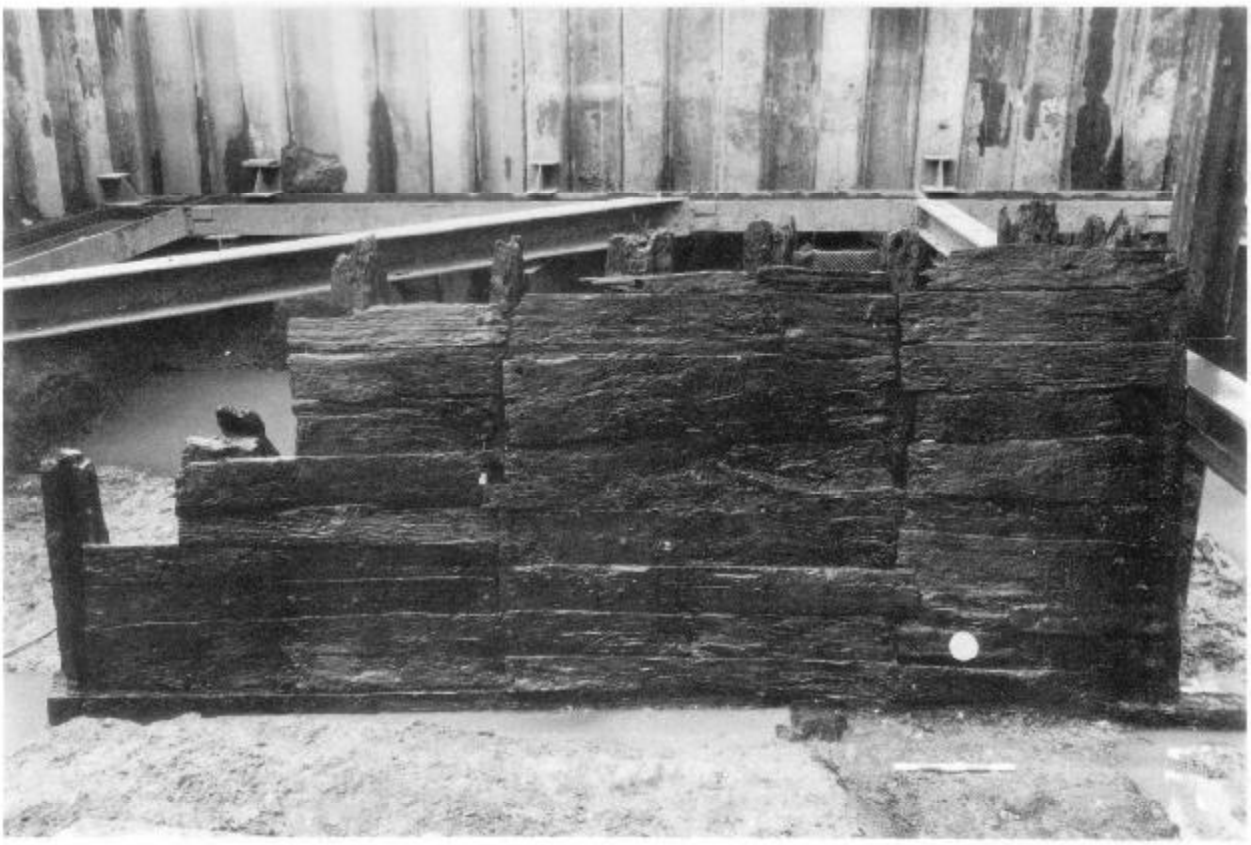

Fig. 1: View of the Billingsgate waterfront *in situ*. Note the carpenter's mark on the planking. The timber in Fig. 2 is marked on the bottom right-hand side.

(Photo: Museum of London)

Tree-ring dating by X-ray scanner

IAN TYERS

THERE HAVE BEEN significant changes in the way museums and archaeological units treat wooden finds in the last few years. The application of dendrochronological dating to excavated structures of oak has produced for the first time a dating framework that is both accurate and independent[1]. This increased importance of timber structures for archaeology has occurred at the same time as a relatively cheap and reliable method of conserving waterlogged timbers has become available, namely impregnation with polyethylene glycol (PEG), which allows previously unmanageable artefacts to be conserved and displayed.

