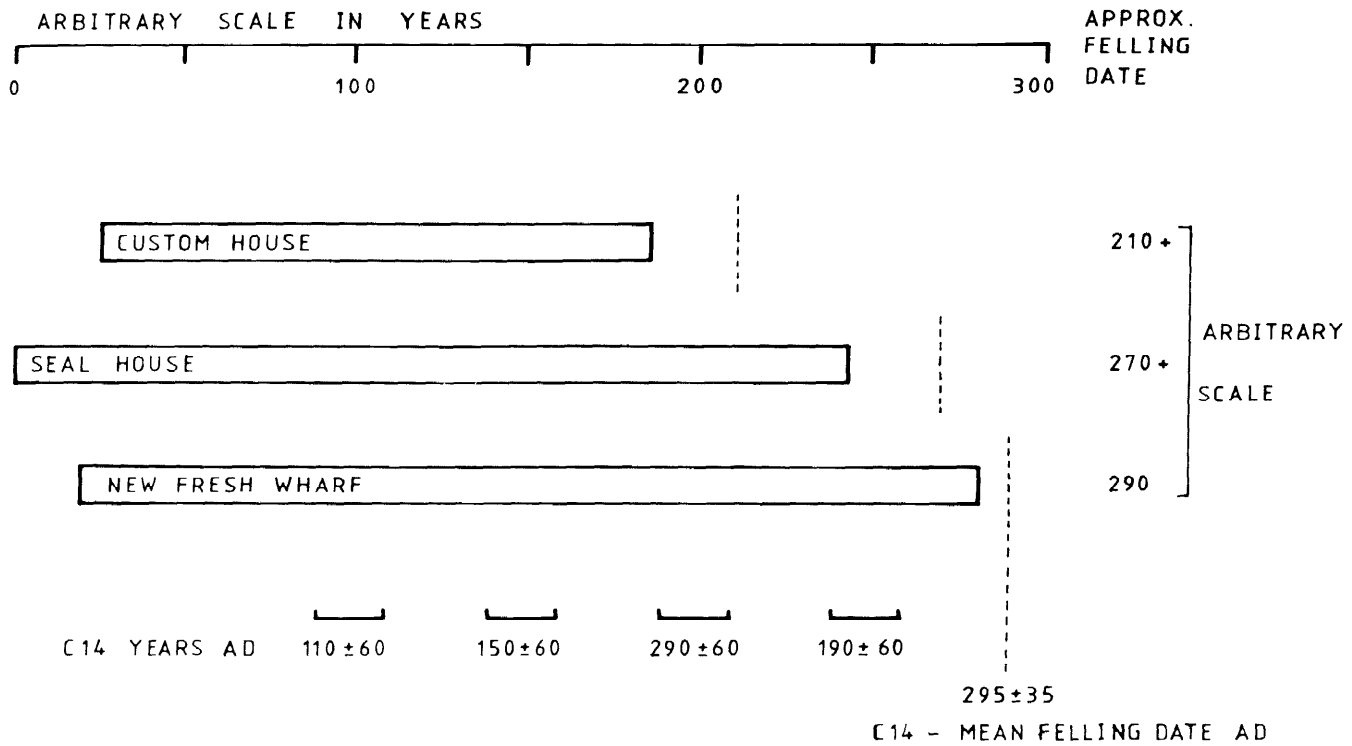


Fig 45 *London Relative positions of the Roman revetment mean curves. The estimates felling dates indicate that Seal House an new Fresh Wharf were contemporary but that Custom House could have been older been by up to 80 years*

that two parts of the same structure had been found. The resulting chronology of 282 years cross-matched well with the timbers from the Custom House site (Tatton-Brown 1974). Incomplete or absent sapwood meant that the exact felling dates could not be determined but the relative dating suggests that Custom House was slightly earlier than the other structure (Fig 45).

Radiocarbon dating was used to fix the Roman chronology in time: a total of five samples from the Seal House/New Fresh Wharf structure were analysed by the Harwell laboratory. The results clustered around ad 300, when corrected for growth allowance. This dating again disagrees with archaeological evidence, which postulated a late 2nd century date. Further samples were submitted to Harwell from the Custom House timber; provisional results suggest a comparable mid to late 3rd century date.

Absolute dating by dendrochronology would be decisive in this matter, but so far there is only tentative cross-matching with several other floating chronologies and with the dated curves from Germany, partially published by Hollstein (1972). Since the Sheffield dendrochronology laboratory aims at providing completely reliable tree-ring dates, we have not published these provisional results and shall not do so until further confirmation is obtained.

Tree-ring analysis of the timbers from the three stretches of riverside wall has shown that the sites are roughly contemporary (Fig 39). Although none of the samples contain more than 100 rings, and some only 50, the cross-matching was well replicated and the agreements acceptable, both visually and statistically. It is hoped that this will eventually be linked to the floating Roman chronology but, in the meantime, radiocarbon gives a mid to late 4th century date for the felling of the youngest timber, a result which is happily in accord with that of the archaeologists. Exact interpretation of the relative dating is again difficult but it suggests that the timber was not felled in the same year (see above).

These results illustrate the validity of long-term projects, such as that undertaken by the DUA, in that they have allowed the above information to be extracted and will no doubt in future produce more timbers from the defensive riverside wall which will allow this work to be extended.

Conclusion

It is hoped that this briefreview of the present state of research at Sheffield into the daring and examination of waterfront timbers has emphasized several points. First, sampling must be extensive in order to increase the chances of obtaining dares and to allow an accurate interpretation of the results; it should preferably be discussed with the dendrochronologist beforehand. Secondly, a corpus of information is being built up on woodland history and technology, particularly in the London area, including some aspects which may contribute to the researches of other environmental archaeologists. Thirdly, the complete reliability of-tree-ring dating, its accuracy under ideal conditions, and why dating is sometimes impossible have been stressed. However, the provision of a sample cannot

guarantee a result: in this respect it differs from radiocarbon dating. The implications of such precise dating for some of the structures discussed in this paper may be far-reaching in the interpretation of waterfront sites.

Acknowledgments

The authors would like to thank all the archaeologists involved with the sites described in this paper, and also the DoE for financing the work.

Southwark

M G Dennis

About 10km (c 6 miles) of the south bank of the Thames is within the London boroughs of Sc, ithwark and Lambeth, including all the frontage opposite he City of London. The drift geology of this frontage is fluvial, varying from sand to peat, silts, and clay which extend south from the river as far as its gravel floodplain (Ordnance Survey 1975). Natural topography and hydrology have been critical to the development of the area. In the past it was very low-lying with extensive water-meadows and marshes, intersected by streams and dykes (SLAEC 1978; Codrington 1915; Barton 1962). Archaeological and bore-hole evidence, however, has also identified at least nine raised, relatively dry eyots of sand and gravel. Consideration of Thames water level in the past (SLAEC 1978; Willcox 1975) suggests that they were available for human occupation from the late Iron Age onwards, and the Southwark and Lambeth unit has mainly been concerned with defining these areas of settlement potential. Excavations on the three sandbanks under Borough High Street have confirmed their importance as the nucleus of London's southern suburb in the Roman and medieval periods (SLAEC 1978). Late Saxon or medieval occupation is known on several of the other eyots and, in an area still largely below Trinity High Water, the river would have profoundly influenced these discrete settlement areas. So far, however, there has not been extensive archaeological work on the southern waterfront, partly because, despite the demise of London's dockland, riverside redevelopment has been slow. It is clear though that there has not been continual encroachment into the river, and that the reverse, erosion, has occurred.

Most of the archaeological work for the Roman period has been carried out around London Bridge, but consideration of the waterfront and the southern bridgehead remains speculative as the Roman bank no longer survives. Just east of I,ondon Bridge excavation on the riverfront at *Toppings Wharf* (Sheldon 1974) revealed Roman buildings, entirely cut away towards the Thames by the late 13th century river erosion. The same erosion was apparent west of the bridge (Evans 1973) and further downstream (observations by SLAEC at *Willson's Wharf).* There is no evidence for expansion of settlement off the raised eyots at this time and a system of Roman river defences and land reclamation cannot be assumed. The area remained intersected by tidal creeks and channels (SLAEC 1978, fig 2). Some were probably navigable, as one contained a 2nd century boat, *c* 450m south of the Thames (Marsden 1965), and inland docking facilities may therefore have existed. 1st and 2nd century occupation in north Southwark is at *c* + 1m OD and above, with no sign of flooding. Unless there was widespread embanking this does suggest that the river was normally below + 1m OD, although waterlaid fills in some of-the channels (Schaaf 1976) indicate that the general level was at times not much below this.

The post-Roman history of the Thames is one of‘ progressive flooding of the estuary from rising sea levels. The ensuing flooding of the banks is evidenced on both sides oft he river (Willcox 1975) and necessitated river defences on the south side. The documentary evidence (Manning & Bray 1814, 224) suggests that a series of riverside embankments linking the firmer gravels at Deptford with those at Vauxhall (a length of *c* 11.5km) were in existence by the 13th century. Their origins might be late Saxon, but archaeological work has been limited as all of them form modern streets. On several sites behind these defences (Marsden 1971) silt sequences continuing into the post-medieval period have been observed, and these areas were still strongly influenced by river regime: the Thames flowed in at high tide through natural creeks and dammed up the ground water draining towards the river. This ebb and flow was utilized by several tide mills, but the number of commercial installations may have been few. Docks and wharves are known (Sheldon 1974; Woodward-Smith & Schofield 1977; Survey of London 1955, 59) but these met rather localized needs: for example, St Mary Overey's dock served the Bishop of Winchester's palace and Battle Bridge dock the house of the Abbot of Battle. Facilities comparable to the extensive quays on the City bank (eg Tatton-Brown 1974) have not been found and much of the frontage was occupied by the manors and town houses of nobles and clerics. The question of post-Roman river levels is difficult as it is rarely clear to what extent a particular building was protected from the river, but occupation deposits in north Southwark are found during this period from approximately + 2 to + 3.5m OD. Low water must have been below OD and probably below -0.5m OD, as evidenced by late medieval foreshore deposits excavated at *Bankside* (observations by SLAEC) and *New Hibernia Wharf* (Evans 1973).

From the 16th century, particularly after the disposal of ecclesiastical property at the Reformation, the south bank became more commercial and private residences were gradually replaced by wooden granaries, warehouses and wharves. Some of these were well-protected from flooding: a 17th century riverwall at *New Hibernia Wharf* (Evans 1973) had a rubble core with stone facing and timber rubbing posts and rested upon horizontal planks over wooden piles. There was, however, no marked encroachment towards the river, this wall lying less than 10m behind its modern counterpart. Commercial enterprises varied from brewing to the boring of elm waterpipes. By the 18th century wharfrngering and lighterage operating from ships in the Pool of London were dominant, particularly with the increased authorization of ‘sufferance’ warehouses for the bond of dutiable goods.

Runnymede Bridge

S P Needham and D Longley

The discovery of a timber waterfront at Runnymede Bridge datable to the late Bronze Age has profound repercussions not only for that period, but also in tracing the development of commercial exploitation of the Thames. Excavation in two areas-in 1976 (Longley 1976; Longley, forthcoming), and in 1978 (Longley & Needham 1979)-has revealed the existence of intensive settlement on the floodplain immediately south of the present Thames course. Occupation has been dated to the 9th-8th centuries BC on the basis of pottery, metalwork, and radiocarbon analysis and appears to have been associated with a dense pattern of buildings or structures. Economic data indicate a permanent basis for the occupation. The variety and quality of the artefact remains recovered, including much fine pottery (as well as coarse), some 50 metal fragments, amber beads, and shale bracelets, suggests a comparatively wealthy community. In addition to normal domestic industries-spinning, weaving, etc-several finds attest the practice of metalworking in the immediate vicinity.

The settlement area extends in a north-easterly direction to the edge of an ancient river channel fully choked with silt, its period of active flow apparently spanning the duration of occupation on the river bank in the Late Bronze Age. The ancient river bank had been revetted with a double row of vertical pile-driven timbers set a short distance into the channel (Fig 47). The timbers are young oak trunks with only their lower ends worked. A complex stratigraphical succession surrounding and sealing the piles can be divided into three main phases of deposition: silts pre-dating pile emplacement, silts accumulating around an upstanding barrier, and those deposited after all trace of the timber structure had vanished above riverbed level. Many of the river channel silts yielded occupation refuse which belongs consistently to the Late Bronze Age and is comparable with that on the river bank. Some of this material may be in a secondary context, having been eroded off the adjacent area in times of flooding, but much appears to have been dropped *in situ.*

The waterfront structure is envisaged more as a wharf than a purely defensive work, although an element of sheer ostentation is not to be ruled out (Needham & Longley, forthcoming). A minimal reconstruction might see the piles extending upwards to support a series of horizontal timbers level with the crest of the river bank, and perhaps tied in to post-set timbers there. For a functioning wharf capable of accommodating river craft, the contemporary river level would have been fairly critical and potential problems arising from likely seasonal variations have been considered elsewhere. A cusping plan evident for the waterfront (Fig 46) would have provided a framework for division in terms of function or moorings allocations, even if this form originated in the attainment of greater structural rigidity. An inclined layer of brushwood on the riverbed overlain by a few branches was enclosed by one 'bay' and is tentatively interpreted as a beaching ramp, or hard, usable in times of low water (Fig 46). Outlying posts recovered further into the river channel could have been mooring posts or supports for narrow walkways or for fences.

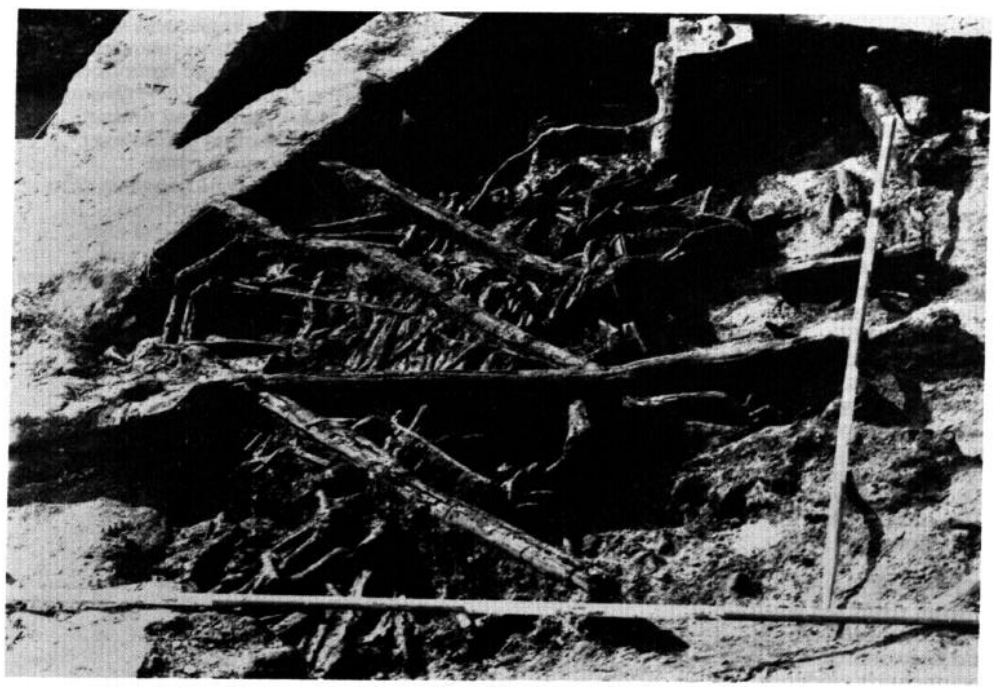


Fig 46 Runnymede Bridge: brushwood structure on riverbed outside the Late Bronze Age pile rows. Scales: 4×050m

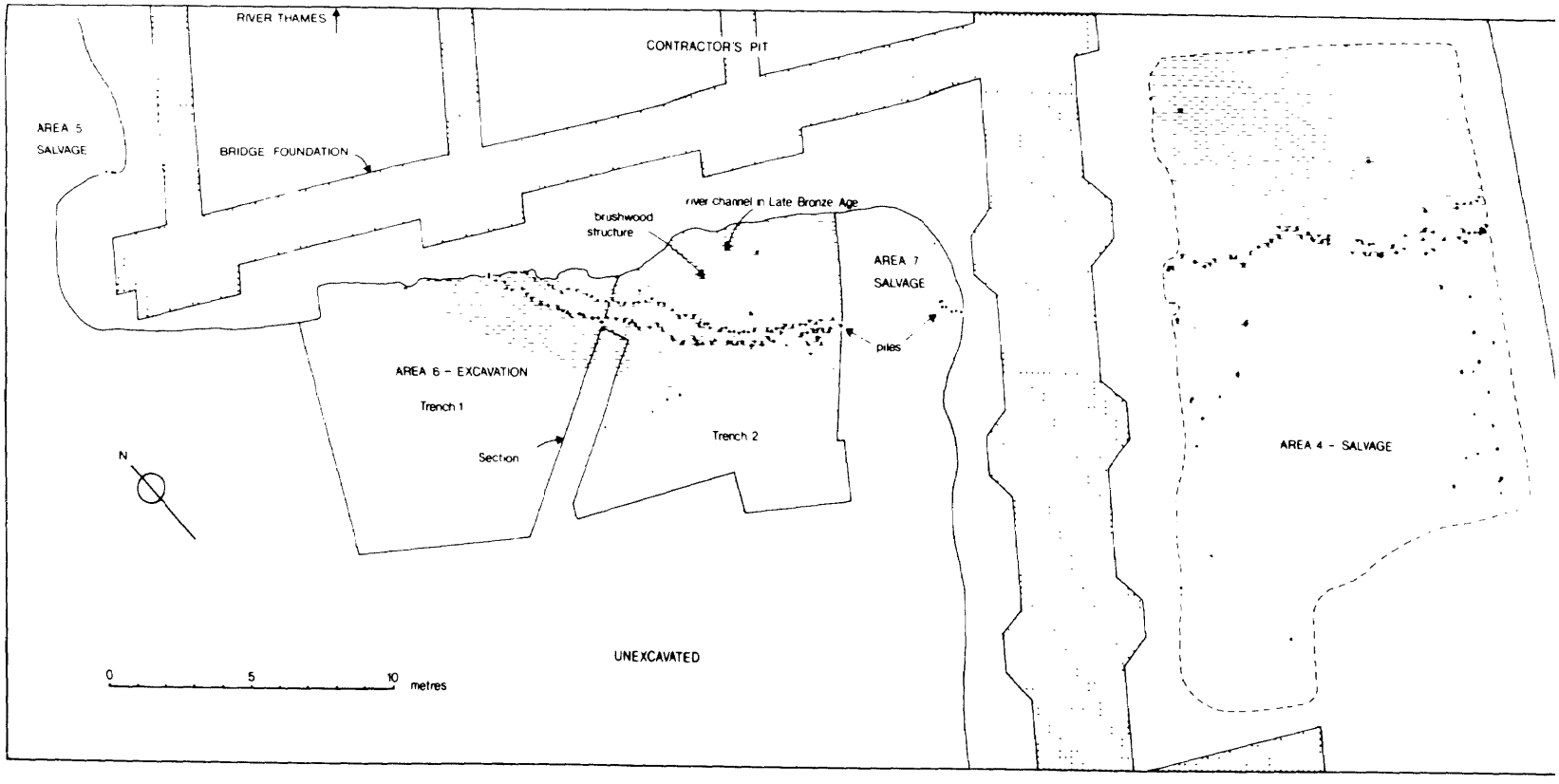


Fig 47 *Runnymede Bridge: general plan of site to show pile rows and position of southern bank of Late Bronze Age river channel*

In contrast to many medieval waterfront structures, there was no attempt at Runnymede to consolidate the timber revetment artificially by the dumping of material behind it. The entire silting sequence appears natural: indeed this accumulation, possibly quite rapid, might have impeded a functioning waterfront prematurely. Man's interference with the local ecological balance might have affected the character and rate of deposit ion, for-there is a significant change at the horizon associated with pile insertion.

Good evidence for comparable prehistoric settlements with associated structures in Britain is lacking. Potential sites either remain unexplored or were inadequately recorded in the process of destruction. Similar timber formations seem to have existed in the Lea valley (Hatley 1933, 16-7), but are undated. Occasional sites in riverside locations yielding indications of comparable status and date to Runnymede Bridge may be singled out-eg Old England, Brentford (Wheeler 1929) and Wallingford (Oxon) (Collins 1948-9)-and suggest tentatively a recurring pattern in the Late Bronze Age landscape.

It is argued that the siting of Runnymede Bridge is not likely to be concerned merely with the exploitation of riverine and floodplain resources, but more specifically with the control of traffic and consequent manipulation of exchange networks. Taking into account evidence suggesting a settlement of comparative wealth, Involved in specialized production, able to acquire foreign material, and possibly even attract foreign expertise, siting and waterfront may be viewed as intimately connected with riverborne commerce. The rewards gained, or anticipated, through such control and manipulation might in fact have conditioned the siting of a settlement in this inconvenient location with its inherent flood risk.

The scale of-settlement is uncertain on account of the small areas excavated, and the critical relationship to Late Bronze Age settlement at Petters Sports Field in particular, some 300m distant, cannot as yet be ascertained (O'Connell & Needham 1977). A complex extending over some hectares could conceiva blv be represented, and in combination with the various specialized functions and activities envisaged, a proto-urban situation may be postulated. There is evidence f-or the exploitation of fairly large tracts of land in terms of agricultural and economic produce, but none as yet to suggest redistribution of material to a wider hinterland, although this seems feasible.

The demonstration of an entrepot settlement at Egham in the Late Bronze Age would establish a considerably greater antiquity, not entirely unexpected, for organized exploitation of Thames-borne commerce than hitherto possible. Divergences are manifold, but Runnymede Bridge may nevertheless be seen to represent an early stage in a logical development towards the waterfront quarters of Roman and medieval London .

Ships and ports in Pomorze

Przemystaw Smolarek

This paper considers some of the factors which governed the interdependent development of shipping and the ports on the south coast of the Baltic, by outlining the main events in the development of warships and merchant vessels and elucidating the origins and evolution of Baltic harbours, landing stages, and ports. It must be stressed that it is written from the point of view of an historian, not an archaeologist.

Despite general similarities, the development of boat-building in distinct regions of the Baltic exhibits certain differences, and the geographical-hydrographic conditions also vary. Thus the remarks concerning the interdependence of ships and ports are restricted to the southern coast of the Baltic, particularly that of Poland. The terrain of Poland is flat, with a gentle slope from the Carpathians and Sudeten Mountains northwards towards the sea. Two great rivers, the Odra and Vistula, cut across the area from south to north, their multi-branched tributaries covering almost the whole interior of the south Baltic coast. Several smaller rivers flow into the sea in the coastal belt, in which there is also a large number of lakes frequently connected by rivers. The Baltic coastline is broken by large lagoons and bays, and there are also islands in the western region. The banks of the rivers flowing over the plain are mostly low and flat, so the swollen rivers frequently flood the nearby fields and meadows. For the most part, the sea coast is also low and flat, the sandy beach being washed by shallow inshore waters. Such favourable hydrological conditions were conducive to the early development of shipping, and their character had a fundamental influence on the type of the ships and harbours used.

Boats and ships

The dugout and raft would appear to have been the prototype of the Slavonic boat. The long first phase in the evolution of Slavonic boat-building covered the development from the prototypes mentioned of a boat built from planks and propelled by means of oars (Fig 48). Over many centuries the improvements in form and construction of floating units which gradually evolved opened up new perspectives in the field of transport and communications. On the other hand, new demands made on shipping made increasingly better boats imperative and forced the introduction of innovations in existing units. The new transport-communications requirements were the result of changing social-economic conditions. The oldest means by which man could sail may be called 'floating craft'. They served primeval man for all his water transport-communications needs, having in a certain sense a 'universal' character. However, the different nature of these needs ultimately led to the development of distinct types of ship (Smolarek 1972, 13).

The second stage covered the evolution of the oar-sail and sail-oar boats fitted with a side-rudder. This development took place at a time when important social-economic changes were taking place in the Baltic area. The changes in the character of production, the increasing social stratification, the intensification of trade, and the formation of urban-type centres and the early-feudal states were accompanied by the development of shipping of inland, coastal, and sea-going types, emphasizing the differentiation of tasks in the sphere of transport-

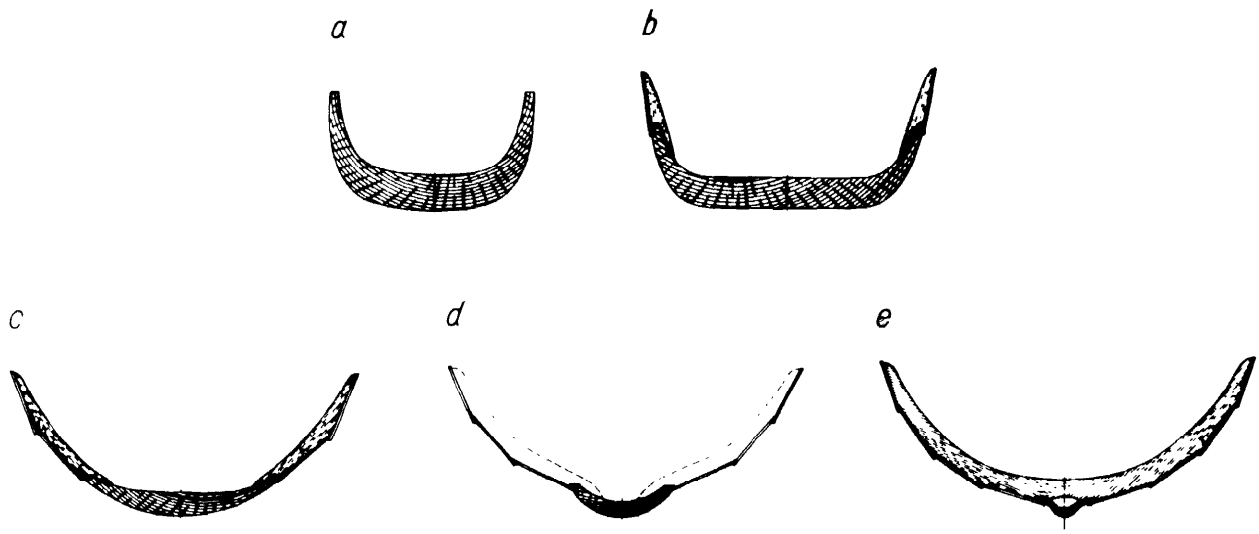


Fig 48 Diagrammatic cross-sections of some boar types which evolved from the dugout: (a) dugout; (b) dugout with single strake added (this type was presumably the forerunner of the present-day fishing boats from Lebsko Lake); (c) dugout with two strakes added (a similar construction was recorded on a boat discovered in 1896); (d) relict dugout with three strakes added (the older types of the so-called Rostock boats could have had a similar construction; the shell may have been supported by ribs whose position is suggested by the dotted line); (e) boat built on a hollowed keel with four strakes (the so-called Kalmar XII could be built in a similar way). Note: Thwarts are not shown on these drawings

TABLE III Dimensions of early medieval Slavonic ships

Name of site	L	B	H	Capacity (kg)	Light draught	Loaded draught
Orunia I	12.76	2.37	0.70	1 500	0.20	0.30
Orunia II	11.00	2.27	0.87	3 500	0.38	0.58
Orunia III	13.30	2.46	0.27	1 500	0.25	0.35
Mechlinki	9.32	2.47	0.80	2 350	0.35	0.55
Charbrów	13.20	3.30	1.00			
Czarnowsko	13.26	3.35	0.85		0.25	0.50
Szczecin	8.10	2.20	0.70			
Frombork	17.36	2.78	0.92		0.32	0.52
Dzierzgon	11.90	2.60	0.86		0.32	

communications services. This phenomenon was reflected in the gradual crystallization of types of ship designed for specific operational purposes (Smolarek 1963, 45).

The evolution of the two basic types, the merchant ship and the warship, will be considered.

The introduction of the sail (probably in *c* 500 in the Baltic) gave rise to major changes in the form and construction of vessels in the area. The proportions and structure of a rowing boat are determined, to a certain extent, by the type of propulsion, and so they are low and narrow. After the introduction of the sail, these proportions changed, particularly as regards the height and the breadth. The new ratios between the main measurements show that attempts were made to improve the sailing qualities of the vessels.

The improvements in form were related to the developments in construction. As a result of comparing the cross-sections of rowing-boats from the 4th century with oar-sail ships from the 9th century, it may be said that the rowing boat became the submerged part of the oar-sail ship which-broader in proportions-had higher sides and a sail as well as oars (Brøgger & Shetelig 1953, 58).

The vessels which developed from these rowing boat traditions never lost the character of the 'long' boat and this line gave the Scandinavians; Slavs, and other Baltic peoples the warship.

The concept, function, and construction of the warship underwent interesting changes in northern Europe. In the Baltic region, the warship (serving initially to transport armed men across the sea, and later as a means of actual warfare) originated from the 'universal' type of vessel. It then developed along with the evolution of social and state organizations, and especially with the evolution of military systems (Smolarek 1969, 96).

However, some features indicating divergences from this line of evolution have been found. In wrecks discovered at Äskekärr, Skuldelev, Galtabäck, Falsterbo, and elsewhere, a separate space was found in the hull, amidships, designed for the carriage of cargo. These wrecks, together with iconographic material, indicate that the assignment of space for use as a hold was related to specific changes and modifications in both the construction of the ship and its shape. Generally speaking, ships used to carry cargo became shorter, wider, and higher than warships. A similar development has been observed in Slavonic boat-building, and the evolution of cargo ships built by the Prussians and Estonians also seems to have been along the same lines.

It should be emphasized that the oldest wrecks of this type are dated to about the 9th century. This, of course, may be merely coincidence; coincidence is, however, not the only explanation possible. About 20 years ago I advanced the hypothesis that among the Baltic peoples suitable conditions for the evolutionary development of a merchant ship appeared in the period when towns were growing up, with their accompanying complex of social-economic phenomena. The appearance of the profession of the merchant also played a very important role. So long as members of an agrarian society were engaged in commerce, trading voyages were an exceptional phenomenon in their lives, and the objects of trade were expensive goods obtained in relatively small quantities, it was possible to use ships that were in general similar to pirate vessels or warships for trade. In view of the uneasy situation at sea, this was, indeed, advisable. When, however, commercial voyages became more frequent and became transformed into an occupation in their own right, this had to be reflected in the adaptation of ships to suit the new operational functions (Smolarek 1963, 97; 1969, 145-54).

Although the general lines of development of warship and merchant ship types in the Baltic were similar, they differed in both construction and in shape. Some of the smaller Slavonic boats had flat bottoms with no keel. Others, particularly the larger ones built along the coast, were built on a keel. They had a slight rise of the bottom and a soft bilge.

All the Slavonic ships known archaeologically from the early Middle Ages had very small draughts, as illustrated in Table III.

As can be seen, even the largest of the ships discovered had a draught of about 0.50m loaded, the light draught being between 0.20 and 0.38m (Figs 49 and 50). This meant that the ships could navigate even the shallowest rivers, while the shapes of the keel boats enabled them to sail in Gdansk bay, the Vistula lagoon, the Szczecin lagoon, and the Baltic. These vessels could beach on the flat banks of rivers, lagoons, or sea coast. Written sources frequently mention such situations: for example, in 1243 the fleet of Prince Swietopelk of Gdansk sailed some distance up the Vistula to the Chelmno area. The boats sailed right up to the river banks, with the intent to invade enemy territory (Toeppen 1861, 75).

Describing the expeditions of the Slavonic pirates to Denmark, Saxo Grammaticus mentions that the Slavs' ships tried to come right up to the shores of the Danish Islands unnoticed at unguarded points, from which they made sudden attacks on neighbouring settlements. The same source also describes cases when, during an attack on the Slavs, the Danish fleet had difficulty in sailing up rivers (eg the Warnawa or the Dziwna) which did not constitute

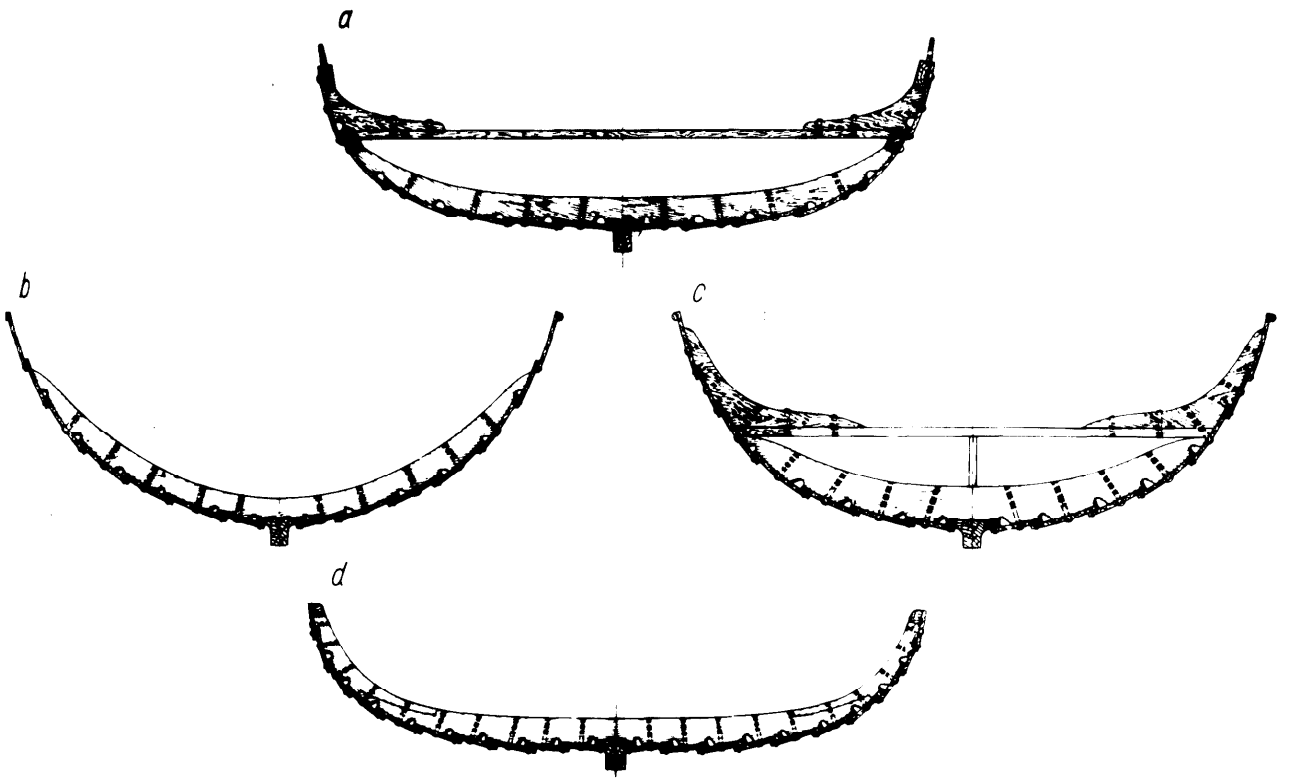


Fig 49 *Cross-sections of some Gdansk-Pomeranian types of boat: (a) mid-ship cross-section of Orunia I; (b) cross-section on frame 4 of Orunia II; (c) mid-ship cross-section of Orunia II; (d) cross-section of frame 6 of Czarnowsko I (after 0 Lienaua)*

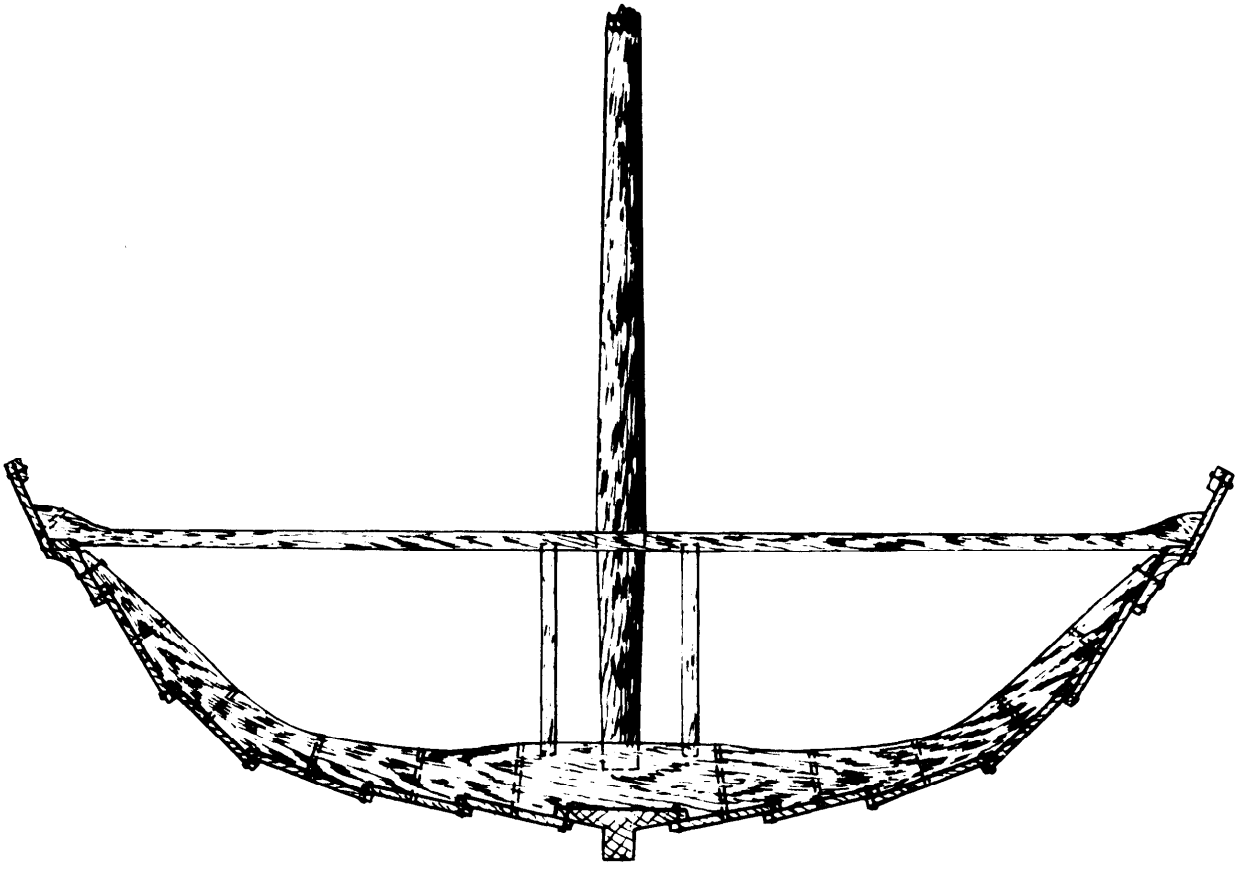


Fig 50 *Cross-section of Dziergon boat (after the reconstruction by H Conwentz and E Reitan)*

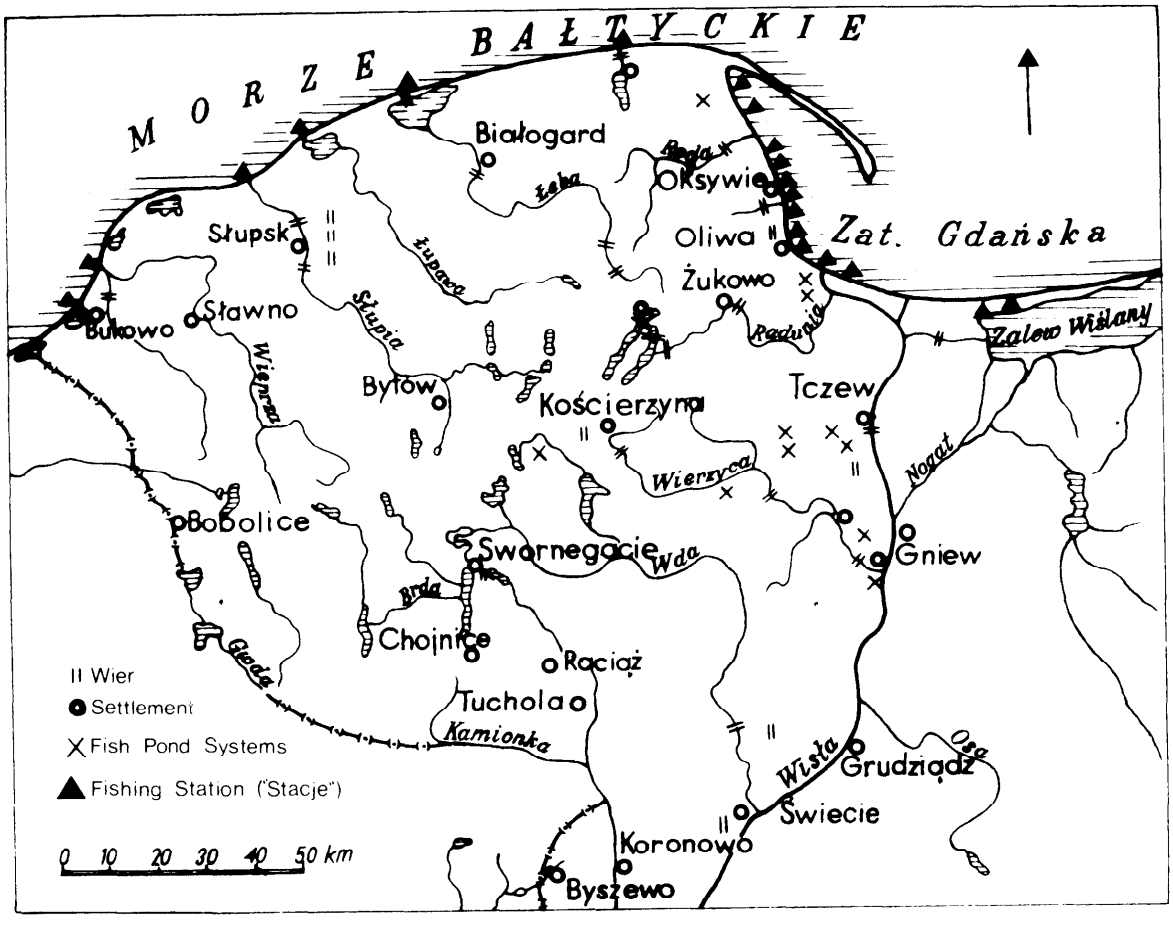


Fig 51 Fishing ports in Pomerania (after W Lega)

any special obstacle to the Slavs' own vessels (Saxo Gram, 92; 132; 134; 454-5; 478; 523-4).

The third stage in the development of boat building in the Baltic commenced around the 12th century and covered the period when the sailing ship fitted with a stern rudder was evolved. The social-economic changes that took place in the 12th-13th centuries gave rise to transformations in the character of shipping. The objects of trade in the early medieval period were so-called luxury goods, but the intensity of this exchange was probably less than is sometimes thought. Now new more bulky cargoes appeared in the ships' holds, destined for a wider circle of consumers. This new type of cargo and the intensified trade exchange forced merchants to charter ships with a large capacity in order to ensure higher profits.

The most characteristic vessel of the new era was the 'cog'. In general terms, this was a large, strongly built single-masted ship, relatively short but wide in the beam, with high sides. In size and capacity, it was far superior to the ships of the Scandinavians, the Slavs, or any of the other Baltic peoples. By its very nature, it had a larger draught. One of its characteristic features was the stern rudder, the use of which on large cargo ships are among the greatest inventions in the history of north European ship-building.

The role of the cog in European shipping is sometimes wrongly evaluated. It was not the size of the cog which brought about changes in the character of shipping and commerce-rather the opposite: changes in the character of commerce and shipping influenced the development and diffusion of the large ship called the cog (Smolarek 1969, 143).

Thanks to its height and rugged build, it also compared very favourably with the Baltic long-ships (warships), the shortcomings of which then became more obvious. The importance of the latter began to decline (although the *Ledung* -type fleet continued to exist in Scandinavia throughout the whole of the Middle Ages). On the south Baltic Coast, however, the naval system underwent reorganization. During the feudal period, the power of rulers was weakened and armed forces were decentralized. In this situation, security at sea was taken over by those centres most interested in merchant shipping: the towns, with their strategically sited strong walls.

Harbours and ports

It was the character of the rivers and seacoast which determined, to a certain extent, the location of harbours and ports.

Several types of south-Baltic harbours can be distinguished:

a those on the seacoast or in bays
b those situated on a river estuary where it opens on to the sea or a lagoon
c those further upstream on a river or on lakes.

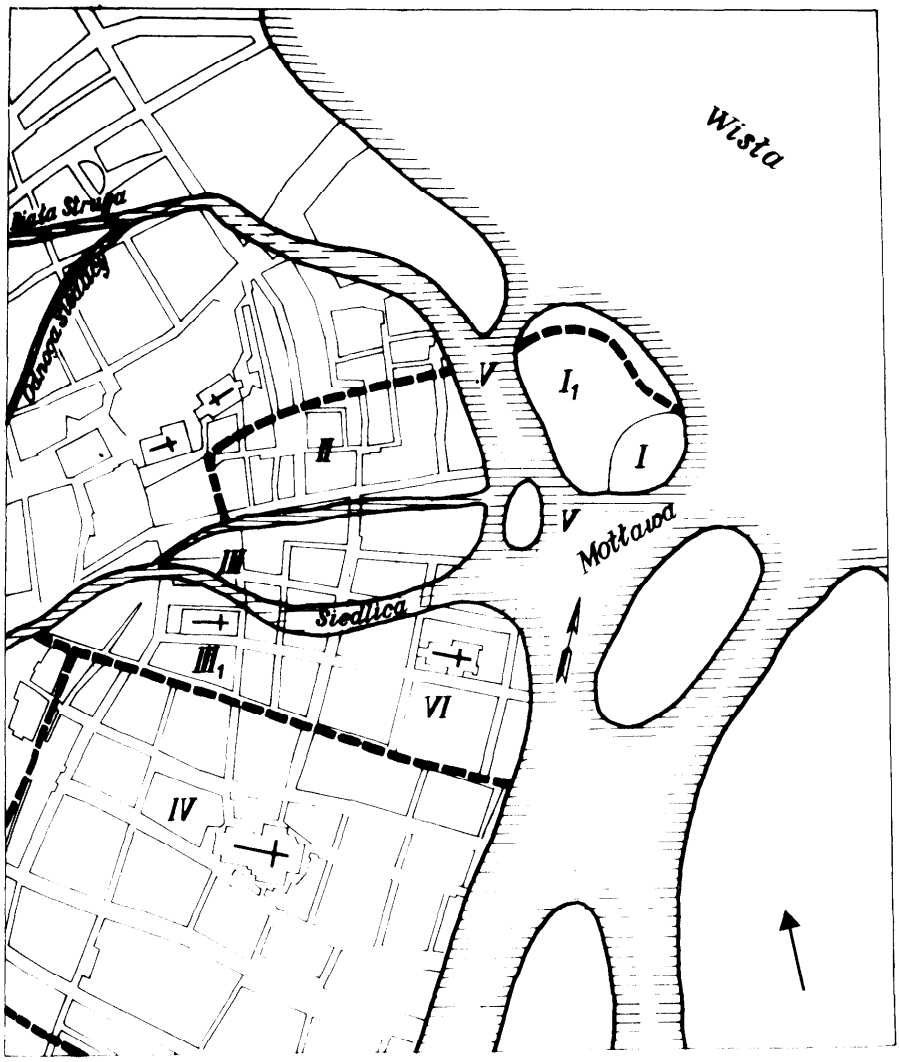


Fig 52 Gdansk: topographical development. I gród (?castrum): seat of duke from the end of the 10th century to 1308; I, craft and fisherman's podgrodzie (?suburb) from late 10th century to 1308; II mercantile and craftsman's podgrodzie with harbour from second half of the 12th century, under ducal law; III market and associated settlement, 10th-13th century; III, Dominican precinct from mid 13th century; IV town (Burgum) founded on Lübeck law in 1261-3; V harbour; VI land used by Dominicans from 1227

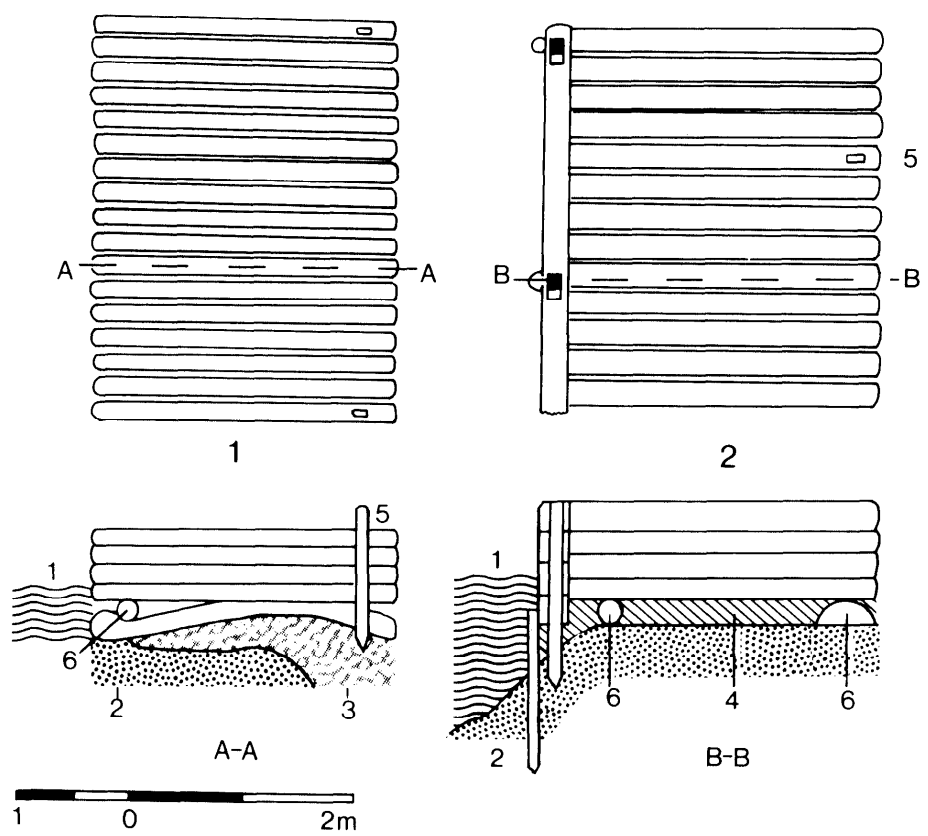


Fig 53 Gdansk: ul Grodzka 3-4. Two types of wooden structure built to consolidate the river bank around the gród island (Fig 52, I, I,) and used for the mooring of boats. (After A Zbierski) **1** *river level;* **2** *river silt;* **3** *dumped foundation of earth, brushwood etc;* **4** *clay;* **5** *pile supporting structure also used as mooring post;* **6** *supporting timber*

Such harbours could serve small rural or fishing communities, a fortified centre or *gród,* its extra-mural settlement or *podgrodzie, or* a town.

Basically speaking, only fishing ports *(stacje)* were situated immediately on the seacoast or Gdañsk bay. Figure 51 shows the small coastal fishing ports in Gdañsk Pomorze (Pomerania) mentioned in 12th and 13th century documents. These *stacje* were harbours and meeting places for fishermen. There was room to spread out nets and store gear, and it was here that state officials checked the work of the fishermen and collected charges for each boat. These small ports belonged to the prince, who granted privileges to persons or institutions permitting them to use his harbours or establish their own (Lega 1949, 12; 37; 169).

It is not known whether these harbours had any facilities such as jetties, but it would seem most unlikely. Even to-day, there are not usually such facilities at the small coastal fishing villages. These fishermen fish as they say, 'from the beach', and their boats are built 'on a flat keel'. The boats are usually pulled up on the beach with windlasses, and are simply pushed back into the water when required.

The larger ports used by shipping were not situated directly on the Baltic but on river estuaries: for instance, Gdañsk lies about 5km from the sea, Wolin 23km, Szczecin 65km, Uznam 35km, Wotogoszcz 14km, and Starogard 14km (Leciejewicz 1962, 200).

Bends in rivers, small bays, or indentations in the coastline were the most favoured location for establishing these ports. What was their origin?

In the lands of the Slavonic peoples the *grody* (fortified places) played an essential role in social-economic relations. During the period of so-called 'territorial communities', from the 6th to the 9th century, they were fortified places (large or small) in which local chieftains or population could live or find shelter and protection, or which were centres for the 'communities'. If they were situated on the banks of rivers, lagoons, or the sea, they could also be used by shipping. Unfortunately no harbour installations have as yet been found with any of these.

Some port towns might also originate from seasonal trade-places or from unfortified settlements. It is, however, assumed that most of the later ports of the western Slavonic region developed from tribal *grody* (Slaski 1969, 38).

Another type *of gród* appeared in the 9th century and was fully developed in the 10th and 11th centuries. Its appearance was connected with the needs of state authorities; some were built as seats of representatives of the feudal class. This type of settlement consisted of a *gród,* one or more *podgrodzie* (suburbs), and a market place *(forum)* (Podwiñska 1978,42-45).

The *podgrodzie* in which the merchants and craftsmen lived expanded in the 11th- 12th century. As a result, the fortified *gród* became primarily the seat of state authority and the officials employed by the prince, his retainers, soldiers, and those employed for the immediate needs of the overlord, whilst the centre of the economic life shifted to the *podgrodzie,* outside the *gród* fortifications (Leciejewicz 1969; Slaski 1969, 134)

The development of such urban centres situated on shipping routes was naturally accompanied by that of port facilities. Archaeological investigations have shown that basic port facilities were built when settlements began to acquire urban features (Leciejewicz 1971, 145).

In Slavonic towns, harbour installations were the property of the ruler. The population of the nearby villages and town had to do the repairs and later building work (lega 1949, 167, 180-90; Slaski 1969, 139). The town and port were governed by representatives of the overlord, who resided in the *gród.* They collected customs dues, checked on the safety of-shipping, and enforced the *ius naufragium.* The overlord himself granted trade privileges to the port customers (Lega 1949; Slaski 1969).

As a result of German expansion, the Baltic Slavonic lands were gradually overrun from the west from the 10th century onwards. This movement became even more intensive in the 12th century, with the Danes also taking part, until the Germans had seized the Potabszczyzna and later, at the beginning of the 14th century, Pomerania. A new town which became the base for German trading and shipping expansion over the whole of the Baltic grew up in place of the earlier Slavonic Lubeka. Previously, the German merchants had come to the Slavonic towns as 'guests', having taken up residence in the *podgrodzie.* Newly founded quarters, ruled by a system differing from that of the Slavs, then grew up alongside the old, whilst in some cases the whole Slavonic town was brought under German law *(ius Theutonicum).*

As a result, new ports were established in some newly founded quarters or towns; in these the jurisdiction was taken over by the authorities of the new towns.

Ports and ships in the 13th- 15th centuries

The development briefly outlined here, is best illustrated by studying the growth of Gdañsk.

The oldest harbour in Gdañsk was alongside the walls of the *gród* (Fig 52, I). Fragments of the 10th century wooden structures built during the foundation of the *gród* have been uncovered; their construction is shown in Fig 53 (Zbierski 1978, 244). They were very simple and permitted vessels with relatively low draughts, such as those represented by the wrecks previously discussed, to tie up. Ships with greater draughts were probably able to moor at the wharf jutting out into the river.

When the later *pogrodzie* began to develop outside the *gród,* it was given its own new harbour and quays. The quays are dated to the 12th and 13th centuries and differ in construction from the earlier *gród* quays (Zbierski 1978). The reconstruction of this part of the port and quays, suggested by an archaeologist, is, in my opinion, still more theoretical than actual (Fig 54).

These new quays are nevertheless related to the development of trade and shipping in Gdañsk, as well as to the increasing size of vessels calling at the port on the river Mottawa. In this context, the passage from the customs tariff issued by the Prince Swietopetk about the year 1227 speaks for itself. It includes this fragment: '. . . *Koga, si naufragium in terminis nostris pertulerit, X marcas, minor navis V, salvis rebus, persolvat. Si in portu nostro fundum tetigerint vel inpediantur, auxilio qualicumque voluerint, adiuventur . . .* ' (Perlbach 1882, 29). From this it may be assumed that there were shallows either at the entrance to the port or inside it, or more likely, that the port basins

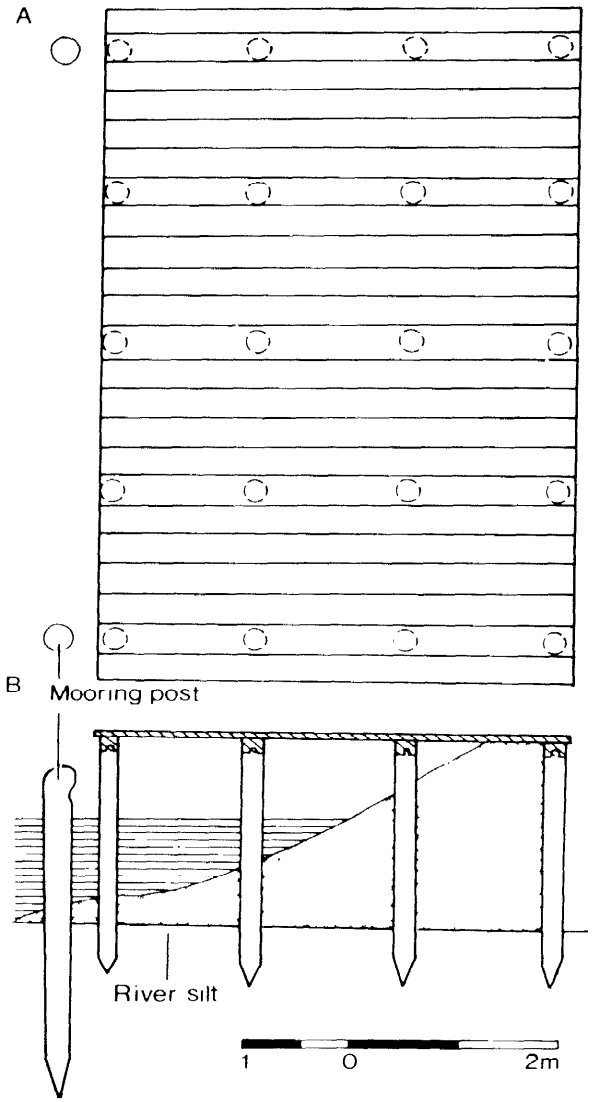


Fig 54 Gdask: Stare Miasto, ul Podwale Staromiejskie 44b. 12th -13th century timber landing stage with mooring post: (a) plan; (b) side elevation (After A Zbierski)

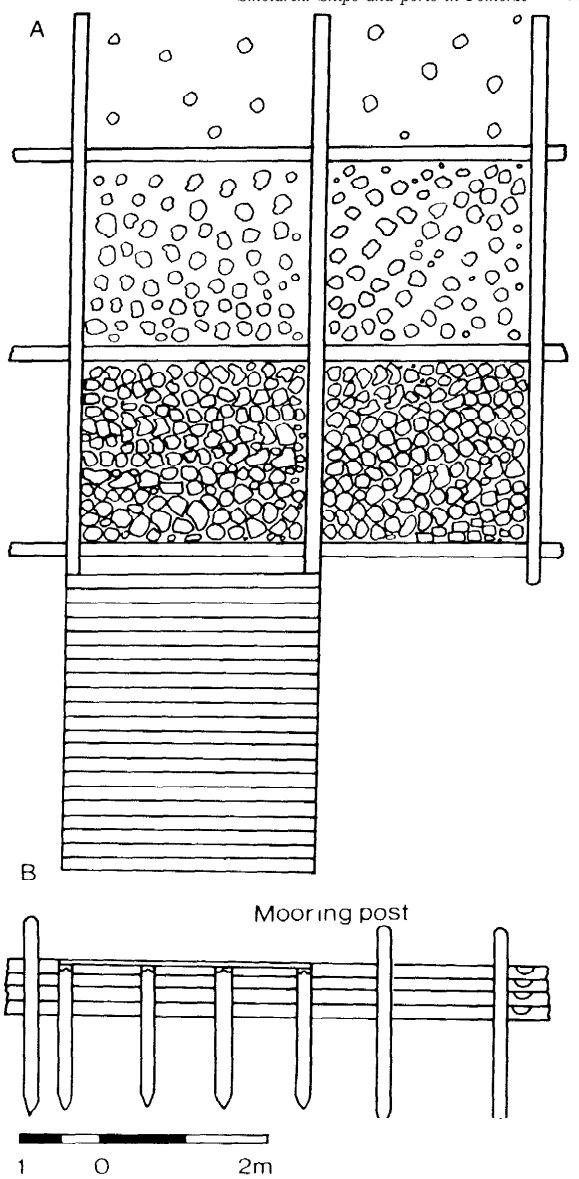


Fig 55 Gdansk: Stare Miasto, ul Podwale Staromiejskie 57–9. A type of 13th–14th century harbour structure: (a) plan; (b) front elevation (after A Zbierski)

were simply becoming too shallow to take the biggest types of ship sailing in the Baltic at that time. At any rate, the later so-called 'Main City', which was granted Lubeck rights in the second half of the 13th century, utilized a much more convenient waterfront running along the river Motlawa from Szeroka Street to Za Murami, particularly at the 'Cog Gate' which closes the Dlugi Targ (Fig 56). Unfortunately, this section of the port has not yet been investigated archaeologically. The first documentary reference to the port is dated 1341 (Biskup 1978, 412).

In the 14th century, the bank of the river Motlawa was to have been cut back by about 25m, as it was also marshy, which hindered offloading. The landing stages built at the Cog Gate and at the gates to Chlebnicka Street and Szeroka Street served as mooring and handling berths. The latter gate was transformed into the main port crane and prior to 1363 was known simply as 'The Crane' (Fig 57). The city wall was extended to fill the sections between the gates (Biskup 1978). Most of the handling in the port was carried out by porters who set up their own trade guild in the 14th century. The cargoes discharged at the landing stages were carried into the town through the gates (Fig 57 and 58), and then stored in or behind domestic buildings.

These stores and the few landing stages at the gates were unable to satisfy the demand when the port began to expand rapidly. Because of the walls that closed the left bank of the Motlawa, granaries had been built on the other side of the river in the 14th and 15th centuries, and preparations were made to open up the so-called New Motlawa to shipping (Kloeppel 1937, 76).

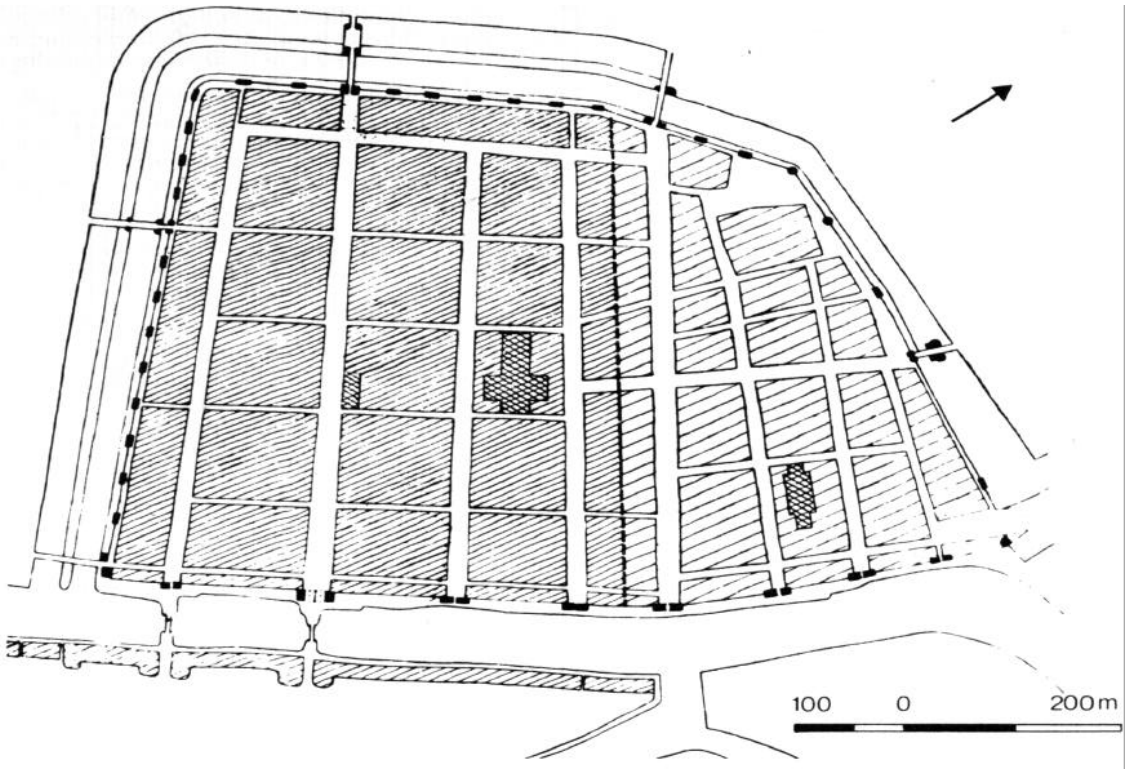


Fig 56 *Plan of medieval Gdañsk with town under Lübeck law heavily shaded, showing the watergates on the river Mortawa*

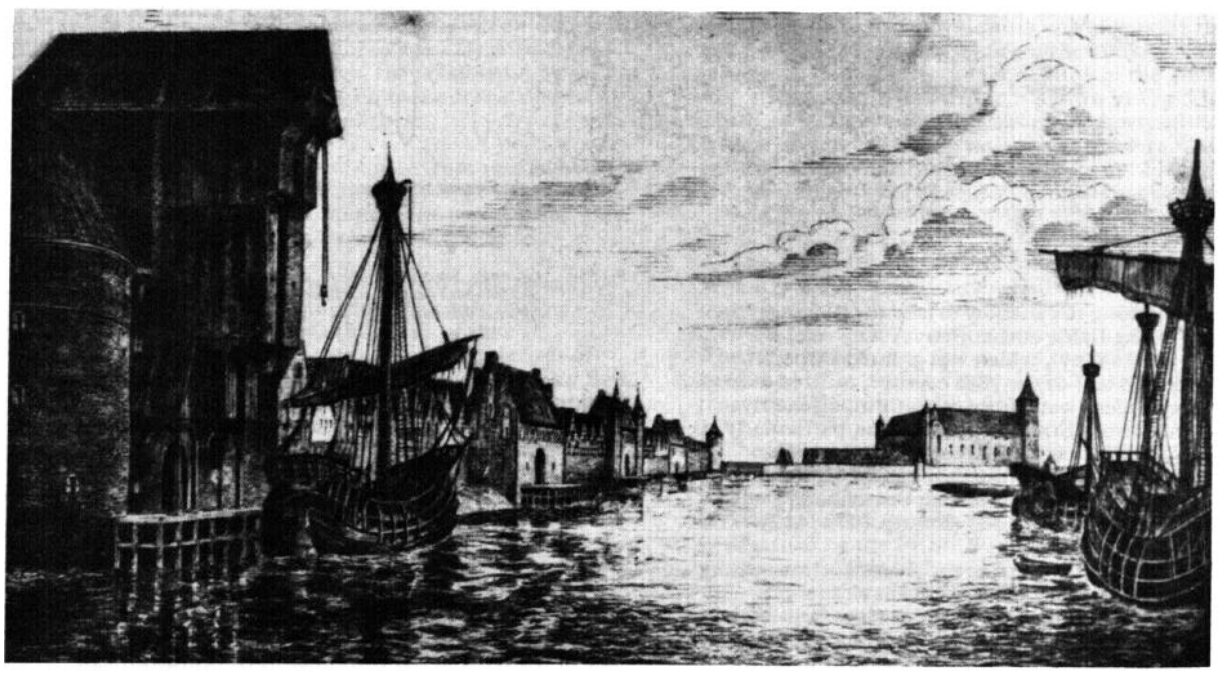


Fig 57 *Gdañsk: O Kloeppel's reconstruction of the 14th century waterfront, showing landing stages at each Watergate*

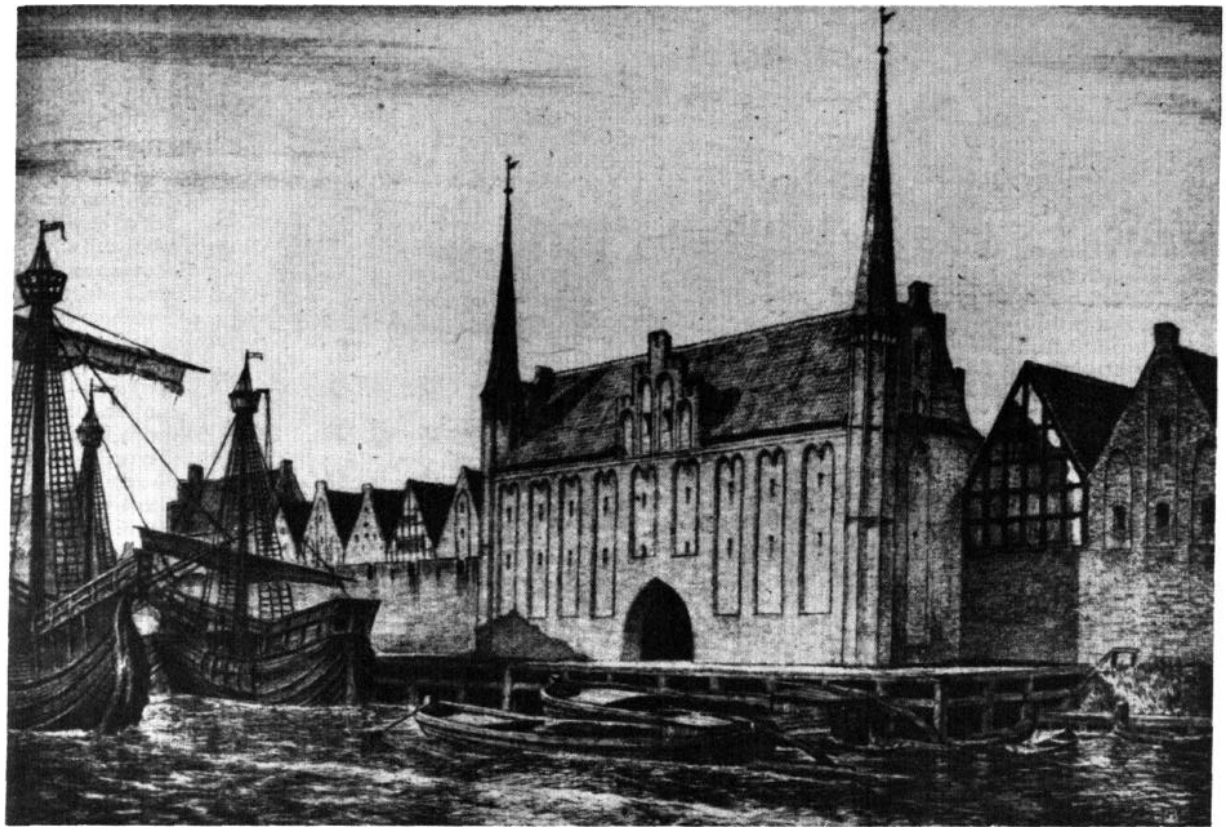


Fig 58 Gdañsk: O Kloeppel's reconstruction of the medieval Chlebnicka Gaze with its landing stage

With the increase in the size of ships and shipping traffic, the administrators of the port of Gdañsk were faced with the problem of maintaining the depth of the river. This was a serious problem, as both the Mottawa and Vistula channels were subject to silting. The movement of silt and rubble in the Vistula caused sandbanks to form at its estuary, and these gradually became permanent land. For example, in only 50 years, from 1622 to 1672, about 400m of land accrued (Biernat 1959,202). Work on the dredging of the Mottawa was put in hand at the beginning of the 15th century. In 1425, the town council drew up a contract for deepening the river by 5 ells (*c* 3m) and for clearing the banks so that ships could tie up at the quay (Biernat 1959, 194).

Maintaining navigability was the concern of all the south Baltic ports, from Lübeck to Riga. Their average depth is reckoned as being *c* 2-3.6m, which meant that such ports were accessible to ships with capacities of about 100 lasts (Vogel 1915, 532). Thus in some ports it soon became necessary for ships to offload part of their cargoes in the roads or in the port into lighters.

Mention of roads had already appeared in the 13th century, when increasingly larger ships began to call at the small Baltic ports situated on the rivers. The order of the Rugian Prince Wistaw dated to 1278 established the order of handling work in Strzatowo, and also the mooring berths for ships and lighters etc (HUB I, no 810, 280). The privilege granted to the merchants of Lübeck and other towns by the Norwegian king Magnus in 1278 reads: *'…infra territorium quod vulgariter skipraeider dicitur…*' HUBI, 283). The document dated to 1326 concerns relation; between Reval and Finland and states '. . . *in confinio portus, porfu Revaliensi et redha juxta portum'* (HUB II, 184).

Substantial changes took place in north European ship-building about the middle of the 15th century; the new method of building hulls-the so-called 'skeleton' method-began to spread. At the same time, the traction of the sails gradually increased after a further two masts were stepped in addition to that which already existed. This opened the way for the development of the large three-masted ships which opened the era of geographical discovery and the consequent expansion of European shipping to all the oceans of the world.

In Gdañsk, it was the *Pierre de la Rochelle,* left in the port by the owner of the refit, which marked the beginning of this new era. The Gdañsk shipwrights repaired her in c 1470, which gave them opportunity to become well acquainted with the new technique.

The Pierre *de la Rochelle (or Peter von Danzig)* was a much larger than average ship. She had a capacity of 525 lasts and draught of 5m *(Weinreichs Chronik* 728: Lienau 1943, 7). In order to be able to receive such ships and later larger ones, the ports and their facilities had to undergo

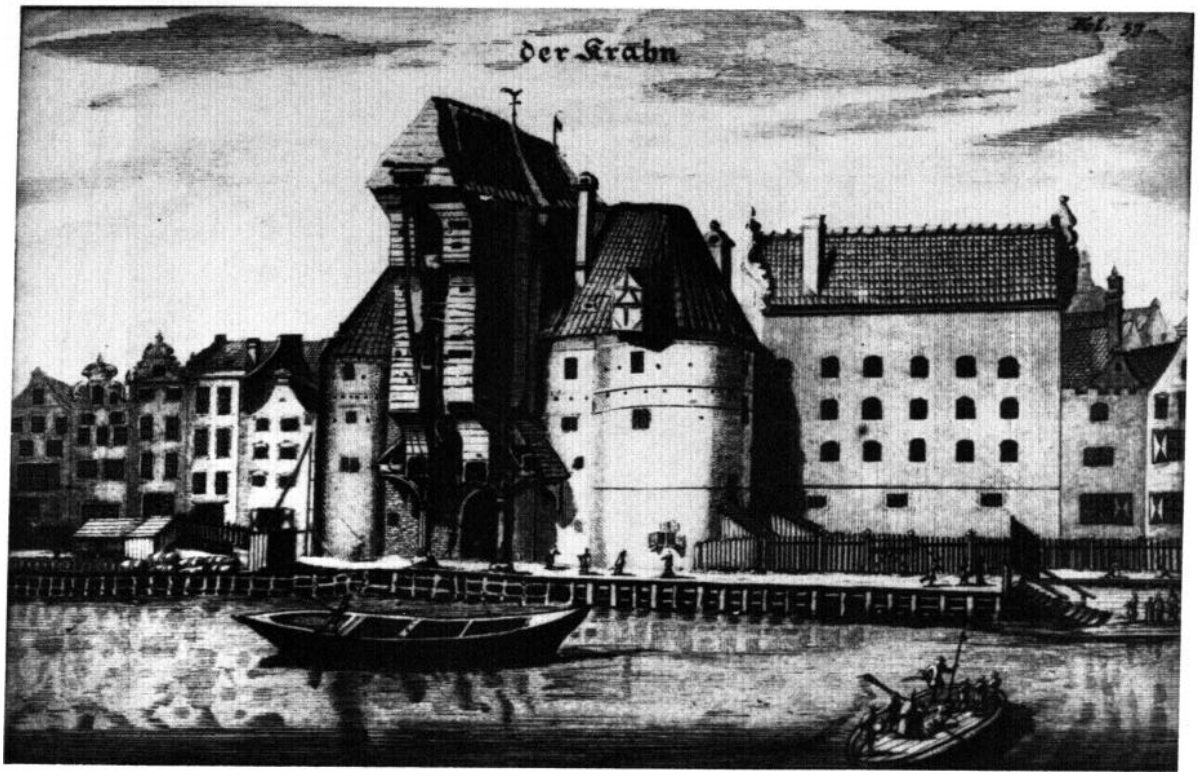


Fig 59 Gadañsk: 17th century etching by Reinhold Curickes showing the development of the medieval landing stage into a continuous quay: cf Fig 58

appropriate evolution, but this problem goes beyond the chronological framework of this discussion.

The geographical discoveries of the close of the 15th and beginning of the 16th century, together with the whole complex of social-economic phenomena accompanying them, led to a fundamental change in European shipping. The era of the Hanseatic hegemony passed into history. The centre of gravity of trade transactions shifted to the ports situated on the Atlantic. The development of industry at the expense of agriculture in the Netherlands and England, with agricultural recession in other west European countries, gave rise to a tremendous demand for agricultural and forest products. Poland became one of the main suppliers of these goods, as well as many industrial raw materials, exporting products down the rivers through the ports of Riga, the town which is now Kaliningrad, Szczecin, and primarily her own port of Gdañsk. Thanks to the great increase in exports, Gdañsk entered into her 'golden age'. At the close of the 16th or beginning of the 17th century, the port expanded, quays being built along the whole stretch of the left bank of the river Mottawa (Fig 59) and the river itself was dredged. As a result, the Dtugie Nabrzeze (Long Quay), which runs from Zielona Brama (Green Gate) to Targ Rybny (Fish Market), came into being. Following further expansion, the total length of the quays in Gdañsk in the 17th century amounted to about 3 000m, on which 315 granaries were standing in 1643, some of these rising to six or seven storeys (Biernat 1959, 213); it was said that the usable floor space of the granaries was more than that of some towns of the time.

Thus ships and ports, two very closely related elements of shipping, had a strong influence on one another. The determining factor in their evolution was the demand in the field of transport and trade exchange resulting from the evolution of economic relations.

Jacob's description (c AD 965/6) of the town belonging to the Weltaba tribe referred to Wolin. He said: 'They have a powerful city on the Ocean, which has twelve gates. It has a landing-place where they applied halved tree-trunks' (Kowalski 1946, 50, 58, 96, 136). By 'halved tree-trunks' he meant split boards. Wolin was at that time the largest Slavonic harbour city. The existence of quays was confirmed in 1124, when Bishop Otto from Bamberg was in Wolin on a mission (Herbord II, 23). While fleeing from the town he was pushed off a quay and the knight who saved his life had to wade in mud up to his groin, which shows that the depth varied and that there were shallow places in the harbour which required the building of quays for larger vessels. It is difficult to assess boat sizes from the few fragments of sheathing and the stern-frame discovered, but the waterline on the wrecks from the beginning of the 11th century found in Szczecin (Wieczorowski 1962, 1979-84), from the 11th-12th centuries in Czarnowsko (Linau 1939, 13; Filipowiak 1957, 342-5) and in Ralswik (Herfert 1968, 13, 211-222) can be assessed. It did not exceed lm even with a full cargo.

Finds from the port also include some wooden structures, a few pottery fragments, and horn and wood refuse, but the most important are the bronze kettles discovered in a layer of silt 6-7m deep (Fig 69). That they were probably typical equipment of early medieval boats is confirmed by the boat equipment found at Oseberg and Gokstad (Brögger & Shetelig 1928, 135–8, fig 76; Nicolaysen 1882, fig 1).

Protection of the port of Wolin from the waterside, especially from the north (ie the sea), is another problem. Access from the south was closed by the bridge (Fig 61). From the north it may have been defended by an underwater stockade analogous with that at Haithabu (Jankuhn 1962, 206, fig 44) and the one from the period of. Danish invasions of Wologoszcz (Wolgast) in 1170-6 (Eggert 1928, 54–66). However, subsequent reclamation and dredging may have destroyed all traces of such a stockade.

Along the sailing route between the sea and Wolin there was a system of signalling stations based on a chain of fortified castles along the rivers Dziwna and Swina. On the Dziwna the chain of fortresses was 20km long and included, in addition to Wolin, Jarzebów, Sibin, Polchowo, and Kamien. Experiments using fire and smoke signals carried out to test the system proved that at full alert it took ten minutes to pass information from Wolin to Kamien (Cnotliwy 1962, 124-7). Identical communication systems existed on the stretch between Wolin and the castles at Lubin and Przytor to prevent attacks from the sea and the Swina river, which nevertheless often occurred during the Danish invasions in 1170-85. The castle at Lubin played a special role: situated on a high bank at the south-western border of the island, it served as a watchtower over a considerable area of Szczecin Bay, including the mouth of the Piana river.

Archaeological material from the castles of this defensive system confirms that it was developed in the second half of the 9th century and functioned till the 12th century. In the 11th century it played a significant role when piracy reigned on the Baltic and some retaliatory invasions were undertaken, one of them under the leadership of Magnus the Good in 1043, when Wolin-Jom remained unconquered. Only the suburbs were devastated, judging from the layers of ashes and burnt soil. The Danish raid led by Eric I in 1093 against Wolin was purely retaliatory in character,

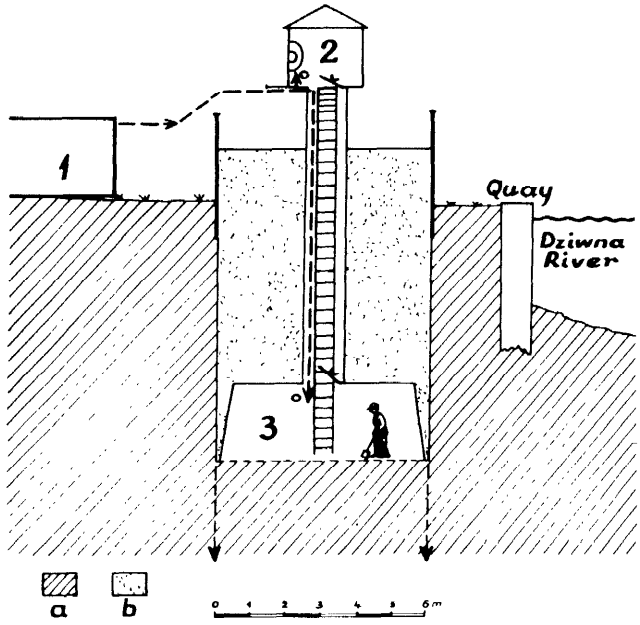


Fig 63 *Wolin: schematic diagram of caisson I excavations:* **1** *air Compressors,* **2,** *entrance chamber equalizing pressure differences* **3** *excavation in base chamber (a) solid ground; (b) caisson concrete*

since It was in Wolin that pirates and Danish outlaws took refuge. The outlaws were handed over but, judging from the traces of devastation in the suburbs of Wolin, there must have been some fighting too. The fierce piracy of the 11th century was not tolerated but was severely punished, as confirmed by 12th century documents such as those concerning the piracy of Wyszak from Szczecin. The archaeological record also includes an interesting example from 12th century Wolin. On the highest point of the 'Hill of the Hanged', which can be seen from the entrance to the Dziwna waterway from the Szczecin Hay, the skeleton of a tall young man was discovered. It was without its skull and there were traces of a thick stake between the legs, suggesting that the man may have been punished by beheading and that his head was exposed on the stake. Standing near the main waterway it would have been a warning against all misdeeds at sea and piracy.

In addition to the defensive system, there was another to assist navigation to which the lighthouse *(Olla vulcani),* mentioned by Adam of Bremen in *c* 1074 belonged 'which is called Greek fire by the Inhabitants'. This is the oldest reference to a lighthouse on the Baltic coast, but in spite of persistent searches, its location has not been established.

Topographical and economic growth of Wolin in the 9th-12th centuries

Wolin expanded as a direct result of the rapid economic changes which began in the middle of the 9th century. It developed in relation to the natural topography, the Dziwna river and the parallel stretches of bogland providing natural defensive conditions. The most important feature, however, was the waterway along which settlements grew up: it can be said that it developed 'facing the waterfront' (Fig 61).

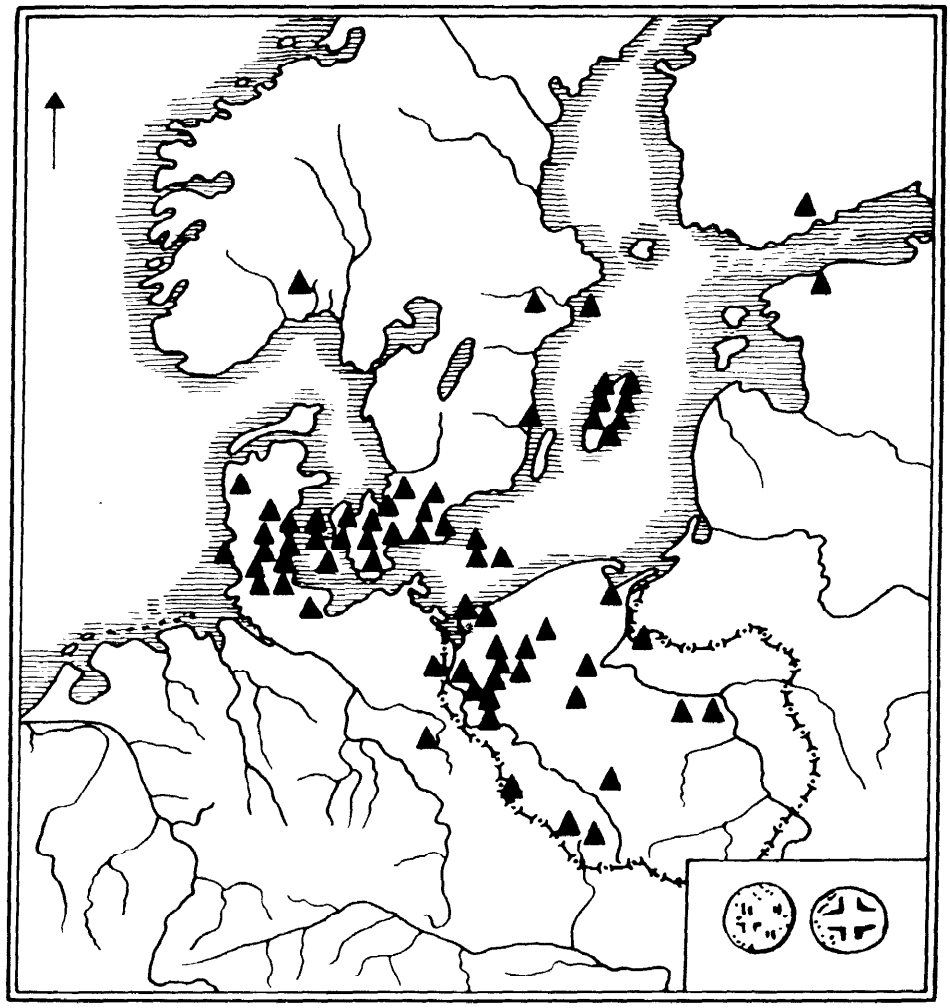


Fig 64 *Import of half-bracteates of Hedeby type in late 10th early 11th century from Danish regions (after H Jankuhn with author's additions*

In the second half of the 9th century occupation covered the whole sandbank, which was fortified with embankments, with a port on the Dziwna as the main centre of the town. Further espansion towards the end of the 9th century saw new town quarters developed: a craftsmen's quarter to the north on the so-called Silver Hill, between the town and Silver Hill, and a fishermen's quarter to the south (Fig 61.2). The craftsmen's district on Silver Hill was fortified with a strong S-shaped rampart of wood and earth between the Dziwna and the marshes (Fig 61.6). The settlement comprised single, upturned boats used as temporary workshops, while the dwellings were usually sunken floored buildings. The settlement was concentrated on the eastern and southern part of the hill, but its flat summit was free of-buildings, as archaeological investigations have proved. It is believed that the market place was there, having been transferred from the centre: it is mentioned, together with the inn, in 1140 (Cislowa 1958, 172-4). Since that the main track passed Silver Hill, the market and the inn must have been there.

Numerous refuse dumps, hearths, vestiges of ironwork, non-ferrous metals, crucibles, artefacts, semi-finished products, and horn and amber refuse provide evidence for local industry. The finds in two early 11th century workshops comprised 49,468 pieces of horn refuse and semi-finished articles, which provide evidence of the scale of-production (Cnotliwy 1970, 209-87). Glass production was also significant towards the end of the 9th century and in the 10th century, with a distinctive series of small local dishes covered with dark green and purple glaze (lead glass) and beads (Olczak 1963, 3-130). As well as from local manufactures, there are items imitating products from Scandinavia in form and ornamentation. There certainly were foreign craftsmen, possibly itinerant, in the Baltic area. Adam of Bremen confirms the presence of Saxon, Greek, and other 'barbarian' merchants in Wolin in his writings. The craft and trade centre in the suburb on Silver Hill played a major role in the economic life of the city, in contrast to the suburb to the south of the town, between the river and the marshes, which was probably not

little venison was consumed (3.5%), 96% of the meat consumed being provided by domesticated animals (Kubasiewicz 1959, 5–145).

Fishing was of some importance in the town and its vicinity as there was an abundance of water around. Archaeological evidence comprises fragments of fishing nets (dragnets were used), netting needles, floats, sinkers and hooks, iron crampons, and remains of fish bones and scales. The last-named materials show that mainly freshwater fish were caught in the Dziwna, Szczecin Bay, and the nearby lakes (Rulewicz & Zajdel-Szczyrska 1970, 325–66).

Economic and political changes in the 11th and 12th centuries

Wolin's decline has been examined from different points of view, but it is only possible to summarize many years' research by describing some of the principal factors here.

Archaeological changes are detectable from the second half of the 11th century. Single buildings appeared in the town centre which were poorly maintained and of a less durable construction than their predecessors. The intensity of handicrafts production was also decreasing, both in the city and in the suburb on Silver Hill. The once steady flow of silver from the East ceased, although there was a small influx of western European coins. This may be attributed to the breakdown of the trade with the East along the Volga route. Wolin's importance as an entrepot for the hinterland in the Odra estuary also came to an end with the temporary collapse of the Piast dynasty. The changes were influenced by local social and economic development. In neighbouring regions new urban centres developed. One was Szczecin, which began to play a dominant role as Wolin declined, weakened by Danish invasions in 1043 and 1098. In the 11th century new local urban centres developed, such as Uznam (Usedom), Wołogoszcz (Wolgast), Dymin (Demmin), and nearby Kamień, where, at the turn of the 11th century, political power was located when a duke took up residence there. The new towns endeavoured to meet the demands of the local market, taking part in maritime trade at the same time. From the beginning of the 11th century onwards the new duke's authority was concentrated on uniting all the Pomeranian regions and subordinating all the towns in the Odra estuary (Leciejewicz 1962, 260–90).

The first half of the 12th century saw some revival in Wolin's fortunes, with increased production of some handicrafts such as horn and amber working and goldsmithing, concentrated in the town centre. The economic importance of the suburb on Silver Hill gradually diminished. In the 12th century the town still was of considerable importance, as can be seen from its independence from the duke's authority. The dominant role, however, was taken over by Szczecin, which gradually developed into the main city centre in Pomerania. This is clearly shown at the time of Bolesław Krzywousty's conquest of Pomerania and the introduction of Christianity in 1124 and 1127–28. Kamień was the political capital at that time, but it was at Wolin that the first episcopal see was established in 1140, although this was transferred to Kamień in 1176.

Wolin's economic potential in the 12th century gradually turned towards the demands of the local market. Archaeological sources point to some share in the Baltic trade but only on a small scale. This was ended by Danish incursions in the Odra estuary in 1170–85. The invasion of 1170 destroyed only the suburbs, but the campaigns of 1173 and 1177 completely destroyed the whole town. Those events are revealed by the layers of burnt material, especially the burnt fortifications (Fig 66). After having been destroyed in 1173 the town was rebuilt, but four years later it lay in ruins again. The devastation which affected the whole area of the Odra estuary was of crucial importance for the later development of Wolin, which never regained its former splendour. In the new political and economic structure of the Duchy of Pomerania it became a local craft and trade centre.

This outline history of Wolin, which some documents identify with the legendary Wineta (Kiersnowski 1950) or Jomsborg (Labuda 1953, 283–332), shows a close relationship between the growth of the town and exploitation of the sea. The dramatic end of its glory likewise came from the sea.

The early Roman harbour in Velsen, Netherlands

J Morel and M D de Weerd

Prospecting and small-scale excavation in Velsen since 1972 have answered questions about the dating of its early Roman harbour site (Morel & De Weerd, forthcoming). The finds suggest a military base, most probably associated with Germanicus's expeditions to Germany in AD 14- 16, the occupation of which ends at about the time of Corbulo's withdrawal *cis Rhenum* in AD 47. The present site is referred to as Velsen I to distinguish it from the later site Velsen II, an area lying 1150m to the north-west.

Morel's analysis of the pattern of wooden posts and postholes and other traces on the former south bank of the river Oer-IJ (the most northerly branch of the Rhine in the Roman period) suggests a 1 ha military base.* Of this base only the features shown in Fig 71 survived the later flooding of the internal structures, and the analysis revealed two building phases of the stockade, gate, and ditch. The base controlled a harbour with a series of moles and jetties which projected into the Oer-IJ and a landing platform for ships adjoining it. The remnants of the Oer-IJ deposits seem to lie *c* 50m further north than was the case in the Roman period, on account of the later erosion of the old surface. In Fig 71 the original position of the Oer-IJ is reconstructed.

The evidence suggests that the Romans brought the idea of enclosing the harbour with massive moles (phase 1) from the Mediterranean. However, they were virtually unacquainted with tidal movements in a north European river delta and so, to overcome the problem of silting in Velsen's harbour, they were compelled to adopt a system of open jetties to control the currents (phase 1a and 2).

*J Morel is grateful to H Donker for discussion on this point.

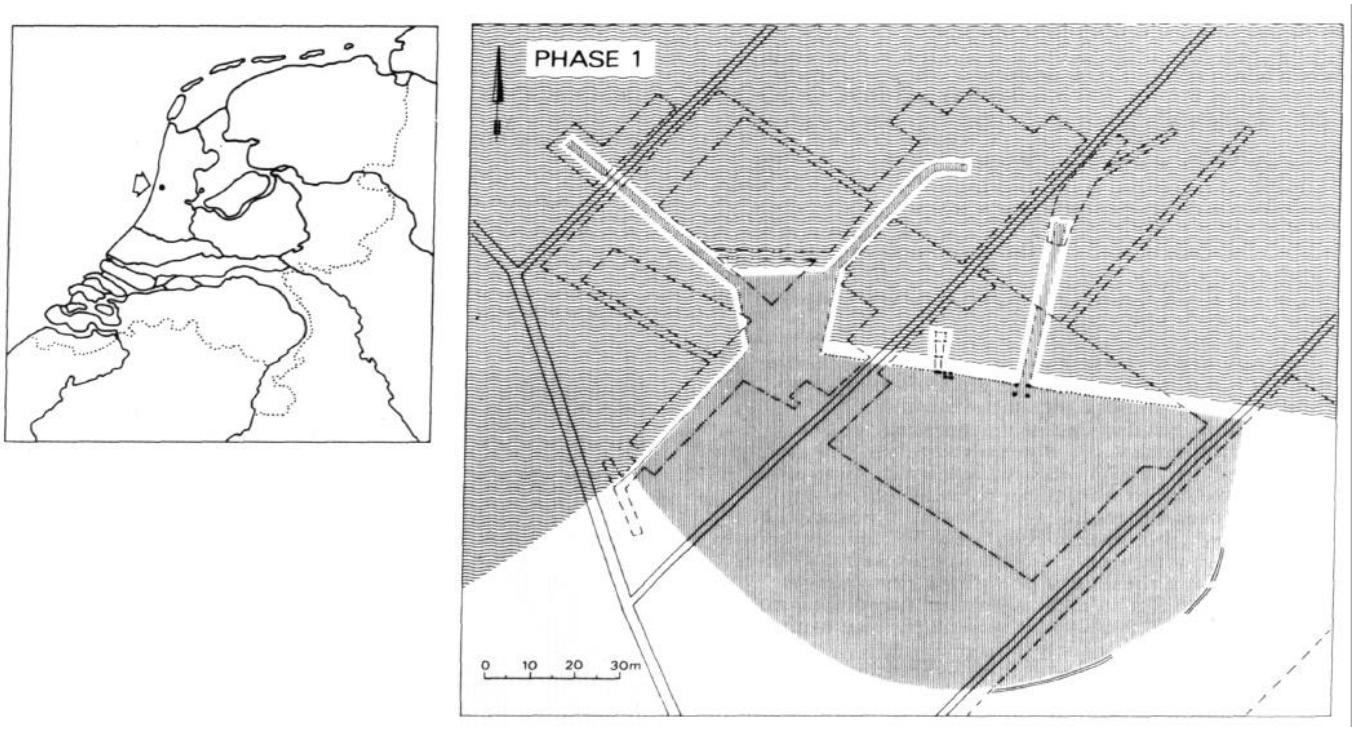
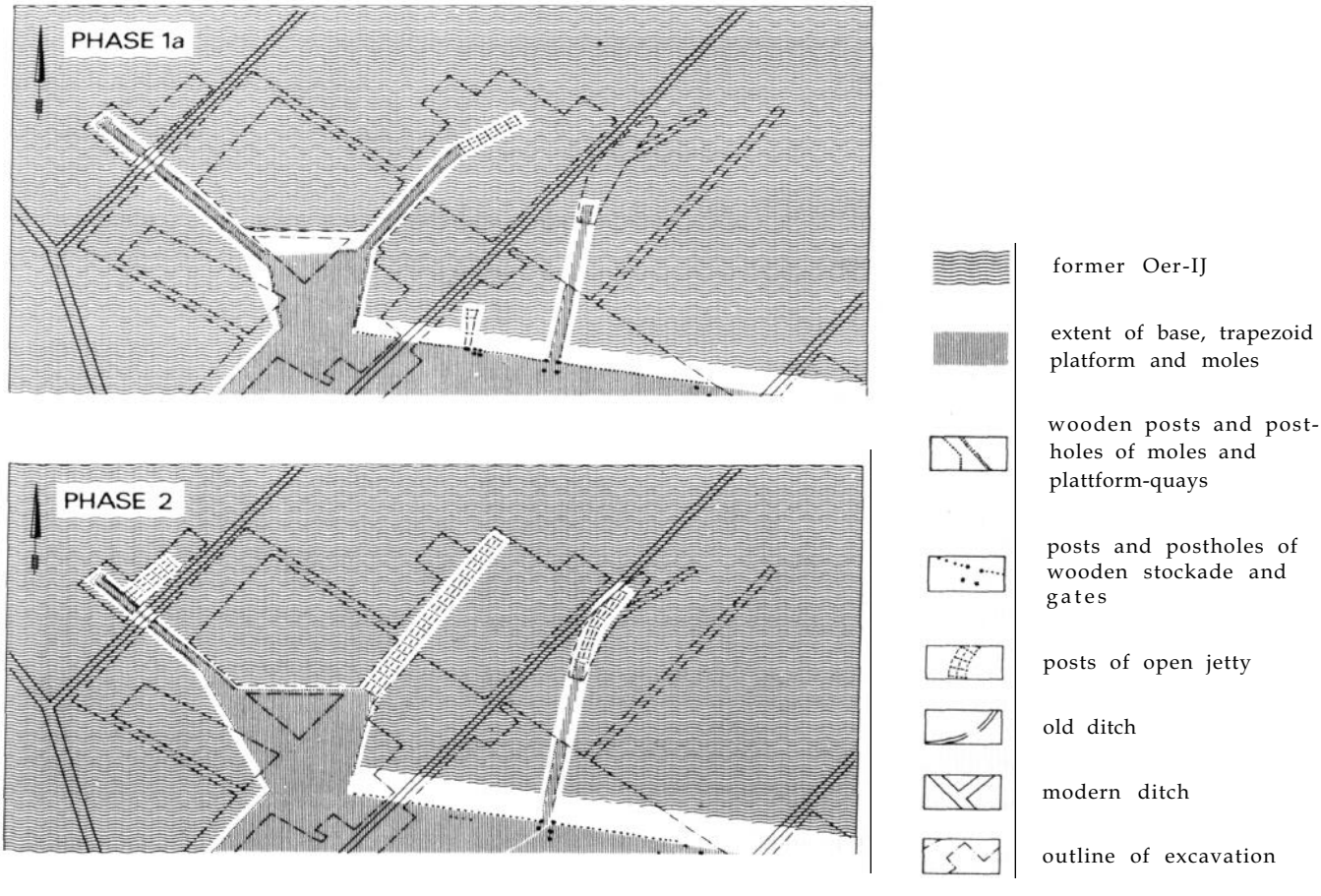


Fig 71 Velsen: early Roman harbour (plans designed by J Morel, drawn by JP de Wit)

The three quays around the platform as well as the massive moles hastened the process of silting up from the west, which resulted in the quays being extended river-wards.