Unfortunately dendrochronology is a destructive process. With art-historical artefacts such as panel paintings and chests it is often possible to get the ring sequences from clean timber ends without damaging

1. For an introduction to dendrochronology see M. G. L. Baillie *Tree-ring dating and archaeology*, London (1982) or J. Hillam and R. A. Morgan 'The dating of the riverside wall at three sites in London', *London Archaeol* **3** no. 11 (1979) 283-8, or H. L. Sheldon and I. G. Tyers 'Recent dendrochronological work in Southwark and its implications', *London Archaeol* **4** no. 13 (1983) 355-61.

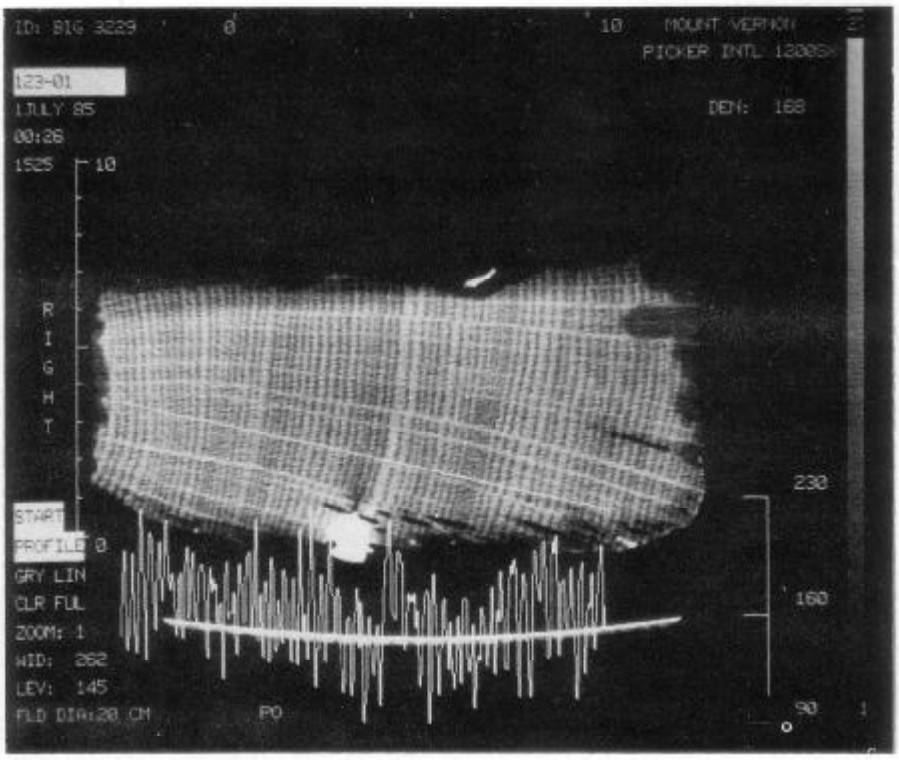

Fig. 2: X-ray of timber 3229. The rings date from AD 1105 to AD 1177. The plot at the bottom is the density along the white line on the timber (measured in Houndsfield values). Scales at left and top in cm.

(Photo: Picker International)

the object. Archaeological timbers are however usually badly rotted at the ends; the best ring sequences are usually to be found near the middle of the artefact. In order to date these timbers it is necessary to cut a slice from them. With some large finds it is possible to either take cores using borers, or notch the back of the object, but this technique is generally not as successful as slicing the timber. However, such methods are incompatible with the display of some artefacts.

The Billingsgate waterfront

The excavation by the DUA of the Billingsgate Lorry Park site in 1982-3[2] produced a series of waterfront structures. These were quite well preserved, and a 5m (16ft) section of one of them is to be part of an exhibition in 1986 for the World Archaeological Congress (Fig. 1). It will later go to the Docklands Museum for permanent display. Several hundred timbers were excavated at the site and most of these have been sawn up as usual for dating purposes and dispatched to the Sheffield Dendrochronology Laboratory. The waterfront posed several problems. For the archaeological record precise dates for its construction and any later repairs are required. Ideally all the timbers should be examined for dendrochronological analysis, because many timbers from waterfront structures have low numbers of rings and most lack sapwood. Thus the dating quality of the individual timbers is low and only by dating as many of the timbers as possible will the date ranges for the phases be acceptably small. Some of the waterfront timbers were cored or notched on the hidden sides, but the facing planks were too thin to withstand this process.