The successive modifications shown in the three plans in Fig 71 include the addition of open jetties to moles, and, in one case, the replacement of such a mole and jetty by a new extremely long jetty running from the platform's north-east corner. The eddying observed in the river sediments around the posts shows that the jetties were left open underneath. When preparing for the building of the longest jetty, the posts of the mole were extracted cleanly or were worked loose or, in difficult cases, were broken off. If the post came out easily, the hole, which was sometimes still lined with the bark of the extracted posts, immediately filled with sand mixed with bone and charcoal. Posts that were more difficult to pull out were worked loose and sand filled up the space thus created, which sometimes contained fragments of the broken posts. Many of the posts were sampled for dendrochronological analysis.

A detailed report will be published by the authors in the Proceedings of the XIIth International Congress of Roman Frontier studies, in the British Archaeological Reports series.



Dorestad: a Carolingian waterfront on the Rhine

WA Van Es and W J H Verwers

Dorestad was situated at the, junction of the rivers Rhine and Lek. It originated during the first half of the 7th century and developed into a flourishing international trading centre, particularly during the 8th and 9th centuries. The site of 7th century Dorestad is as yet unknown. It may have been founded in or near a Roman *castellum,* which until the second half of the 3rd century had been one of the chain of fortresses defending the Lower Rhine frontier. The part of Dorestad which was excavated between 1967 and 1977 belongs to a later period, from the end of the 7th century until well into the second half of the 9th century (Fig 73).

The excavated area lies at the northern end of the settlement, covering a portion of the settlement proper and also parts of the former Carolingian Rhine bed. The houses of Dorestad stood close to the river's edge. Its waterfront probably consisted of a row of closely spaced large wooden buildings lining the left bank of the Rhine. Unfortunately, the zone in which the first row (or rows) of houses may be assumed to have stood had already been destroyed before excavations had started. The houses behind this zone do not seem to represent the actual trading quarter of Dorestad, but were probably mainly farms.

Excavation of the Carolingian Rhine bed on the Hoogstraat O-IV sites showed that, in places, it lay up to 3m below the turf line. The most intensive investigation was at Hoogstraat I in 1972, when an area of 2ha was opened up, up to *c* 270m long by 120m wide (Figs 74, 75). The highly interesting results showed the way in which Dorestad's inhabitants adapted themselves to changing environmental conditions. At an early stage of the occupation period, the river started to move gradually away from its original left bank. An ever-broadening stretch of low-lying land, a kind of shoal, developed between the high bank and the river beach. Communications between settlement and harbour were hampered. The inhabitants reacted by constructing an extensive system of causeways made of earth and wood in order to preserve the accessibility of their roadstead.

The excavations revealed many long rows of piles aligned east-west, with ditches filled with occupation debris from the settlement running parallel to them (Fig 72). The rows of piles enclosed some twelve narrow strips between 6 and 8m wide. In some places it was observed that fragments of planking up to 0.50m wide were still attached to piles, while the rows of smaller piles suggest that wattle-work may also

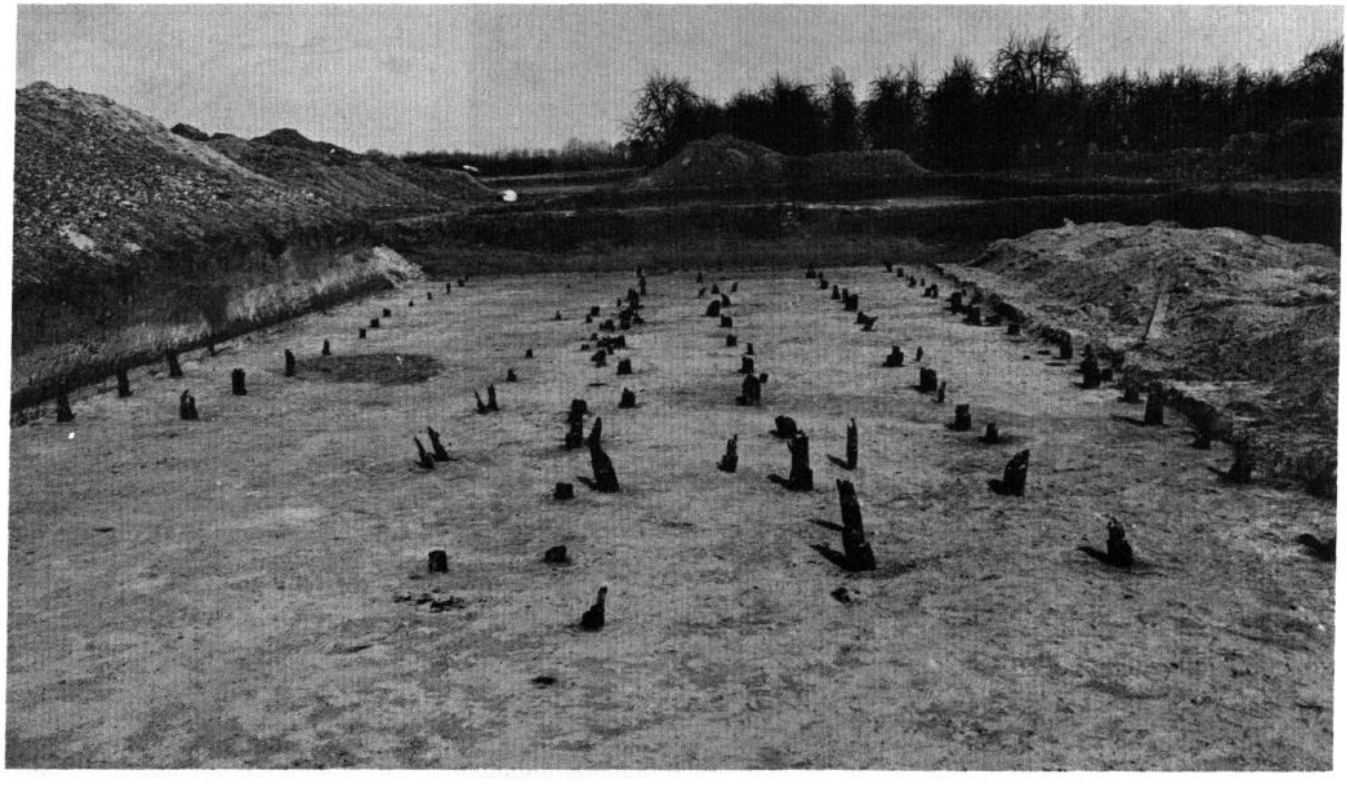


Fig 72 Dorestad: pile rows in the bed of the Rhine, Hoogstraat III

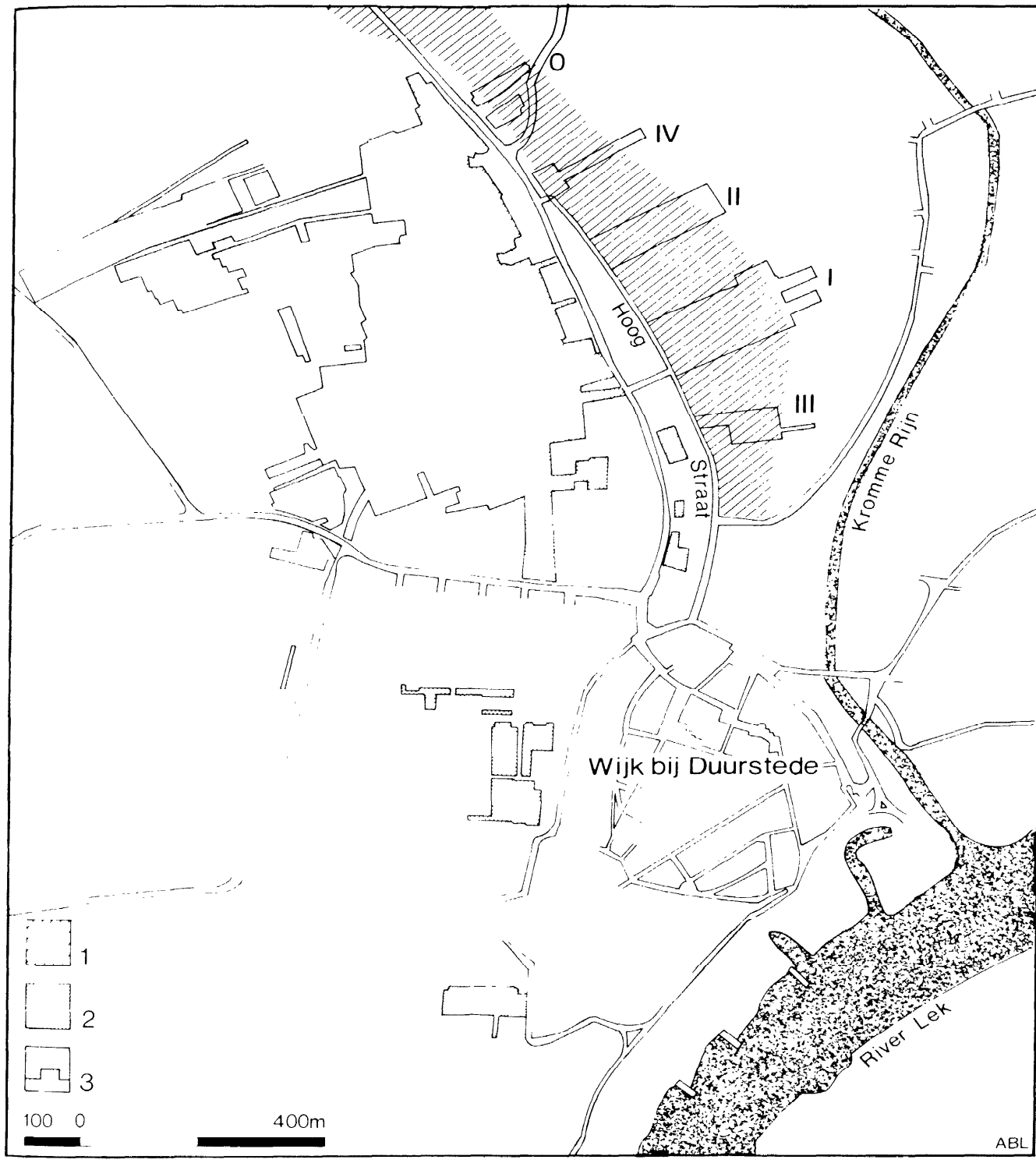


Fig 73 Plan of Dorestad, showing **1** *bed of Carolingian Rhine,* **2** *extent of settlement,* **3** *extent of excavation*

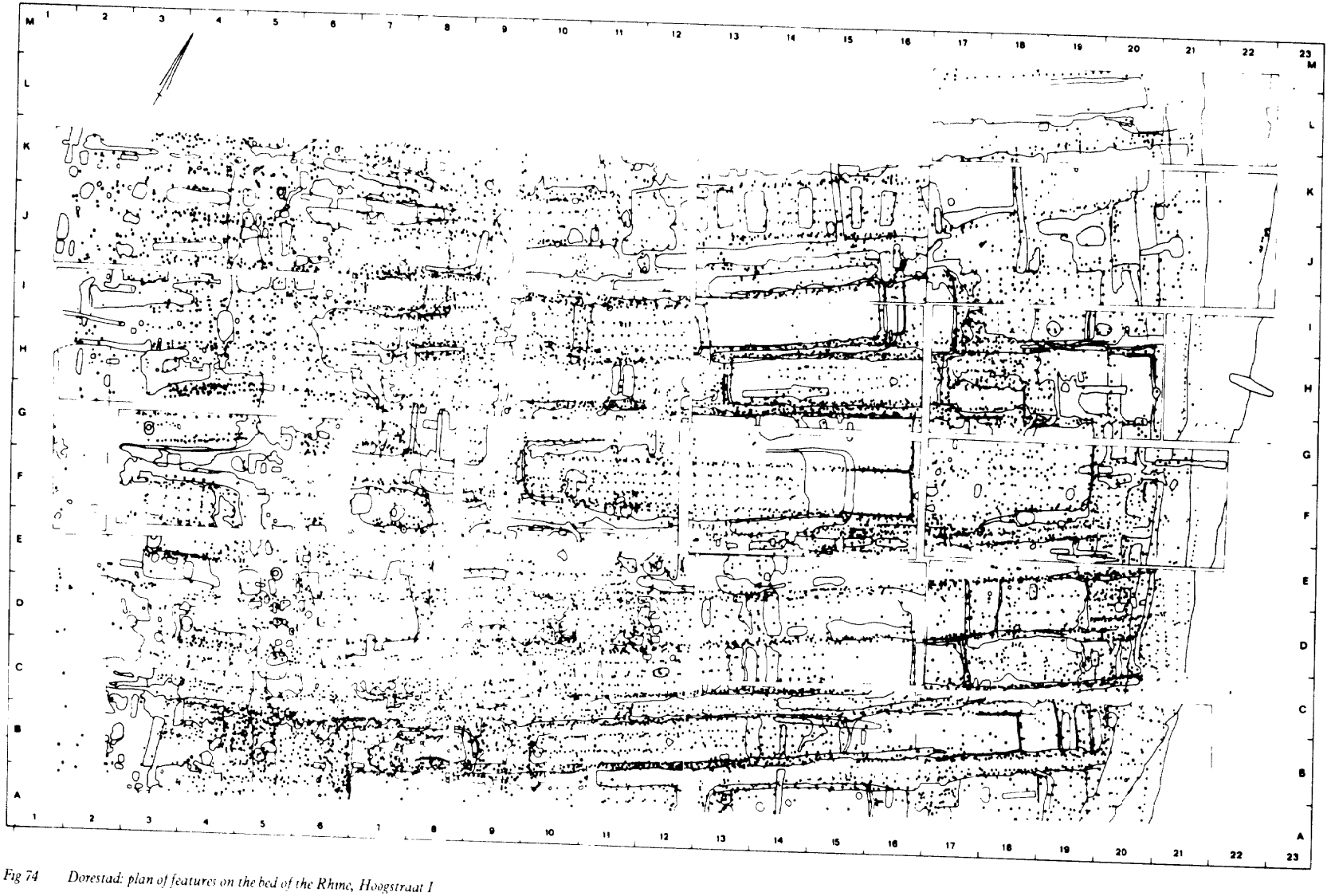


Fig 74 *Dorestad: plan of features on the bed of the Rhine, Hoogstraat I*

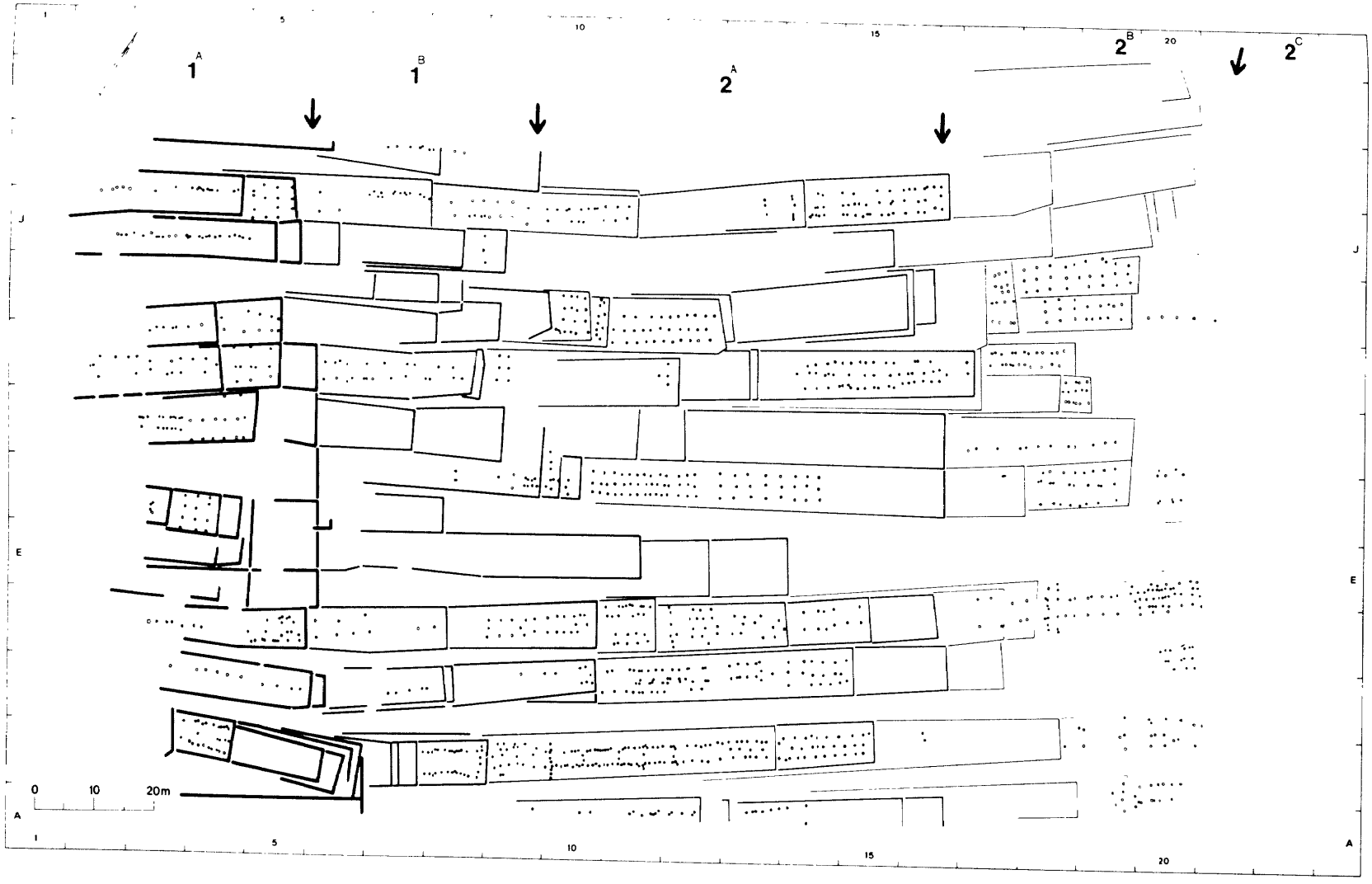


Fig 75 *Dorestad: plan of the features on the bed of the Rhine, Hoogstraat I: Periods 1A-1B c 675-725; Periods 2A-2C c 725-825*

have been used. It is assumed that all the piles had some sort of cladding attached to them. The strips were further subdivided from east to west into compartments marking the gradual advance of the strips, some of which contained many piles while others had next to none. It is assumed that the strips were covered by a platform or wooden road, which may have been laid on joists or hurdlework attached to the vertical piles or carried above the ground as a jetty. These features clearly had to withstand great stress on the waterfront as the piles were driven into the river bed for between three-quarters and five-sixths of their length, in marked contrast to the posts used in the construction of the associated houses, only one-third of the length of which was set into the ground.

The system of causeways was not laid out in one operation, but was extended in several phases. From *c* 675 to *c* 825 the causeways were repaired or extended some ten to twenty times, the size of the extensions varying from as little as 2 or 3m to as much as 60m. In some places the causeways eventually reached a length of about 200m. The successive phases of construction can be dated by archaeological finds (mainly pottery) and radiocarbon evidence. The impressive building activities on the riverbed demonstrate the attachment of Dorestad's inhabitants to their chosen site, and how it involved them in a tenacious, almost pathetic struggle for life.

One observation made during the excavation at Bryggen in Bergen is that the waterlevel has remained virtually the same ever since the town was founded in the latter part of the 11th century. On this basis, reconstructing the topography from the foundation has been comparatively straightforward. At the foot of the mountains on the eastern side of Vågen only a narrow strip of land about 70–130m broad and 500m long was fit to build on (Fig 79). This strip of land represented an area of about 60 000m^2 between the beach and the 15m contourline and an additional 20 000–30 000m^2 to the south. In front of this primary habitation area was a wide beach which sloped smoothly down to the sea. The width of the sandy beach at normal high tide would be *c* 17-18m, with the sea at mean level *c* 22-23m, and to where the bottom shelved *c* 30-31m. These were the conditions along the excavated tidal strip; earlier excavations indicated similar conditions along the entire shore. However, according to recent observations this fine expanse of smoothly sloping beach seems to have been cut in two by jutting rocks at about midway, and it is not impossible that such a topographical division of the shore region would have influenced the habitation pattern in the initial phase of urbanization. However, this issue will not be pursued further in this paper,

Archaeological data are meagre along the west side (the Strand side) of Vågen, but written records indicate that here, too, the area was well endowed with beaches. The Town Law of Bergen reserved the west side for sale of timber, grindstones, and ships, 'wherever this does not hinder the beaching of vessels' (Robberstad 1923, VI, 8). The innermost part of Vågen has very irregular contours, but the shallowness and uneveness of the sea bottom in general would have impeded the passage of large ships. Thus, although the topography of the coastal strip no doubt had its irregularities, the over-riding impression is that there were highly suitable, not to say ideal, landing places, in the shape of beaches, on either side of Vågen, especially along its eastern side which was well shielded from prevailing winds and currents.

The factors which governed the foundation of Bergen no doubt included the importance of its geographically central location and the distinct merits of its harbour, and certainly also the presence of a royal estate at Ålrekstad 2km inland, As such, Ålrekstad may well go back to about AD 900. It is generally maintained that the royal harbour of the pre-urban phase was situated within the inner part of Vågen, not just to seaward of the estate, as otherwise might be expected. This was presumably due to the strong tidal currents and frozen sea during the winter in the inner basin, and certainly also for strategic reasons, If this assumption is true, the King may have reserved the inner part of the area for himself for some time after the founding of the town. On the other hand, the King built his official residence further out in the new town, and Holmen soon became the political, naval, and ecclesiastical centre of the town. These are the few topographical and historical factors of pre-urban and early urban Bergen that are worth mentioning, before proceeding to a more detailed survey of the development of the harbour and the harbour conditions of the town.

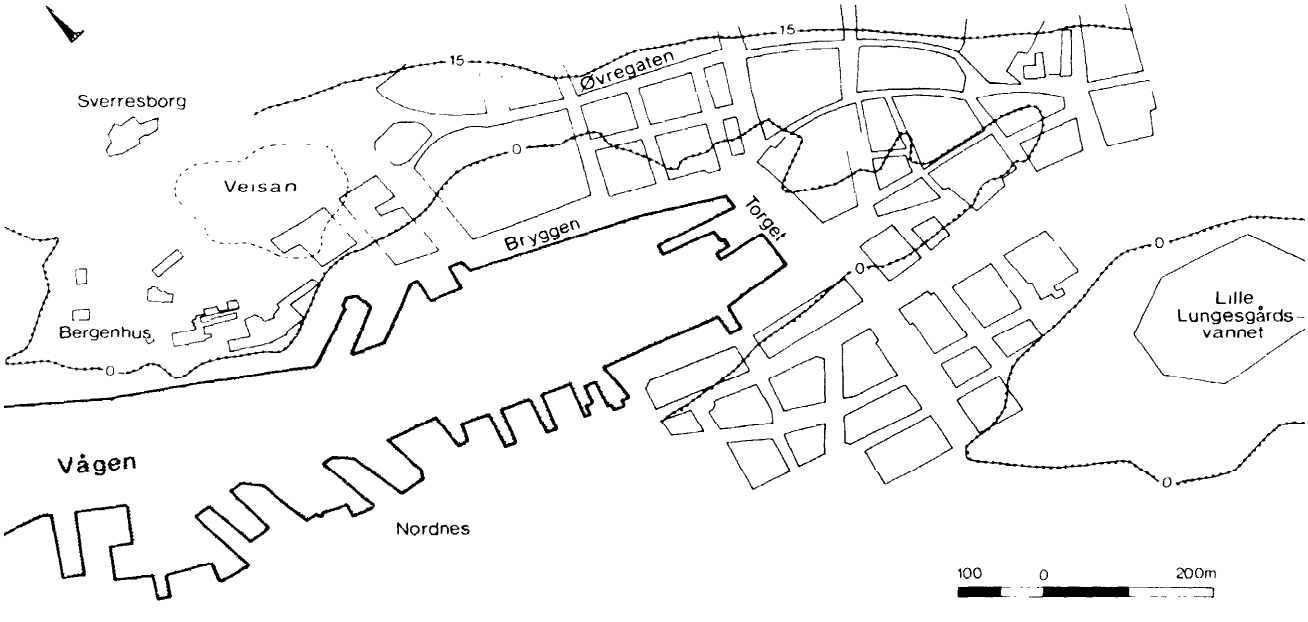


Fig 79 *Bergen: plan of the harbour (Vågen) showing primary habitable land between the 0 and 15m contour lines. Bergenhus, the royal centre, to the east, king's estate at Alrekstad 2km inland to west*

Fig 80 *Bergen: extensive traces of early harbour occupation were sealed beneath mid to late 12th century levels. The square-built timber boxes carried narrow passageways, the piles supported the contemporary buildings*

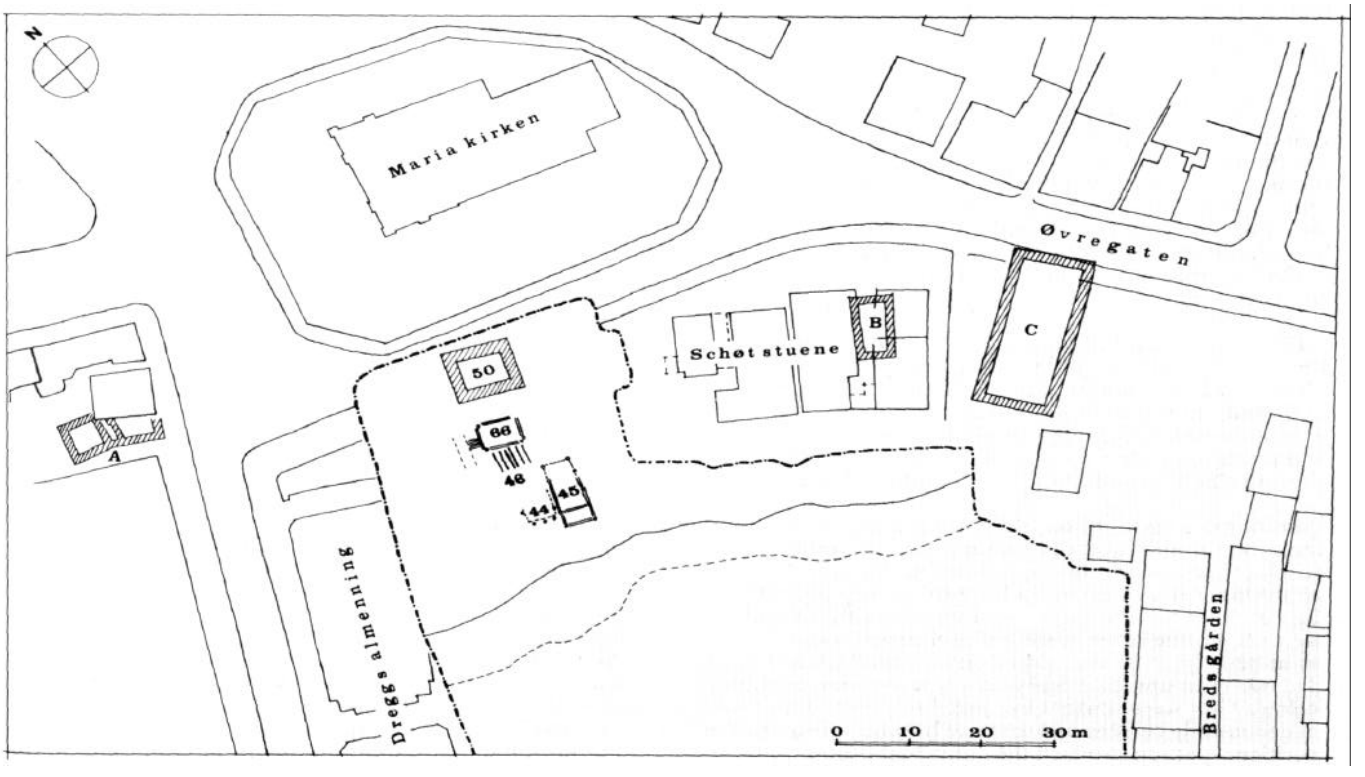


Fig 81 *Bergen: plan of excavated tidal strip showing earliest pre c 1170 building phase, with level of high tide marked*

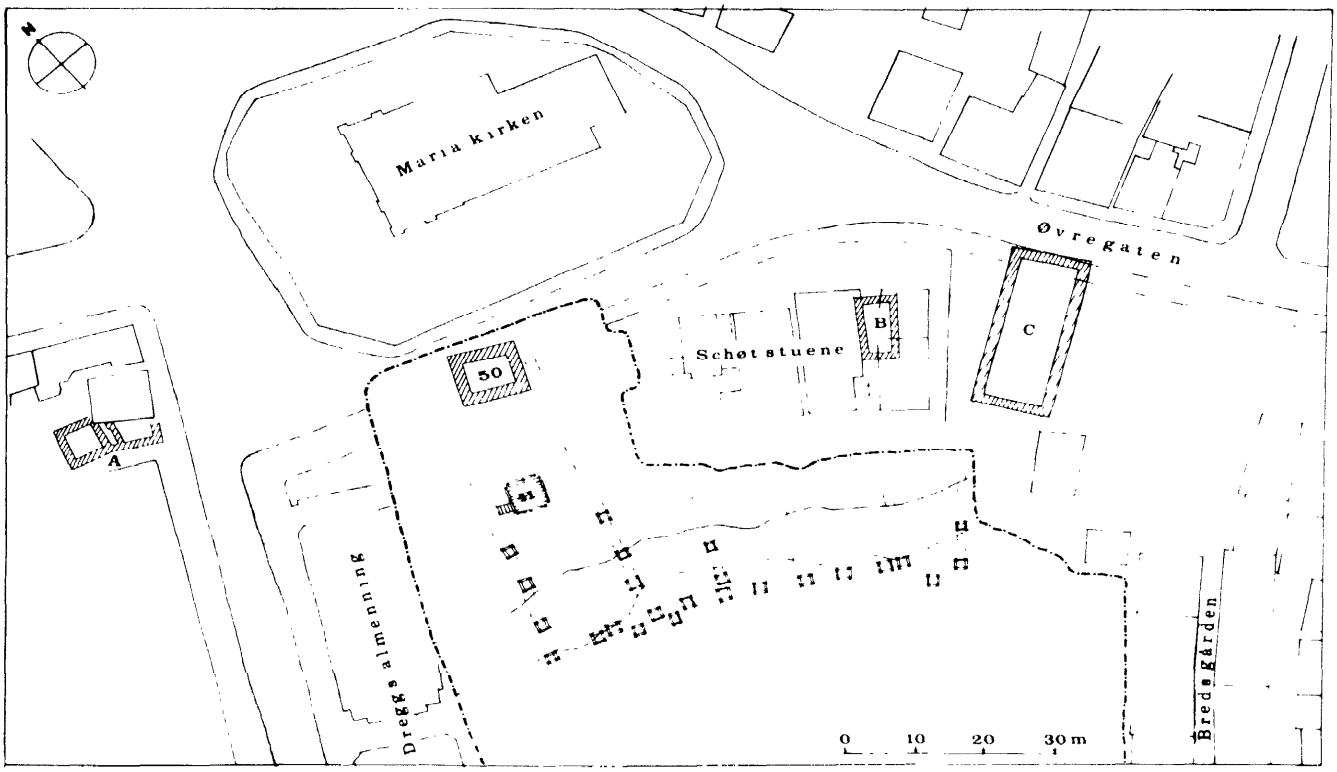


Fig 82 *Bergen: plan of second building phase on beach, c 1171-98. Waterfront on shore-line shelf marked by square timber boxes. Five double and one single tenement have been identified on thls 70m stretch of beach*

As already stated, the land initially available for building was confined to a narrow waterfront moraine at the foot of the mountains. From this restricted start, the occupation area expanded rapidly, spreading to some extent along the shoreline, but more spectacularly and perhaps unexpectedly towards the sea. There are two distinct phases in this seaward expansion, covering first the beach and secondly the harbour basin.

During the earlier phase, during the first century after the town's foundation, little artificial modification took place. The beach was then used for embarking, loading, and unloading, apparently without any physical installations. Extensive evidence of this type of early harbour occupation was preserved under a closely packed layer of pebbles deposited in the middle to late 12th century (Fig 80).

During this early period, the beach was gradually incorporated into the area of permanent occupation. The first buildings-storehouses, boatsheds, etc–were built on the beach itself, leaving only a narrow strip of dry land between them and the high-water mark (Fig 81). These were simple one-storey warehouses of varied construction, some being built on sills placed directly on the sandy beach and others on upright posts with a type of cellar, or lavatory below. They were situated in parallel rows with little trace of deliberately constructed passages between them, but the positional pattern to which the individual houses conformed seemed even at this early stage to anticipate the subsequent clearly documented 'double tenement' pattern.

Certainly this plan form is well documented for the next phase of building. This followed the fire in 1170/71 which razed most of the contemporary structures. After the fire, building activity thrust right out to where the sea bottom shelved, some 22-23m further out (Fig 82). By this time the double tenement had become the normal constructional unit. Five double and one single tenements have been identified along the 70m stretch of excavated beach. The buildings were now, without exception, erected on upright posts with narrow gangways or passageways running in between. The latter were supported partly on posts and partly on small, square-built timber-boxes known as *kar* in Norwegian. All the structures, houses and quays alike, terminated at the edge of the shelf, where they were laid on stone-packed timber boxes with vertical anchorage piles providing further support. The boxes vary slightly in height, but were on average 1.50– 1.60m. 'The passages would in some places project 2 or 3m in front of the houses, while smaller quays supported on posts have been identified in front of some of the premises (Fig 83).

This phase of building was destroyed by fire in 1198, after which the second phase of land reclamation began, characterized by a tendency to build out over deeper water into the harbour basin, in places for as much as 70m and over depths of 8–10m. Today's wharfline has accounted for a further 70m in an overall seaward expansion of 140m. During the 50 years following the fire of 1198, two major building periods have been identified. Of the first only fragments survive, but the second (which ended with

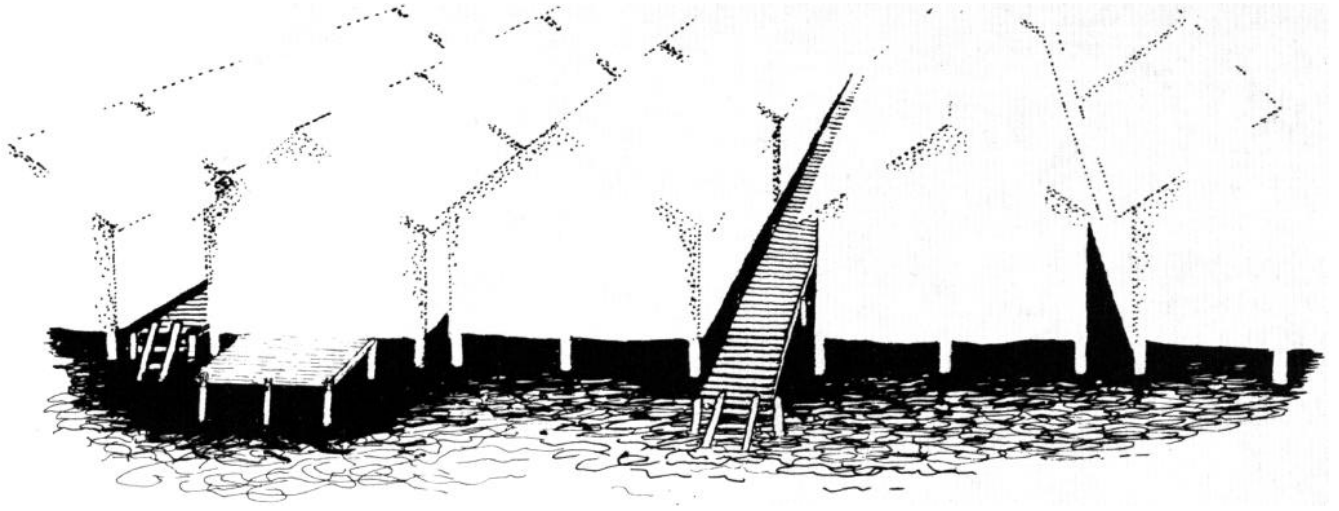


Fig 83 Bergen: sketch of late 12th century waterfront

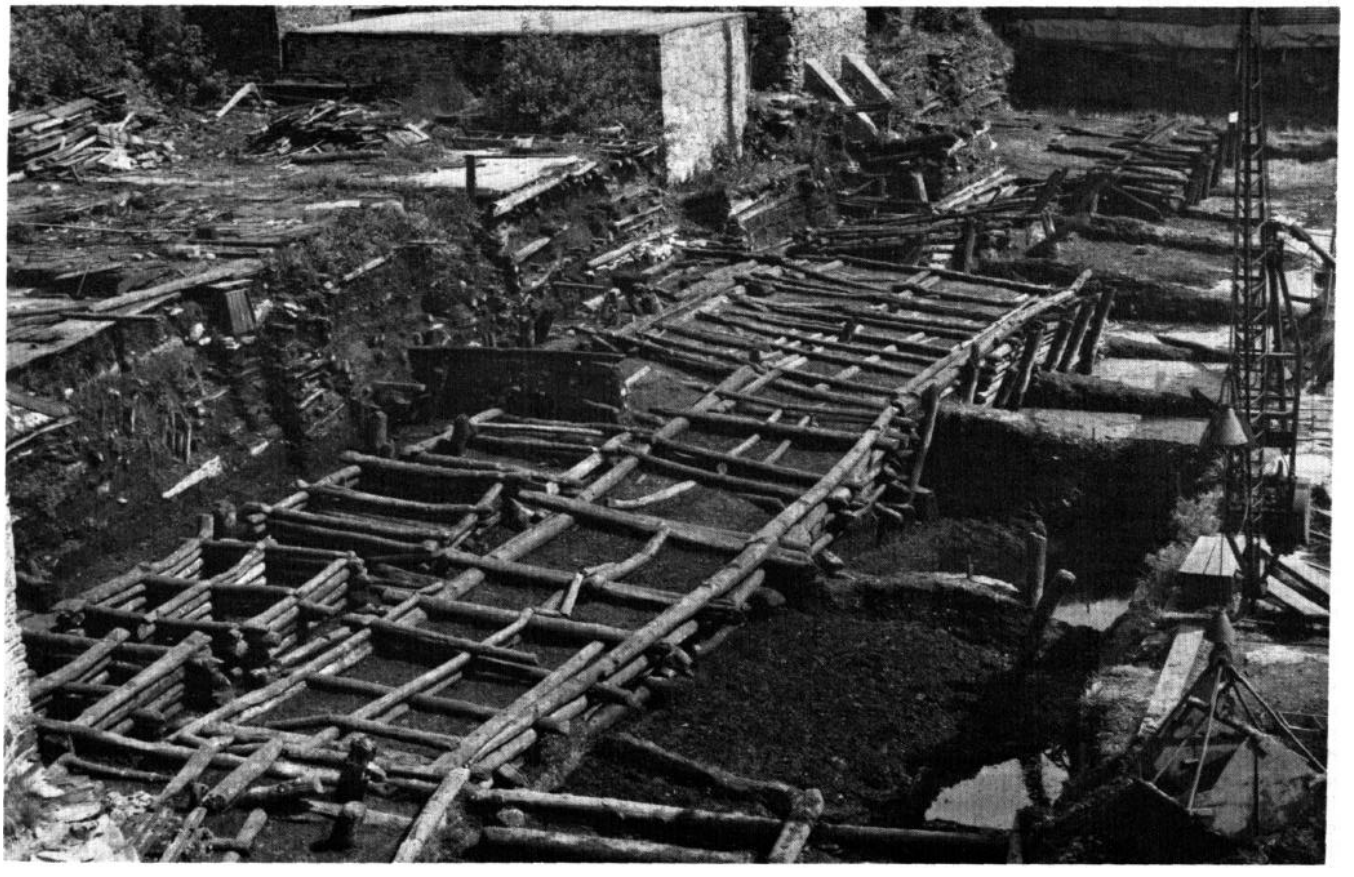


Fig 84 Bergen: post-1198 waterfront, after several tenement owners had brought their quays into line. Total length of contemporary quays c 55m

Fig 85 Bergen: square-built timber boxes without stone ballast used as house foundations in deeper water

the fire of 1248) is better known, since many of the quayside structures built after that fire retained the earlier building lines on the waterfront (Fig 84). This was presumably because the existing depths of between 1.60 and 2m were considered satisfactory. Before 1198, the sea-front buildings mainly rested on posts with some on small timber boxes, but after 1198 buildings as well as quays were extended over deeper water, thus calling for greater solidity in the substructures. From this time on, therefore, the exclusive use of larger timber boxes as supporting submarine structures served this purpose. However, the lighter quays out in the front continued to be set on piles or posts, and this seems to be a tradition traceable throughout the medieval era.

The earliest phase of box-construction in deeper water is characterized by rows of smallish boxes *(c* 2.8 x 3m) scarcely larger than those used across the tidal strip and along the shore-line shelf, though, unlike these, they lacked stone ballast (Fig 85). It may be that the buildings laid upon them provided the necessary stability in themselves. If so, it may be presumed that the earlier stone-filled boxes either supported flimsier buildings or were not house foundations at all but supports for quays, Any functional analysis of this state of affairs must of necessity be confined to the drawing of conclusions by analogy since nothing remains of the structures these boxes once supported. After 1198 it became general practice to frame these boxes to the height of the water-level or possibly a little above. They were then brought into line and stabilized with long overlapping beams both lengthwise and across until the appropriate height (c 0.75m above mean water level) was reached. This would be satisfactory because the difference between the mean and the high water-levels was very small: today it normally amounts to 0.47m. In the course of the 13th century, the constructions took on a more substantial and professional character. The small or middle-sized boxes were no longer used, the wharf requirements of a double-tenement *c* 8m in width now being completed as one single constructional unit. The internal stability of such structures was supplemented by buttressing them in front with deep-driven piles firmly attached to the main structure (Fig 86).

Following the fire of 1248, better coordinated building activity becomes evident, the owners of several tenements or house rows bringing their quays into line so as to form a long straight stretch of solidly built quay apparently adjusted to three tenements. To both the north and the south of this, quays remained more individualistic, being adapted to the widths of the double tenements they served. The total length of the excavated contemporary quays amounts to 55m. In contrast to the more individual solutions before and around 1200, the different quays were now levelled in order to benefit the waterside traffic. The sea-front picture also changed radically during the first half of the 13th century (Fig 87). From the late 13th century onwards there seems to have been a reversion to letting single tenements set the norm for foundation width. They were not attached to the second house row of a tenement until normal sea-level was reached. These foundations incorporated up to 36 layers of beams one above the other, totalling *c* 5.5-6m.

How the problem of building at a depth of 5-8m was solved is not known in detail. What can be said is that all

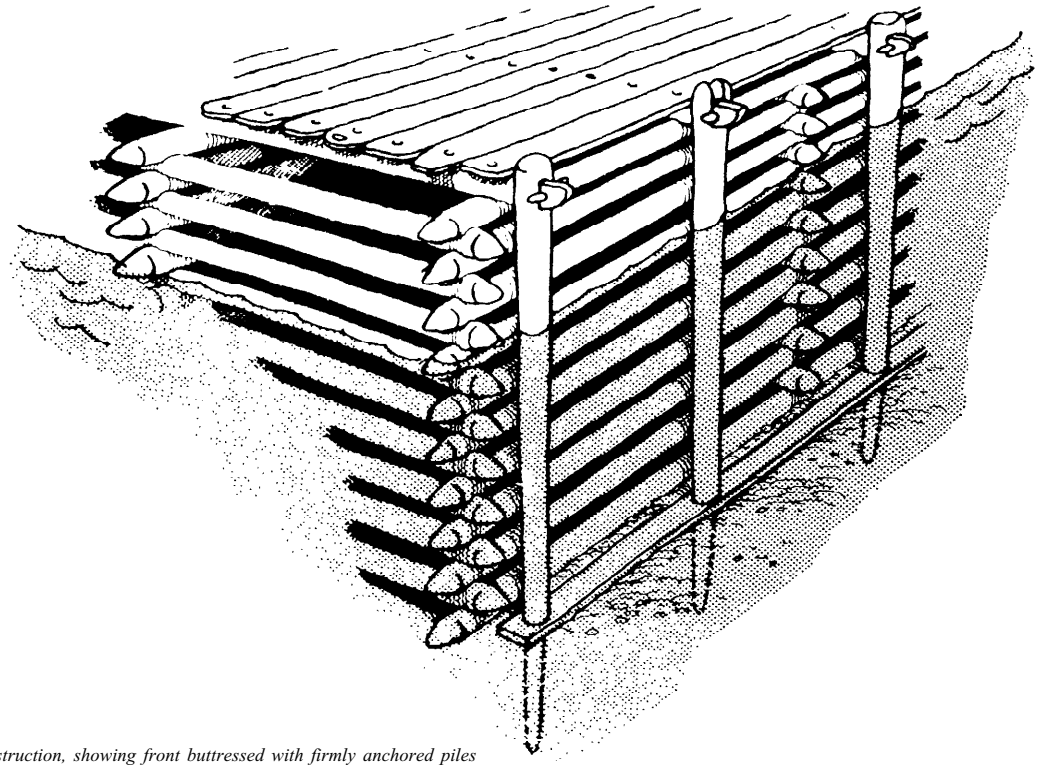


Fig 86 *Bergen: detail of quay construction, showing front buttressed with firmly anchored piles*

the deeper substructures were made fast by driving piles into the substratum; neither ropework nor ballast was used. The timber was presumably freshly cut and well soaked, long floating having helped to ensure that. Individual variations in the rate of harbour development are suggested by the varying quay width and length in front of the houses. That the broken line of the quays faithfully reflects a correspondingly broken line of facade, is an open question and I assume it reflects nothing of the kind. The straight frontage line of more recent date is in all probability one of the many conservative elements in the local building pattern. It will be evident from the above that no definite assessment is possible of the width of the quays, ie of the distance from edge of quay to actual buildings. There are indications that the quays in the early 13th century may have been as narrow as *c* 3-4m wide.

With its advanced and manifestly up-to-date quay layout, extending in all likelihood right along Vågen's eastern side for a length of 400- 500m, the town had now acquired a harbour that commanded respect. The quayside depths of 1.60-2m recorded from *c* 1250 are modest enough by the standards of a later age, but they meant that the quays were well suited to cater for the largest types of vessel then known, and all the more so since the ships were required to dock stern-on to, instead of alongside, the quays. The waterfront structures of the mid 13th century no more represented a static situation than did those that preceded them or the many that have followed. The excavations have revealed that major or minor improvements and extensions were an ever-recurring phenomenon in the harbour basin. The principal extensions came in the wake of the numerous fires, but from about 1200 the line of quays was constantly in a state of flux, partly because of straight-forward demand for space, partly as a consequence of the development in shipbuilding technique, and partly because of local, but highly illegal, emptying of refuse. Rubbish dumping off the quays was an international problem, since prohibitions against it are known in many towns. In Bergen, this clogging-up must have taken on formidable proportions from the very earliest settlement, for underneath the medieval quay foundations the entire harbour basin was covered with a massive layer of-discarded refuse 6-7m thick. These strata were composed of household rubbish and waste-twigs, pine needles, chippings, moss, nutshells, branches, and the like-while only a small proportion was formed of sedimentary deposits contemporary with the period of occupation. Some of this dumping was desirable and indeed necessary to facilitate the intended waterfront extensions, since it reduced the depth to which foundations had to be constructed. But quayside depths were so modest in the 13th century that all other dumping must have caused problems. The written records confirm this, but ever since the end of that century the depths of many quay sides (at least 4m in *c* 1300) was suficient for a certain lack of restraint to be tolerated. Even so, there were vulnerable areas calling for a special degree of caution throughout the medieval period.

The substantial layers of rubble upon which the waterfront buildings eventually rested gave rise to problems, as might be expected. The high compressibility of the dumped material resulted in subsidence and lopsidedness in houses and quays alike, and present-day Bryggen is the best evidence for this. People would hardly go in for the amount of modifications and repair work effected just for the fun of it, so problems must have arisen frequently. Rain, slops, and fish innards must have been some of the things that made surfaces slippery to walk on, and the heelless shoes then worn can have afforded little frictional

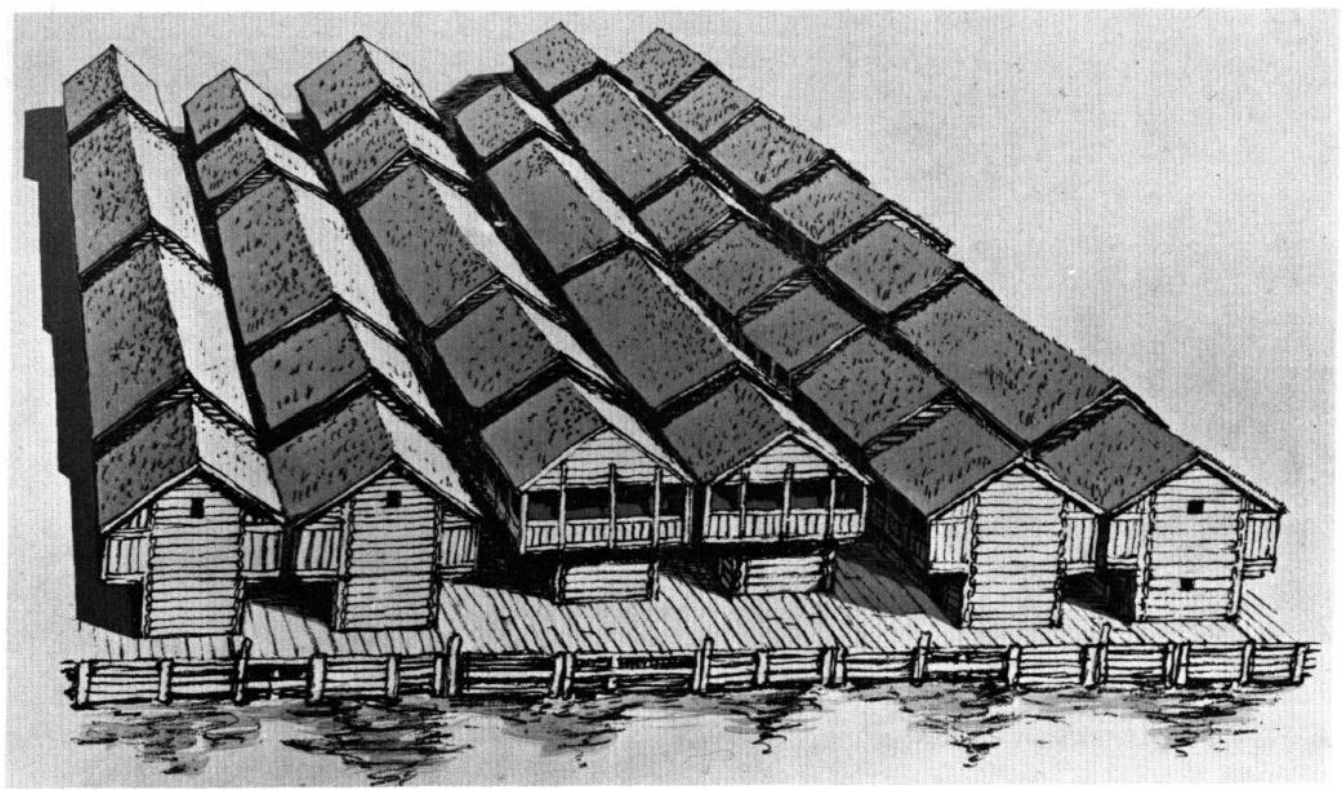


Fig 87 Bergen: sketch of mid 23th century waterfront

support. To offset the hazards of a skewed and tilting quay, the uppermost beam was studded and restudded with two or three rows of 20-30mm pebbles. This did at least give those arriving by boat a sound initial foothold on landing, and a last chance to those who missed their footing on the sloping planks. Official directives concerning the maintenance of level quays after the fire of 1702 show that these problems persisted into a later time.

In the mid 13th century, the harbour was 350-400m in width and *c* 600m long, excluding the shallower and narrower inmost reach. There was ample room even for the 200 vessels known to have assembled in the harbour in 1248, and such numbers account for the need for regulative ordinances. The Town Law (Robberstad 1923, VI, 15,2) for that matter expressly states that seafarers sailing in to Bjørgvin were 'to discharge their cargoes in town premises, neither buying nor selling on board ship, save in case of purchases for the royal residence' (which had a three-day pre-emption on all incoming wares). This ordinance was not exclusively-and perhaps not even primarily-due to demand for docking space. It is further laid down in Chapter 15 that all 'shall dock at the quays at the place where they have lodging, but as soon as their cargo is unloaded, shall lay out in Vågen, so making room for those arriving with their ships laden. But those owning ships and residing or lodging behind the seafront buildings shall dock in front of the Allmennings, ie the streets running down to the shore.' It is interesting to compare these excerpts from Bergen regulations for seafarers with roughly contemporary ones from London. Written records from the late 10th century (Birch 1887) seem to indicate that vessels were drawn ashore, while those abroad traded and lodged in tents or stalls set up on the beach. By the early 12th century, however, things were different. Because quays or wharfs had by this date been built along the Thames, seafarers were to stay the night on board, subsequently selling their wares there too. Thames Street marked the boundary between the town and the Thamesside market and was only crossed by those who had paid a specific fee 'escawinge.' That was apparently the precondition for finding a hostel and selling one's wares in the town.

Particular interest attaches to Bergen Town Law VI, 15,2 (Robberstad 1923), which states that 'those who have a docking place shall turn one end of their vessels towards Vågen and the other towards the wharves.' It is uncertain what occasioned this unique style of docking, but it may simply reflect the problems of docking space, which may have been in short supply. Each tenement was of very limited width, and as a number of different merchants would own premises within each, demands for space at the quay in question might have caused problems. In any case, such a way of docking presupposes special loading and unloading gear, as severe problems would arise if goods had to be conveyed over the sheer (the forepart where the ship's rail ascends). The special hoisting spars peculiar to Bergen from more recent times are well known: they might be said to have dominated the harbour scene even as late as the end of the last century (Fig 88). It is tempting to conclude that the Town Law requirements assume the presence of cranes able to reach some way into the vessel, and as the hoisting spars are tailor-made for this job, it is reasonable to suppose that they date back to Town Law

times, ie to the middle of the 13th century. Where no quays existed in front of the wharf buildings, loading and unloading would take place by means of simple hoisting devices, with some use of block and tackle and possibly of-windlasses as well, while gangway planking and barges could also be employed. Several of the old methods are still in operation in Bergen, though the windlass is now broadly speaking an antiquary's find.

Irrespective of how ships docked, merchandise had then to be transported to numerous different warehouses in the harbour region, so hoisting gear was just as much needed there as at the quayside. Most of the buildings at Bryggen are therefore found to have winching arches or projecting beams for block-and-tackle. The beam hoist is an item which is common in warehouses throughout the North European area. In the later medieval period the treadmill crane, the so-called 'Hanseatic Roman' type, is also known, some examples of which are still in use in Germany.

Once the medieval harbour towns were equipped with quays, the earlier need for beaches as landing places naturally diminished, although suitable beaches were still in demand for repair work, tarring, and the laying up over winter of-large and small vessels. Since beaching of larger ships or 'shiphauling' normally called for large teams of men, it was no doubt in the public interest that such beaches should be found close to the town. It is evident that a good deal oft he Strand side of Vågen in Bergen was reserved for beaching vessels even as late as the end of the 13th century. In 1602, a shipyard named Bradbenken was established between Bryggen and Holmen, Bergenhus Castle, with the sole right to large-scale ship repair in Bergen. It is likely, though not certain, that the area was put to the same use at an earlier date. The Town Law (Kobberstad 1923, VI, 17) is, however, quite specific about what is expected of-people in such cases, for 'shiphauling' was a universal civic duty for anyone who had spent three nights in town, while not even new arrivals were excluded if particularly big ships were involved. Only what the law specified as unavoidable failure to comply would be accepted, and fines were assessed with regard to whether the job had to do with cargo vessels, ships on the Baltic run (ie engaged in the Baltic trade). or big oceangoers. All types could be drawn ashore.

No specific information is available on the extent to which special technical devices-apart from rollers-were used to bring vessels ashore, but use of such is recorded in the Sagas (Holtsmark 1961) and may be reasonably conjectured from the use of block and tackle, capstan, or windlass for related purposes. Attention may be directed to the winch from North Ferriby, of a type surely familiar to present-day Mediterranean holiday makers (Wright 1947, 123). Especially interesting us the slipway construction unearthed by Haarnagel in Hessens near Wilhelmshafen (Ellmers 1972, 144). This consists of two parallel flat beams secured to the ground with rows of 0.5-0.6m long rivets This singular 7th century construction was designed for a flat-bottomed ship, and its anchoring system endowed it with lightness and mobility. Ellemers, in fact, goes so far as to suggest that it might have been part of every ship's standard gear along with such items as gangplanks (Ellmers 1972, 144). Even with such slid rails on board, there would no doubt be a need for rollers whenever ships were beached or set afloat again. But whatever technical equipment might have been to hand, extensive use of cordage was inevitable. During major beach repairs at Bergen, ropes were manually operated under officer's orders, The Town Law (Robberstad 1923, VI, 17, 2-3)

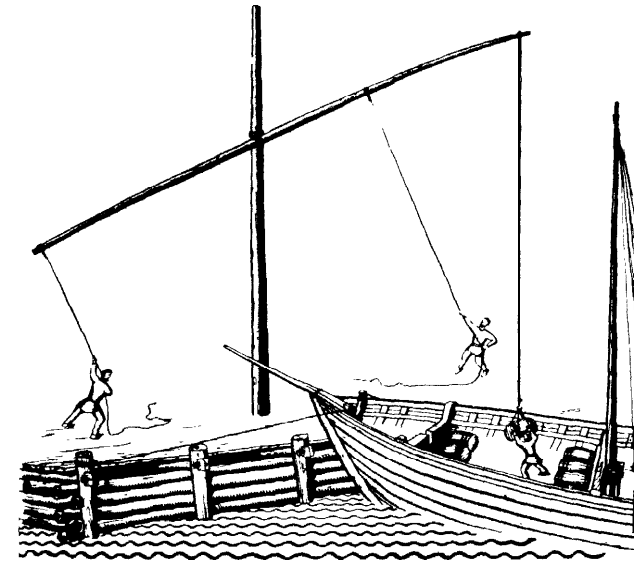


Fig 88 *Bergen. hoisting spars were used to load and unload vessels which, according to Town Law, docked stern-on to the quay at specified berths*

specified how people were to act in various emergencies if-the rope snapped, the way a man was answerable for having hauled too soon, how the chief officer could demand that the bugle signal be given for shiphauling, etc. This ship-hauling duty was as much a civic duty as the obligation to help in firefighting if fire broke out: one could not ask for a clearer illustration of the priorities of urban life in a good old harbour town.

Bergen not only had laying-up space for vessels of every size and type, it had also shipyards at its disposal. Håkon Håkonsson's saga tells of large ships being built in Bergen, and *Mariasuden II* and *Kristsuden* were among the largest known to have been built in Scandinavia (Brøgger & Shetelig 1950, 249). Nor was it just the dock area and the waterfront buildings with their special equipment which gave the coastal towns their own peculiar character. The inhabitants were bound up with everything that had to do with seafaring to an obsessional degree, and legislation turned this into a bounden duty. There are also physical installations that have now mostly vanished from the scene, but which in the medieval period and the age of sail gave harbour towns their characteristic look, such as the numerous ropewalks whose main function was to keep a large and demanding fleet supplied with cordage. Only two now remain in Bergen, both disused, but quaint and narrow stretches of straight alleyways here and there in the town remind us of an activity once so widespread that it played its part in shaping the town right up to the present day.

In 1972 when I began a systematic study of the development of harbours from the Roman to the medieval period, there were few excavations to which I could refer, but as a result of the recent extensive work in London, Dorestad, Schleswig, and other places the situation has changed remarkably for the Baltic and North Sea areas. The conference has thus been able to examine waterfront research in far more detail than was previously possible.

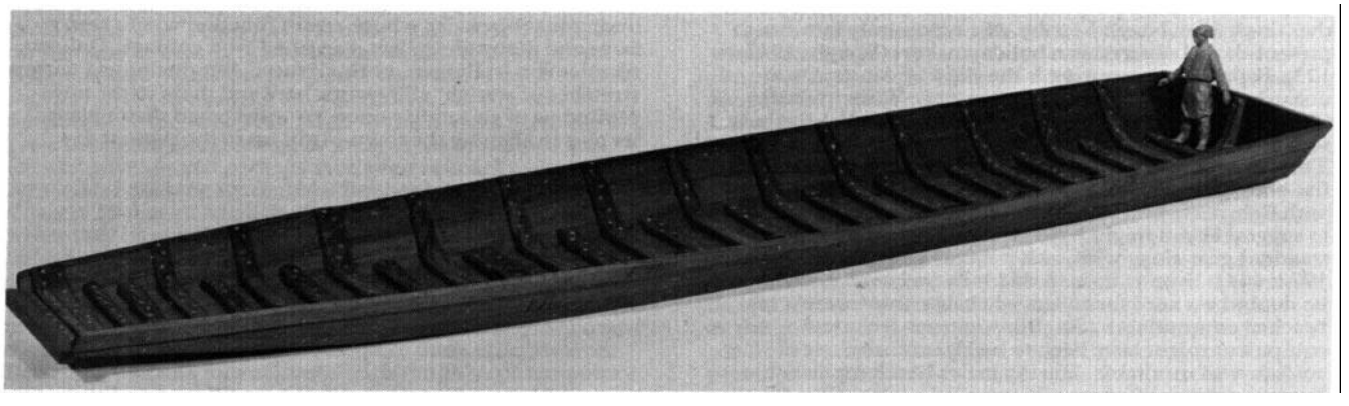
The development of the many inland harbours on the continent is a much more difficult study. The most investigated area is the Rhine and its tributaries, where a large number of naval ports, quays, harbour basins, and other waterfront installations of Roman date have been excavated. However, for the post-Roman period there have only been a few exploratory trenches cut, none of which revealed buildings or other structures, and there have been no excavations of harbours. Other sources must therefore be examined in the attempt to build up a picture of the general development of the waterfront from what little evidence is available.

First stage

To start the discussion in the post-Roman period it is necessary to keep in mind the urban structure of the economy of the Roman Empire, with traffic routes being organized by the state–roads as well as waterways (eg towpaths)-and harbours being parts of fortified towns, though situated outside their walls. During the Migration period the lands bordering the Rhine were occupied by Franks and Alemans, and the economic life of the towns virtually died, a situation which had dire consequences for the economy as a whole. Most families in this early post-Roman period depended upon subsistence agriculture, which drastically reduced the flow of traffic. The waterways were therefore reorganized primarily to serve the needs of farmers, although the wine trade remained as the principal branch of the export economy.

Arguing from the negative evidence, it can be seen that the withdrawal of the Roman army was crucial, for not only did the lucrative consumer demands of the army dry up, but their naval bases and supply organizations were also abandoned. The dockyards in which Mediterranean ship building techniques were practised stopped production, and their ships disappeared from the area forever. Developments in the civil sector were not quite so radical. Quays decayed, harbour basins silted up and filled with rubbish, warehouses were robbed of their stone or were used by monasteries, but river traffic did not stop completely, although the number and average size of the ships was drastically reduced. People only used those types of boat which did not need special quays but could be beached. Excavation and research over the last decade has revealed and unbroken shipbuilding tradition stretching from pre-Roman times to the 19th century, and types of vessel for many different purposes seem to have survived the changes during the Migration period. The commonest and universal multi-purpose boat was the *Nuchen,* which had been developed in pre-Roman times from the dugout (a boat made from a hollowed-out tree trunk), of which several different variations are known. They are still used today by farmers, fishermen, river engineers, and army pioneers, as ferries, or as pleasure boats by students in Tübingen: even today they land by beaching on flat riverbanks. Though there is no known excavated boat of the Migration period, it is possible to judge from the long life of this type that the *Nuchen* with its flat bottom, small draught, and less than 15-16m length was able to manage most of the work available on the river in the post-Roman period.

Although there was therefore little demand for more specialized types of boat, three examples are worth describing. One of these was the ferry large enough to transport carts, horses, and cattle. These are known on the Rhine from the 3rd century BC: they were catamarans built from two dugouts with a wooden platform on top, and were usually found at important river crossings. They also only needed to be beached on a sloping riverbank. So, too, did one special type of cargo boat with open bows from which heavy barrels could be rolled on board (as on the roll-on/roll-off ships of today), without having to heave the heavy loads over the side (Figs 89, 90). Unfortunately, the name of this type of boat is not known. The barrel became the main container (more so than in the Roman period, when amphorae were also used) not only for wine and other liquids, but also for all other goods which had to be kept



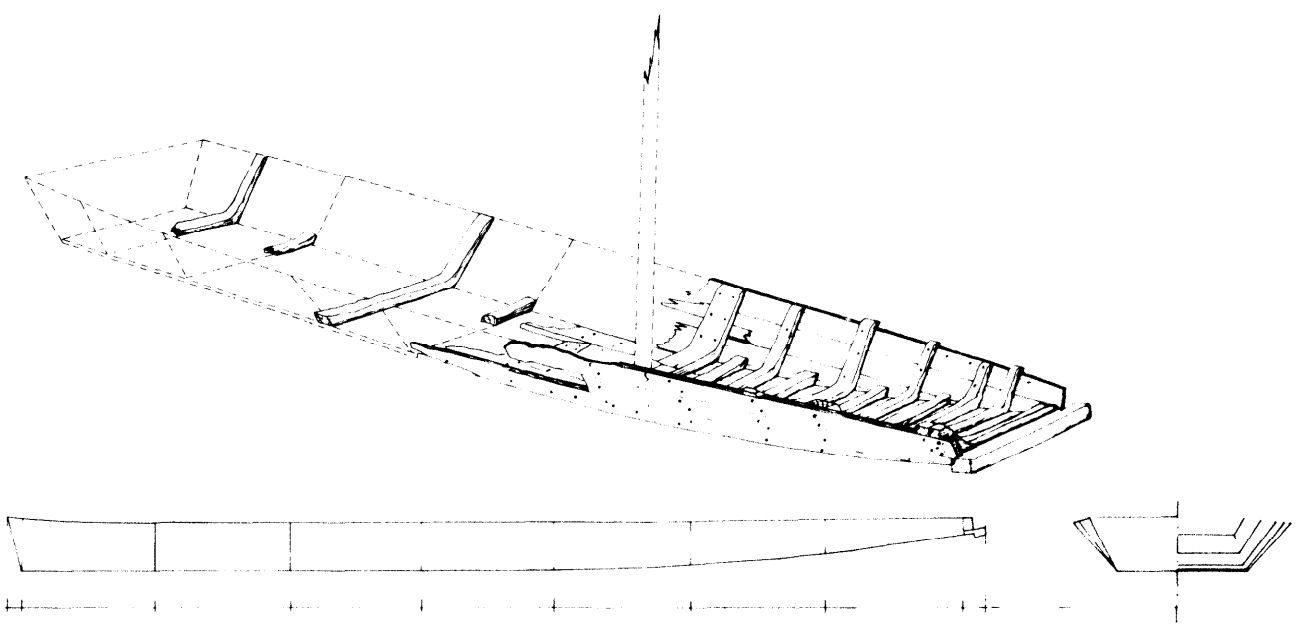
Figs 89, 90 Barge with open bow (Bugpforte) for roll-on-roll-off trade, Krefeld 13th-14th century

dry on the open boats. Landing by beaching was more difficult for the second type of cargo boat known as *Oberländer,* as their bottom was not cvrved upwards at the bow but met a sort of transom at a sharp angle. In the late medieval period, this type of vessel was the biggest cargo ship on the Rhine, and was berthed at low quays. The boats were probably smaller in the early medieval period, and may have moored close enough to the banks for carts to come alongside them in the water to take off the cargo. This offloading technique could be observed in the Rhenish towns as late as the 19th century. The archaeological evidence for this technique is layers of stone or paving slabs extending from the dry land down below the surface of the water, but so far these have been found in Germany only at Hamburg, in a 9th century context. The provision of specialized cargo boats during the Migration period suggests that special bulk cargoes were being handled, but the nature and organization of this traffic is not known. The late 6th century documentary sources must suffice, which refer to river-based merchants as being among the remaining inhabitants of the towns. Their boats were floated downstream with the current and the smaller ones were poled upstream, and so they were quite independent of any structures along the riverbanks. Manpower was also used to pull the bigger boats from the Roman towpaths, which were well looked after for long distances and can still be walked along even today. (Incidentally, the Roman practice of collecting tolls was also partially retained.) It is remarkable that no evidence has yet been found for Germanic boats which could have been brought by invading Franks or Alemans: everything seems to suggest that the new landowners made use of the vessels of the remaining native population for fishing and water transport. This would explain why the early Celtic techniques of shipbuilding continued without interruption into the era of the Frankish Empire.

From the 8th century, the serfs of the Frankish nobility who lived on a part of the riverbank suitable for beaching boats did not pay tax in cash or kind, as other serfs did. Instead, they were obliged to build and maintain boats in good repair, and to use them to provide transport as required *(non solvit censum, sed navigat).* It seems that many landowners were particularly interested in adding the ownership of the *Hörigenhufe* (the serfs' smallholdings) of those who were experienced boatmen to their more widespread holdings. Traces of this feudal use of shipping were still evident until the early 19th century. In the early medieval period the basis of the serf's life was not the shipping but the small farm, which had to be managed by the wife while the husband provided the obligatory boat service in return for it, or while he was away on his own account.

The archaeologist can glimpse the structure of the one such *Schiffersiedlung* (boatman settlement) at the Merovingian cemetery of Ingelheim-Nord (Fig 91) at the junction of the little river Selz and the Rhine (Ellmers 1973). A gravel beach had formed at the mouth of the Selz, forming a bank of solid ground ideal for beaching boats. The mouth itself offered a protected harbour during bad weather or when the waters of the Rhine were swollen. Early harbour settlements are repeatedly found at such locations, where a small river meets a larger one. Ingelheim-Nord was the harbour of the later Carolingian *Kaiserpfalz,* the Emperor's castle in the province, in Unteringelheim at the foot of the Mainzer Berg, a drier location more suitable for agriculture, some 3-4km away. Such distances were not uncommon at the time, goods being taken by cart and the men travelling on horseback.

Archaeologists can differentiate between farmers, who lived at the foot of the hills, and boatmen, who lived on the flood plain and water meadows, and so can study the remains of a *Schiffersiedlung* which was dependent upon cattle and pasture, but had insufficient land under the plough. Unfortunately the gravegoods of the Merovingian riverboatmen are no different from those of the other Ingelheim farmers. As at most other contemporary cemeteries, two classes of inhabitants are represented, Class A with few grave goods, and the richer Class B (Christlein 1973). While Class A obviously includes riverboatmen's graves, the richer Class B graves are harder to classify socio-historically. It is useful to observe that the Class B graves are also found at most of the other *Reihengräberfelder* (cemeteries with graves in rows): because they are so numerous and so chronologically frequent, it is assumed that they must belong to members of residential families. The even richer Class C graves are found in few *Reihengräberfelder.* There is no evidence for the recurring



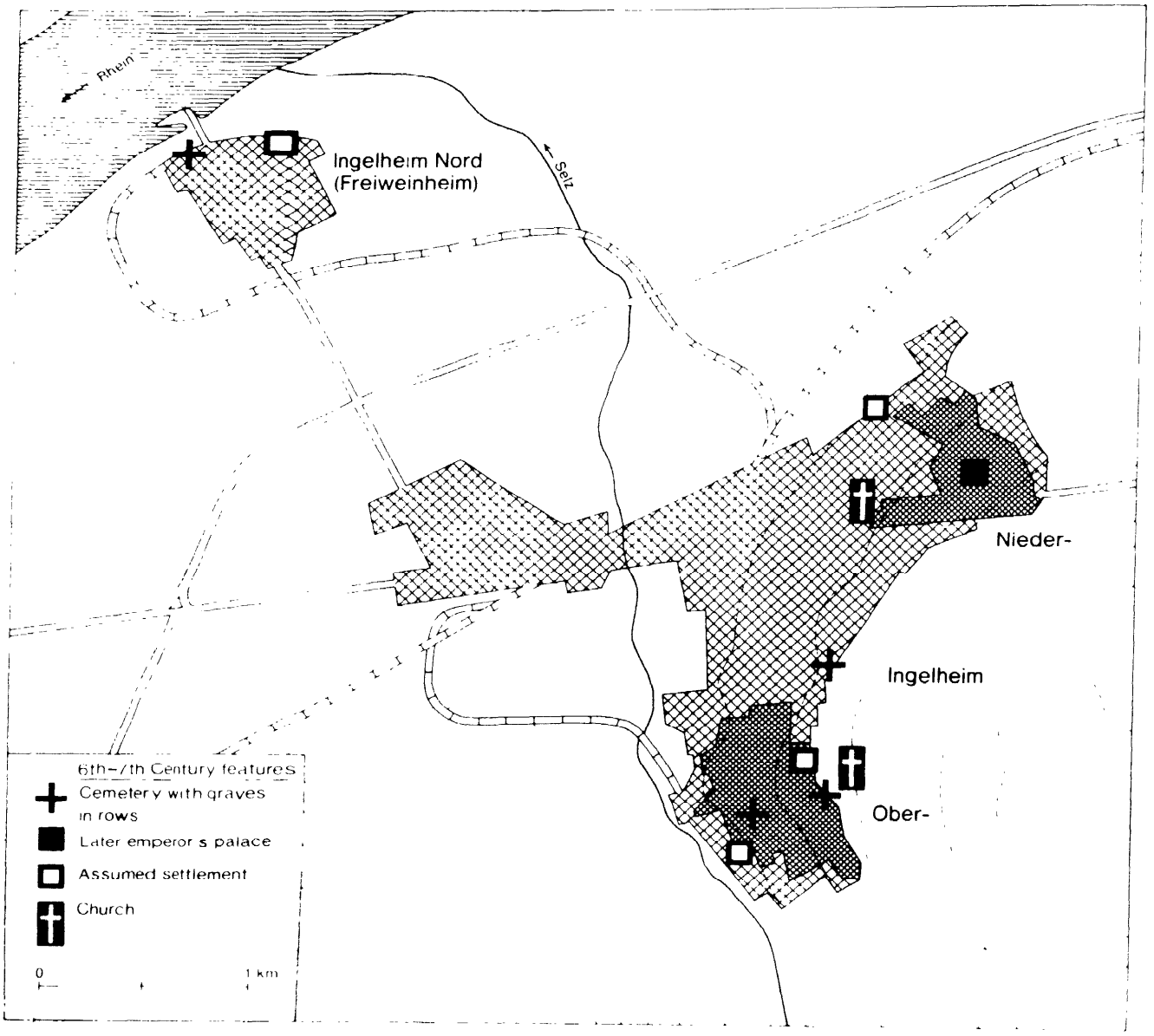


Fig 91 Ingelheim-Nord: the harbour of the Carolingian Kaiserpfalz

burial of family members in this class in the same place, so Class C persons must have owned several settlements. If the Class C graves are those of the landowning nobility, then the Class B graves (which are present on lands belonging to the King, the Church, and the nobility) must belong to those who held an intermediate position between them and the serfs. They may perhaps be seen as the administrators of a demesne in an early medieval settlement which included many serfs' small holdings.

This twofold division of the ordinary agricultural settlement is evident at Ingelheim-Nord, with its harbour settlement for the royal court of lngelheim. The administrators of the demesne not only organized the general agricultural work of the serfs (which was mainly cattle raising), as was usual in agricultural settlements, but also the serfs' ship work. The harbour and towpaths had to be rnaintained and boats had to be built or repaired and kept in good condition and in sufficient numbers for the use of the King and court. These boats were most probably the multi-purpose *Nachen* type. It would have to be ensured that sufficient boatmen who knew the dangers of the Rhine were available to guarantee the safe conduct of the King downstream to the next manor, in this case Koblenz, a day's journey. From there the serfs brought their boars home again, while the King continued his journey, either by boat from Koblenz further down the Rhine or overland on horseback. In Ingelheim the serfs also had to operate the ferry across to the Rheingau on the other side of the river, using both small ferry boats and the larger catamarans to carry the carts. Excavations near Heilbronn on the river Neckar demonstrated that a third dugout was also carried

underwater as a spare for the catamaran so that, in the event of an accident, the ferry would soon be fit for service once the relevant members were exchanged.

The court's need for fresh fish had also to be met, as well as the delivery of all riverborne items from produce collected as tax to the precious goods imported from further afield. Carts, waggons, and horses for important visitors to the court also had to be made available. Even when the actual work was carried out by serfs, all the organization, co-ordination, and supervision had to be done by the demesne's administrator. It is not surprising to find that one of the wives was buried with a balance for weighing coins in *c* AD 600: she obviously assisted with some of the many different aspects of administration and financial transactions, although this was not a common practice at the time. Documented complaints from the time of Charlemagne demonstrate that, in spite of their relatively high standard of living, these administrators had to struggle with many problems and could not always satisfy their lords.

Second stage

It has been necessary to describe the working of the Rhenish agricultural boatmen settlements in so much detail because this is not yet widely known. In addition, an appreciation of its operation is important if the development of the more dynamic free-trade shipping is to be understood. The latter development led to new dimensions, thereby overshadowing the relatively static shipping conditions of the agricultural harbour settlements.

Evidence of the new development has also been found in the cemetery at Ingelheim-Nord, in the form of a pagan cremation dated to the reigns of Charlemagne or Louis the Pious, in an urn from Badorf near Köln. All the other known contemporary cremation are found on the Frisian coast. Bearing in mind the strict interdictions of pagan customs successfully asserted by Charlemagne in particular, a pagan cremation interred so close to the Emperor's court would normally be considered quite unacceptable: only exceptionally privileged people would be allowed to bury their dead in this fashion in this cemetery. Frisians enjoyed such privileges, and they were only merchants whose ships supplied the colonies in the more important of the o former Roman towns on the Rhine, providing the impetus for the decaying towns to outgrow even the boundaries of the former Roman towns. These trading settlements are found not only on the Rhine but also in England and even outside the former Roman empire in northern Germany and Scandinavia. The Frisian trade network had been extended as far as Rome to the south by AD 800.

In order to understand the development of-the Rhenish ports, their topography at the beginning of the era of Frisian trade must be examined. It is known from the sparse documentary evidence that the merchants beached their ships outside the walls of the former Roman towns and pitched tents in which their goods were displayed and in which they slept at night. There is no surviving archaeological evidence for such markets as they did not require substantial buildings and were situated in areas which were subsequently extensively developed. Thus archaeological evidence must be sought in other regions: there is a useful parallel in Iceland, where it was discovered that the merchants were obliged to pitch their tents over sunken floors *(Gruben)* because of the cold climate, rather than directly on the ground surface. As the open markets did not develop into trading towns in Iceland the sites were not complicated by later disturbance. The type site is the medieval waterfront market of Gásar on the northern coast of Iceland (Bruun 1928), where the merchant ships were pulled up on dry land in a long row. Just a few metres away from and parallel to this row was a line of sunken-floored tents arranged in groups, each group representing the number of the ship's crew. These sunken-floored complexes were partially paved and had hearths. It was clear that the same groups of sunken-floored features had been used over and over again, which in spite of seasonal visits suggests a relatively stable relationship. A shorter second row of sunken-floored tents lay behind a road running parallel to the first row on the landward side, and behind that was a third, even shorter, row. Because there was no direct access to the sea and ships from these rows of tents, it is possible that they belonged to the Icelandic inland merchants and other inland trading partners of the shipping merchants. Further up the hill surrounded by a ringwork was the merchants' church, which had many duties concerned with the market quite apart from its purely religious functions. It provided a house of prayer and a cemetery for strangers, a fortified refuge in the event of sudden attacks, and a stable well protected warehouse during the winter.

A study of documentary sources and urban topography can reveal evidence of a similar layout in the oldest of the merchants' permanent settlements in the early medieval Rhine ports (Ellmers 1972). The Frisian merchants' properties were aligned in a long row on the waterfront on a suitable beach, connected by a road running parallel to the houses on the landward side. The merchants who were responsible for transporting the merchandise overland lived on the other side of the road: in Worms, for example, this was a Jewish community (Fig 92). Such settlements have been termed, somewhat inaccurately, *Einstrassenanlagen* (single-street settlements) but, as the most important topographical feature is not the road but a bank which was suitable for beaching, it would be more precise to term them *einzeilige Ufersiedlung* (single-row riverbank settlements).

The function of the settlements will now be described. Each of the merchant's properties had its own area where the boats could be beached at the back door of their houses. In Dorestad these landing places developed an unusual shape because the river altered its course: instead of moving the merchants' houses, the lanes leading from them were extended, sometimes for lengths of up to 100m. Thus, instead of a public landing place used by all the merchants, a large number of private wharfs developed (see p 72), to enable merchandise to be transferred quickly from the ship to the back door of the merchant's house, on the landward side of which the market was held. The merchant properties were therefore transit stations and warehouses for waterborne and inland trade. The arrival of a ship was a comparatively rare event, but it meant that a large consignment of merchandise had to be brought in and despatched simultaneously. The imported commodities were sold by the merchant during the intervening period, as he stockpiled the local produce ready to load on the next ship. It is evident that these permanent settlements had developed out of the above mentioned seasonal waterfront market places along the Rhine, which, although well organized, did not initially require any substantial buildings. Trading took place on the narrow strip of land between the river and the Roman town wall.

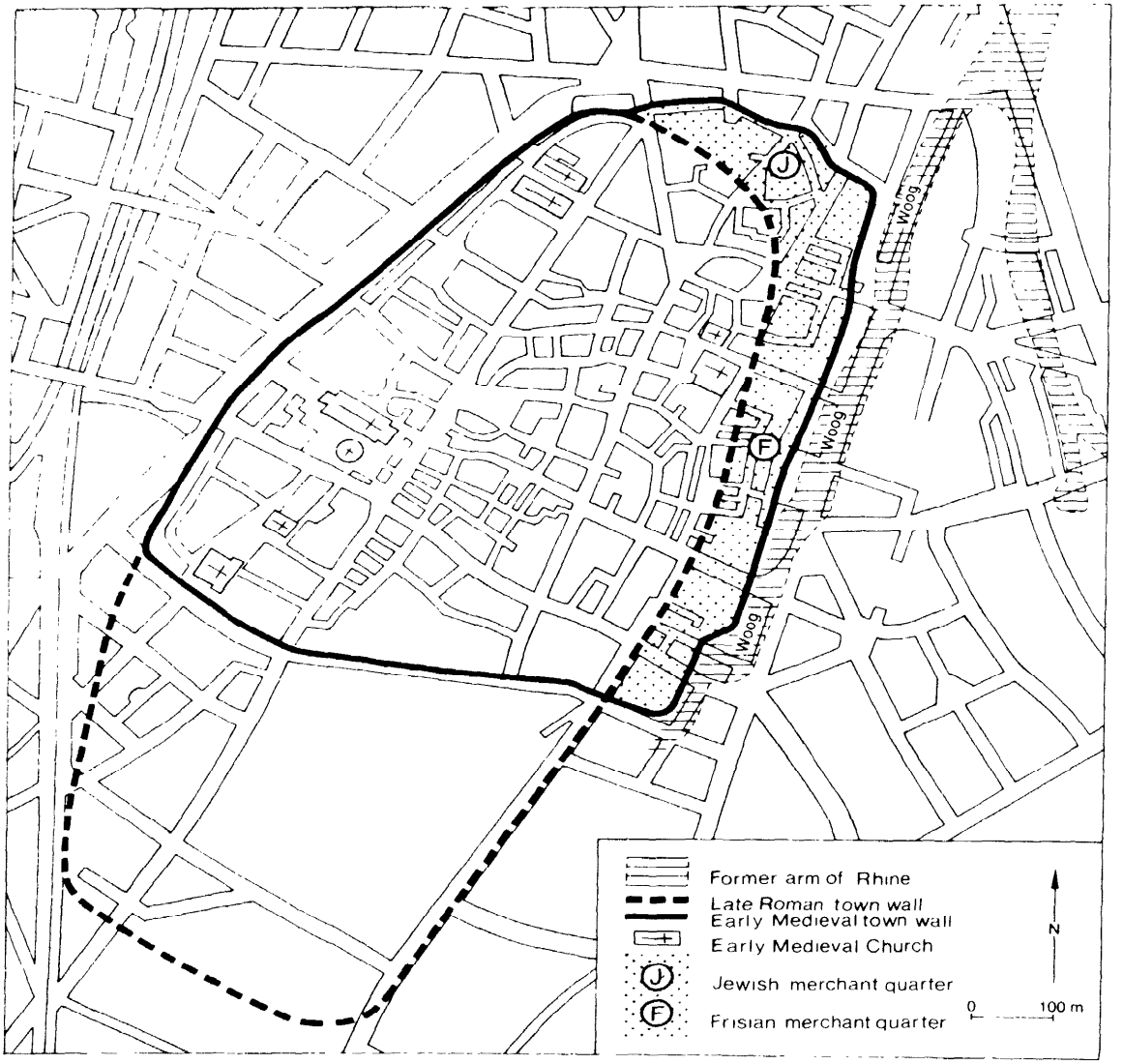


Fig 92 Town plan of Worms, with early medieval Frisian quarter on waterfront outside Roman wall

The earliest intensive use of the waterfront is dated to the second half of the 7th century, on artefactual evidence. Beyond the former Roman Empire established medieval merchant settlements of the late 7th and early 8th centuries show the same structure as the one or more row riverbank settlements. The layout is still evident today in Bergen and Trondheim in Norway, for example. In Germany it can only be seen in fishing villages, close to the Rhine, eg at Bamberg. In all the early medieval merchants' settlements of this type, not all the waterfront was settled, for certain areas were left as common market places. Foreign merchants could beach their boars there, even if they did not have a close relationship with the resident merchants.

Some of the merchants' churches associated with these early medieval settlements still dominate the scene in their quarter of the town-Gross St Martin in Köln, St Marien in Bergen, etc. There could be a large number of merchant churches in one town if merchants from several different districts or countries were established in the town to trade with their homeland, as was the case in Sigtuna. Security for the occupants of the new settlements was provided by fortified refuges nearby, while those living outside the former Roman towns could retreat behind the town walls. None of these waterfront settlements themselves were defended before the end of the 9th century.

Much is known about waterfront properties through the study of the documentation concerning the Rhine. The ground was divided into small allotments called *mansa apsa* (courtyard places), strips of land not used for agriculture. The tenants had to pay for them either with money, in the case of the merchants, or with service. The owners were various members of the nobility or the church whose principal residences were often far from the market. The merchants were free men, but they tried to get royal privileges and protection or subordinated themselves to a church in order to participate in its customs privileges and

were thus incorporated into the feudal system. Either they or their ancestors had come from a distant country, to erect buildings and waterfront installations on rented land. Then with their ships they travelled for some distance seeking business. During this period, the wife, the eldest son, or an administrator looked after the local business. Even in the 9th century, trading was so lucrative that the waterfront settlement in Mainz where the Frisians lived was considered to be the best quarter *(optima pars)* of the town. Although the Frisians played such an important part in the development of contemporary Rhenish towns, there were other traders living there who also dealt in waterborne trade, such as the Franks. The special role of the Frisians depended upon their ships which, unlike the majority of contemporary river craft, were also able to cross the open sea. An impression of-these ships is provided by the 18m long *Holk* from Utrecht, which not only sailed to England in the 8th century but was also taken up the Rhine as far as Alsace. Frisian trading was more profitable because the merchants were able to undertake longer journeys without having to unload at the mouth of the Rhine, and they had a close network of compatriots in all the trade centres. As importers of foreign goods they were much sought after by the King and nobility, who endowed them with privileges to ensure the supply of these commodities.

Third stage

The Viking threat in the late 9th century drastically altered this waterfront system. The merchants did not feel secure enough in single-row settlements on exposed riverbanks outside the city walls. By AD 900 they had abandoned their once advantageous waterfront situation in preference to one behind the town walls, which were extended towards the river and, from this point onwards, divided the merchant's dwelling from his landing place. The Roman arrangements of living and trading from behind the protective walls some 500 years before had now fully re-established itself. Only the equipment and installations necessary to load and of lload the ships remained in the undefended waterfront area. All merchandise now had to be transported between the merchant's house and ship by cart through the few harbour gates. The result was that the ship-owning merchant had no longer to live at the riverside but could erect his house wherever he wanted, though many merchant families preferred to remain on the properties where they had lived for generations.

The communal features, such as the merchant churches, market places, stalls, warehouses, and hospitals, all remained on the waterfront where the houses had once stood. Such areas can still be distinguished in present-day urban topography: those who were not aware of the background may be surprised to find the houses of rich merchants squeezed into the fringes of the town.

The initial result of the military situation which required towns to be surrounded by walls may be seen in the East German foundations of the 12th century, which started with Lübeck. Here, the merchants' houses were no longer concentrated into a single-row settlement along the waterfront, but were laid out along the streets running from the town centre to the harbour gates in the city wall.

Once the urban waterfronts on the Rhine had been protected by walls from *c* AD 900, the main area of the harbour initially looked rather empty. The customs houses were there, but very little work has been done on them although there are several still standing today in Rhenish towns (Gönnenwein 1939; Kuske 1913; Siegel 1926; Weissenborn 1901). A study of engravings has revealed wooden embankments and low stone walls as well as paved ramps for ferries and cargo boats with open-ended bows. Also depicted are horsedrawn carts driven into the shallow water alongside moored ships to transfer cargo, and grids of wooden beams built out into the river upstream to protect the boats from flotsam or pack ice. Floating watermills, anchored in the stream, are known since the end of the 8th century. They played an important role in the economy of-the towns, and were well known both as a common feature of the urban waterfront and as an impediment to other ships. At the Alpine (southern) end of the Rhine, its tributaries ran through many lakes. Their ports protected their harbour areas from the waters of the lake with a breakwater of palisade-like posts driven into the ground which had a narrow entrance. Similar structures in much older harbours may possibly have served the same function, as at Riedschachen I in the Neolithic and Buchau in the Hallstatt period on the Federsee in South Germany (Schmidt 1937; Kimmig 1979) and at Viking Haithabu.

It is still not known when the earliest vertically walled quays were built into the deep water on the Rhine to facilitate the landing or docking of floating ships. What is certain is that seagoing ships had been increasing in size from the 9th century. By the 12th century they could only sail as far upriver as Köln, and could not even reach as far as this later on. Landing while still afloat was important not only for seagoing ships, but also for river craft such as the barges heavily laden with cargoes of wine barrels, for example. By the end of the medieval period, most of the towns along the Rhine had at least one crane, alongside which ships could float, for handling wine barrels and millstones.

No paper has yet been written on the development of harbour cranes (but see Timmerman 1977; Salemke 1971), even though seven old treadmill cranes still survive along the Rhine and its tributaries. They have not as yet even been classified, although they were a prominent feature of the late medieval waterfront in many Rhenish towns. For this preliminary survey, five different types of crane are distinguished, all standing close to the deep water, within reach of ships still afloat.

1 Beam hoists (Kranbalken)

In Trondheim, Hamburg, Bremen, and other seaports in which ships could sail directly to warehouses built into the water, goods could be lifted with a short horizontal beam-hoist fixed to the gable end of the warehouse on the required storey. Each storey of the warehouse therefore had a corresponding door in the gable and a hand-operated winch inside the building to hoist the loads. This method was not practised on the Rhine, because the town walls usually separated the warehouses from the river.

2 Mast cranes (Mastkräne)

Mast-cranes are high tower-like buildings built out over deep water. At the top is a fixed horizontal or diagonal arm, similar to the beam hoists just described, used to lower masts into newly built ships or into river craft, which could then use sails from this point on. The Crane Gate at Gdansk (Salemke 1967) was used both for setting masts and for moving heavy goods as well. Carts could approach the

Fig 93 Mast crane and floating crane at Köln (detail from woodcut by A Woensam, 1531)

ships below this crane through the gateway, and be loaded from the ship without having to turn round. The windlass in the tower was driven by treadwheel. A crane from Köln in 1531 which was solely used for raising masts was also driven by treadwheel, and is shown on Fig 93. This is a relatively high timber-framed tower, in the ground floor of which the treadwheel is clearly visible, although the beam under the roof is not so evident. The principle of buildings with beam hoists in the gable was thus also known on the Rhine. The mast crane stood on a jetty built out from the quay into the Rhine so that ships could float beneath the beam of the crane and anchor there.

3 'See-saw' cranes (Wippen)

In Bergen, Bremen, London, and other seaports the commonest cranes were the so-called 'see-saw' cranes. They worked on a similar principle to that used for wells like a two-handed lever. The arm of the crane was joined to a vertical pole, like the yardarm of a sailing boat to the mast. In fact, sailing boats may originally have loaded and unloaded their cargoes in this way. Although this method was only suitable for raising relatively light loads, it was difficult to extract any of the cargo from a ship's deep hold without a crane. There is only one example known of a crane of this type on the Rhine, as late as the 17th century.

4 Quayside treadmill cranes

On many urban waterfronts along the Rhine and in many seaports such as Bruges, Hamburg, and Bremen, heavy-duty cranes were set on turntables and were operated by a treadwheel within the crane housing. The principle was based on an ancient invention used for major building works in the Roman provinces. In Roman harbours they were also used for unloading heavy cargoes as required, but were not apparently permanent features. Nobody so far has studied when they became permanent installations of harbours, but they certainly became indispensable in the medieval period for transferring goods from ship to shore.

5 Floating cranes

From the 15th century onwards, Rhenish towns which did not possess suitable quays (perhaps because of the nature of the river banks or the high cost of installation and maintenance) could employ floating cranes (Fig 93). These were wooden cranes with a treadwheel mounted on *prahmes* (river barges) and anchored close to the bank. Ships manoeuvred alongside the floating cranes which then lifted the cargo and swing it on to the river bank. Köln seems to have been a centre of production for these floating machines, for which there is little evidence beyond the Rhineland.

Although the first major changes in harbour equipment had started in the 19th century, with increased industrialization greatly affecting shipping, medieval cranes were still at least partially used into the early 20th century along the Rhine.

The medieval waterfront of Schleswig

D Eckstein

The town of Schleswig (population now 35 000) is situated about 150km north of Hamburg on the northern bank of the Schlei, a long river-like inlet of the Baltic Sea. It is the settlement which superseded Haithabu, the town on the south bank of the Schlei which was one of the most important trade centres in North Europe during Viking times in the 9th and 10th centuries, but was destroyed in the middle of the 11th century by Slavonic tribes and presumably abandoned afterwards. During the second half of the 11th and the first half of the 12th century Schleswig was an important transfer point, mainly for the long-distance sea trade between western Europe and both Scandinavia and Russia (Vogel 1977). For a variety of reasons only partially understood, the town lost its attraction as a trade centre soon afterwards, and its function is presumed to have been superseded by Lübeck in the middle of the 12th century. Figure 94 shows Haithabu surrounded by a semi-circular embankment, with its successor Schleswig on the northern bank. Because of their close functional relationship, Schleswig and Haithabu are considered as one and the same settlement, but one whose location shifted from the southern to the northern bank of the river Schlei in the 11th century. Some of the developments associated with this change will be described in this paper, based on the dendrochronological analysis.

Because the dendrochronological dating method is now well established in archaeological research, it is only necessary to draw attention to some basic principles here. Trees form a new growth layer every year during spring and summer which is deposited like an overcoat around the whole woody body. On a cross-section of a tree these growth layers are visible as circular zones, the tree-rings. The width of such tree-rings is influenced by several environmental conditions particularly those prevalent during the growing season, so the tree-ring series of contemporary living trees are similar to each other. If the tree-ring series of different building timbers are found to be the same, the trees from which they were derived must have been living at the same time. If the age of one of these trees is known, the age of the other timbers can be determined. This means that, in order to date a timber, it is necessary to have a tree which existed during the time in question until the present. Since such old trees do not exist in most countries, they must be constructed artificially, utilizing timbers from different time periods. For northern Germany such an artificial oak tree has been established, the tree-ring series of which goes back as far as AD 436 and serving now as a dating basis (Eckstein & Schietzel 1977). The primary aim of each dendrochronological analysis is the dating of the tree-ring which was formed in the last vegetative period in the lifetime of the tree. For this purpose a timber's complete tree-ring series must be fitted into the standard sequence just at that position where the two tree-ring patterns are most similar to each other. The longer the tree-ring series is, the more reliable the match attained: in practice at least 50 rings or preferably 100 are needed. The wood samples from the excavations in Schleswig had on average only 75 tree-rings, so some difficulties were to be expected.

The excavations that started in 1970 were conducted to support and supplement the scanty written sources about the history of Schleswig and the whole situation around the Schlei, including some open questions concerning Haithabu. Fortunately, the archaeologists discovered thick undisturbed cultural layers with numerous remains of timber structures. The objective of the excavations on the Plessenstrasse site was to examine the monastery, which was founded in the 13th century and destroyed in the 16th century. Underneath the stone monastic foundations were found the remains of wooden houses (Fig 95), and beneath these even older wooden structures. They comprised rows of closely spaced stakes and planks standing upright. The area between these rows had been infilled artificially, whereas the layers in front of them were recognized as water-laid deposits. These structures (Figs 96 and 97) are interpreted as representing an attempt to stabilize the bank. On the basis of these findings it is now possible to reconstruct the medieval town of Schleswig as well as the process of its development at its southern border (Vogel 1977). This is shown in Fig 98, where all constructions are shown schematically; the dates indicated refer to the dendrochronological results.