Computer Tomography (CT)

Since a non-destructive technique to retrieve the ring sequences was needed, the Museum of London approached Picker International, manufacturers of both X-ray and nuclear magnetic resonance (NMR) whole body scanners. These two types of machine allow images of slices of patients to be produced for diagnosing illnesses. It was originally felt that NMR would produce more useful results. However using some trial pieces from the Sipson site, Hillingdon[3],

2. See B. Richardson, 'Excavation Round-up' *London Archaeol* **4** no. 7 (1982) 274 and **5** no. 2 (1985) 47.

3. See Mosaic, *London Archaeol* **5** no. 3 (1985) 84.

it quickly became apparent that the X-ray CT scanner allowed the structure of the wood to be seen quite clearly. Measurement off the photographs allowed the ring sequence to be obtained non-destructively.

The result was that one evening in July, about 40 timbers from the Billingsgate waterfront were taken to the Mount Vernon Hospital scanner centre. Some of these were further trial pieces and the rest were the planks. The timbers were all X-rayed in about 3 hours and the images were stored on disc to be processed at Picker's headquarters.

Limitations and successes

It appears that several factors affect the resolution of the image. The lower end of the machine's resolution of tree-rings is about 1mm, restricting the application of the technique to faster grown timbers. However, trees with all their rings over 1mm wide are not uncommon. Another important factor is the difference in density between the spring growth and the summer growth of a particular timber. All trees differ in this respect, but more important is the length of time and the conditions under which they have been buried. The medieval timbers from Billingsgate gave better contrast than the Roman timbers from Sipson.

The timber shown in Fig. 2 has no rings less than 1mm wide and has good contrast between the spring and summer wood. This is the first archaeological timber to be dated without optical examination of the tree-rings. From left to right across the photograph the rings go from AD 1105 to AD 1177. Another slice of the same tree ended with the heartwood/sapwood boundary at AD 1179. This gives an approximate felling date for the waterfront of between AD 1190 and AD 1235. These results and others will be provided for Jennifer Hillam at Sheffield who is dating the rest of thetimbers from Billingsgate.

Future possibilities

I am not suggesting that this technique should be applied to many timbers as it is expensive and time consuming and will not successfully date all timbers that can be dated by normal techniques. Only where it is impossible to obtain the ring sequence any other way can it be considered. It might be potentially most useful for turned objects such as bowls or for planked objects such as boats. The physical limitations are that the object should not be more than about 0.5m by 0.3m (20in by 12in) in cross section nor more than 3m (10ft) long.

When scanners were first produced they did not have the resolution needed for this sort of study. As the technology has improved they could probably be used now for about half the timbers excavated, the rest being too narrow-ringed for the resolution. The use of density plotting functions in the scanners allows the rings to be shown where it may otherwise be difficult. An example of such a plot is shown on the bottom of Fig. 2. The relative horizontal distance between the peaks on the plot is a measure of the ring widths.

Another possible use for such a machine is as a check on PEG penetration during conservation. It is always difficult to ensure that the PEG has reached the centre of an object and this has unfortunate results on its long term stability. The technique could be useful as a quick way of checking the results of conservation.

Acknowledgements

In this experimental study I have been assisted by a great many people. I would particularly like to thank Raquel Farrington, Graham Parrott, and many other staff of Picker International for their help and interest, at the original tests, the evening at Mount Vernon, and the subsequent processing at their headquarters. Dr. P. Strickland and his staff at Mount Vernon Hospital, Northwood, Middlesex kindly allowed us to use their new scanner centre outside patient hours. Thanks are also due to Suzanne Keene, Helen Ganiaris, Kate Starling and other staff at the Museum's Conservation Department for the original discussion, the organising and carrying of the timbers and much other assistance. Thanks also to Alan Vince for discussion of the dating and archaeology of the Billingsgate site and permission to use the Billingsgate material.

Local Societies – amendments

THE THIRD SET OF amendments to the list of local societies (Vol. **4**, no. 15, 403-4) is as follows:

Beddington, Carshalton & Wallington Arch. Soc. Sec. Miss M. Pugh, 57 Bramblcdown Road, Wallington, Surrey.

The Essex Society for Archaeology and History (formerly The Essex Archaeological Society) Membership Sec. Mr. R. W. Coleman, 23 Somerville Gardens, Leigh-on-Sea, Essex SS9 1DD.

Kingston upon Thames Arch. Soc. Sec. Marilyn Bellidori, The Garden Flat, Argyle Mansions, 37 The Avenue, Surbiton, Surrey.

Nonsuch Antiquarian Soc. Sec. Mrs. P. Bedwell, 37 Seymour Avenue, Ewell, Surrey.

Change of address:

Islington Arch. & Hist. Soc. Sec. Peter Watkins, c/o Resident Clerks' Flat, Main Building, Ministry of Defence, Whitehall, S.W.1.