Originally, the bank of the Schlei was located 60- 130m to the north of its present location. The earliest settlement was protected against high water by bundles of faggots which were not datable by dendrochronological analysis. Parallel to them was a wall of vertical planks dated dendrochronologically to 1081/84. Subsequently, more structures were erected, not on the bank itself but in the open water. Each of them comprised a wall parallel to the bank at a distance of some 13m from it and two walls running perpendicularly towards the bank. The oldest of these structures was erected in 1087 (Fig 98). In 1094/95 these installations had already been extended with the construction of a further quay and two jetties. The jetties

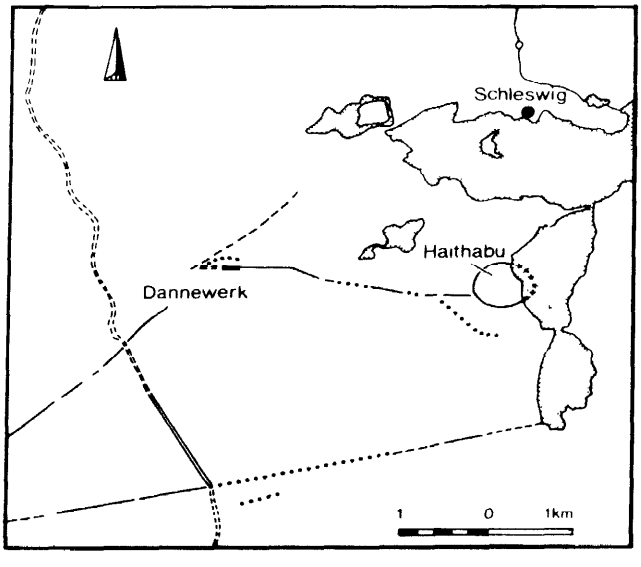


Fig 94 The situation of Schleswig and Haithabu

Fig 95 *Excavations at Plessenstrasse, Schleswig. Monastic stone foundations viewed from the north, with a well in the foreground and remnants of a wooden feature dated to 1094. (cf Fig 98)*

advanced the waterfront southwards by at least 20m. The process was presumably repeated several times, but the area in question was not available for excavation, so the later development of the port remains unknown. The revetment dated to 1081 represented the earliest southern border of the settlement, but just as the port installations shifted into the open water, so the settlement itself extended southwards. Originally, the houses were erected on the natural bank along a wooden trackway dated to 1075/1106. Then they were built on top of the abandoned jetties which had been erected from 1087/95, one of the houses dating to 1099, only four years later than the associated jetty.

The oldest dated timber was cut around 1075, the youngest from 1106. Thus it has been possible to establish an absolute chronological sequence covering a 30-year period and to reveal the development of the installations of the harbour as well as the subsequent advance of the town. One of the initial questions, whether there was or was not a hiatus between the demise of Haithabu and the rise of Schleswig, may be answered now in favour of the latter assumption, thus supporting the idea that Haithabu and Schleswig represent a real unit.

In addition it could be ascertained that at the same time as activity in the harbour of Schleswig began, an area near the present market place, some 300m to the north, was also settled. There, the cultural layers were up to 7m thick and include a period beginning in the 11th century, which could be dated by the dendrochronological analysis of fourteen wooden houses and one trackway, the oldest building being from 1071.

The establishment of the harbour installations described above is related to the transition from the use of shallow beaches on which ships were landed for loading and unloading, as at Haithabu, to the building of quays where the ships could be loaded and unloaded while remaining in the water. The reason for this change is thought to be due to the increasing size of the ships during the 11th century (Vogel 1977).

Thus, the excavated harbour installations of Schleswig represent a rapid adaptation of this trade centre to the changing shipping conditions and constitute tangible evidence for the rise of this town in the 11th century. However, the quay installations in the area studied had been superseded by 1239, when the monastery was erected

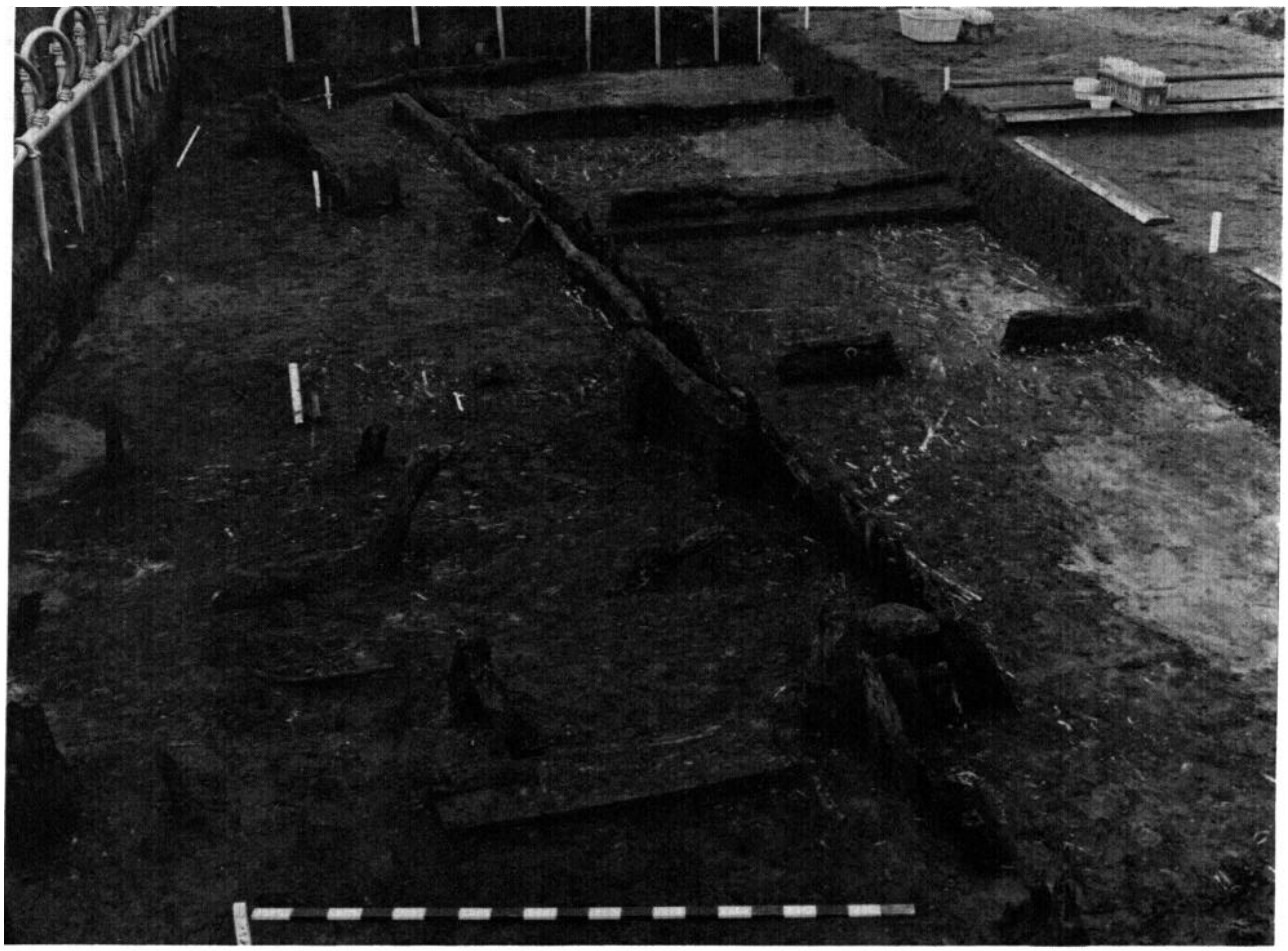


Fig 96 Excavations at Plessenstrasse, Schleswig. Revetment dated 1087 (cf Fig 98)

partly on top of them. By that time, the waterfront must have been advanced to the south beyond the limit of excavation.

Some 800 oak wood samples from the waterfront excavations have been analysed dendrochronologically, and *c* 50% of them could be dated. In terms of individual structures the result looks very much better, because out of 34 structures 29 were datable. Since in many cases the wood samples contained sapwood or bark the given dates are very precise with only a small or even a zero variation. In those cases where bark and sapwood were missing it was only possible to suggest a *terminus post* quem.

This raises two principal questions: what is the reason for this low proportion of datable timber, and is it necessary to analyse such a high number of samples?

In Fig 99 the total sum of the samples is subdivided into those with 50 or more tree-rings and those with less than 50 tree-rings. From the first subgroup 86% were datable, whereas from the samples with less than 50 tree-rings only 14% could be dated. There are statistical and biological reasons why this threshold of the method cannot be reduced: the pattern of wide and narrow tree-rings of, for example, a 20-year series may be found at several positions in the 1500-year series of the regional mean tree (master chronology), but only one can be the right one. But a 100- or 200-year pattern is unique and will not happen twice in a thousand years. Furthermore, building timbers with less than 50 tree-rings were often cut from relatively young trees which grew in the shadow of older ones. Their growth was more influenced by the local conditions in the forest interior than by the regional climate, and therefore their tree-ring pattern may not reveal a significant similarity to the standard tree. Therefore, the greater the number of annual rings on a sample, the greater is the chance of dating it. This is, however, a statistical statement and it is not possible either to guarantee the datability of a certain sample because of its high number of tree-rings or to reject another one because of its relatively low number of tree-rings. It is also not possible to guarantee that an excavation will produce *any* timber samples with more than 50 rings.

Nevertheless, these difficulties can be minimized by collecting as many samples as possible, and by studying them not as anonymous numbers, but in structural groups

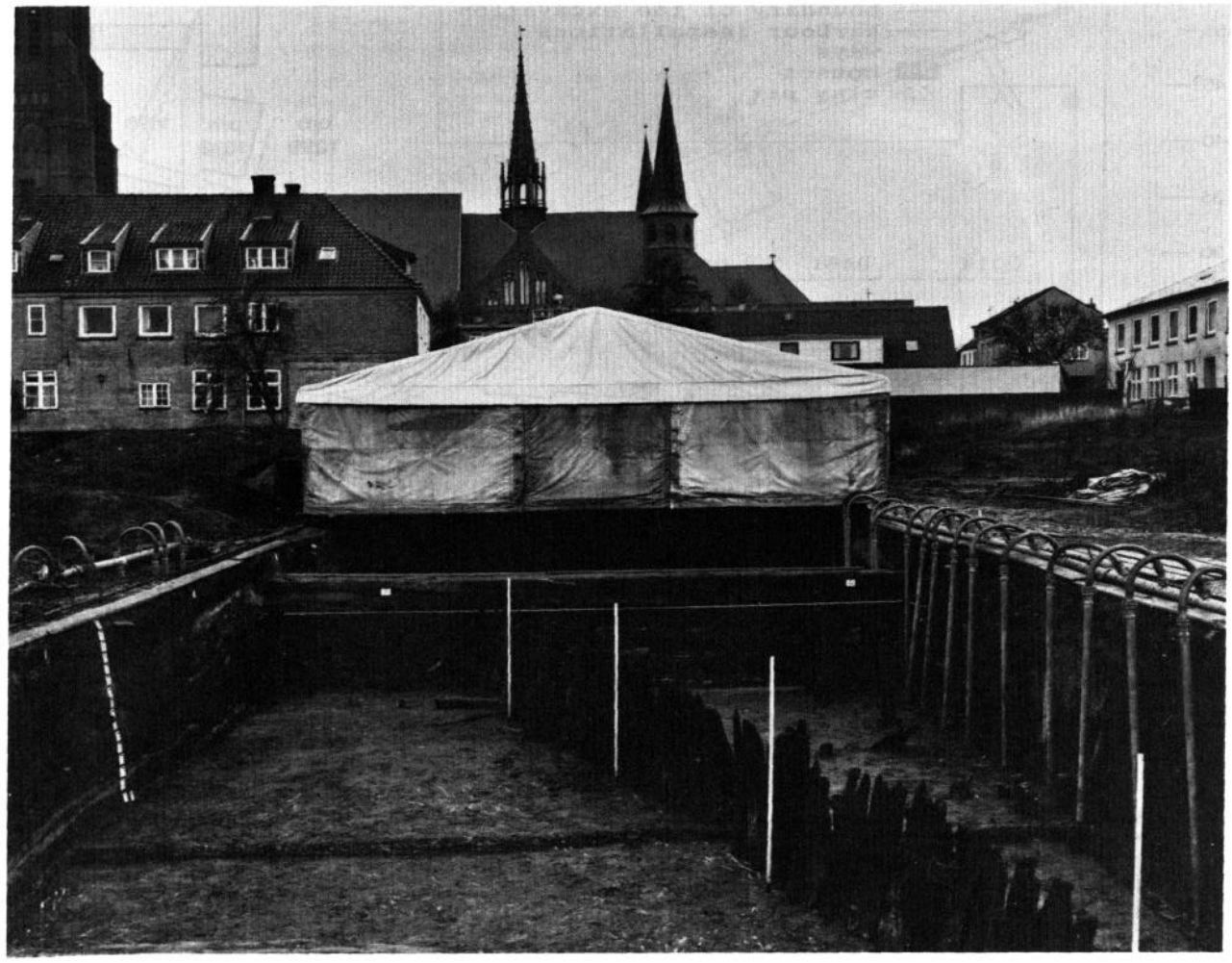


Fig 97 Excavations at Plessenstrasse, Schleswig. Jetty wall dated to 1095 (cf Fig 98). Schleswig Cathedrai in background

or units. The possibility of dating a feature increases in spite of the presence of samples with a low number of tree-rings with the increasing number of samples forming a structural group: for example, one such unit at Schleswig contained 98 samples. This can be explained by the assumption that the building timber for a particular structure was probably felled in the same forest area and at the same time. The tree-ring series of the timber from one building are more likely to be similar than those from different buildings; the assumption that timbers in a structural group are very likely to be contemporary justifies the initial search for similarities between such samples. If at least two tree-ring series fit together, a crystallization point is found in order to synchronize further tree-ring sequences with it. Thus it is possible to eliminate step by step the untypical tree-ring variations of individual trees by gradually establishing the typical tree-ring pattern of the average tree of the region in question. Indeed, it may happen that single tree-ring series are not datable because the individual differences between trees may be too large: when averaged together into a structural mean sequence, however, the characteristics of this new tree-ring pattern may become free of individual influences and thus the whole number of samples from a structure can be dated simultaneously.

There are other reasons why it is preferable to take as many samples as possible rather than to analyse only a few and base the archaeological conclusions on them. This should become obvious from the following figure. Figure 100 shows the vertically planked wall already described, dating from 1081/84, and a trackway running in front of it

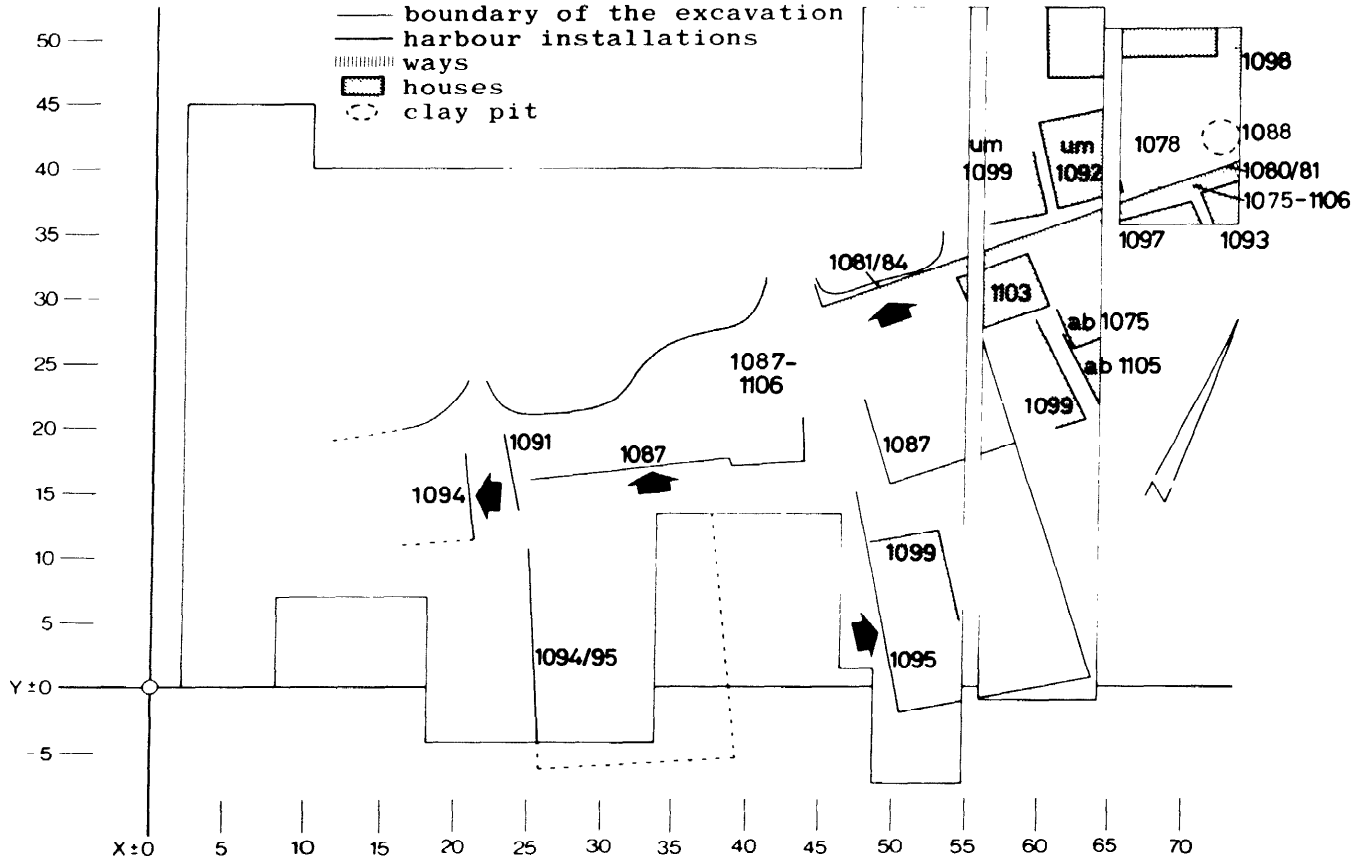


Fig 98 *Plessenstrasse, Schleswig. The dendrochronological results showing the development of the harbour installations. The arrows refer to features shown in Figs 95, 96, 97, and 100*

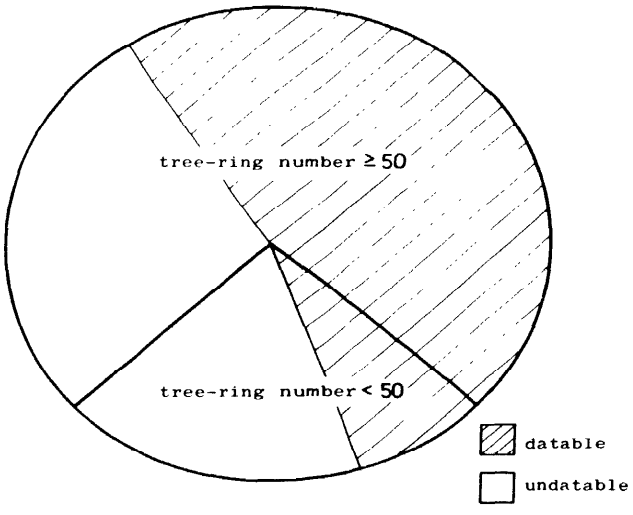


Fig 99 *Diagram to show dendrochronological samples subdivided into those, with 50 or more tree-rings and those with less than 50, as well as the datable and undatable ones*

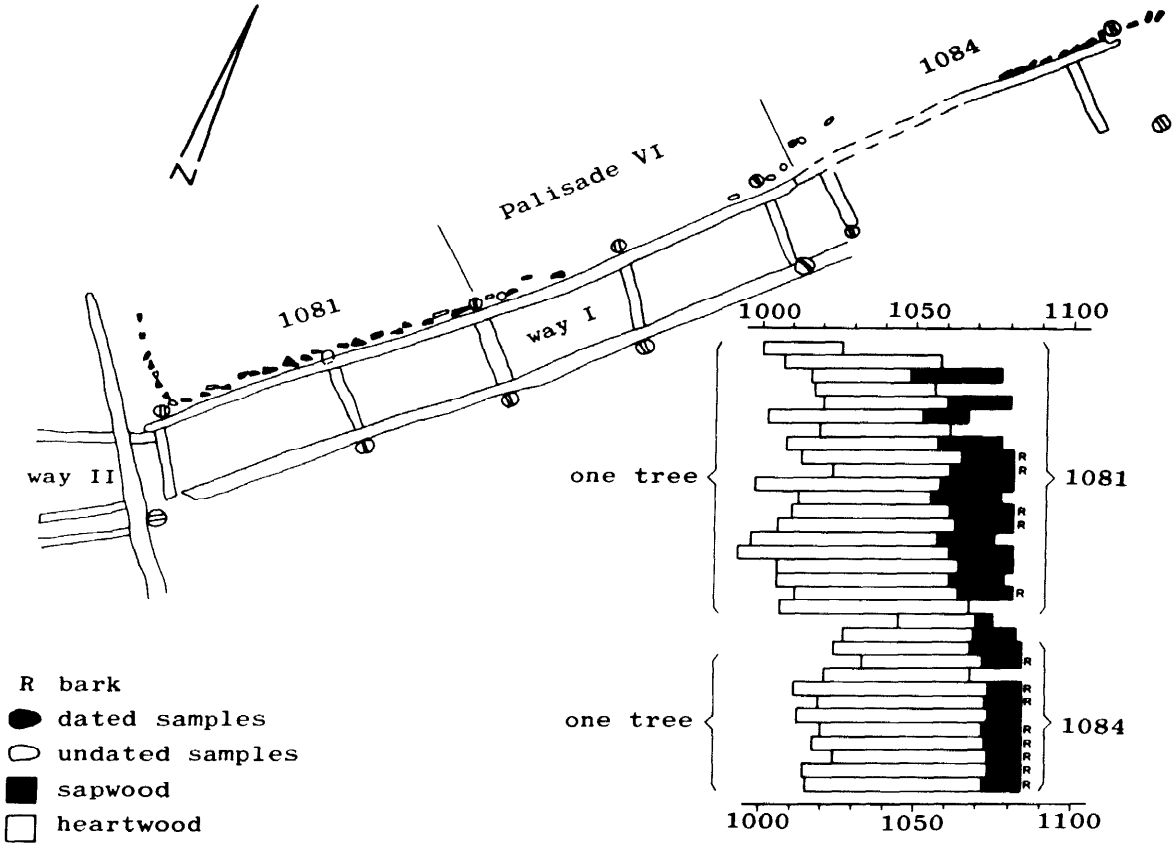


Fig 100 Diagram to show the dendrochronological dating of the wood samples of a palisade at Plessenstrasse, Schleswig (cf Fig 98)

dating from 1075/1106, with the single planks and stakes subdivided into dated and undated ones. The inset on the right shows the dendrochronological result. Each bar symbolizes a tree-ring sequence, the black blocks represent the sapwood present, and the letter *R* means bark. First of all it is obvious that if by chance only the uppermost sample was studied as representative of the whole structure, the dating would end in a mistake of about half-a-century. The analysis of a number of samples, however, results in their close matching and dating to within one year and in the recognition of two distinct building periods, in 1081 and 1084. The fact that the samples of the two different cutting years are strictly separated in the construction itself-and that many samples still retained their bark proves that the trees were felled for this specific structural purpose rather than taken from a storage place. For this section of the wall only two or three oaks have been cut, because a group of ten and of twenty could be attributed to individual trees on the basis of their tree-ring patterns. Thus, not only chronological information can be derived by dendro-chronological analysis but also technological and economic information.

To summarize, both the possibilities and the limitations of the dendrochronological method are demonstrated on the excavations in Schleswig. In addition, the archaeologists' understanding of the requirements of the dendrochronologists should be strengthened by the awareness that timber is the product of long-living organisms which, during their life, are influenced by factors known and unknown.

Acknowledgements

This report was prepared with the close cooperation of Dr V Vogel (Schleswig) and Mrs S Wrobel (Hamburg). Figures 95, 96 and 97 are taken from *Ausgrabungen Schleswig Alstadt*.

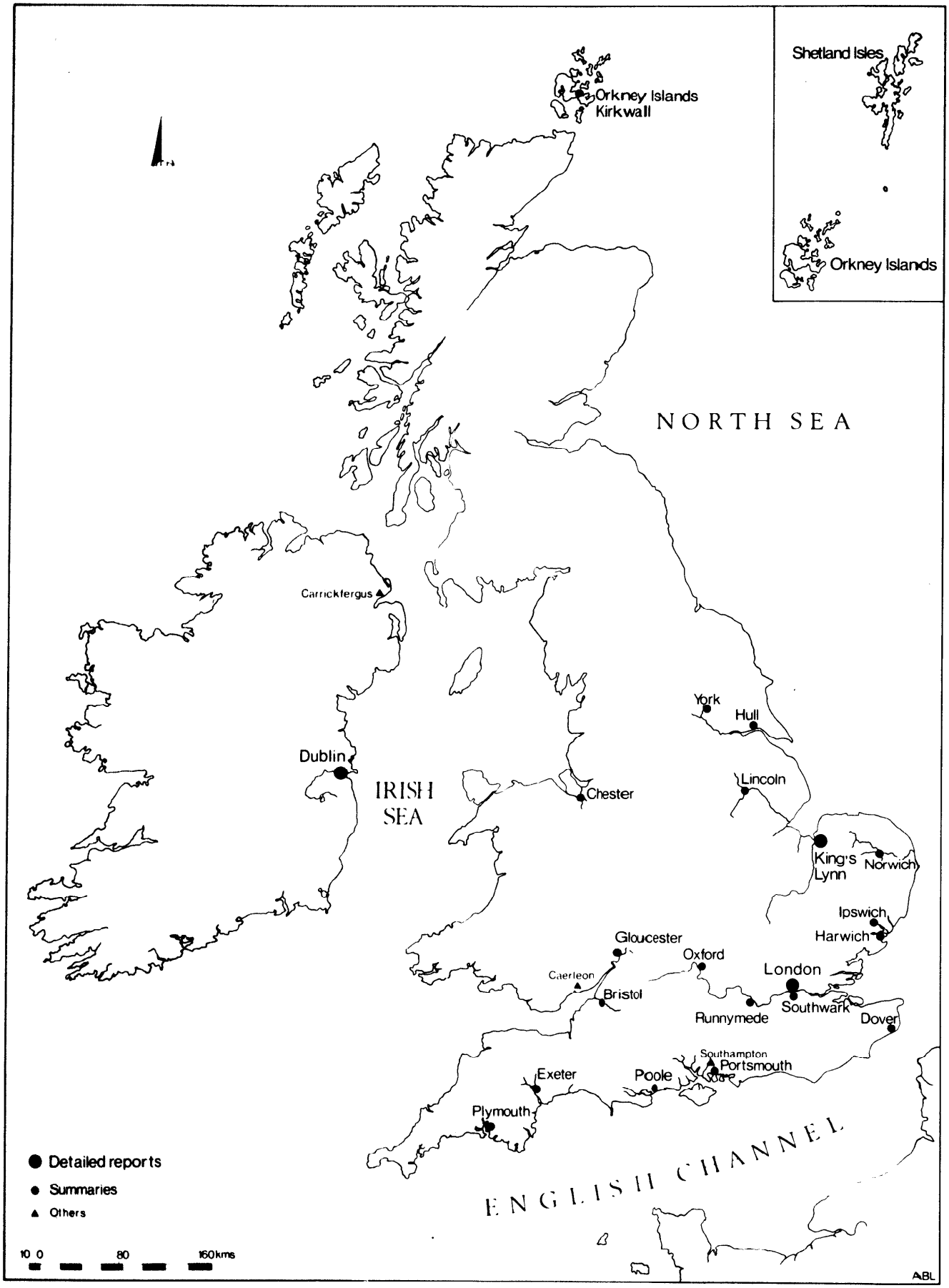


Fig 101 Location of towns mentioned in text

Link to next section

Bristol

M W Ponsford

Bristol's position as a leading medieval port, at times second only to London, has made the study of its dockside activities a priority for current and future research (Fig 102). The investigation of the waterfront has so far been incidental to the general programme of research, because the riverside is either already built upon or development sites have been concentrated away from it. The main waterfront problems may be summarized as follows: there is virtually no information on the structure of the quays and docks before the 19th century, on the various Avon and Frome bridges, on the former route of the river Frome in Lewin's Mead and south Baldwin Street, or on the effect of high tide on the local environment. The extent of land reclamation in the suburbs of Redcliffe, Temple Broadmead, and Lewin's Mead is becoming clearer, but more work is needed (Fig 102). Recent research has gone some way towards providing evidence on these topics.

At the St Bartholomew's Hospital site (Fig 103), two square pits may represent parts of a Saxon bridge over the Frome. Evidence for a 13th century jetty of seven short oak planks with stone side walls and foundations was recovered, while a cobbled area north of it may have provided a hard standing for off-loading goods. The hospital itself was built at the edge of the infilled Frome channel, and south of it the edge of the 1240s cut was found. Lewin's Mead is therefore the infilled channel of the Frome raised with the product of digging the new one. Bristol's later prosperity was assured by the new channel, as the harbour space was more than doubled, and the drainage of the marsh improved. All the friaries in Bristol were founded on reclaimed marsh land (Fig 102).

Fragments of the medieval Bristol bridge were found in 1975, cut by the foundations of its 18th century successor, with evidence of a medieval quay to the north.

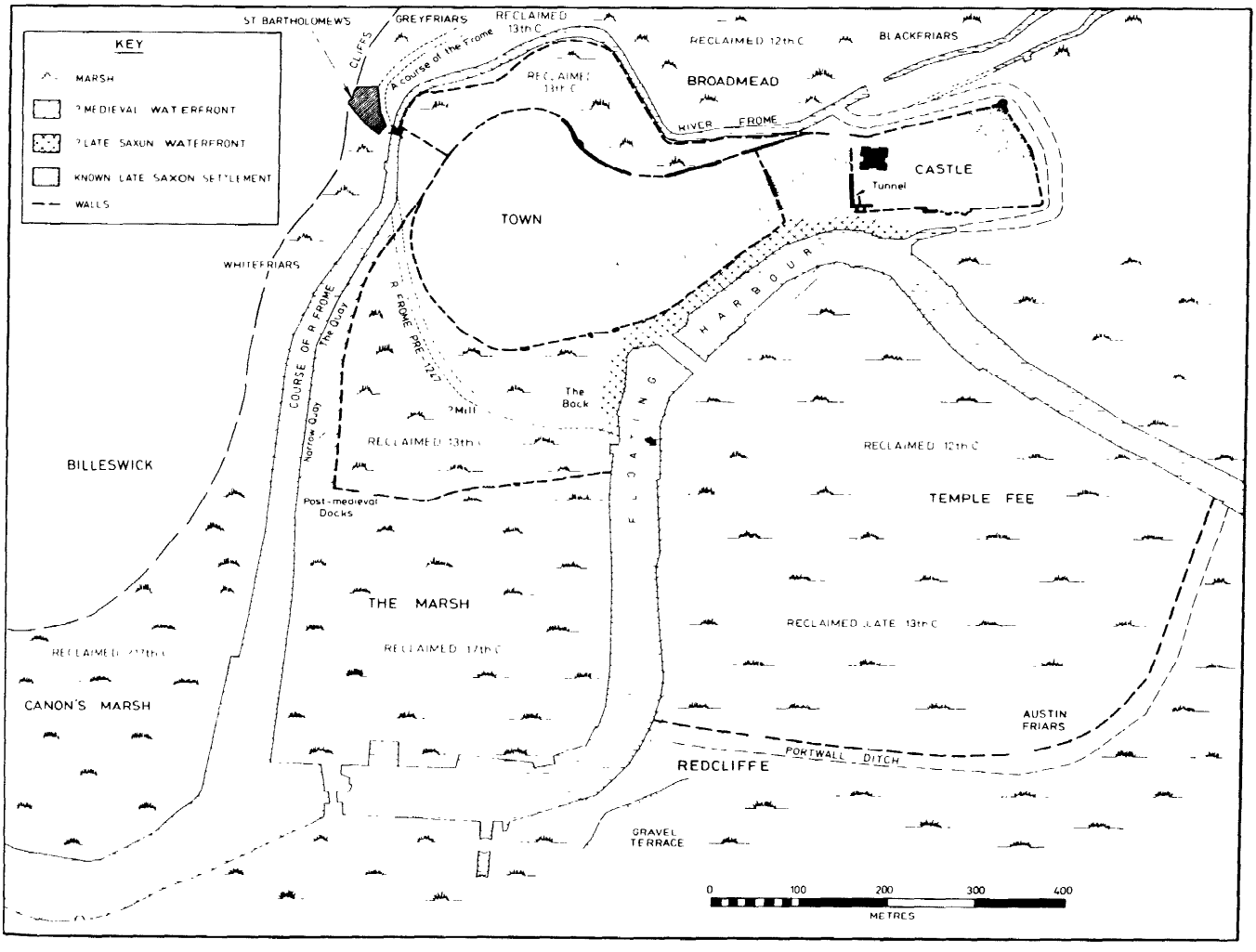


Fig 102 Bristol and its waterfront

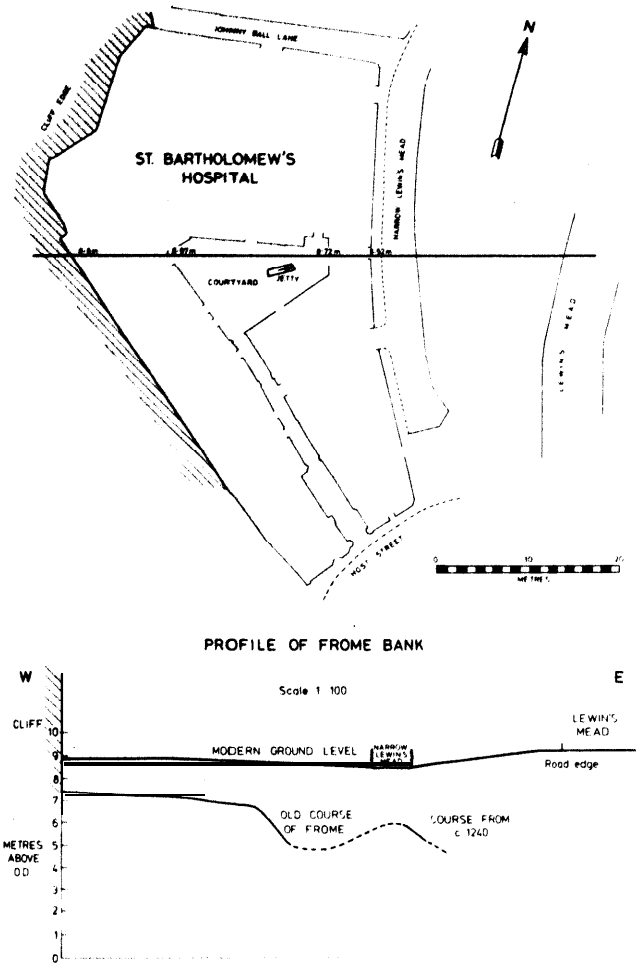


Fig 103 *Bristol: plan and section of the two Frome channels at Lewin's Mead*

High-tide level in the sally port at Bristol Castle was between 11.8 and 12.4m above OD, or some 4m above modern high-tide level. This is ambiguous, as sluice gates may have been used to retain tidal and river water in the ditch. In the Temple area, settlement was limited until the Portwall and its ditch were constructed at the same time as the new river channel. Afterwards, the communal Law Ditches helped drainage. In Queen Square a mass of 17th century rubbish shows that the marsh was not reclaimed until that date.

At Narrow Quay, a known site for medieval shipbuilding, at least two docks of early 17th century date were recently excavated, *c* 30m from the present-day waterfront. One, possibly built by Richard Aldworth *c* 1625 and filled in before 1673, had a stone wall and contained fragments of ships' timbers in its filling. To the north was a large pit 4-5m wide and over 19m long with no evidence of structures. It may have been St Clement's Dock, which was used for shipbuilding in the 16th century.

Further research at Narrow Quay, in the present Dock area, and Redcliffe, the last underdeveloped area in central Bristol, should provide more information on quays, warehouses, merchants' houses, and possibly ships. Future opportunities to investigate the waterfront may otherwise be limited. Documentary research is continuing.

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Chester

T J Strickland and S Ward

In the past, the development of the waterfront and of the city as a whole were inseparable. Now the waterfronts are amenity or residential areas. Consequently there has been little opportunity for modern excavation.

The site is on a sandstone ridge north of the Dee at the lowest bridging point with the original estuary immediately to the west (Fig 104). This is now a low, ill-drained area called the Roodee.

The Roman legionary fortress was sited on the hill and a civil settlement developed between it and the river. The harbour facilities probably lay west of the fortress and the fortress granaries were located inside the West Gate. On the shore line a massive sandstone revetting, the 'Roman Quay', has been traced for 200m. Its date, however, is uncertain except that it cannot be later than the medieval City Wall.

In 1959 a Roman building interpreted as stables was discovered south of the Watergate. The Grey Friars Court site south of this has recently produced more information. A substantial masonry building, probably built by the army, was erected late in the 1st century on a terrace cut into the hillside above the river. Most contemporary military buildings were timber, and so a special purpose may

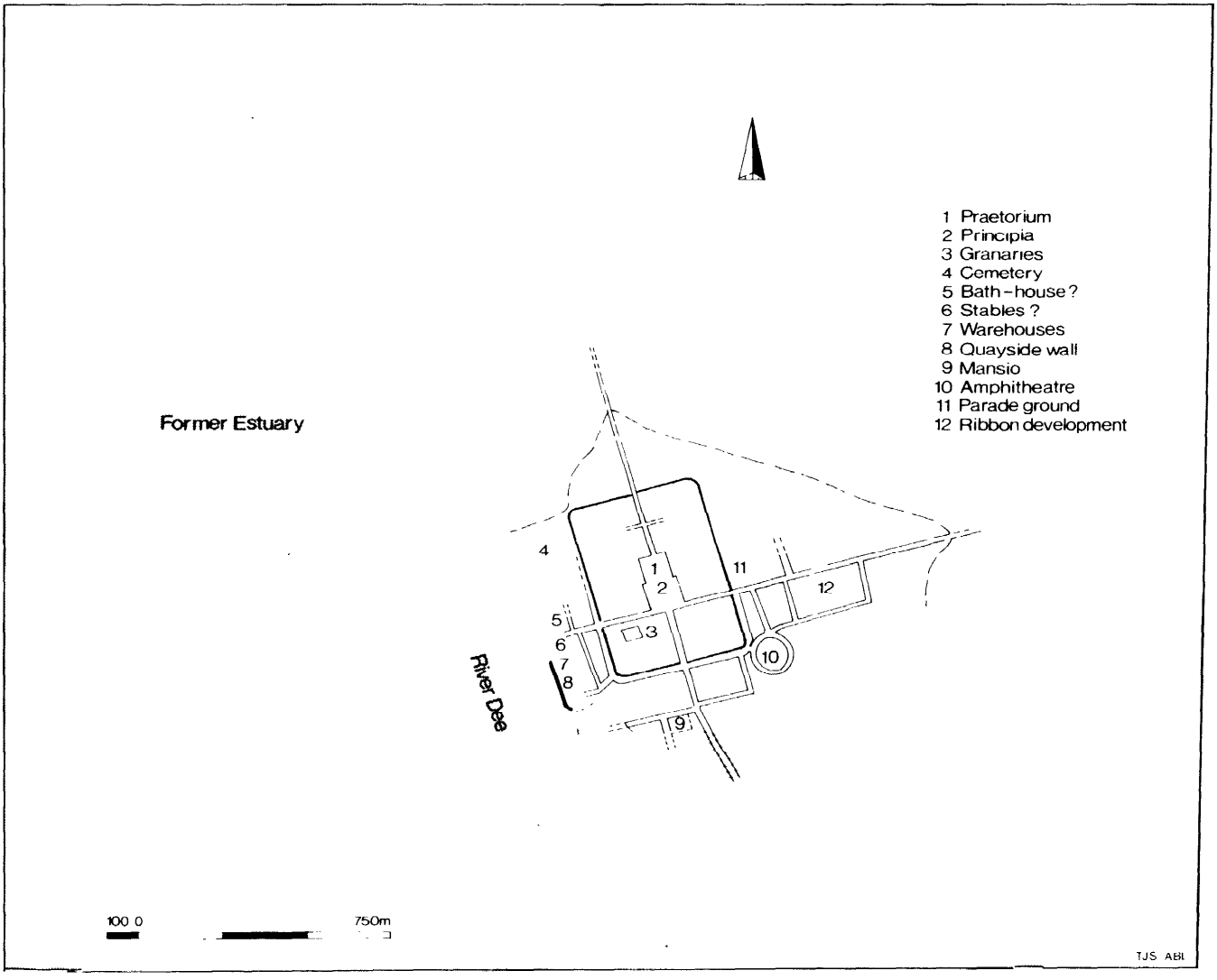

Fig 104 Roman Chester

be inferred for stone ones: this one may be warehousing. If the 'Roman Quay' is Roman another terrace down to the river may be postulated. The floor of the building is 3m above the surviving top of the quay.

It was rebuilt, perhaps in the 2nd century, and replaced some time after AD 150 by a clay and turf bank. Only a 4m length, which was badly disturbed by medieval features, was exposed so the feature may be purely local. It may, however, be a defensive rampart around the civil settlement. In any case, it represents a complete change of land-use on the river front. The bank survived till buried by medieval deposits.

Little is known of the period up to the Norman Conquest. The Roman harbour probably silted, but the 5th century Mediterranean wares found at Abbey Green suggest that maritime contact continued.

During the Middle Ages Chester was the base for expansion into Wales and Ireland. The City Walls extended the fortress enclosure to the river (Fig 105). In the west a large area of open ground was enclosed but, although adjacent to the quays, it did not develop and was subsequently granted to religious houses. These wharves were protected in 1322 by building the Water Tower, which projected into the river. More wharves lay close to the Bridge and access to them was by the Ship Gate.

In spite of canalization and various outports further down the Dee, the port declined. Silting and the development of Liverpool eventually finished the port during the 18th and 19th centuries.

It is intended that the research programme for the future will incorporate a scientific survey of the Dee estuary, which would also examine sea-level changes. The river

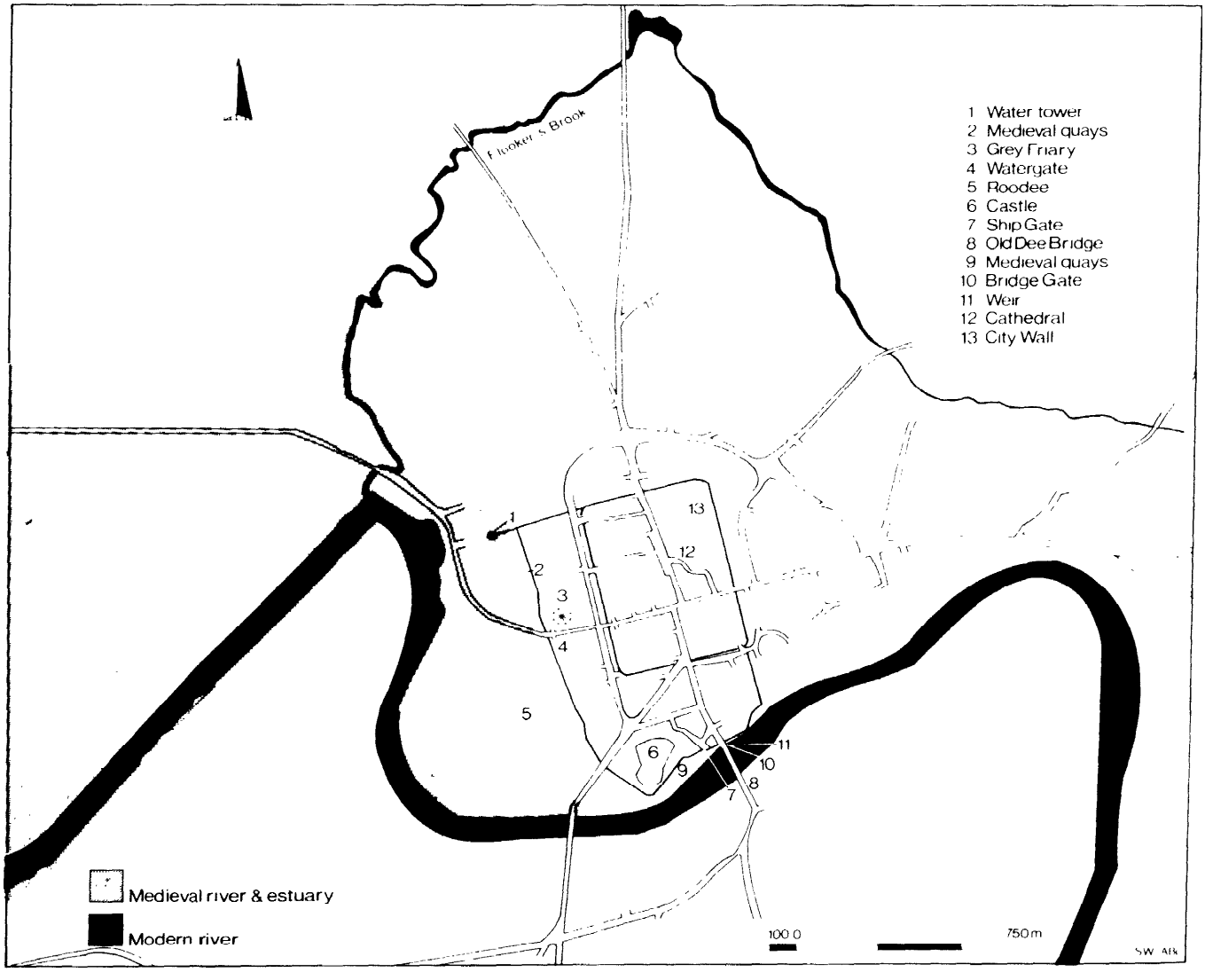

Fig 105 Medieval Chester

level at Chester appears to have dropped from from + 2m OD to 0.5m OD in the Roman period, was +2m OD in the 12th century, and is now at OD. A fluviogeomorphological analysis may also be undertaken, using boreholes, environmental studies, geophysical surveying, and the correlation of documentary and archaeological evidence.

A programme of excavation and (where relevant) documentary research will be formulated to answer specific questions relating to the development and decline of the port in all periods.

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Dover

B J Philp

Dover is situated astride the only gap in 20 miles of towering chalk cliffs at the shortest crossing point from Britain to the Continent. Since prehistoric times it clearly served, as now, as the Gateway of England, dominating trade routes and the famous Straits of Dover. The Dover Gap takes the form of a deep, narrow valley cut by the river Dour. In Roman times this was a 200m wide tidal estuary. but today it is no more than a small stream about 8m across and less than 1m deep. Land submergence, silting. shore drift. and human factors have been responsible for these considerable changes.

The English Channel itself was probably created in the 8th millennium BC. In late Neolithic times a settlement existed close to the estuary mouth and during the Middle Bronze Age a vessel carrying weapons from the Continent was wrecked under the cliffs. having failed to make the Dover Gap, and its submerged cargo was found in 1974 (Stevens 1975, 67). In late Iron Age times the Eastern Heights were almost certainly occupied by a major hill-fort which dominated the mouth of the estuary and forced Caesar to the Deal area in 55 BC.

The first large-scale development of the estuary as a port was in the 2nd century when the Roman fleet in Channel waters (the *Classis Britannica)* established its British headquarters on the west bank. Here they built a major fort, discovered and excavated by the Kent Archaeological Rescue Unit in 1970-5 (Philp 1971, 74). A corresponding harbour was formed in the estuary with a substantial outer seawall crossing its axis. This was found in 1855 and appeared to consist of a broad frame structure more than 30m in length (Rigold 1969). In 1956 a 15m length of piled and planked quay was found at Stembrook, and this probably represents part of the 3rd century waterfront. Nearby was a small jetty (Rahtz 1958). Deep silt deposits have been noted over a wide area. On the north side of the fort lay an extensive extra-mural settlement, located and excavated 1974-9, with prime buildings, such as the 'Painted House' (Philp 1977). From here led Watling Street, the principal land route to London and the north-west. A major stone lighthouse on each headland flanked the harbour and completed a sequence of unparalleled installations that marked Dover as the gateway of Roman Britain and almost certainly provided a regular channel service to the corresponding port at Boulogne.

For more than 200 years Dover was to be a port with its own garrison, for in *c* AD 270 the Roman army constructed a larger fort, north-east of the naval fort, but still close to the harbour. This measure reflects the threat to shipping routes from Saxon raids. This fort was found in 1970 and is now under excavation ahead of redevelopment (Philp 1972).

Little is known of the harbour in Saxon times, though the identified Saxon structures all lay within the ruins of the late Roman shorefort. It seems likely that post-Roman land submergence caused massive silting of the Roman harbour and that by 1086 only a narrow river marked its site. Then a single mill could cause great trouble to ships entering the harbour (VCH 1932, 203). The town at that time was flourishing: it was a Royal Borough with special privileges and became the head port of the Cinque Ports confederation. The medieval town and port were dominated by a large castle on the Eastern Heights, started by William I and very substantially enlarged and rebuilt in stone by Henry II (Brown 1966). The town flourished, with a crop of churches, monastic buildings, and a mint, though suffering from French raids. The construction of more than 1km of town wall by the 14th century, including at least ten gates (B M Add Mss 29615), demonstrates that the medieval town had spread across most of the deeply silted Roman harbour.

The exact sites of the medieval harbour and waterfront are not known, but continued silting and the severe storms of the 13th century caused continual problems. By the end of the 15th century the harbour works had moved more than lkm west to the Archcliffe area, and a shingle bar seems to have blocked off most of the original estuary. From about 1495 a succession of new harbours and waterfronts, shown on later maps, was built in the Archcliffe area and included towers, piers, and sluices. These are now mostly covered by port installations. It was hereabouts that the Dover Harbour Board was granted its Royal charter in 1606, by which time the settlement had expanded to infill the area between the new harbour and the ancient town.

Very large-scale archaeological excavations 1970-8 across *c* 3ha (8 acres) of the town have mostly kept to the area of the Roman forts and only fringed the ancient harbour areas. The latter now lie deeply buried beneath the modern town and, owing to land submergence, are normally well below the water-table. Some opportunities have been taken to examine the silt deposits over part of the area during minor redevelopment and it is hoped that in about 1980 one large site on the edge of the harbour will be available for excavation.

Dublin's waterfront at Wood Quay: 900-1317

P F Wallace

Excavations have been conducted by the National Museum of Ireland in the old city of Dublin since 1962 (NM1 1973; Ó Ríordáin 1973). While the previous excavations have shed considerable light on the dwelling places and the industrial sectors into which the early medieval town may have been divided as well as revealing considerable information on contemporary crafts and art, the current waterfront excavations at the 1.6ha Wood Quay site (Fig 106) have provided new data on the development of the port, the earliest defences, and the date of the earliest stone wall, in addition to detailed topographical information. The excavations also uncovered evidence for early shipping, shipbuilding, and carpentry in addition to the quays. Unevenly documented details, such as the impact of Norman trade before the AD 1169 Anglo-Norman invasion, the differences between the material cultures of the Vikings and the Anglo-Normans, the Influence of native Celtic material culture on that of the Vikings, and the continuity of urban property boundaries from the 10th to the 13th centuries have all been assisted by the recent discoveries.

Nine stages (Fig 107) by which Dublin's medieval waterfront was advanced into the tidal estuary of the river Liffey between the 10th and 14th centuries have been uncovered since 1974. Earthen banks of the 10th and 11th centuries, a stone wall of about AD 1100, a series of wooden quay revetments of the 13th, and an early 14th century(?) stone quay wall have been unearthed (Wallace 1976; Wallace 1979; Wallace, forthcoming). The site is bisected roughly from east to west by a stone wall, built around AD 1100, which delimits the pre-Norman town. Since 1977 the excavation programme has concentrated on the pre-Norman (10th–12th centuries) area south of this wall, while the 1974–76 programme dealt with the area north of the wall which was reclaimed during the expansion of the port in the 13th century, when Ireland and especially Dublin shared in the great expansion of European trade and commerce.

The massive extent of the gradual encroachment on the Liffey in the Middle Ages becomes obvious if the hypothetical line of the original shore is compared with that of the late medieval quays. An indication of the line of the ancient shore is provided by the number of borings and observations made by the Geological Survey of Ireland between 1903 and 1915 (Camplugh *et al* 1903, 88–91; Haughton 1945, 55), when a wide spread of river alluvium was found to overlie a large area of the Boulder Clay on which Dublin is built. This indicated that the Liffey was originally much broader than it is now. Recent excavations have confirmed the position of the alluvium along Wood Quay and the importance of the medieval high-water line in relation to the siting of flood banks and the earliest defensive embankment.

Whilst the Liffey was wide and tidal, it was also fairly shallow; the shallowness seems to be the main reason for 13th century attempts to increase the draught of water for the increased size of contemporary ships. This problem was to continue even after the 17th century when the active port and docks area had moved eastwards in search of deeper water in the direction of the mouth of the river. The river was also fast-flowing and subject to flash floods

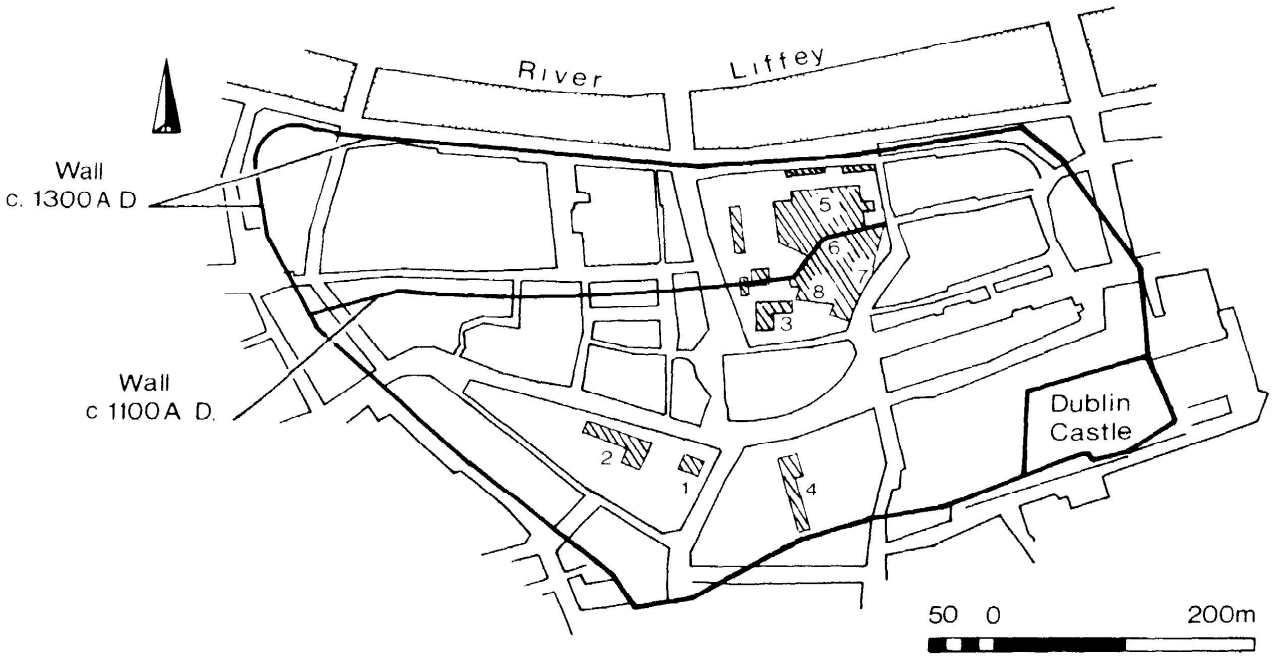


Fig 106 *Old City of Dublin showing line of stone walls, extent of original littoral, and sites of excavations.* **1** *High Street I, 1962-3;* **2** *High Street II, 1967-72;* **3** *Winetavern Street, 1969-73;* **4** *Christchurch Place, 1972-5;* **6** *Fishamble Street I, 1975-6 (all directed by B ò Riordan);* **5** *Wood Quay, 1974-6;* **7** *Fishamble Street II, 1975-;* **8** *St John's Lane, 1978-(all directed by P F Wallace)*

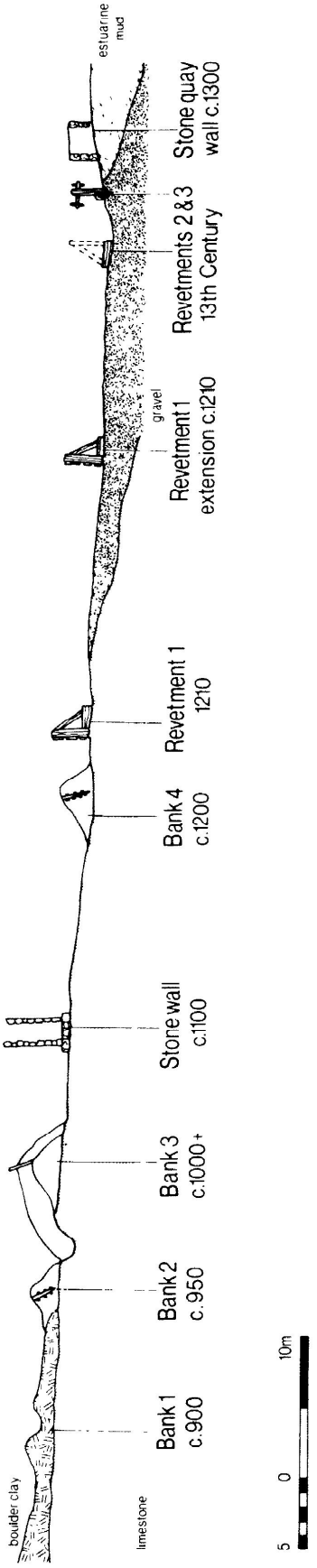


Fig 107 Dublin's medieval waterfront at Wood Quay: schematic cross-section to show positions of waterfronts from 10th to early 14th century

(Semple 1776), as is suggested by its original name in Irish, *Ruirteach* (Little 1952; Clarke H B 1977, 32) which means 'tempestuous', *Laoife* or Liffey (Byrne 1973, 150) then being applied to the plain west of Dublin through which the river flowed to the sea.

History records the earliest Viking foundation at Dublin as the AD 841 *longphort* or ship fortress, but no definite trace of this has come to light in the course of the excavations. It was built on the high spur of ground overlooking the river where the city was to develop and expand in the 10th and 11th centuries. The *longphort* was probably built at the confluence of the Liffey and its southern tributary, the Poddle, just east of the present Wood Quay site. While there is as yet no archaeological evidence for a pre-Viking township at Dublin, scholars have recently looked afresh at historical references (Little 1952) and topographical indications (Clarke HB 1977) which seem to suggest the existence of a monastic foundation of quasi-urban character. Even if such monastic establishments are accepted as proto-towns (Delaney 1977, 48-9), it is generally agreed that the Vikings were responsible for the establishment of the first real Irish towns (Butlin 1977, 11 -27) as Ireland was brought firmly into the mainstream of a north European commerce based largely on trade routes pioneered by the Scandinavians.

The earliest waterfront, AD 900- 1169

Bank 1

Recent work at Wood Quay has shown that low flood bank(s) were scarped out of boulder clay above the high-water line, probably in the early 10th century. These were not more than lm high and do not appear to have been topped with palisades. It is not clear yet if there is more than one of these banks or if they are concentric. It seems that they were primarily intended to keep the Viking properties on the slope above the foreshore dry. TWO skeletons, one male and one female and both orientated east-west, were found buried in the Boulder Clay at this level.

Bank 2

Sometime later, probably about AD 950, an extensive embankment was erected along the high-water line of the shore. Although conceived as a unit, it seems to have been built in a number of sections. This bank was partially built on top of dumped organic refuse including animal bones, discarded carcases, layers of sewage and moss, and was stabilized at its core by a post-and-wattle boundary fence against which was heaped the earth and gravel of which the bank was built. It appears to have been bonded in estuarine mud and was placed on the rising ground of the river bank, making its external aspect much higher than its internal. It would seem that the bank was started at the east of the site towards Fishamble Street and in the direction of the original *longphort,* where it was protected from the erosive action of the tidal river by a post-and-wattle breakwater secured in a channel cut into the rocky foreshore. A cobbled stone pathway may have existed just inside and parallel to the bank along this eastern section. A deep ditch *c* 1.60m in depth and *c* 2m in width was cut into the natural limestone bedrock immediately outside the central section of this bank. This can hardly have been defensive and may

Fig 108 Wood Quay, Dublin: mortised boards which originallyfronted the 10th century Bank 2 reused in the 11th century Bank 3

have been intended to retain water at low tides to facilitate docking ships. A boarded slipway(?) comprised of wide ashen boards set edge-to-edge on the outer slope of part of this bank, to which they were originally pegged through square mortises in their broad faces, may have facilitated the beaching or launching of boats (Fig 108). The most western part of this embankment was constructed on the higher-rising Boulder Clay well above the water line. The total extent of this structure is not known, as it extends beyond the confines of the excavation. The fact that the bank appears to follow higher ground at the west of the site where it appears to turn south-westwards suggests that this feature may not have been solely connected with the waterfront but may have encircled the early township, fulfilling an enclosing defensive function as well as the docking facility it seems to afford along part of the shore. The bank was built from east to west, encompassing exposed bedrock, natural sands and gravels, and Boulder Clay as it progressed westwards across the site.

Bank 3

Probably about AD 1000, a more substantial embankment built in at least four different stages was erected outside or farther out in the bed of the Liffey than that just described. The breakwater basketry of the early bank was partly used to retain the later bank, which was also protected by a post-and-wattle breakwater. Gravel, stones, and earth were used in the construction of this bank, which was reinforced by discarded post-and-wattle screens and by bundles of brushwood. Some of the boards which faced the outer slope of Bank 2 were turned over and used to stabilize the redeposited estuarine mud which forms part of Bank 3, showing the shortness of the time which elapsed between the final use of one bank and the erection of its replacement. This bank also had a series of long poles laid at right-angles to its long axis. These were either for reinforcing and bonding the loose ingredients of which it was comprised or, more likely, used to support palisades or fences. A post-and-

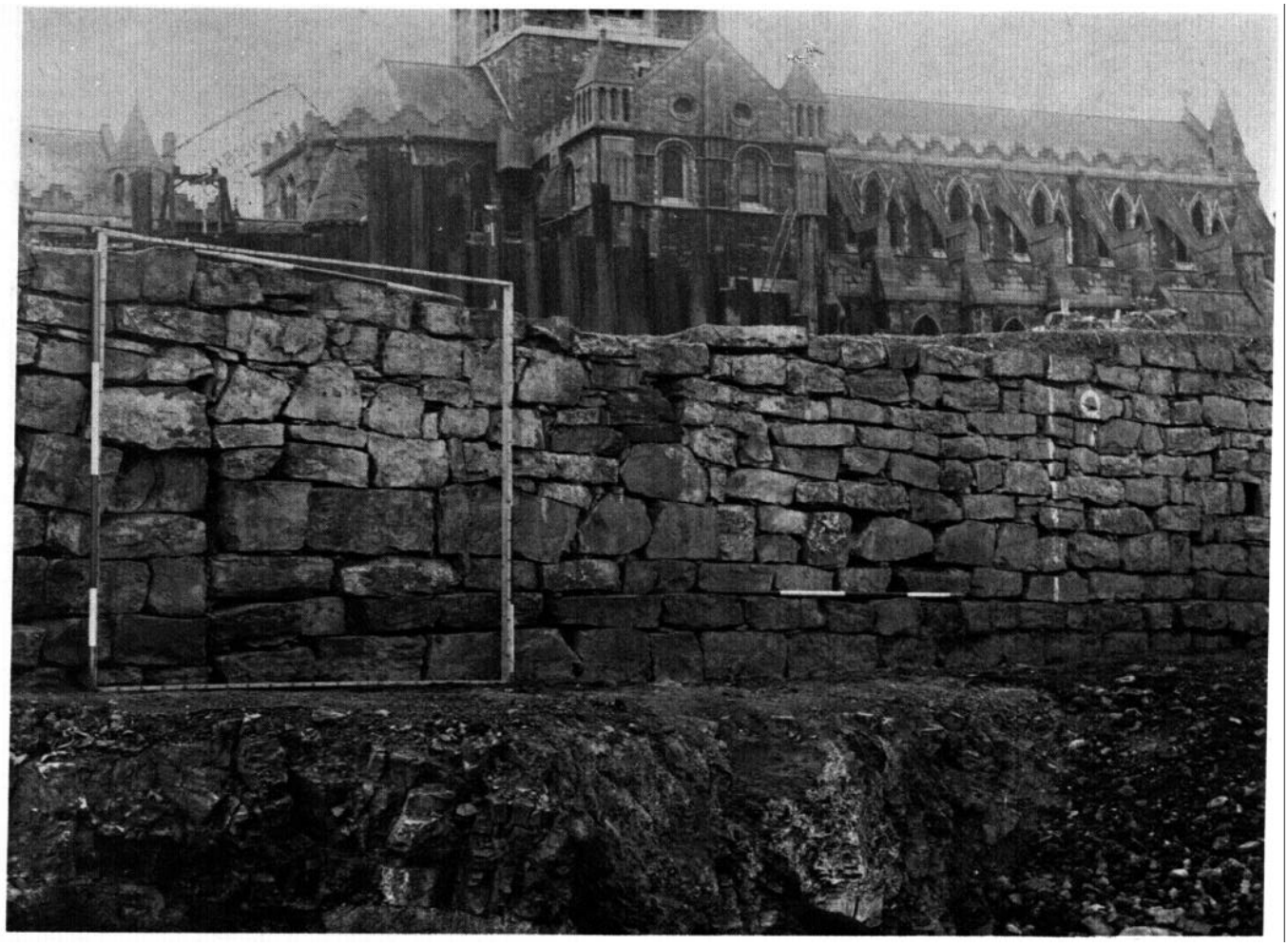


Fig 109 Wood Quay, Dublin: stone wall c 1100, with Christchurch Cathedral to north

wattle fence which crowned it was found, as was a later stave palisade which was anchored or tied from the inside. The bank was revetted on the riverward side by boards driven into the ground and, in another place, by a post-and-wattle revetment. A wattle revetment connected with one of its structural phases was bedded in a channel cut into bedrock, the stones of which had been backfilled and tamped around the upright posts. In its final phase this bank was covered over with estuarine mud brought from the bed of the river. This dried out and formed a hard and firm surface. Like Bank 2 which it replaced and in its final stages incorporated, Bank 3 extended beyond the limits of excavation and seems not to be confined to the waterfront, but may once have encircled the town, as was suggested in the case of its predecessor. It may have been more substantial at the landward side of the *enceinte.*

Whilst Scandinavian fortifications in Britain and Ireland have been discussed recently (Talbot 1974, 37-45; Dyer 1972, 222-36), there would appear to be few excavated parallels for the waterfront embankments at Wood Quay. Although there is a general similarity between the Viking fortifications at Dublin and the more massive structures at the great Scandinavian trading centres of Birka and Haithabu (Almgren 1966, 32-64), and an even closer relationship in structural detail between the vertical boards on the slope of the 10th century embankment at Wood Quay and the pinned horizontal planks on the inner faces of the Kanehave Canal (Wilson 1978, fig 4), the banks at Dublin appear to be far more closely paralleled at Hungate, York, where Anglo-Danish ramparts of roughly similar height and construction have been discovered (Richardson 1959, 5l-114). The erection of a bank 'to complement the natural defences' seems to mirror the experience at Dublin, though whether the earliest of the banks at York and Dublin were to prevent flooding (Hall 1978, 33) or to act as a military defence must remain unanswered. There is little doubt that the earthen bank with its timber palisade near the 'Anglian Tower' *(Medieval Archaeol,* **16,** 165-7) is defensive and similar to Bank 3 at Wood Quay.

An English rather than a Scandinavian inspiration for these banks is more acceptable, as it coincides in Ireland with a new wave of Viking colonization in the early 10th century which came not from Scandinavia but from Britain (Sawyer 1970, 89). The fact that the early 10th century was also a period of intense contact between Dublin and York

(Smyth 1975) adds further weight to York as the probable source of this influence. That the height and composition of the banks at Wood Quay resembles that of the average Irish rath and monastic enclosure may mean that the Dublin banks were a foreign idea executed at a local scale to meet the demands of local warfare. This also made it possible for the Irish to take Dublin about ten times in the period 840- 1169 (Smyth 1977, 185)!

Earliest wall, c AD 1100

The next advance into the Liffey is represented by a stone wall *c* 1.50m wide and possibly about 3.50m in original height (though its present surviving height averages *c* 2m) (Fig 109). It runs roughly parallel to and about 5-10m north of Bank 3. It runs east-west for 61 m from the east margin of the site at Fishamble Street, turns sharply north-east/south-west for 22m, resumes its east-west line for another 23m, and extends beyond the west margin of the site at Winetavern Street. The change in orientation may reflect the change from the limestone outcrop to less stable gravel, or the existence of a pool in the Liffey estuary at its confluence with its northern tributary (the Bradogue) or a desire on the part of the builders to follow the line of the earthen banks, the positions of which may themselves have been determined by a combination of similar natural conditions. The wall comprised a rubble till within mortared stone facings, although the mortar on the outer face was probably eroded by the tidal estuarine waters. It was partly built on a dry stone plinth or base, to the south of which have been found mortar platforms where the mortar for the upper courses was mixed. There are a number of divisions in the wall on its inner face, indicating that the outer face was built first and the wall completed on the inside. There is also evidence that the wall was repaired in the 13th century. Organic refuse was dumped inside the wall to stabilize it from the pressure of the river and a deposit of estuarine mud was placed on top to reinforce this layer. This suggests that the ground surface behind the wall was much higher than that to the north (like the earlier embankments), and so if the wall was not free-standing it may have been a revetment or a quay wall. However, the surviving maximum height of the wall at the west of the site suggests that it was a defensive structure. It was built *c* AD 1100 and, like the earlier banks, was extended right around the city. It has been suggested that the reasons why the Normans were so desirous of capturing the Viking towns was that they were walled fortresses and seaports from which they could maintain contacts with their home bases (de Paor 1976, 36).

South of the wall and the embankments work has concentrated on 11th and 12th century houses and on the boundary fences between which they were situated. As is known from the earlier National Museum excavations in Dublin, the houses tend to be of rectangular plan and to average *c* 7m x 4m. They have hearths at the centre and a bedding of brushwood along the side walls. In *c* 3m of layered organic habitation remains which survive, boundary fences replaced one another in exactly similar positions, showing a continuity of and respect for boundaries in l0th-12th century Dublin. The property boundaries are trapezoidal in shape and unequal in area and appear to have their narrowest end fronting on the quayside, from which they widen as the approach the rising ground at the south-east of the site. It is hoped that the present excavations will establish the original early 10th century layout of these boundary fences and houses along the Fishamble Street side of the site and the relationship of these property boundaries to the first waterfront embankments, and indicate the extent to which the topography of this part of the city was determined by the position of the banks.

A number of 10th and 11th century ships' timbers, some of which were reused as a foundation for a pathway, have been found as well as a wide range of domestic articles and ornaments of the same period. While the slave trade appears to have been the 'key factor in the economic life' of Scandinavian Dublin in the late 9th and 10th centuries, when Saxo Grammaticus described the city as 'filled with the wealth of barbarians' (Smyth 1977, 166-8), owing to its position on the Atlantic trade routes of the Vikings, there were also other items of trade. Imported steatite, walrus ivory, and great quantities of amber have come from the 11th century levels at Wood Quay, while wheel-stamped Anglo-Saxon pottery of the 11th century and later and early 12th century Stamford, Thetford, Andennes, and French grey wares have also come to light. Coins of the Saxon Kings Eadgar and Athelstan also attest to trade, as does the occasional sherd of Roman samian ware, which may indicate contact with a town in Britain (York?) which was once settled by the Romans. Finds of souterrain ware or native pottery are tangible proof of contact with the native rural population, while objects decorated in 11th century Ringerike ornament show the influence of the wider Scandinavian world.

In the absence of definitive dating, it is unwise to equate the building of the banks or defending of Dublin to the reign of any one of her Scandinavian Kings. Wilson (1976, 110) sees the rise of Dublin's trade as following on the expulsion of Eric Bloodaxe from York in 954, but it could also be said that the erection of the embankments are as likely to date from periods of renewed Scandinavian aggression or military recovery, with the recovery of Dublin in 917 possibly coinciding with the building of Bank 2. Future excavation may discover fortifications ascribable to the return of Ivar and Olafr in 871 and to the *longphort* originally built in 841.

The Anglo-Norman waterfront, AD 1170-1317

The 1974-6 excavations were concentrated on the reclaimed area north of the city wall. The broadness and shallowness of the Liffey appears to have made Dublin inaccessible to the larger ships which had to anchor at a distance from the city. Close approach was made increasingly difficult by the gradual accumulation of silt and the absence of adequate dredging facilities. Excavation at Wood Quay has shown that land was advanced (ie reclaimed) to meet the ships, since they could not approach the land. The need for improved docking facilities in the early 13th century was all the greater since the recently settled Normans actively engaged in a flourishing European trade, which had led to an increase in the size and draught of ships.

Prince John's 1192 Grant of Civic Liberties to Dublin confirms Henry II's 1171 charter and is addressed to citizens 'dwelling both without the walls as within' who were to improve themselves 'in making buildings wherever [they] shall wish upon the water [ie river]' (Curtis & McDowell 1943, 24-6) which implies that land was being

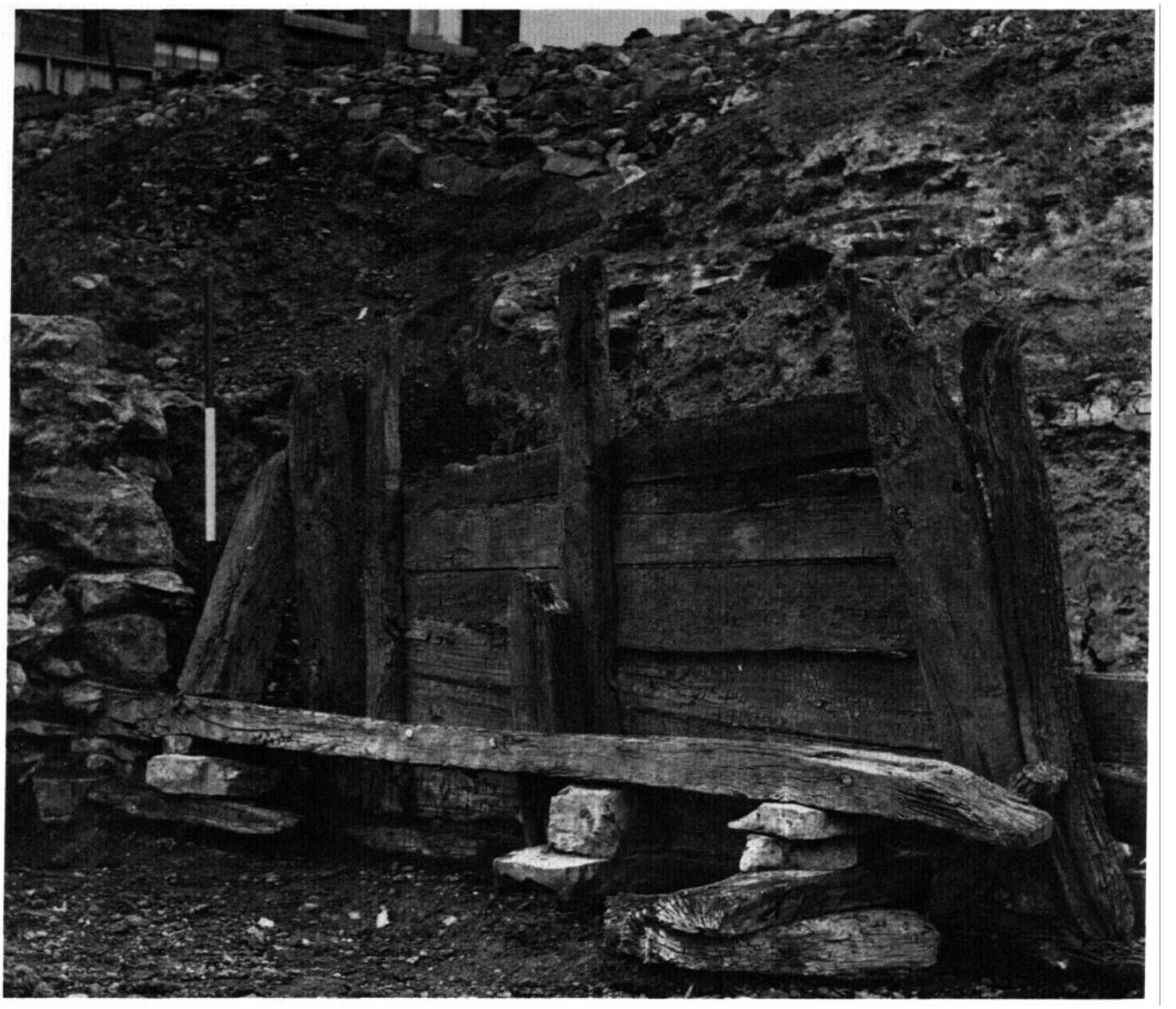


Fig 110 Wood Quay, Dublin: revetment 1, c 1210: Section A

reclaimed from the river at this date. A text of a decade later (1202) confirms possessions 'in sands and mudbanks' (McNeill 1950, 29).

Post-invasion embankment (Bank 4)

The earliest advance on the Liffey north of the city wall at Wood Quay seems to have been about or shortly before AD 1200, when a line of post-and-wattle *c* lm high and 35m long was erected on the river gravel roughly parallel to and 25m north of the wall. This line was intended to provide a stabilizing core or retaining fence for an embankment (Bank 4) which was probably meant to increase the draught of water. Its west end was discovered midway across the site, but its eastern end extended beyond the east margin of the site under the present Fishamble Street. This rather flimsy support for Bank 4 collapsed soon after it was erected. It may thus have only been intended as a temporary measure, as a wooden revetment soon replaced it. Six lines of similar nature divided the interval between Bank 4 and the wall into a series of rectangles. These appear to be property boundaries or extensions into the water of the messuages or burgage plots of the type mentioned in the 1192 charter, but may also have facilitated reclamation. In at least three cases these

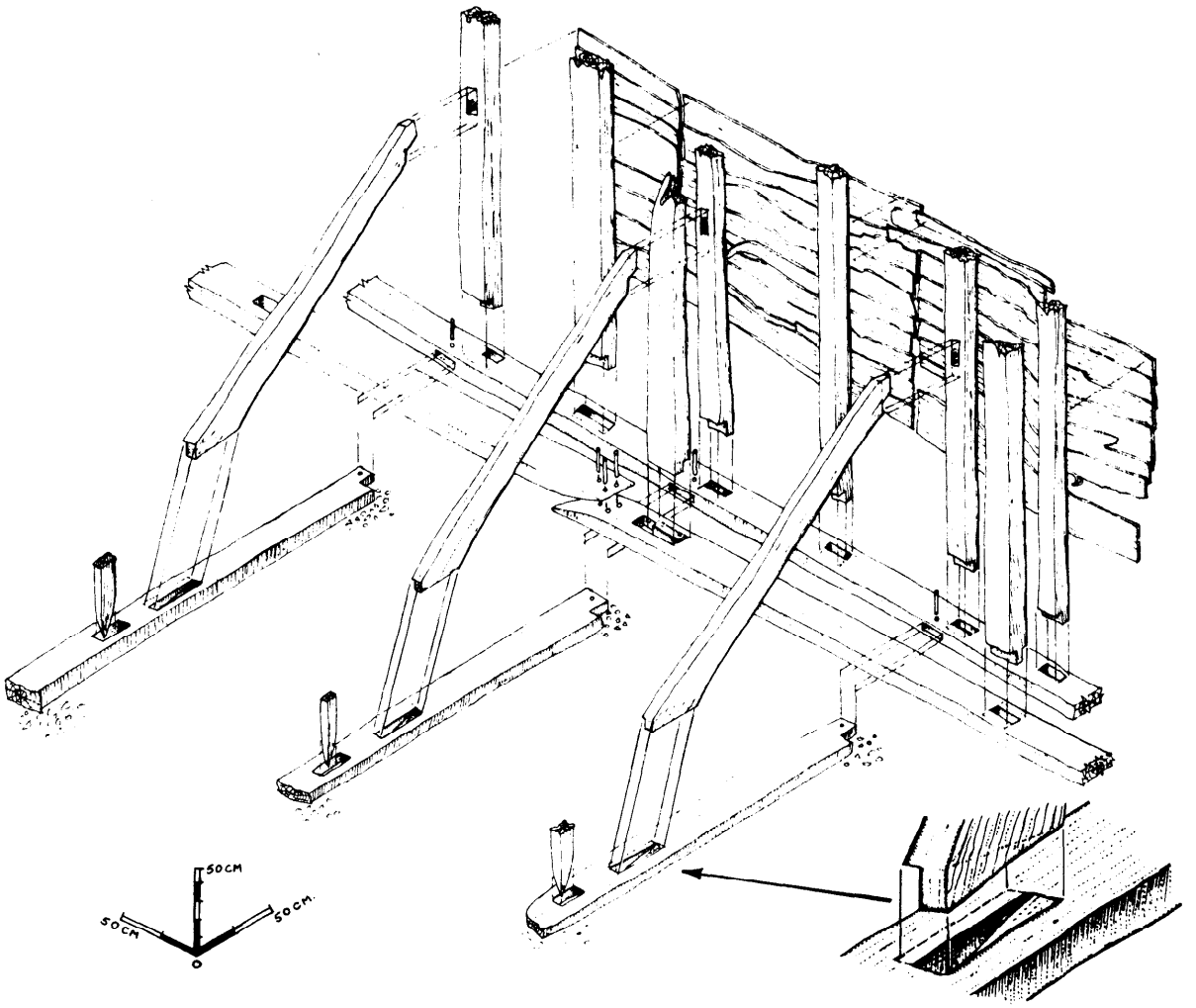


Fig 111 Wood Quay, Dublin: revetment 1, c 1210: Isometric drawing of Section D

north-south fences were overlain by later 13th century sill beams of a warehouse complex, showing a continuity of these property lines.

Early 13th century revetment: revetment 1

In *c* 1210,[1] a stout wooden revetment was built across the site in a fairly straight north-east/south-west line *c* 2-3m (and in one place only 1.5m) on the riverward side of Bank 4. It comprised squared oak posts behind which were placed horizontal planks set on edge and held in place by the pressure of the town refuse heaped behind (Fig 110). The posts were tenoned into footbeams or baseplates and were supported on the front by braces tenoned into subsidiary baseplates fixed at right-angles to the principal baseplates. So far, six distinct units of this revetment have been identified, all conforming to the front-braced 'vertical' tradition of north European wooden quay building. Each of the units measured *c* 12-15m in length and was built as a separate element, although it is clear that they were meant to join up in a continuous line along the waterfront. The units imply either a division of ownership or responsibility or, less likely, of the building contract. That they were built together on a line suggests a civic or municipal control which was not as strongly manifested as in the case of the earlier pre-invasion embankments and the stone wall.

The five sections of the revetment uncovered in the recent excavations have been labelled *A, B, C, D,* and E from east to west. In *B* the principal posts were supplemented by midspans between each pair of principal posts, and auxiliary posts were stubbed into the baseplates near the principals to retain the horizontal boards, which had buckled forward under the pressure of infill material. In *B* the principals were braced, whereas in *D* the midspans were braced (Fig 111). Subsidiary baseplates at right-angles to the main plates were used to retain the tenoned brace heels in *A, C, D,* and *E* but not in *B,* where the heels simply butted into the gravelly foreshore. Most principal posts were just over 1.8m tall. The braceplates were squared oak beams *c* 0.25m x 0.20m up to 4.82m long, and had a simple groove on their upper surfaces to receive the lowermost of the horizontal planks, which were tapped into the main groove via a feeder groove from the edge. The absence of plough planes meant that these grooves were often of uneven thickness and unable to accommodate the equally uneven adzed boards.

In general, no nails were used, as the overlapping boards behind the posts were secured by the pressure exerted by

the dumped deposits. The radially cut planks were of triangular section and about nine were used per panel in sections *B* and *D*, where they were *c* 2.2m long. The subsidiary baseplates of *A, C, D,* and *E* were tenoned into the northern edges of the principal baseplates. Each subsidiary baseplate had two mortices: an inner to take the raking or supporting braces and an outer to take a peg which secured them to the ground. Posts and wedges were also driven into the ground in front of the principal baseplates to prevent the revetment from slipping riverwards.

A structure consisting of vertical posts and baseplates was placed on top of the subsidiary baseplates across the site. This was not secured to the revetment and was probably meant to act as a 'buffer' to prevent docking ships from colliding with the raking braces of the quay wall. The baseplates of the 'buffer' bear no upper surface groove and their uprights are about 2.70m apart, in contrast to those of the main revetment, which stood at intervals of *c* 1m, suggesting that it was never intended to clad the outer structure. The vertical posts of the 'buffer' were larger than those of the boarded revetment, standing *c* 2.20m high. The revetment's pegged scarf joints face eastwards, indicating that this structure was laid from east to west, in contrast to the 'buffer'.

Detailed study of these timbers has greatly expanded knowledge of Irish medieval carpentry. There appears to have been considerable use of chisels, spoon bits, and augurs but little evidence for sawing. Few nails were used by carpenters, who depended on dowelling and mortising. The muddy conditions of the shore made prefabrication necessary, as is evident from the lengths of the boards and the well-cut chase mortises and tenons in *D*. The number of unpegged mortises may also mean that the tidal estuary and the Liffey's flash floods militated against prolonged periods of sustained work.

Revetment 1: extension

Revetments l's section *C* was either never completed or had been dismantled, as no primary uprights or boards were found with the baseplates, which survived with the overlying 'buffer' phase. This may have been due to a change of mind on the part of the builder or owner of this section of the quay front, as another revetment was erected *c* 20m farther out from section *C* in the bed of the river. This was similar to the main revetment and was composed of vertical posts, principal baseplates up to *c* 8m long', and subsidiary baseplates. In contrast to the other revetments, whose boards had been pre-cut to similar lengths, the cladding here comprised the boards of a dismembered ship still nailed together. This 'boat revetment' was initially held in position by the weight of the revetted material, but this pressure subsequently caused it to collapse outwards into the water. The collapse may have been hastened by the clinkered boards' resumption of their former curvature, This smaller revetment was-linked to the main quayside by means of a rough fence, which probably served as a boundary demarcation rather than to facilitate berthing shins on its east side. This side was also protected (from tides?) by a post-and-wattle break-water infilled with estuarine mud. Although the timber-faced quay, Revetment 1, extended east and west beyond the confines of'the Wood Quay site, it cannot have extended very far west as the area now known as Merchants Quay was called the Strand (Clarke H B 1979, 37) in the 13th century, which suggests that it was a river bank lacking a sea wall. The 1221 Murage Grant 'in aid of enclosing that city and for the security and protection of it, as well as of the adjacent parts (Brooks 1936; Gilbert & Gilbert 1889, i, 7) may mean that the wooden quay front was later extended westwards along the Strand. The area of the quays was guarded by one or two warships ('grand galleys') moored in the river: one of these had been loaned to Bristol in 1233 and a second one was built in 1241 (Wood 1915, 255).

Revetment 2

Later into the 13th century a long wooden revetment was erected still farther out in the bed of the Lifley. In contrast to the first revetment and its extension, this appears to have been back-braced, although only the baseplates were recovered at the north-east corner of the site near Fishamble Street. This structure ran east west across the site and may have been connected to part of another revetment secured with a curious A-brace some 75m to the west on the same east -west line. This revetment made a sharp right-angled turn at Fishamble Street and appears to have presented a boarded quay corner on the east west and north-south fronts. The sharp turn upwards at Fishamble Street may have been to protect the revetment from tidal action like the earlier breakwater, or it may be associated with a 'fysshe slypp' at Fishamble Street, for which there is considerable later medieval documentary evidence. This was a slipway that enabled fishermen to land their catches before hauling them up to the fish shambles (Gilbert & Gilbert 1889, i, 290, 469).

The A-brace on the revetment at the west of the site was designed to combat the great pressure that the river exerted on the wooden quay front especially on its exposed back-braced uprights which were tenoned into baseplates. A large triangular brace *c* 2m high was half-lapped and pegged at the top, its legs being notch-jointed and pegged to main plates on each side of a pegged scarf-joint. The legs were also pegged to one of the posts which was thereby locked in position and prevented from jolting the joint out of place in the event of river pressure.

Revetment 3

A final wooden quay front was erected just north of that described. It was a back-braced revetment comprising uprights, boards, and principal baseplates which were anchored from the landward side by means of holed tie-backs. The latter were threaded through the revetment, a post in the hole at the outer end of the brace being pulled against the outside of the upright and a short post on the inside being secured in the ground by deeply driven pegs. This device had been used in Wood Quay almost three centuries earlier when securing the stave built palisade on top of Bank 3!

The wooden revetments or quayfronts at Wood Quay may have been primarily intended to act as the facing for an expanding vertical dockside outside the city wall protecting this reclaimed ground from riverine erosion. Secondly, the associated encroachment into the Liffey was probably intended to increase the draught of water. Whether the builders ever seriously believed in the possibility of such an achievement must be doubted, as the accomplishment of such a task in a broad shallow estuary seems to have been doomed to fail, as historical references reveal it did. Anyway, it may have been contemporary practice to let ships rest on the river bed until they were floated by high tide. This may have been the case at London, where there

were boarding stairs in front of the revetments (Milne 1979; Milne & Milne, forthcoming), though there is no evidence of these at Dublin, unless the wooden drains which ran between the sections of the revetment served in this capacity. Certainly, one of the drains had a top decking which could have been walked on. The inclusion of front braces at Wood Quay suggests chat ships may never have actually docked directly at the revetments, although the 'buffer' device might argue that it was intended that they should. A third reason for the revetments may be related to the desire to reclaim more land, perhaps to increase the available warehousing area at the busy port.

Stone quay wall, c AD 1300

In *c* AD 1300 a stone quay wall was erected just north of Revetment 3. This marked the final medieval extension to the waterfront and brought the line of the quays almost to that of the modern quayfront. About 18m of an apparently low (1.75m high) and broad (2.75m) wall was built just north of the last wooden revetment. It was not possible to establish whether its broad upper surface was original or whether the wall had been robbed down to this level. The possibility of a low wall with timber-framed supported tower house on top cannot be dismissed, as such structures were known in Waterford and Limerick even before the arrival of the Anglo-Normans (de Paor 1974, 255; Scott & Martin 1978, 67, 151).

The wall may not have been started until after 1305, when a city watchman was placed in charge of the 'entire of the River *Bunk'* (Gilbert & Gilbert 1889, i, 233) in this area, suggesting that the wall had not as yet been built. It was certainly started before 1308, when Geoffrey de Mortone fraudulently obtained the right to levy a custom on goods brought into the city for sale, claiming that the tower over the bridge was accidentally burnt and the city wall thrown down. Even though there were then (1308) defensible embattled houses between the gate towers along the Wall at Wood Quay (Jope & Seaby 1959, 115-18), in 1317 when Edward Bruce threatened to attack Dublin the Mayor and Commonalty took stones from St Saviour's Priory 'to make up their walls in the north side, upon the key and also the walls by Saint Tovins's [Olafs?] church and beside the gate there they made a tower and after repaired the walls by the Wine Tavern street' (Brewer & Bullen 1871, 138), suggesting that the construction of the eastern part of the wall along Wood Quay was not completed until it was hurried along by threat of the siege. It was probably this wall which was exposed during the building of Richmond Bridge to the west of the site, where the foundation of a wall found 'four feet above rudely formed boats (caulked with moss)' on a sank bank (Gilbert 1861, i, 381). The bottom of the wall found in the recent excavation rested on a similar bank at a higher level than the bottom of the revetments which it replaced.

Although *c* 85m of land were reclaimed from the Liffey at Wood Quay between 900 and 1317, the need for a greater draught of water appears to have persisted from medieval to later times. Even after the erection of the quays in 1305, 'no large ships laden with wines or other merchandise can touch at the port of Dublin until they are partially discharged whereby, according to a custom which has hitherto prevailed, ships laden with wines were wont to touch at Dalkey and there partly discharge and the wines so discharged were wont to be conveyed to the city of Dublin in small barks' (Sweetman 1886, 135). Dalkey remained the deep-sea anchorage for Dublin long after the completion of the stone quays, for as late as 1358 the merchants of Dublin complained to Edward III that 'from want of deep water in the harbour . . . . there never has been anchorage for large ships from abroad' (Gilbert & Gilbert 1889, i, 19-20).

As well as the shallowness of the river and the navigational difficulties which it presented, there seems to have been constant obstruction from the fishing interests of the abbeys of St Mary and St Thomas and the priory of the Holy Trinity. They made a pool or dam across the river so that 'boats can no longer pass up and down' (Went 1953, 163-73), and a dam was also built across the Poddle on the south side of the river (Clarke H B 1979). A directive was issued in 1220 to 'cause the river to be so enlarged and the pool so rectified that ships and boats with every kind of victuals, with stones and wood, may have free passage up and down the river' (Sweetman 1886, 149). Following vandalism by the priors of the fixed net near the bridge of Dublin near Wood Quay an agreement was made in 1261 whereby nets were to be emptied on the north bank of the Liffey (Gilbert & Gilbert 1891, i, 161), which meant that the Wood Quay area was free for trading vessels. The Mayor and Commonalty had also given permission to the Abbot of St Mary's Abbey 'to place nets and stakes on the land and strand of the north side of the river' (Carville 1972, 35-48).

The medieval encroachment on the Liffey was not confined to the south side. In the 13th century St Mary's Abbey on the north bank (near the present site of the Four Courts) had its own fleet of ships and a harbour (the Pill) which was made by lengthening the estuary of the Bradogue river (Carville 1972, 35-48). This harbour was not directly opposite Wood Quay so it can hardly be regarded as part of a concentrated attempt to confine the Liffey between quays on both banks.

Drains, first of wood and later of stone, were another major structural feature of the site. Some were built of reused ship's timbers and all ran roughly north-south at right-angles to the city wall and the revetments. They appear to have issued from wooden tanks outside the wall. The contents of the largest appear to have been periodically removed by the ebbing tide after the water had been admitted to the tank through a sluice gate. This drain measured over 40m in length, averaged 1.5m wide, and was was *c* .75m high. It was built in six different stages with uprights, baseplates, headplates, and side sheeting, which was secured in place by the pressure of dumped material. The top appears to have been used as a footpath at least for a time, perhaps to facilitate the loading of ships sitting on the river bed beyond the quayfront. Two of the wooden drains were replaced in later medieval times by stone drains, in use until the 18th century. Such great continuity from medieval to modern times recalls the earlier example of continuity in pre and post-Norman property boundaries.

The site has yielded a considerable number of ships' timbers of 13th century date in addition to those of the 11th century already mentioned. Among the parts of 13th century ships to have been found are frames, a bulkhead, stems, a keel, a beamknee, and two large Y-shaped timbers which may have been mast crutches or *mykes*[2]. Recent dendrochronological analysis of the Wood Quay ships' timbers (Baillie 1978, 260) showed that the wood is of Irish origin, so the boats were probably made in Dublin, possibly at or not far from the site under discussion. This is supported by documentary evidence which suggests that ships may have been exported from Ireland in the Middle Ages.

Considerable evidence of the trade contacts of the medieval port of Dublin has come from the artefacts recovered in the course of the excavation. Pottery was imported mainly from the Ham Green kilns at Bristol and from the south-west England-Severn Valley area generally, although Chester and east English wares are also in evidence. Glazed and polychrome jugs from the Saintonge and less fine specimens from north west France were also found, along with pottery from the Rouen-Paris-Beauvais region. Rhenish skillets, painted French and Mediterranean wares, Dutch vessels, and archaic *majolica* are much less numerous. English and French coins and ampullae from Canterbury also attest to foreign contacts.

Notes

1. The National Museum of Ireland is grateful to Dr M Baillie of the Queen's University Belfast, for the dendrochronological analyses.

2. We are indebted to the National Maritime Museum, Greenwich, its Archaeology of Ship's Department, and Chief Archaeologist Dr Sean McGrail for specialist assistance with the Wood Quay ships' timbers.

Exeter

C G Henderson

Port facilities

Exeter is situated on the river Exe 6km above the port of Topsham (Fig 112). Small boats were able to reach the town until the late 13th century, when the river was blocked by the construction of a fish weir at Countess Wear. Even before this, however, the lack of a deep-water channel made it necessary for larger vessels to discharge their cargoes at Topsham (Jackson 1972, 61-2); from here goods could be carried to Exeter by road or up the river in lighters. After *c* 1284 all goods went by road until the Exeter Canal and Quay opened in 1566. The early canal was suitable for vessels of up to 16 tons, and only after 1701 were ships of 100 tons and more able to reach the Quay. The first quay had a 70m (230ft) waterfront and was provided with a crane for loading and unloading. Works completed in 1676 increased this to 147m (483ft) and the accommodation remained this size until large-scale improvements were carried out in the 1820s (Clark 1960, 27-48).

Medieval Exe Bridge

Excavations in the vicinity of the medieval Exe Bridge were undertaken in 1975-79 by the Exeter Museums Archaeological Field Unit in connection with a scheme to conserve and display the remains of the bridge. The project was supervised by S W Brown and J F Pamment and generously grant-aided by the Department of the Environment.

The river crossing at Exeter has long been the focus of the route system of south-west England. A small trench excavated beneath St Edmund's church demonstrated the existence of a ford here in the period immediately before the bridge was built: a deposit of river gravel up to 0.5m thick contained numbers of nails and horseshoe fragments. No trace was found, however, of the footbridge composed of 'Clappers of Tymbre' said by Hooker to have preceded the stone bridge (Harte *et al* 1919, 602), but this may have lain outside the area excavated. The date when the stone bridge was started is not recorded, but work was probably in progress by 1196, when 'the chaplain of the bridge' appears as witness to a document (Hoskins 1960, 29): construction is likely to have been complete by *c* 1214, when the two parochial chapels on the bridge are first mentioned (Rose-Troup 1923, vi). There were probably seventeen arches (of which eight and a half survive), spanning a distance between abutments of about 172m. The bridge has an average width of 5m, and the height at the north-east abutment is 3.05m, rising to 6m over the middle arch. Arches 5, 7, and 9 are pointed and of ribbedconstruction; the other surviving arches are round-headed (see Fig 113).

On the north-west side of the bridge stood St Edmund's church (Fig 114). In its original form it measured

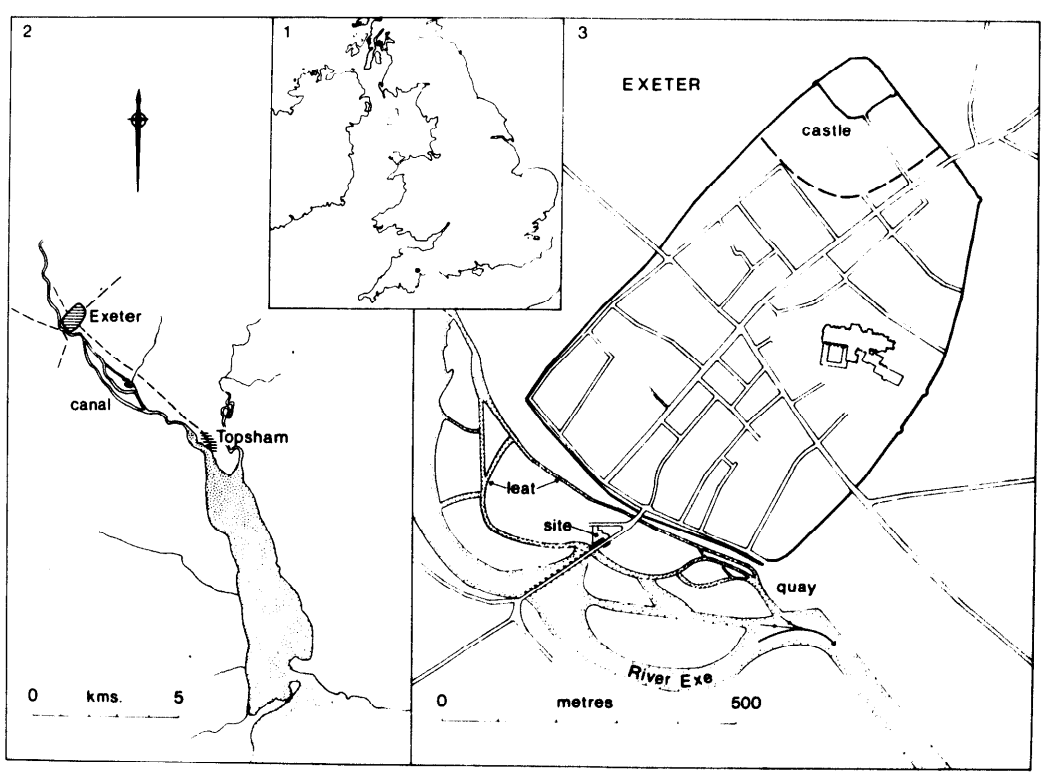


Fig 112 Location maps showing the position of Exeter, the Exe Bridge, and the excavation site (drawn by S W Brown)

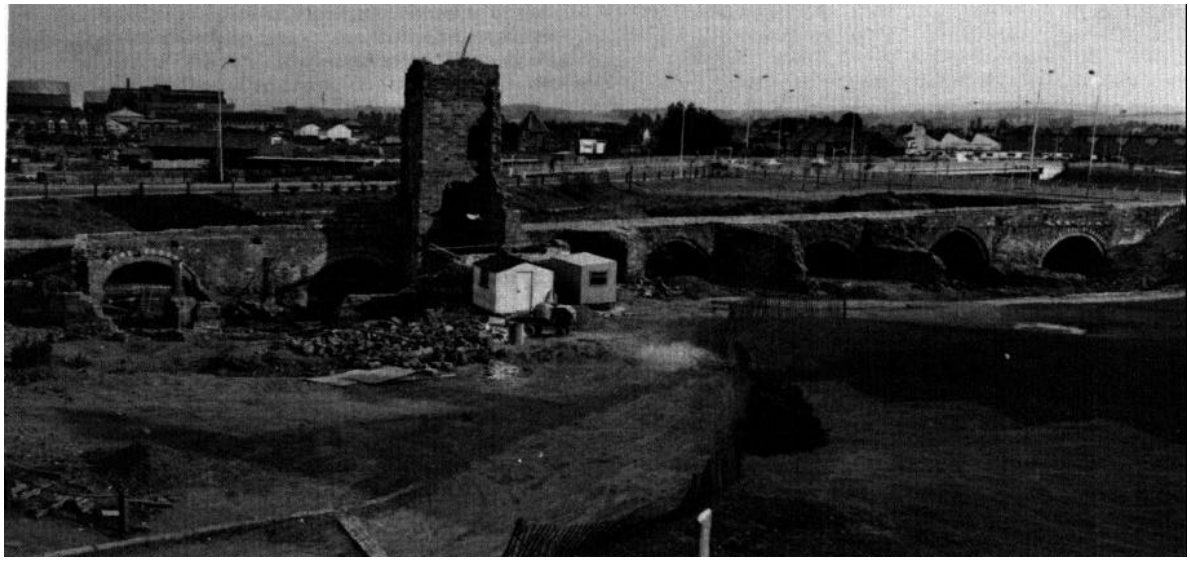


Fig 113 *Exeter: the medieval Exe Bridge, seen from the north-west during restoration (photo: Nigel Cheffers-Heard)*

Fig 114 *Exeter: general view after excavation of St Edmund's church and the riverside tenements from the 19th century tower of the church (photo: Nigel Cheffers-Heard)*

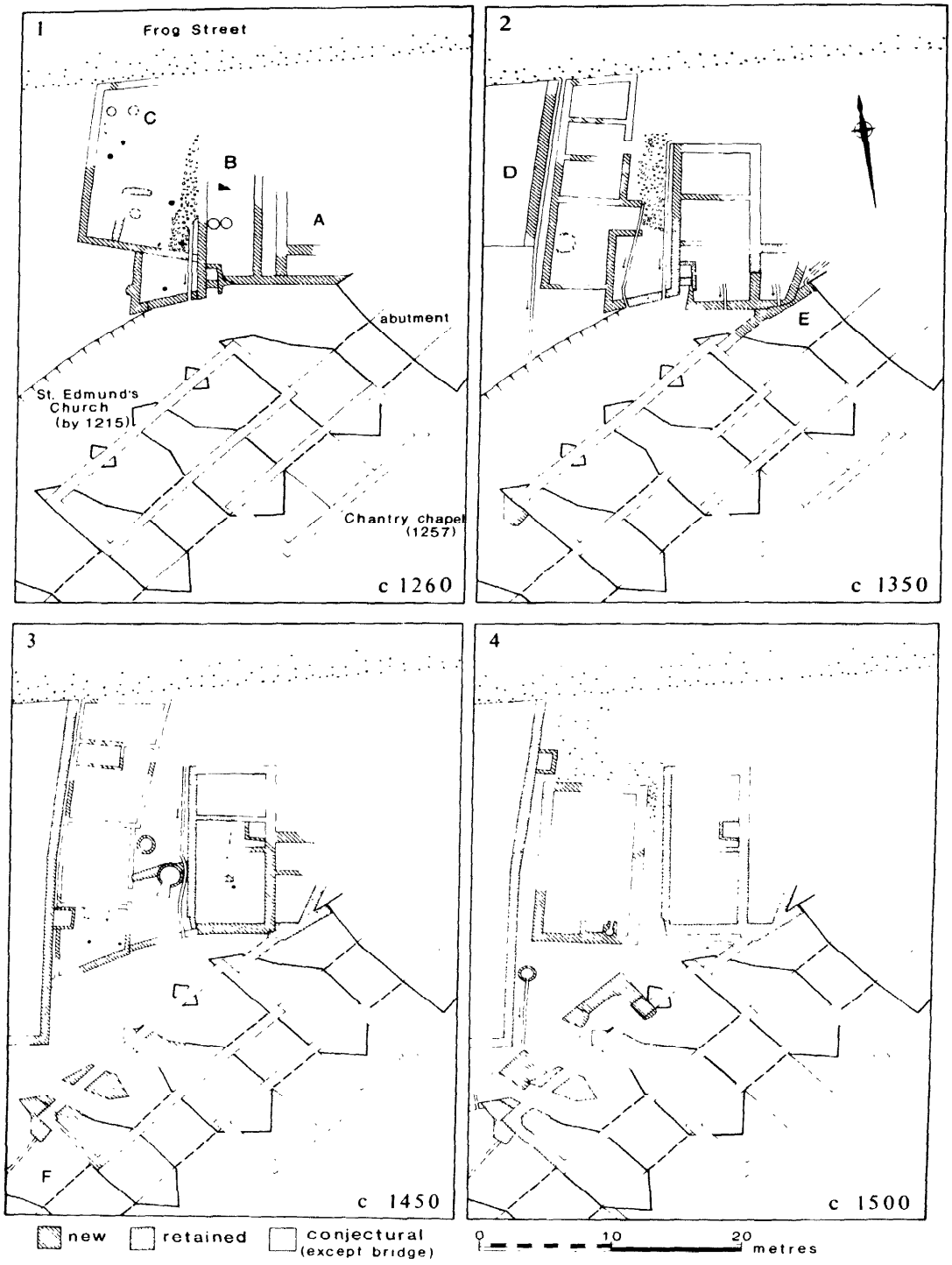


Fig 115 *Exeter: simplified plans illustrating the main stages in the development of St Edmunds church on the Exe Bridge and the riverside tenements to 1500 (drawn by S W Brown)*

18.6 x 5.2m internally; the end walls rested upon specially designed cutwaters, whilst the north wall was carried by a row of four arches. The west end was rebuilt in *c* 1450 with the addition of a tower, and a north aisle was added *c* 1500. In a similar position at the other end of the bridge was St Thomas' church, and opposite St Edmund's was a chantry chapel dedicated, in 1257, to St Mary the Virgin.

There were houses on the north-east end of the bridge by the 1340s, when the series of Bridge Warden's accounts starts. The substructure of building *E* (Fig 115), dating to the first half of the 14th century, consists of a masonry wall, pierced by an arch, which supported a two-storied timber-framed building described in the late 15th century accounts as a pair of shops *(ex inf* S Reece). The foundation pier of building *F* (also described as shops at this time) is probably also 14th century in date.

Frog Street riverside tenements

Permanent colonization of the river bank took place around 1250. Previously the area had been liable to flooding, and in use only as a sand quarry and for the disposal of rubbish: the presence of large numbers of horn-cores suggests that a horner may have been working nearby at this period. Prior to the construction of the first riverside buildings (Fig 115, *A* and *B),* dumps of sand, clay, and gravel were laid down in order to raise the ground level. The foundations of the buildings were of stone, and a shared river wall, which continued for a short distance to the west of building *B,* formed a revetment to the bank intended to reduce the risk of erosion and flooding. Building *B* probably had an industrial function: in one phase it contained a pair of barrels set into the floor associated with a large rectangular hearth. The first building in tenement *C* was a small timber structure founded on cill-beams resting directly on the ground; following a fire this was replaced by a walled compound containing a few pits and postholes but no recognizable buildings. Subsequently a small single-roomed building, approached by a cobbled path, was added to the rear of the compound, partly incorporating the earlier river-wall. Major alterations were made to buildings A and *B* early in the 14th century (Fig 115); these included the construction of a new length of river-wall to retain a reclaimed strip of ground 2.5m wide. Soon after 1300 a large house was built on tenement *C,* but it was evidently not considered necessary to provide a river wall along the full width of the property. House *D* was probably built during the first half of 'the 14th century; by 1450 it had been extended to more than twice its original length and one corner of the building projected into the river (Fig 115). Around 1400 a timber-framed building replaced the earlier house in tenement *C.* Finally, reclamation of the whole area in the angle between St Edmund's church and the riverside houses took place *c* 1500, when a new waterfront was established in line with the west end of the church (Fig 115). Although serious floods undoubtedly occurred from time to time in the period before 1500, the water under the church must usually have been quite shallow, and for parts of the year the riverbed would have been dry. It is therefore perhaps a little surprising that the area was not reclaimed sooner, though the demand for extra space may not have been great enough to make this worthwhile until the period of rapid population growth which occurred in Exeter in the later 15th century.

Gloucester

Carolyn M Heighway and A P Garrod

The town of Gloucester is situated at the lowest crossing point of the river Severn, on a raised spur of gravel overlooking a point where the Severn divides into two (anciently three) different channels (Fig 116). This position commanded in earlier times the principal route into Wales. All three river channels were, before the construction of modern weirs and locks, fiercely tidal; nevertheless, the river was navigable up to and beyond Gloucester, which was a port in its own right until silting of the channels hindered shipping, and the rise of Bristol in the late middle ages eclipsed the older town. Even so, a canal re-opened the water routes to Gloucester in the late 18th century and today a small quantity of waterborne commercial trade still comes to the town.

The town originated, further north of its present position, as a Roman fort built in the 60s AD (Hurst 1975; Green 1942, 39-47). This site was abandoned when a new legionary fortress was built in the 70s on the site of the present town. Both military establishments were positioned on the now-vanished third and easternmost loop of the divided river (Hurst 1975, 268).

The Kingsholm fort may have been so placed because it was beside a ford and it may have had a waterfront, but nothing is known of either. The Gloucester site is slightly better understood. Even when the existence of the legionary fortress was still unsuspected, Green postulated that there must have been a late 1st century harbour settlement on the west side of the city, on the riverfront (Green 1942, 47-51). Green, however, was unaware of the importance of the third eastern river channel (Fig 116), although he recognized that it had once existed: instead, his 'harbour' was centred on a basin or artificial pool built in the present Quay Street area, This hypothesis was based on a line of stakes observed during excavations in 1938 (Knowles 1939), and on a 'curved foreshore' observed at the same time. However, as Rowbotham (1978, 7) has pointed out, 'it is certain that any attempted harbour, basin, creek or indentation opening off the tidal Severn will silt up as

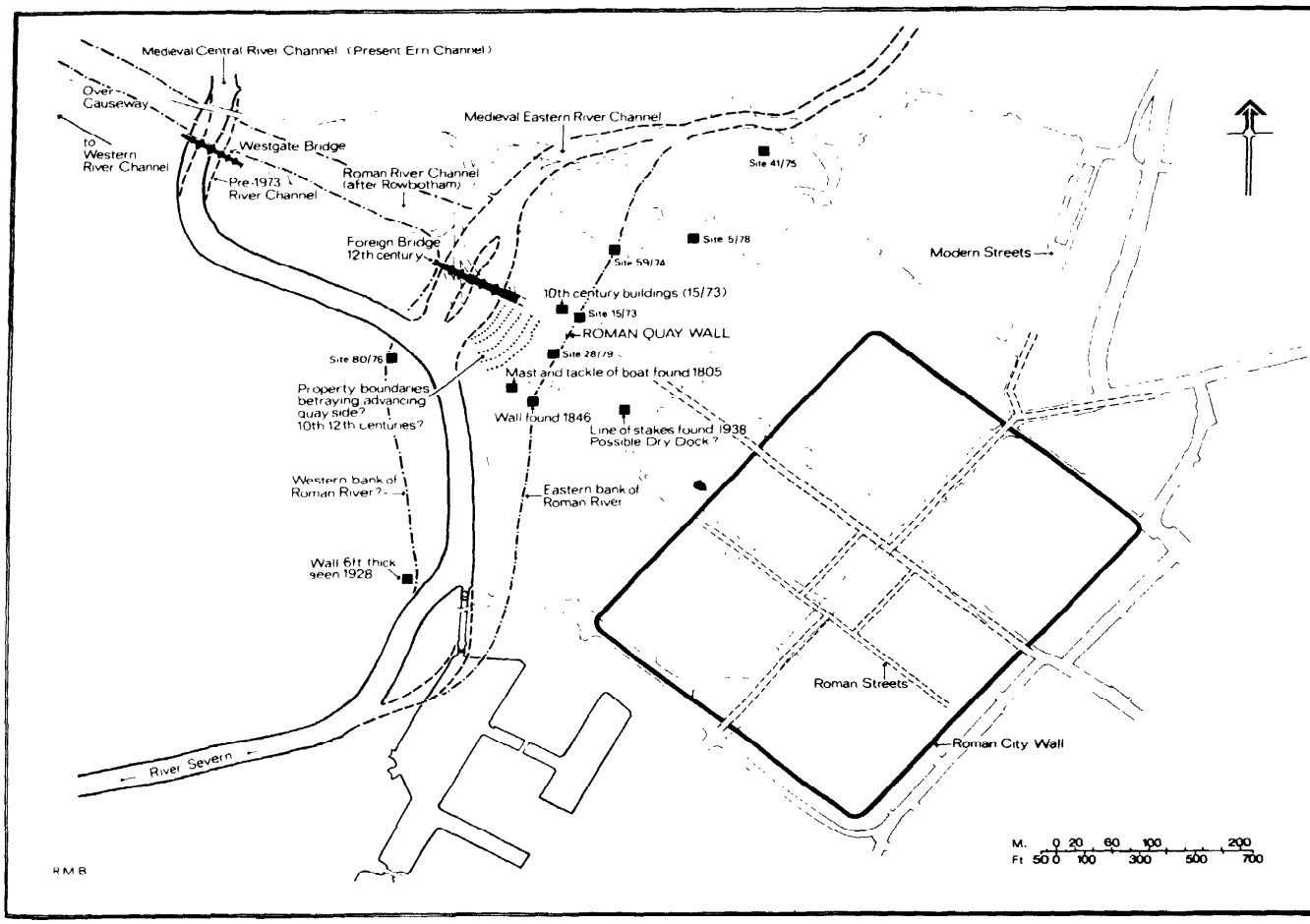


Fig 116 Gloucester: waterfront development

fast as it can be dug', and he offers the convincing hypothesis that the posts represented a 'dry dock', of a sort used up to the 19th century for the repairing of barges.

The changing patterns of the several river courses were vital to the history of Gloucester as a port, and a most likely explanation of the development of the river has been given by Rowbotham (1978). He concludes that in Roman times there were no bridges, but that the crossing of the river could be made by ferry, using the tidal flows, aided by a towpath. When Foreign Bridge was built in the late 11th century, it was the only bridge necessary, since the channels still joined above it. The Roman towpath had become Over Causeway. Later alterations to the river courses caused the increase in size of the central channel, and thus the building of Westgate Bridge, whilst the old east channel silted (probably because of the presence of Foreign Bridge) and finally disappeared altogether (Rowbotham 1978,6-8).

Rowbotham's hypothesis about the river channels in Roman times concurs with archaeological evidence, which suggests that there was a stone quay fronting the east bank of the old east river channel.

Traces of possible Roman quays have been found at several times in the past. 'A wall of Forest of Dean stones, three or four feet square, over lft thick, and laid on piles' was discovered in 1846 at the west end of Quay Street, parallel with the present Quay, not less than 40m (120ft) east of it, and 6-7m (18-20ft) below the then ground level (Fullbrook-Leggatt 1968, 56). Fullbrook-Leggatt also records that a wall 6ft (c 2m) thick on the other side of the river was seen in 1928, in a position (if it was Roman) which would demonstrate the Roman channel here to be about 100m wide. These finds have been further extended by the discovery, during building works, of what is very probably another length of the Roman quay wall (recorded by A P Garrod: Hurst 1974, 46). The wall (Fig 116, site 15/73) was founded on a masonry platform, and was constructed of coursed rubble. It was traced north-south for 16m. The stratigraphy, with redeposited loam east of the wall, suggested that there had been dry ground to the east. To the west, an extensive area of alluvium has been recorded in boreholes (Hurst 1974,42, fig 15). The masonry platform west of this wall was at 6.75 OD (Hurst 1974,48). Minimum Roman water level was at 3m OD; a quay at about 7m OD would provide scope for mooring and working vessels over a useful range of tides (Rowbotham 1978, 7). Roman occupation levels are found at or above 8m OD. The present ground water-level is *c* 8.9m OD (data from recent excavations and Hurst 1974,48, note 2). All this suggests that the purpose of the 'quay wall' was to revet higher ground to the east and prevent erosion during the flooding that certainly occasionally occurred. The masonry platform west of the wall must represent the quay itself.

Further north, in Clare Street, A P Garrod has recorded a section across the line of this quay wall (site 59/74). The wall was not located, but a robber trench 3m wide on its projected line may represent its position. Roman metalling 20.7m wide east of the wall was limited by a Roman building, suggesting an extensive hard-standing area.

Excavations still in progress (site 28/79) have confirmed the line of this Roman wall, which has been robbed but which originally also revetted Roman levels to the east. More detailed evidence of the dating of this quay wall and the sequence of levels west of it will ultimately be available from this site.

Levels representing the possible base of the Roman river bed, with silting levels above, have been recorded between 7 and 8m OD west of the modern river channel (site 80/76). Tegula tile fragments with burnt and unburnt clay flecked with charcoal suggest that some of this material was washed down from the 2nd century tilery (Heighway & Parker, forthcoming: site 4l/75). The river in Roman times was wider at this point than at present.

The quay area of the Roman town may have been populous and wealthy. A large Roman building with painted wall plaster and mosaics has been found underneath the church of St Mary de Lode (site 5/78; excavation by Richard Bryant; Fullbrook-Leggatt 1968, 58). There were other Roman buildings at St Oswald's priory, near the tilery of the *colonia* (site 41/75).

Very little is known about the medieval quayside. The presence of late 10th century timber buildings 15m west of the Roman quay wall (site 15/73: Hurst 1974, 48: pottery reassessed by A G Vince) shows that the waterfront must have shifted considerably to the west in post-Roman times. The pattern of burgage plots south of Westgate Street (Fig 116) suggests the positions of advancing quay frontages which appear to predate the 12th century Foreign Bridge. Tradition also places a medieval quay near St Oswald's Priory (Toulmin-Smith 1908, 57). By the post-medieval period the quay was south of the bridges, out of the eastern channel (by then silted up), and in the area still known as 'The Quay' (Rowbotham 1978,7; Hurst 1974).

An account of 1873 says that in *c* 1805 the mast and tackle of a boat were found 'at the bottom of Bearland', ie modern Quay Street (Bellows 1877, 176, 179). The exact position of this discovery is uncertain, and the vessel may have been either Roman or early medieval. The find suggests that quayside excavations may have some important discoveries to offer. Forthcoming excavations at 129-139 Westgate Street may yet be significant in this respect, but the excessive depth of the waterlogged levels would make recovery of the evidence excessively expensive.

Harwich

S R Bassett

Harwich occupies an area of *c* 6.5ha on a narrow neck of land surrounded on three sides by the estuary of the river Orwell. The port was probably founded in the late 12th century, certainly before 1229, by the Earl of Norfolk within the parish and manor of Dovercourt. The grant of a market and fair followed in 1253 and the borough charter in 1318, and murage grants in 1338 and 1352 show it was walled by the mid 14th century.

In 1972 three excavations were directed by S R Bassett for the DoE and the Essex Archaeological Society. One of these excavations, the Quay Pavilion site to the south of the 15th century Customs House, was on the waterfront (report in preparation). A succession of medieval and post-medieval quays and stairs were located, in which each successive quay rebuild advanced the waterfront seawards.

The earliest quay structure found lay *c* 50m behind the line of the present quay face, and was built of septaria bonded with a hard white sandy mortar. It incorporated part of an elaborate Watergate flanking the western side of a masonry stair *c* 1.30m wide descending to the foreshore, which may have replaced an earlier timber stair. In the early 15th century deeply set timber shuttering was erected 4.5m seawards of the previous frontage and the area between was infilled with compacted sand, gravel, and clay, surfaced with spreads of thin pounded gravel. Associated with the construction of the indented timber-faced frontage was an extension to a masonry building over the area of the former quay. In front of this were two smaller features, both with cobbled floors and both set at the head of indentations in the line of the quay, probably forming the bases of timber-framed pivoting cranes. By the end of the 15th century, the indentations in the frontage had been infilled to form an unbroken quay face, and a timber-framed stair, the famous Lambard's Stairs, erected. Another pair of probable 'crane houses' was found, this time on the edge of the straightened quay. They had been removed by the early 17th century, when projecting wings were added to the Custom House and the interior of the 15th century extension was remodelled to enable merchandise to be stored more efficiently.

By the middle of the 17th century the property on the quay was no longer owned by the King's Revenue Officers but by private merchants. At this time a jetty was constructed with a timber stair in the central indentation. The inlet was eventually infilled with pounded chalk in the mid 18th century, and the masonry building was also substantially remodelled. The wings were amalgamated to form the large brick warehouse with extensive cellarage which survived until the 1850s, when the advent of the railway to Harwich occasioned a further advance of the quay.

Hull

B S Ayers

The influence of port facilities upon the situation, growth, and, in places, recent decline of the town of Hull is amply reflected in the surviving topography (Fig 117). The concentration of shipping in the Old Harbour or Haven throughout the medieval and much of the post-medieval periods led to an increasingly dense population within a small triangular area of some 32.6ha, bounded to the east and south by the rivers Hull and Humber and to the north and west by 14th century defensive walls. Such was the predominance of the port that large-scale extramural growth was only stimulated by the construction of the town's first dock in 1778 on its northern boundary. Further development followed with the opening of two other docks on the western boundary completing the encirclement of the medieval town with water, but the phenomenon of associated expansion reached its peak in the 19th century with docks along the margin of the Humber, often with specialized communities in close proximity, such as the fishing community of Hessle Road adjacent to St Andrew's Dock. Until World War II Hull survived as an elongated sprawl on the north bank of the Humber, with ribbons of development on arterial routes and the river Hull itself. It is only in recent years, with a decline in the importance of the port, a diversification of industry, and enormous rehousing schemes that this traditional topography has been challenged.

Much of the later post-medieval development still remains or is well recorded. However, despite considerable research since Frost first conclusively demonstrated that the town of Hull predated the reign of Edward I (Frost 1827), the medieval origins of the port remain problematic. The river Hull itself, probably with an early medieval outflow in the form of a delta-a situation reflected in a narrow watercourse located in excavations at Sewer Lane, Hull, in 1974 (Armstrong 1977)-would seem to have gradually become channelled into two cuts, a main one known as the Ald Hull, the location of which remains to be firmly established, and an increasingly important, possibly artificial, one known as Sayer Creek (Allison 1969, 12). At some point in the 12th or 13th centuries the river was diverted permanently into this creek, approximately following the present-day line. This may have been a gradual occurrence or it could have been more rapid, one suggestion being that the diversion of Hull occurred *c* 1252-3, concomitant with widespread flooding along the entire east coast (Gillett 1979). It was this new course which provided a haven around which grew a settlement known as Wyke, subsequently Hull (Allison 1969, 13).

This settlement would seem to have originated in the late 12th century, probably to export wool for the Abbey of Meaux, situated 11.5km to the north. It may be the port referred to as 'portus de Hulmo' in 1193 and was included in John's taxation of the east and south coast ports in 1203-5 when it was the sixth port behind London, Boston, Southampton, Lincoln, and King's Lynn. By 1290, immediately prior to its acquisition by the Crown, it was the third (Bilson 1929, 105, 41, 45-46).

The exact location of the 12th century port remains unknown but settlement was firmly established along the west bank of the present River Hull by the late 13th century. The wealth of 14th century documentary evidence surviving for Hull (cf Horrox 1978) would indicate that this settlement was centred on the sinuous line of High Street, which runs parallel to but removed from the present river course, and would seem to have formed the original quayside until subsequent reclamation caused the west bank of the river to move eastwards. The earliest known plan of Hull (Cottonian MSS Aug 1, i, 83) does indeed show the river adjacent to the High Street (formerly known as Hull Street) for part of its length, although this drawing has recently been convincingly dated to the mid 16th century (de Boer 1973). Such a river alignment would seem anomalous at this late date, so it must have represented a known earlier situation. Accordingly it was decided to undertake an excavation early in 1978 to test the proposition that High Street marked the original west bank of the Hull river and to examine any associated quayside facilities (Ayers 1979).

An east-west trench was sunk at right-angles to High Street, north of Chapel Lane Staith and natural clay was located at a depth of 3.04m OD adjacent to the street.

However, it sloped dramatically to reach a depth of--0.63m OD at a point some 17m east of the street. This must have formed the original west bank of River Hull, 70m west of the present-day alignment. Associated with it were the remains of a late 13th century timber revetment, partially destroyed with the construction of a waterfront building upon massive limestone and chalk footings. This building was contemporary with a second oak revetment which extended the frontage to the east and survived to its full height of 3.47m (Fig 118). Within the area of excavation, it consisted of four vertical posts, apparently set into base-plates, braced to the rear, surmounted by a cross-plate, and shuttered on the landward side. It is probable that the feature was constructed in two stages to enable the upper part to be replaced should it deteriorate more rapidly than the lower half, a system paralleled at Trig Lane, London (see 35 above). Joists survived above and at right-angles to the top plate for a planked decking. The timbers were held by mortise-and-tenon and lap-joints secured by dowels, whilst the shutters had been nailed. Saw, chisel, and adze or axe marks were visible.

The area to the rear of the revetment, between it and the waterfront building, was deliberately infilled with rubbish material which included quantities of leather shoes, sheaths, and a decorated panel. The lower part of the river side of the revetment was encased in chalk, which would seem to have been deliberately placed in the river to provide a platform for shipping to rest on at low tide so that unloading could continue unabated. Reference was made to similar platforms at a Harbour Enquiry in 1845 as a hazard to shipping (Wood 1845, 53). The excavated platform meant that the draught of water was reduced but was still of adequate depth for barges, keels, or hulks (present-day river levels are *c* 0.20-0.40m higher than those in the early 14th century). The revetment itself could be dated to *c* 1320 and probably fell into disuse some 50 years later, being replaced by a third revetment only partially uncovered by the excavation. The ground was then consolidated, further

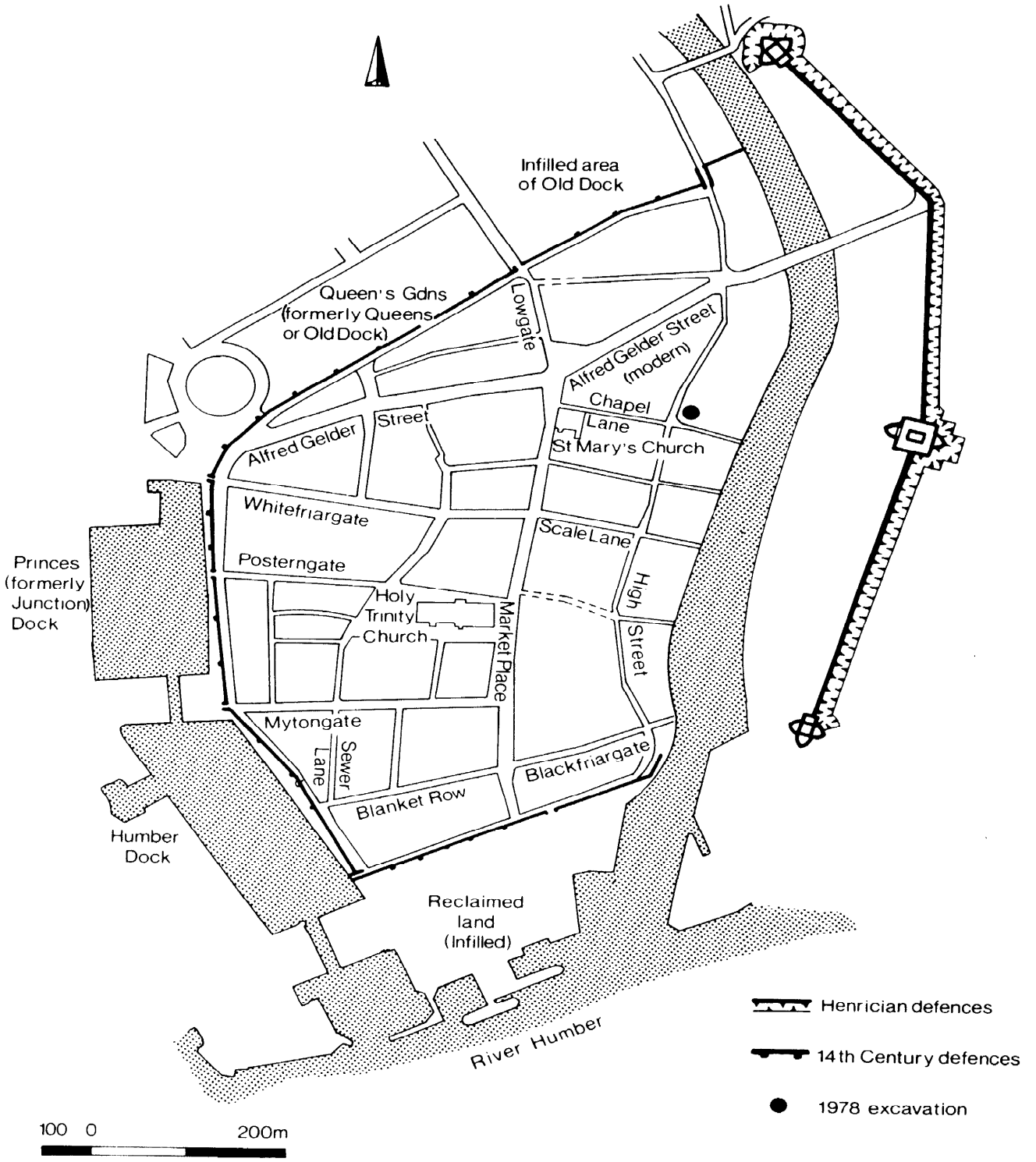


Fig 117 Kingston-upon-Hull: the Old Town

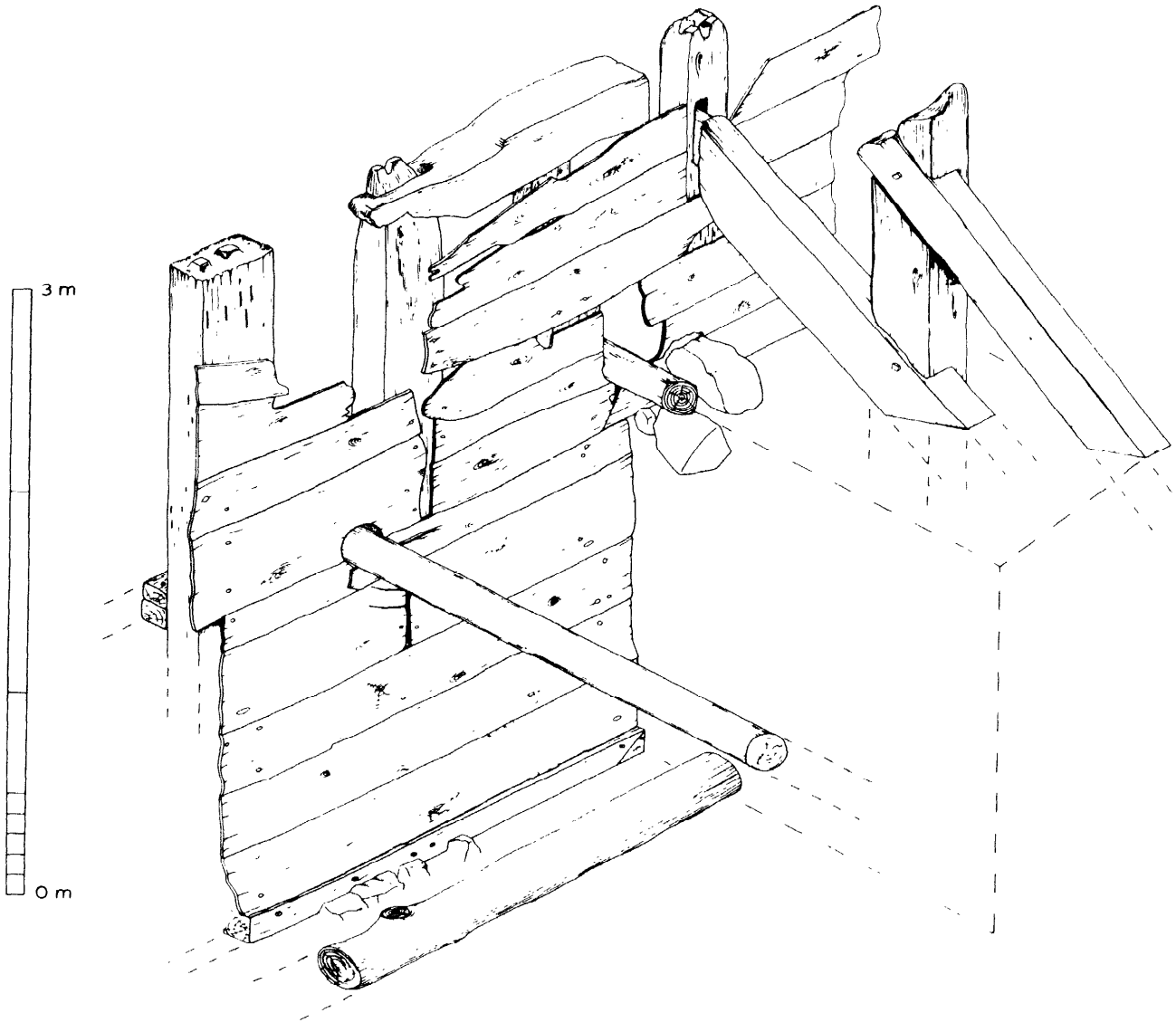


Fig 118 Chapel Lane Staith Hull: isometric drawing of landward face of early 14th century timber revetment from north-west (drawn by Christopher Brown)

quayside buildings, generally with brick footings, being built above.

It would therefore seem that the medieval working waterfront in Hull was gradually extended eastward into the river in common with observed phenomena in other Northern European towns. It is likely that the excavated revetments formed part of a private staith or berth parallel to the street and separate from the common or public staiths, which were mere extensions of the streets running to meet the High Street. Measurements by Hadley in 1788 confirm the difference. The width of private staithes is usually approximately equal to that of the properties behind which they were built, but the width of the common staiths at the river end is the same as the width of the street, and these must have been simple jetties (Hadley 1788, 688). The gradual encroachment into the river is also depicted cartographically. The Cottonian manuscript referred to above clearly shows a relatively wide river, whilst the river width is actually given as 246ft on a plan of the defences dated to the early 1540s (Shelby 1967, 30-31 and pl 8) and as 206ft at high water opposite Chapel Lane Staith by Hadley (1788, 687), comparable with a present-day width of about 175ft. Ultimately the infilling east of High Street was to result in an increase of 6.75% in the area of the Old Town,

This narrowing of the haven only exacerbated congestion and by the 18th century the situation was intolerable. Development east of the river was impossible owing to the location of Henrician and later defences. The agitation for the construction of a new dock, eventually opened in 1788, was bitterly opposed by High Street interests, but as its entrance was through the haven, the latter continued to be

of importance. The completion of the Humber and Junction Docks, however, enabled shipping to reach the first dock by an alternative route and, in consequence, the value of property adjacent to the old haven fell considerably (Allison 1969, 187). Subsequently numerous factors governing both trade and population led to a further decline in the haven's importance until it reached the state of minimal use prevalent today.

The combined use of cartographic, documentary, and archaeological evidence is continuing to advance knowledge of the history of the port, from estimates of tidal range to the use of cranes in the medieval haven. Further, the close association of the town with the port gives study of the historic waterfront a direct relevance to the history of the community.

Ipswich

K J Wade

The chief interest of the Ipswich waterfront must lie in the potential to examine the Middle Saxon wharf known to have been engaged in international trade and most probably under royal patronage (Dunmore *et al* 1975). The exact position of this early quay is unknown, however, largely owing to the lack of modern redevelopment (and hence boreholes, etc). It was probably confined to the area between the 'Wash' to the east and Stoke Bridge on the west, the latter being referred to by name as early as 970 (Scarfe 1972, 129), and was certainly no further back (north) from the present wharf than the south side of Key Street/College Street- The borehole evidence that is available suggests that it lies no further back than 20m from the present wharf.

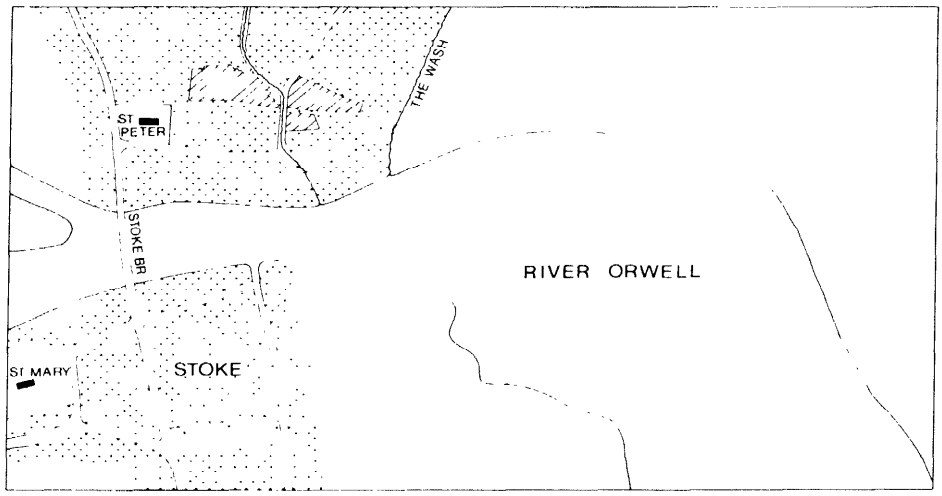
From the early 13th century, with the establishment of St Clement's parish (Redstone 1969,27), the quays gradually extended further east and then south around the bend in the river. The major changes to the waterfront took place in the 19th century. Between 1838 and 1842 the old river channel was deepened, forming a new wet dock, and a new channel was cur alongside for the river Gipping and tidal waters of the Orwell (Redstone 1969, 44).

There has been no archaeological excavation on the waterfront and very few finds seem to have been recovered during the great 19th century rebuilding, apart from a pair of bone skates found with a youth's skeleton 3.3m (11ft) down in the old river mud and some Romano-British material (Layard 1899).

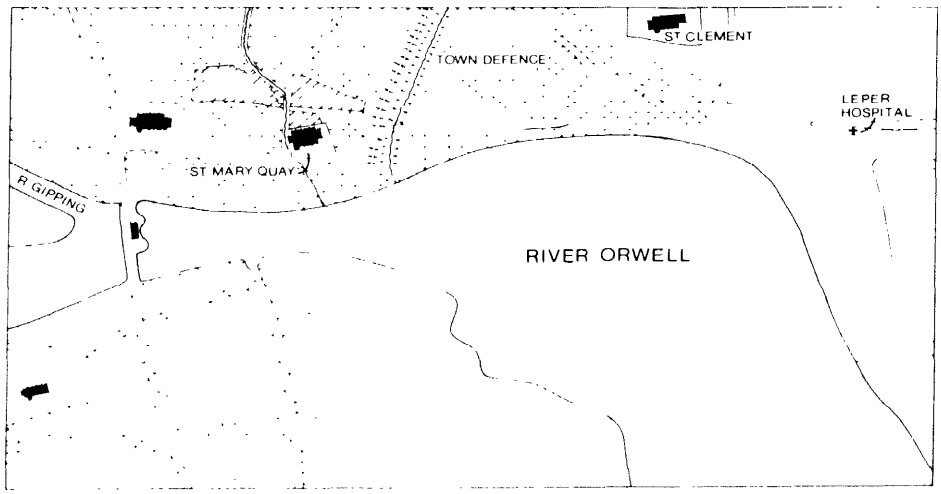
The earliest surviving buildings, other than churches, are a handful of timber-framed structures, none of which are earlier than the late 15th century (Colman 1976, 142; Scarfe 1972, 222-3).

Sites for excavation on the actual waterfront seem unlikely in the foreseeable future, but there are possibilities to the north of Key Street (Fig 119), including the redundant St Peter's Church, most probably the 'early' minster of the town.

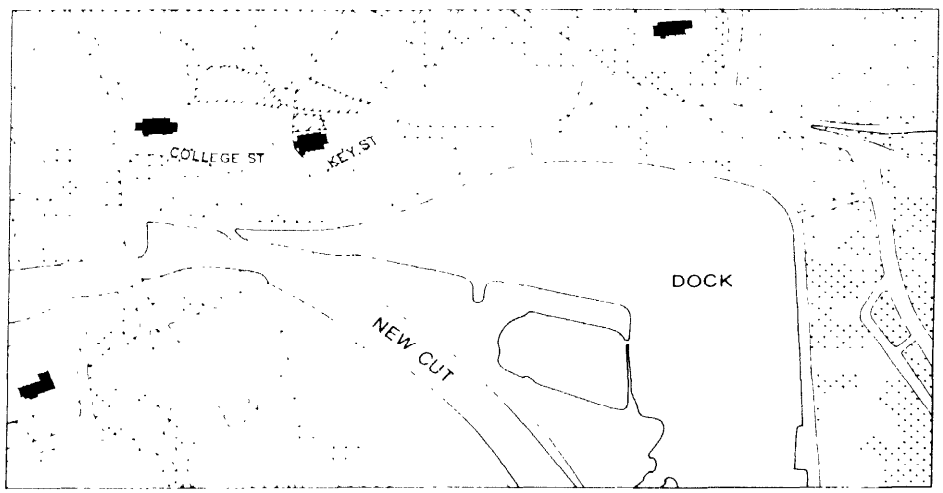
Fig 119 Ipswich: waterfront development vacing page)



MIDDLE SAXON



MEDIEVAL



LATE 19th C

OCCUPIED AREAS

POTENTIAL AREAS OF EXCAVATION

0 250 m

Kirkwall

N McGavin

Kirkwall is first mentioned as a place-name in the 11th century. During the medieval period it became the capital of the Norwegian Earldom of Orkney and the seat of the earls and the bishops of Orkney. In 1468 the Earldom formally passed to Scotland, and in 1486 the town was chartered as a Scottish Royal Burgh. Kirkwall lies near the centre of the main island of the Orkney Archipelago at the east side of Kirkwall Bay. At this point the bay is almost

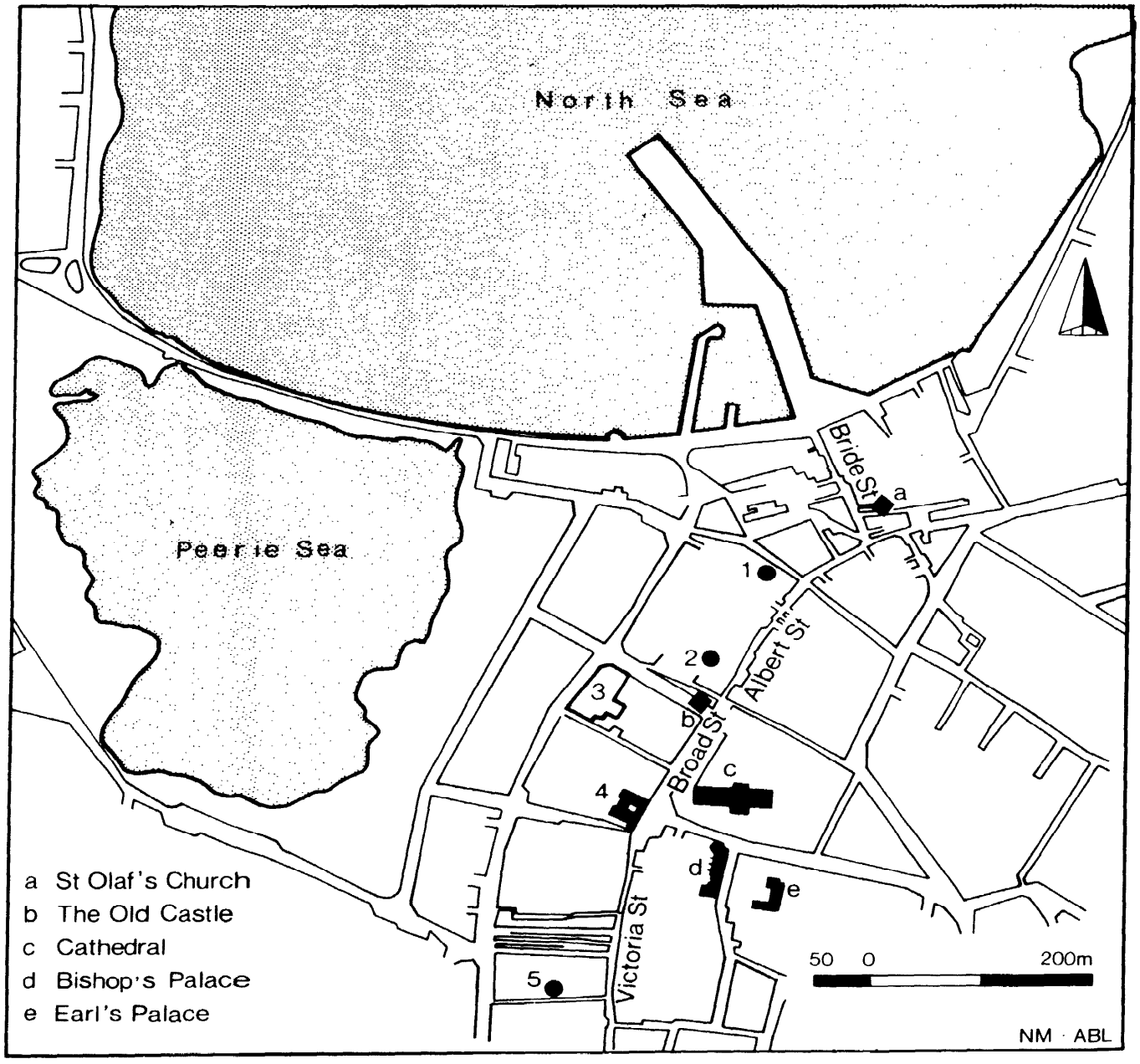


Fig 124 Kirkwall. excavations– **1** *Mounthwlie Lane;* **2** *57 Albert Street;* **3** *Old Gasworks;* **4** *Tankerness House;* **5** *Gunn's Close*

blocked by a sandspit. The town therefore has two waterfronts, one looking north into Kirkwall Bay and the other west into the now almost landlocked arm of the bay known as the Peerie Sea. The northern waterfront-traditionally supposed to have been a centre of early settlement-is occupied by the modern harbour and has not been archaeologically investigated. The western waterfront has been pushed forward across the Peerie Sea by land reclamation, a process which started in the medieval period from the main street line running from Bridge Street through Albert Street and Broad Street to Victoria Street. In 1978 five small trenches were excavated to the west of this street line by the Urban Archaeology Unit. The excavations were sponsored by the Scottish Development Department, Inspectorate of Ancient Monuments.

All the trenches were waterlogged, and wood, leather, and other organic materials were preserved. The line of the medieval waterfront was found only at Tankerness House (Fig 124, 4) where a beach derived from chippings of non-local red freestone, similar to that used in building the Cathedral and Bishop's Palace, was overlain by a probable jetty of grey flagstone. This feature recalls a local oral tradition that ships were sailed up to the steps of the Cathedral, some 50m to the east.

The post-medieval seawalls found at 57 Albert Street and Gunn's Close (Fig 124, 2 & 5) were of local grey sandstone. Substantial evidence of post-medieval reclamation was also recovered from Mounthoolie Lane Fig 124, l), but at the Old Gasworks site natural grey sand directly underlay the topsoil (Fig 124, 3).

No future work in Kirkwall is planned.

Further reference

Gourlay, R, & Turner, A, 1977 *Historic Kirkwall: the archaeological implications of development*, Scottish Burgh Survey, Department of Archaeology, University of Glasgow

Lincoln

M J Jones and R H Jones

Lincoln's extensive waterfront was of considerable commercial importance in the Roman, Viking, and medieval periods (eg Hill 1948, 306). Recent research by archaeologists and geomorphologists have thrown light on the fluctuations in sea level which have taken place since the Iron Age (Simmons, forthcoming), but investigation of the city's ancient waterfront has so far been too limited in scale to add greatly to knowledge of this problem.

No evidence for Roman waterfront structures was recovered from any of the sites recently investigated, although part of a presumed Roman quay formed of huge stone blocks was noted in 1954 on the north side of the River Witham to the east of the walled area *(J Roman Stud* **45** (1955), 131).

Archaeological excavations, all under rescue conditions, have been confined to the north and east sides of the Brayford Pool (see Fig 125). In 1972 work revealed the medieval Lucy Tower on the north side of the Brayford, and the extended western defences, which had been founded on reclaimed land in the 13th century. Immediately to the east of this site, trial excavations in 1975 revealed the line of a timber-faced waterfront *c* 50m north of the modern edge of the Pool, datable to the 10th–13th centuries. This feature was visible from the presence of vertical piles and a vertical break in the stratigraphic deposits, but structural details could not be elucidated. Almost 30m to the south of the timber wharf was a stone wall of late medieval/early post-medieval date. A stone-lined drain which appeared to be part of the same construction was not carried to the south of the wall, suggesting that it may have lain on the contemporary waterfront. The presence of a wide entrance, later blocked, and traces of flooring to the north suggested a commercial structure, probably one of several along the edge of the Pool.

On the site of Dickinson's Mill to the east of the Pool, trenches cut in 1972-3 exposed part of a wharf (or a rubbish dump revetment?), formed of the hull of a boat of clinker construction supported by vertical piles. These had been set in clay which contained pottery of 13th century date. Horizontal timbers were also found, possibly used as bracing for the earth piled against the landward side of the boat hull. The whole feature was subsequently buried and succeeded by a limestone wall further east, founded on timber piles and dated to between *c* 1500 and *c* 1700.

In summary, much is still to be learned of the successive waterfronts of Lincoln, and no work has yet been possible in the area east of High Bridge, which is potentially the most rewarding. Taking into account also the value of waterlogged deposits, rare in Lincoln, as a source of environmental samples, this remains one of the top priorities for future archaeological research in the City.

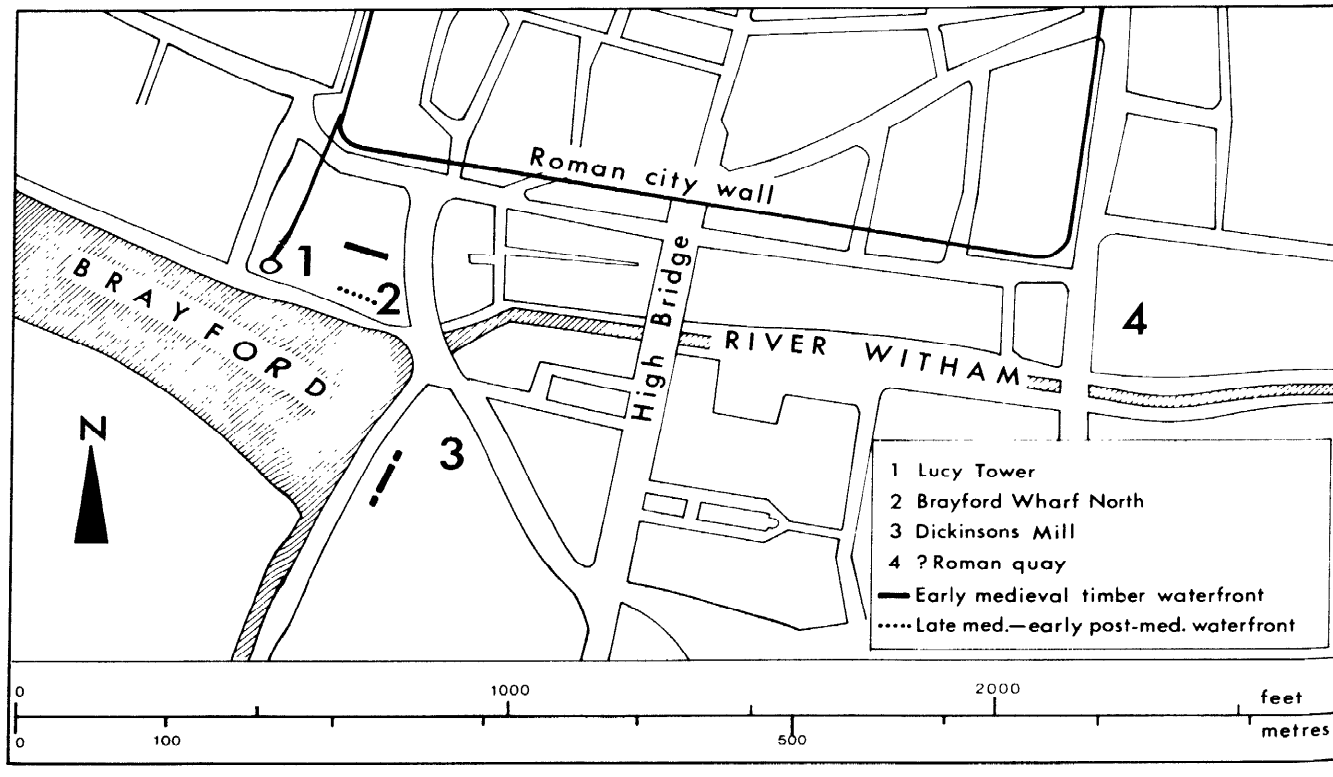


Fig 125 Lincoln: location of excavated waterfront features

The relationship of the river Wensum at Norwich to the settlement on its bank has attracted attention since the early 19th century (Carter 1978, 177-82), but many of the problems are still to be resolved. 17th century and later maps (Speed, Cleer, Corbridge Blomefield, and Hochstetter) show the post-medieval form of the river and mark the positions of the medieval mills, bridges, and wharves but made no direct statements on the extent of flood plain or marsh at any period. An indication of the greatest possible extent of the flood plain in historic times is, however, provided by the form of the streets nearest the water-front (Fig 126), and these indications are supported by the evidence of archaeology, of borehole logs, of place-names and, to a very limited extent, of documents (Murphy, in preparation).

The pre-urban form of-the river and its banks, however, can be reconstructed, if at all, only with difficulty, not least because of the effect of artificial constrictions such as the bridges, the causeways at Bishops' Bridge and Fyebridge, and the mill dams in Westwick and Heigham. It seems probable, however, that the river occupied a broad flood plain above and below the position of the city, that the flood plain narrowed downstream of the site of the Westwic/Heigham mills, and that it was at its narrowest between the sites of the earliest bridges (Whitefriars' and Fye Bridge, the earliest references to which are of the early 12th century).

The city's original wharves seem to have been in the vicinity of Palace Plain (south of *D* on Fig 126), where excavation is planned for the future. Staithes for small boats landing shellfish continued nearby (between Whitefriars and Fye Bridge) into the medieval period (Hudson and Tingey 1910, xxxvi; Kirkpatrick 1889, 67). A movement of the major wharves to below the lowest bridging point (Bishop's Bridge, first recorded in 1269, now surviving in its mid 14th century form) probably occurred in the 12th century. By 1225 Isaac of King Street was being licensed by the King, because he was a Jew, to 'extend and make his quay in the same way as his neighbour' (Hardy 1844, 67). In the 1280s both public and private wharves are recorded (Kirkpatrick 1889, 6, 7) east of King Street, an area where river and road were extremely close and the extent of marsh, if any, minimal. Two wharves, the Old and New Common Staithes, were constructed by the City in 1379 and a contract for the reconstruction of-the latter in 1432, with a crane, is published (Salzman 1967, 501-2).

From 1379 the City exercised a wharfage monopoly: 'no ship or boat shall be laden or unladen except at the staithes belonging to the community, and if it shall happen otherwise, as often as a ship or boat is discovered it shall be arrested for 15 days and amerced at *6s 8d.* . . And that no merchant shall presume to lade or unlade goods or merchandise except at the Staithes aforesaid under the penalty of 20s' (Hudson and Tingey 1910, 233-6). Opportunities for excavation in this area are minimal, and the one surviving riverside warehouse (of the 14th and 15th centuries) has not yet been investigated.

Evidence for occupation of the low-lying ground to either side of the river (usually where the gravel terraces or the underlying chalk, overlain in some cases by River Brickearth, a Late Devensian or Early Flandrian redeposited loess, dip below deposits of flood loam and peat) has come from eight sites.

Heigham Street: 283N. Occupation, on the lowest terrace gravel, began in the late 13th or 14th century. Evidence of possible flooding in the later 14th or early 15th century may be connected with the rebuilding, after a long period of dereliction, of the city's mills in 1430, the immediate result of which was upstream flooding (Hudson & Tingey, 1906, 350-4). The mills were closed for a period of six years (during which period the bakers had to use mills up to ten miles from the city), after which a gauge was fitted in the dam gates and the problem abated (Fig 126.1).

Westwick Street: 159N (Carter & Roberts 1973, 457 60, 464-7). Evidence of scattered 11th/l2th century industrial activity was succeeded by that for ephemeral occupation in the early 13th century. Subsequently substantial houses of merchant dyers were built on 0.3m thick silt-loam deposits overlying the earlier structures. Documentary evidence suggested a westward-moving colonization of the river bank (by dyers, fullers, tanners etc) from the 1280s onwards and intensive use of a mid-stream island or bitmay. This, and other bitmays, may have been formed artificially by cutting diversion channels (Fig 126.2).

Coslany Street: 166N (Carter & Roberts 1973, 463-4). The earliest occupation on the riverward side of Colegate was of the 13th century and industrial in character. This pattern conforms to the scattered documentary and building site evidence available elsewhere (Fig 126.3).

The Duke's Palace: 169N (Roberts *et al* 1975, 100-1). In 1681 this site was aptly described as 'a dunghole place . . . pent in on all sides both on this and the other side of the river with tradesmen and dyers houses who foul their water by their constant washing and cleansing of their cloth'. A deep embayment of the river marsh was made habitable, but only barely so, by massive dumping of redeposited soil in the mid 16th century (Fig 126.4).

The Blackfriars: 176N (Roberts *et al* 1975, 102-4). Massive later 14th century dumping of-soil permitted the construction of large cloisters to the north of the Friary Church between 1345 and 1449 (Fig 126.5).

Wensum Street: 171N (Roberts *et al* 1975, 101; Hudson 1898, 217-32). Evidence was recovered of a late Saxon causeway, heightened in the 13th century, crossing a 110m width of eutrophic valley peat. Permanent standing water was apparently absent during the formation of the peat so that the successive dumps of soil over it and the heightening of the causeway *may* represent reaction to a rising water-table; the fruits and seeds from these layers, however, show no clear trend towards wetness or dryness, while the molluscs from the deposits have yet to be examined (Fig 126.6).

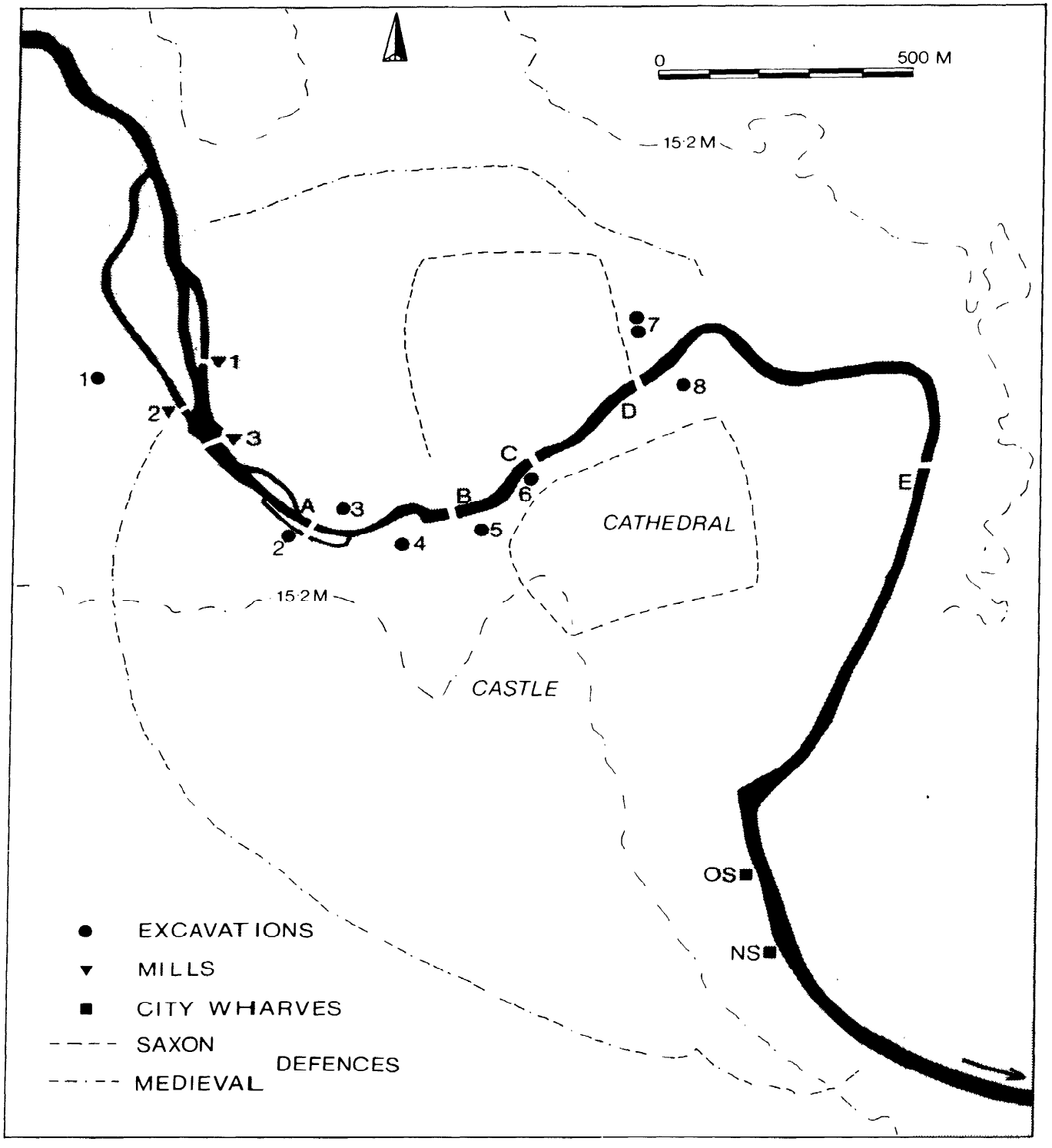


Fig 126 *The Medieval Norwich waterfront. Maximum extent of marsh/floodplain shown stippled between the lines of the waterfront streets. Excavations numbered as in text. Mills:* **1** *Calk Mills;* **2** *Appleyard's Mills;* **3** *New Mills. Bridges:* **A** *Coslany Bridge;* **B** *St Georges Bridge;* **C** *Fye Bridge;* **D** *Whitefriars' Bridge;* **E** *Bishops' Bridge. Wharves:* **OS/NS,** *Old and New Common Staithes*

Whitefriars: 36N and 318N (Atkin & Sutermeister 1978, 20-4; 318N was only summarily reported). At the south extreme of a low-lying area known as 'Cows-Croft' (settled during the mid 12th century: Blomefield 1806, iv, 429), two small sites revealed 13th century dumping of soil over the valley peat. Domestic buildings overlying this were flooded several times before the site was taken over for a friary in 1256; storms and east coast floods, culminating in the disastrous ones of 1287 and 1290, are known to have occurred in 1216, 1240, 1250, 1251, 1271, 1280, and 1286 (Lamb 1977,451; Woodward 1881, 150) (Fig 126.7).

Bishopgate: 156N (Carter & Roberts, 1973, 449-53). In an area adjacent to where the Saxo-Norman wharves are thought to lie, 10th/11th century and later occupation (industrial and domestic) lay directly over terrace gravels. There was evidence on this site neither of flooding nor for deliberate making-up of levels (Fig 126.8).

The reasons *why* the river-front was increasingly exploited (or exploitable) from the 12th century onwards have still to be explained. It is not sufficient to account for it in terms of rising population pressure or an expanding economy,

Addendum

A small excavation (421N) was undertaken by the Norfolk Archaeological Unit in late summer 1979, south of the river Wensum and to the west of Whitefriars Bridge. A gravel beach or terrace was found to be overlain by a series of brushwood mats, Late Saxon in date, generally held in position by dung and straw, which also acted as water inhibitors. This formed a working surface, probably for the beaching of rivercraft. Posts set at intervals were more likely to have formed individual mooring stations rather than constituent parts of a wharf, jetty, or staith. The area was abandoned in the late 11th or early 12th century and it now seems likely that any larger-scale wharves of this period lie to the east of the bridge.

B S Ayers
Field Officer (Norwich)

Oxford

B G Durham

The Thames today plays virtually no part in Oxford's economy apart from the growing traffic of pleasure craft. But as early as the mid 11th century it is clear that the citizens were anxious to improve the passage of river freight to London *(Chron Mon Abingdon* **1,** 480-1; **2,** 282), and the first Thames 'turnpikes', ie pound locks, resulted from an Oxford civic and academic deputation to Parliament in 1624 (Thacker 1914, **1,** 65-72). Records of large consignments carried overland have puzzled historians however, and Salter (1936, 17) provided the logical answer, that for the later medieval period the conflicting demands for water power and fish-trapping meant that Oxford's route to the tideway was temporarily closed to vessels of economic size. Davis (1973) quotes the available sources and suggests there was a long interruption in traffic, causing an overall decline in the town's prosperity. However, one should not ignore Thacker's conviction that through-traffic went on to at least the early 15th century (Thacker 1914, Appendix 2). There is also some uneasiness about Professor Davis's conclusion that river trade was the controlling influence on the town's economy.

There is no evidence for pre-Saxon riverfront activity in the town area (but see Young 1977, 234). Af far as can be ascertained, the town originated at the north or 'Mercian' end of a sophisticated causeway built across the Thames in the late 8th century AD. Excavations suggest that the causeway attracted heavy silting on its upstream side (Durham 1977, 176-80), which makes it hazardous to try to reconstruct the braided morphology of the early river system. The most important evidence is that the river channel closest to the town area, now the Trill Mill Stream, has an occluded channel 50m wide. It would not be too surprising if at an early date the river was modified to force most of the flow along this line just beneath the town, possibly about the time the causeway was built (Durham 1978). The earliest waterfront might therefore be expected just outside the south gate, in the area of Brewer Street and the Christ Church vehicle entry (at present inaccessible for excavation). At some stage the second channel to the south was to take up the role of navigation and with certain alterations continues to the present day. This situation presumably already applied by the 11th

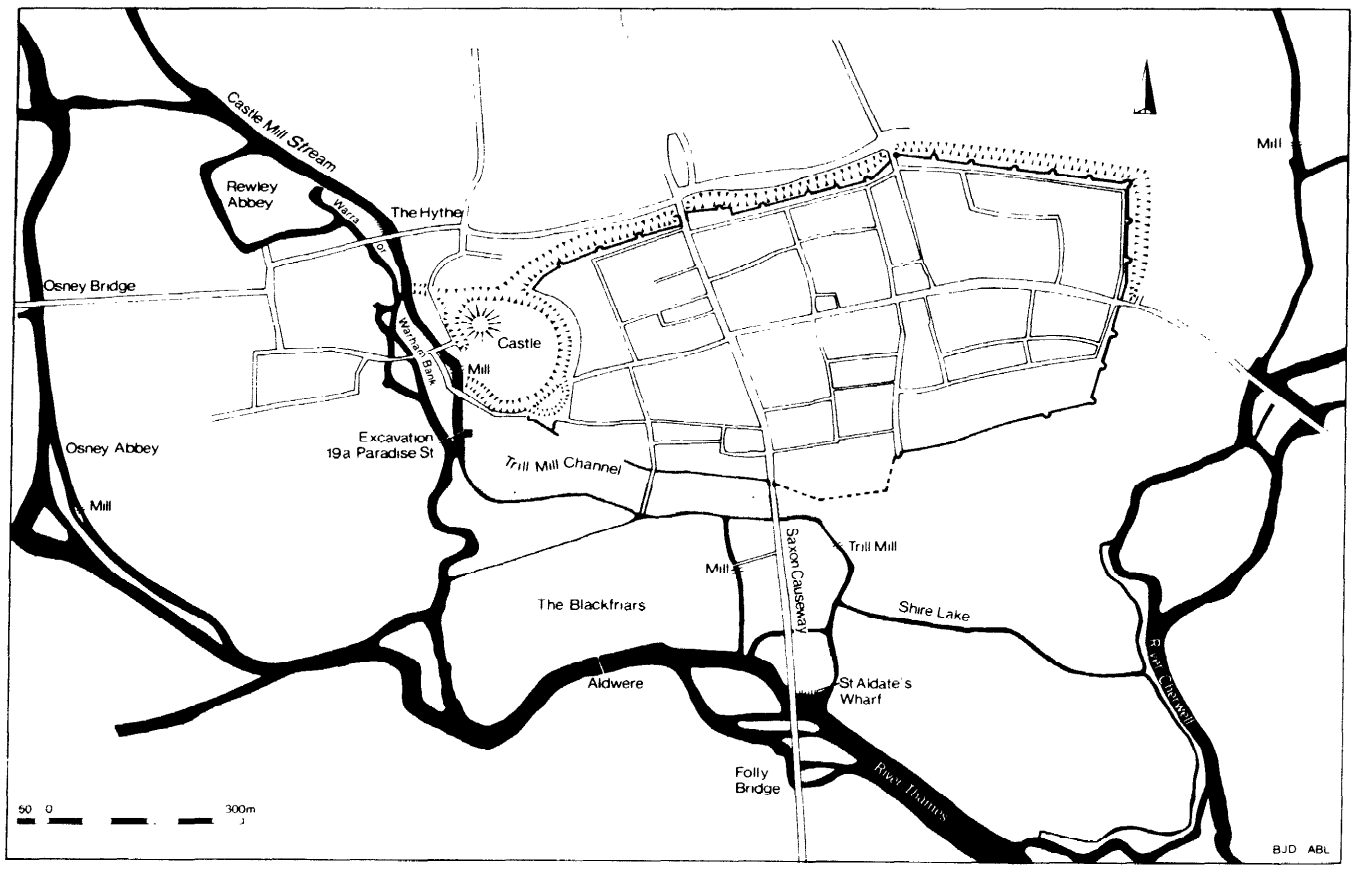


Fig 127 Medieval Oxford and its river channels

century, when there were buildings on the first section of the causeway and a mill and leet on either flank (Durham 1977, 186). The mill races would have provided waterfronts at the rear of some of these properties and there may be an opportunity to excavate such a site within the next two years. Other than this it must be assumed that the main waterfront was the area of the St Aldates Wharf at Folly Bridge, which continued until recently as a working wharf.

Only one area of Oxford's extensive riverfront has been investigated archaeologically: the townward bank of the Castle Mill Stream just below Swan Bridge had two successive medieval revetments but with no evidence of commercial activity (excavation at 19a Paradise Street by J Fox and the OUAS in 1977). The Hythe, recorded as a 'landing place' in 1233-4, was further up this stream above the mill, and the closest riverfront to the north gate. The landing place was on the *warra* or embankment of the mill leet (Salter 1929, 470-3). There is evidence that it was the transhipping point for the river above Oxford (Arkell 1947, 38, 61), which was probably already navigable to 'boats of good burthen and contents' (Thacker 1914, 66). This arm of the river has probably gradually declined in importance as the flow has been diverted to benefit the mills of Oseney Abbey, founded in 1129 (Salter 1929, 462- 70). The result has been that here, as in St Aldates (see above), navigation now follows a channel further from the town and nearer to the middle of the broad valley. The main rise in river levels probably occurred in the 9th to 11th centuries with the establishment of-the river crossings and mills. At St Aldates it brought the level to *c* 0.5m above the natural surface of the flood plain, a rise of well over 1m above the presumed level in the original channels, Since the 11th century the mean level seems to have risen no more than *c* 0.2m.

Current work on excavated pottery suggests that amongst widespread contacts Oxford traded particularly with London in the 9th and 10th centuries, and with the east midlands including Stamford in the 10-12th centuries (I am grateful to Maureen Mellor for this information). It would, however, be premature to link these contacts with any particular mode of transport until such time as early wharfage is located. The river frontage remains one of the more neglected aspects of the city's archaeology, but a programme of investigation is developing and it looks as if the suburban area of St Aldates parish will yield the most promising results.

Plymouth

J Barber and Cynthia Gaskell-Brown

The first extensive area excavation of an urban waterfront in Britain was directed by J Barber for the Plymouth City Museum and the DoE at Woolster Street, Plymouth, from 1963 to 1969 (Barber 1971). The 850m^2 area investigated had been reclaimed by degrees from a former western extension of Sutton Pool between the 13th and 17th centuries (plan published in *Medieval Archaeol,* 13 (1969), 264, fig 80).

The lower levels of harbour silt were almost barren of finds, representing a long period of natural silting with little human activity in the immediate vicinity. However, several fragments of red Romano-British tiles and a sherd of native Iron Age pottery of the 1st century BC or AD were found in the last 0.30m of deposit before bedrock was reached. These slight indications hint at the presence of an early settlement near Sutton Pool, additional to the site at Mount Batten on the opposite side of the Cattewater. Cut through and overlying the silts which had accumulated to a depth of some 3.50m were the foundations of a series of medieval structures. The robbed footings of a stone quay built of massive irregularly shaped limestone blocks were found in the north-west sector of the site, and associated pottery suggests a date in the early or mid 13th century for its construction. It had been buried deep within the foundations of two later buildings which abutted each other and projected out into the harbour. Immediately south of these buildings a quay wall was subsequently constructed. It had a well built seaward face and the space between that and the older walls was filled in with random pitched rubble.

To the east, and broadly contemporary with these structures, was a much larger building (known as Building 1), some 12m wide and 18m long (north-south). It was built on massive foundations and projected southwards into the harbour, initially with open water on three of its sides. An elaborate drainage system had been built into the foundations incorporating a central main drain running the length of the building from north to south, and four garderobe or latrine shafts. One of these was an oval well-like construction, large enough to have been entered by ladder and cleaned out periodically, and communicated with the main sewer by means of a small secondary drain. The other three were contrived within the thickness of the southern wall and debauched directly into the harbour, being flushed clear by the daily movement of the tides. The purpose for which the building was erected is unclear, but it may have served as the combined house and warehouse of a particularly rich merchant. However, the date of the construction is certainly late 13th to early 14th century, on the evidence of the character of a window and of the associated pottery.

It was precisely in the years immediately before and after 1300, late in the reign of Edward I, that Plymouth is known to have emerged, from the relative obscurity of its origins, as a significant port of embarkation for alternating warfare and commerce with France, and for the making of pilgrimages to shrines in Spain and further east. If shelving sandy beaches had sufficed in earlier centuries for drawing up the relatively light vessels of fishermen, now larger boats made regular use of the port, and quays and warehouses built out into deeper water were required.

Not long after the completion of Building 1, an annexe was built beyond its south front, further into the harbour, possibly replacing in stone an original timber-framed platform. The annexe was less well constructed than the main building, and its foundations, though massive, were not sunk so deep. They incorporated four short lengths of drain, continuing the main sewer of Building 1, and the outlets from the three garderobe shafts in its south wall, out to the harbour frontage of the new work. Building 1 and its annexe were subsequently linked into a larger system, by quay walls built from the east and the west, abutting against the south-east and south-west corners of the annexe. The quay wall to the east represented an advance of some 10m from the earlier frontage associated with the two western buildings. The originally free-standing Building 1 had now become an integral part of a much larger group of buildings, presenting an unbroken quay frontage to the harbour, extending a minimum distance *c* 42m from west to east.

This quay was made up of sections of walling of different phases, and the period of its final completion cannot be stated with certainty as yet. It can at any rate be stated with confidence that the quay and the drainage system associated with it survived as a going concern into the first half of the 16th century. Not until sometime after 1525 did the progressive silting up of the inlet finally block the drains, helping to induce-a further period of intensive reclamation, involving the greater part of the southern half of the area excavated. By *c* 1550, the quay line had been moved *c* 12m forward into the creek, reducing it to an area little larger than the present carriageway of the Parade. It was not until a hundred years later, the third quarter of the 17th century, that the long process of reclamation was finally completed, and the western limit of the harbour established at its present position.

Poole

I P Horsey

Poole occupies an alluvial peninsula on the north side of Poole Harbour: until the 18th century the peninsula was virtually an island separated from the heath of the mainland by a tidal dyke. Archaeological and documentary sources indicate an early 13th century origin for the town.

Excavations since 1973 (Horsey, forthcoming) have shed some light on the development of the waterfront since the 13th century, but detailed study of the cartographic, documentary, and topographic evidence is more rewarding for the period since the 17th century.

Excavations at Thames Street (PM9), The Town Cellars (PM 11), and Paradise Street (PM21) are almost the only source of information for the early development of the area of the Great Quay. The Town Cellars is a fine stone 'woolhouse', originally built *c* 1300, set back 35m from the present quay. A substantial building of similar date and construction was excavated on the frontage of PM9 (Fig 128), and may have formed part of a larger complex beside the medieval waterfront. The Town Cellars is built directly on a massive deposit of oyster shells. Excavation (PM21) showed that this deposit continued to slope away south of the Cellars, and may represent a deliberate or inadvertent process of shore-line reclamation. This deposit did not extend as far as recent observations 25m further south, but may be continuous with the deposit at PM24 45m to the West. On the other side of the channel at Hamworthy similar oyster deposits have been shown to be up to 3.4m thick. Physical and statistical examination of the shells from PM11 and PM21 shows them to be the product of cultivation, and two radiocarbon dates have both given a determination of 690AD±100. There is no other evidence to indicate any settlement of this period. Research into these marine shell deposits is continuing.

The Bounds of the Quay (1558) states that there was a distance of 48ft (14.6m) from the Woolhouse to the low-water mark. This seems to imply the absence of a continuous stone quay wall. This is also indicated by the

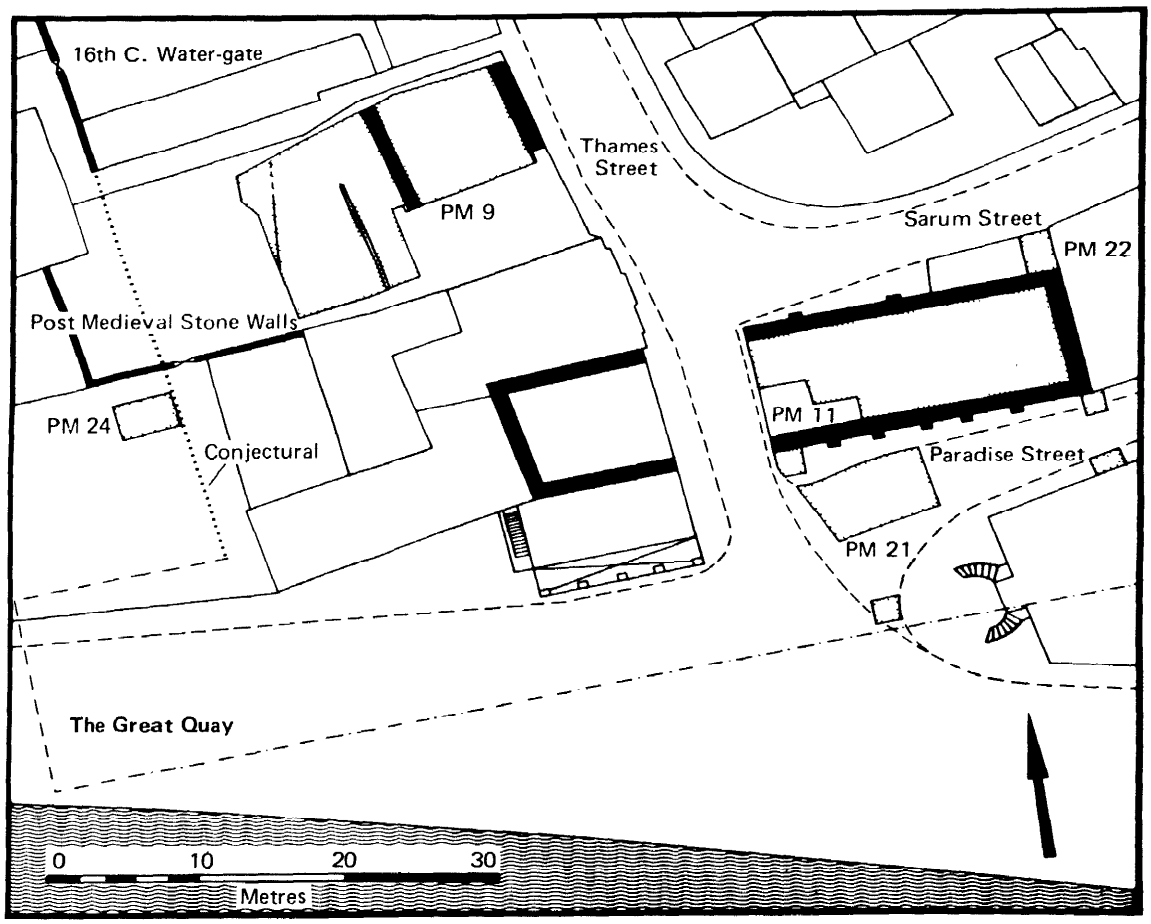


Fig 128 *Poole: excavations near the Great Quay*

stratification of PM21, and by mid 16th century documents relating to the repair of the quay. Probably there was a sloping beach with a timber quay and jetties. To the east, Strand Street represents the medieval waterfront, but to the west it extended north behind Thames Street (16th century Quay Street). To the rear of PM9 the apparent high-water mark of the 13/14th centuries was associated with a dwarf stone wall and numerous timber posts.

In 1558 the quay itself was 240ft (c 73m) long and 48ft (c 14.6m) wide at its head, and it appears that private jetties ran off Strand Street and Thames Street at this time. The so-called town wall may in fact be a 16th century Watergate. The 1634 town plan shows that it then had a quay beyond it, and earlier excavations (Smith 1951, 16-19) showed that the shoreline once came as far as the wall. A recent trial excavation at Pex Marine (PM24) demonstrated that this area had been reclaimed by the late 16th century, when rubbish deposits were dumped on to an organic layer sealing the same (2) oyster deposit as at PM11 and PM21.

The 1634 plan shows the Little Quay (built 1618), and reclamation, but not colonization, off Strand Street. The reclamation of the Strand Street jetties preserved the jetty and property lines in the arrangements of the alleys which survive today. This reclamation is also dated by the Poole Arms on the Quay which incorporates early 17th century fabric (Penn 1979).

Poole prospered on its Newfoundland trade in the 18th century and most of the mudlands were reclaimed during this period (Fig 129). Between 1751 and 1774 the New Quay was built and the West Quay developed. Later in the 18th century the line of the Great Quay and Little Quay was extended south. Observation of, and boreholes associated with, the installation of a large drain behind the present quay, have located the later 18th century quay wall, and jetties constructed of large dressed limestone blocks, sometimes with a chalk rubble core.

The present quay was built between 1886 and 1903 and land is still being reclaimed off West Quay and in Holes Bay. Opportunities for further investigation of waterfront sites are most likely to occur on either side of Strand Street. Observations have located timber piles south of Strand Street, and the area is one of potential for amplifying knowledge of the development of the waterfront.

This short paper makes no attempt to examine the important problem of longer-term sea-level changes around Poole Harbour (May 1968; Bowen 1976), for which a research group has recently been established, However, the origins of the port should be seen in the context of the silting of the higher western reaches of the Harbour and the consequent decline of Wareham (RCHM 1970, 189).

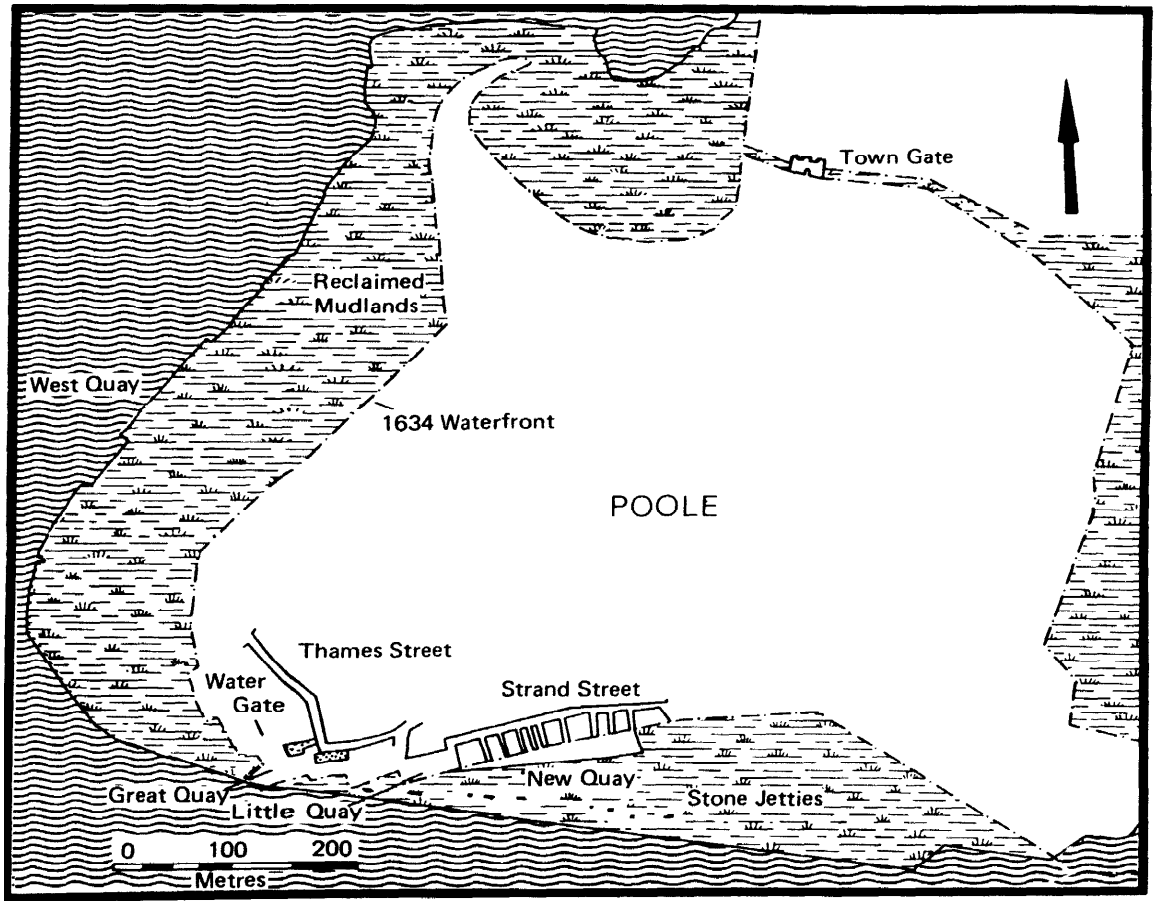


Fig 129 Poole: the development of the quays

Portsmouth

R Fox

Old Portsmouth is situated on the south-western side of Portsea Island, close by the Harbour entrance, and covers an area of *c* 140ha (350 acres). It was the urban, administrative, commercial, and military heart of a basically agricultural island, receiving its first Charter in 1194, and retaining much of its importance into the 20th century. Because it was a walled town surrounded by vast fortifications, expansion became impossible: when land outside the walls became available mainly during the 19th century, developers and later traders were tempted away from the town, setting the seal on its decline.

Archaeological excavations at Oyster Street, Old Portsmouth (Fig 130-p 148), revealed substantial evidence of early shorelines and waterfront activity from the 13th-14th centuries until the present day. The site lies on the east shore of the Camber, a small tidal basin at the mouth of Portsmouth Harbour separated from the main channel by a gravel spit. The results of the excavation may be summarized as follows.

13th-14th centuries The shoreline (1 on Fig 130) was discovered curving on a roughly north-south alignment on the east or landward side of Oyster Street, *c* 40m east of the present artificial shoreline. (A further glimpse of the 13th-14th waterfront was obtained during excavation at Grand Parade, a site *c* 265m south of Oyster Street. Here the old shoreline was *c* 100m east of the present line formed by the fortifications.)

A warehouse or storage complex consisting of a house with substantial stone foundations and two other stone buildings were represented by a ground plan of postholes. There may have been at least one more of these stores, but later disturbance left little trace of it.

14th-15th centuries Modifications to the storage complex (mainly concerned with strengthening the original structures) and the construction of a massive timber cistern in a huge pit. The pit was cut down into the freshwater springs at a depth of 7m from the contemporary ground level. The size of the structure suggests that enough water would have been available to supply visiting/departing shipping.

15th century The first attempt at reclamation (2 on Fig 130) incorporated a rough stone platform with gravel levelling, encroaching *c* 5m into the Camber from the 13th-14th century shoreline.

15th-16th century A small dock was cut into the natural clay and, evidently following a natural depression, ran eastwards from the Camber. It was contained within a wattle walling of which little remained. On the north side of the dock was a hard standing or quay, made up with compacted gravel. A heavy square post was driven into the ground on this side, no doubt providing a secure mooring. This dock had silted up completely by the mid 16th century, as was evident from the pottery from the upper silt levels.

A seawall construction ran southwards from the dock, composed of a wattle backing and a prepared plank facing, with a heavy clay mixture sandwiched between the two. This, too, was redundant by the mid 16th century.

During the early 16th century, what was to become the Town Quay was established at a point *c* 100m north of the site; this was coincident with the demise of the Oyster Street dock and its associated buildings, which were eventually replaced by domestic occupation. The Town Quay is clearly shown on mid 16th century maps of the town.

16th-17th century A series of large box-like structures built of limestone backfilled with gravel protruded into the Camber, representing a deliberate attempt at reclamation. These boxes provided a solid building foundation, and the Oyster Street clay tobacco pipe kilns were situated here from the mid 17th to mid 18th centuries.

17th-18th centuries Defensive works advanced the shoreline a further 20m to the west (4 on Fig 130).

19th century The present line of the quayside was established (5 on Fig 130).

The Camber is still used by small ships on the short sea routes to the Channel Islands, Channel, and North Sea ports, presumably a trading pattern continued from the 14th-15th centuries. However, traffic is now moving away from here to the more modern and more easily accessible facilities further up the harbour.

Further references

Reports on the Oyster Street excavations may be found in *Post Med Archaeol*, **3** (1969), 195; **4**, (1970), 176–7; **5**, (1971), 204, 216–17, pl XA.

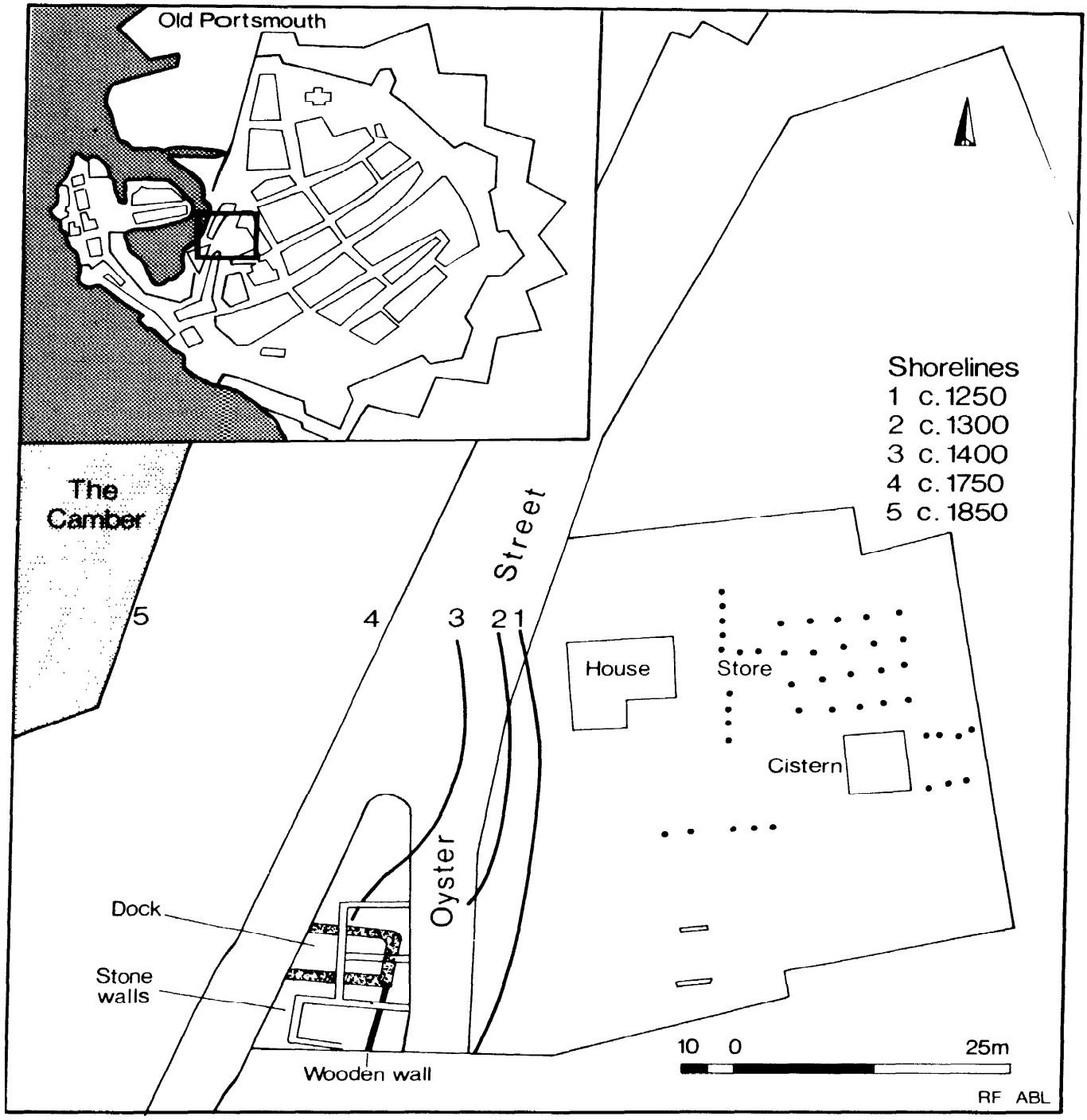


Fig 130 Old Portsmouth: excavations at Oyster Street 1969-71. Location of site shown on inset

York

P V Addyman

York, though well inland, has had many of the aspects of a port since Roman times. The city is at the tidal head of the Ouse at its confluence with the Foss, where the York moraine provides a natural routeway across the formerly ill-drained Vale of York. Distributions of prehistoric artefacts (Radley 1974) and Iron Age settlement (Ramm 1978) show the site's early importance as a river crossing.

Recent excavations (Hall *et al* 1979; Carver *et al* 1978; Hall, Hood, Kenward, & Williams 1980) have shown a wider and shallower cross-valley profile in early times, with light vegetation, prone to flooding but not exceptionally. Waterfront structures developed between the fortress and both rivers. Early Roman grain stores have recently been excavated on the Ouse front (Hall & Donaghey, forthcoming; Hall *et al* 1979) and *canabae* developed along the Foss (RCHM 1960, 49, 64–6). In later Roman times roads were developed along both banks of the Ouse, that to the south in connection with the development of the *colonia* (Carver *et al* 1978). The Foss may have been dammed to produce a non-tidal port, and substantial Roman installations have been found from time to time, including a crane base (RCHM 1960, 64). Much of this occupation is below modern mean water level and thus considerable changes in river regime, the subject of current research, must have taken place.

In Anglo-Scandinavian times the south west bank of the Ouse seems to have been pushed gradually beyond the Roman line (Addyman 1976, 14) and the city centre extended well into the floodplain of the Foss (Hall 1978; Kenward *et al* 1978). Defences or fortifications probably protected the extended town on the Foss (Hall 1978, 33–4) but wharves and river-port installations remain to be discovered, a major priority of research.

Major medieval changes to the York waterfront began with the building of mills and a dam at the Foss mouth (RCHM 1960, 57) causing lake formation upstream. A possible 12th century stone waterfront has been located on the Ouse near Coney Street (Addyman, forthcoming). The process of building out into the Ouse continued throughout the Middle Ages, as well examplified at Skeldergate (Addyman 1975, 225–7) until the present river line was reached in Tudor times (Addyman, forthcoming) as seen in excavations near Coney Street. The river narrowing increased the incidence of flooding, though other factors, such as deforestation of the Pennines, increased run off through improved drainage, and the lowering of the Humber basin, also contributed.

No extensive excavations to modern standards have yet been undertaken on any waterfront sites at York. Sites currently available, and under threat, including the medieval customs house at Skeldergate; the waterfront area adjacent to the Viking Hotel in North Street, near the Dyvlyn stones (Dublin Stones) area of the Scandinavian town; and an area at the Anglo-Scandinavian and medieval bridgehead in Bridge Street. It is unlikely that any will be excavated because of current archaeological commitments in York. Conceivably part of the Viking age and Roman Foss waterfront may, however, be found in the current excavations at Coppergate. The main immediate hope for progress in understanding river utilization lies in botanical and pedological work and watching briefs on development sites.

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