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A study of the archaeological remains of vernacular boat finds from North Wales in the care of University of Wales Bangor.

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A study of the archaeological remains of vernacular boat finds from North Wales in the care of University of Wales Bangor.

by

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In fulfilment of the requirements of the Degree of Doctor of Philosophy in the University of Wales.

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Abstract

This thesis is a study of five individual nautical archaeological finds from North Wales. They are the Llyn Peris logboat, Pwll Fanog wreck, Llyn Peris boat, Llyn Padarn boat and the Talsarnau boat. The five vessels are used to assess the inter-reliability of coefficients and ratios of form.

The main body of the thesis consists of a record of the five vessels to gain a better understanding of their construction, hull form and a general understanding of the boat building tradition of North Wales. Therefore the production of a descriptive catalogue of hull timbers recovered accompanied by illustrations where applicable forms the core of this thesis. The variations in date and location of the vessels gives a maritime in-site into the various historical periods and geographical areas of North Wales. Each vessels is considered in its historical context.

The inter-reliability and usability of coefficients of form generated are accessed against McKee's (1989), descriptive variations of form and the Great Lakes historic ships research project classification of form, termed GHLS (Wilson, 1989: 212). The use of a computer software package, *Hull Form 8,* to generate the coefficients and ratios of form is also assessed.

The body of the thesis is concluded by a discussion on objectives reached and lessons learnt. It is concluded that McKee's ratio of form are inter-reliable whilst the use of coefficients of form are not. The use of a computer software package is deemed viable and of use, however certain cautions must be expressed when using such a package. It should be used as an analytical tool and not a design tool. No further enhancement of the archaeological lines drawing should be carried out.

A full bibliography and glossary of terms finalises the thesis.

For

My Father and Mother

Capt., and Mrs D.I.M^c^Elvogue.

"Per Ardua"

Acknowledgements

First and foremost John Sherwood Illsley my supervisor and former lecturer is acknowledged for having faith in me to complete this thesis. Without his support and guidance the thesis and the vessels studied within would still remain in relative obscurity. I am also indebted to John as an excavator, photographer and researcher of the vessels for permission to use his records and photographs from the original excavations.

All those involved in the initial finds must be acknowledge, not least of all Mr Owain Roberts. It is to Owain's credit that he undertook the responsibility of overseeing what on all occasions were arduous and often dangerous investigations of unknown vessels. As an original finder, diver, recorder, director and personality, Dr. Cecil Jones contribution to the initial investigation of the Pwll Fanog boat cannot be understated. Miss Cemlyn Jones and the trustees of the Pen-y-clip Trust are acknowledge for their financial support. Without such support the timbers from the vessels would still be lying at Ynys Faelog where their long term storage would have been precarious. All references to wood species, their origin and relative significance are accredited to Pat Denham from the School of Agriculture and Forestry, University of Wales Bangor.

This Ph.D., could not have been achieved without the support of a number of un-named people. Their contribution cannot be defined easily; suffice to say all those who have continued to lend an ear, some advice, and friendly company all deserve acknowledgement. The Tutors,Wardens, security and office staff on the Ffriddoedd site must be singled out; in particular Romey and Dave.

Last but not least I must thank my family for constant support in everyway, from the instigation of this thesis to its final conclusion.

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General Introduction

Introduction

"Scholars whose lives have been involved with the history of the landsman have rightly been inclined to avoid the otherness of the world of seamen and boatmen." (Greenhill, 1976.19)

The study of ships and boats has become a legitimate academic subject over the last two decades. It no longer provides just pretty pictures of the vessels under consideration, nor is it there just for the pleasure of other boat lovers (Chapelle,1951). The recording and analysis of the remains of ships and boats has gained more credence in the recent past with articles appearing in mainstream archaeological journals as well as specialists journals (Nayling, Maynard, McGrail 1994; Parfitt, 1993). Ships and boats are viewed as the technological evidence of the past societies that built them (McKee,1989; Steffy, 1994). In this respect the study and analysis of the remains of vernacular boats has also come of age.

McGrail (1998) and Steffy (1994) have both advanced the study of nautical archaeology generally. Their publications on the how and why of recording and analysing boat remains have received wide acclaim even from "landsmen". Of equal importance is the increasing number of publications, both as major archaeological reports and their shorter versions in journals, that have come to fruition in recent years. No longer is it unusual to see the publication of a report on a minor find, be it plank fragments or even the vessel itself. The ready acceptance of such reports by main stream journals helps to lessen the "otherness", of such work (Millet and McGrail, 1987; Parfitt, 1993; Nayling, Maynard & McGrail, 1994).

Despite the above there still appears to be a lack of real understanding of the study of boats or ships and their remains. Recent publications on the matter (Milne, 1998; Buglass, 1997) neglect the need to represent any boat find as a three dimensional object. To that end no mention is given to the importance of taking hull lines or strategically placed sections to compile even a rudimentary body plan. The idea of taking sections in archaeology is not alien. To use such sections to represent a vessel/vessels under investigation as a three dimensional object is. Further still, there is a lack of forethought as to where best to place any such sections. This is highlighted by the fact that only the centerline section is recorded in many instances (Illsley and Roberts, 1979c:334: Milne, 1998), whereas three or five basic sections athwartship would be better. To do so however, first requires an understanding of what the end product of any nautical study should be. As Steffy has claimed the end result of a study of nautical remains should be to try and achieve a representation of the original vessel no matter how rudimentary that might be, and no matter how little evidence exists (Steffy, 1994:6). It should also try to attain a wider understanding of each vessels economic and cultural background (Westerdahl, 1998:364).

General background (Fig. Intro.1)

The vessels under consideration were all found and/or investigated in North Wales between 1976 and 1988. Each vessel was excavated, either totally or partially without the direct involvement of professional archaeologists. Owain Roberts, at the time a school teacher and amateur archaeologist, had an involvement in the recovery, excavation or post recovery recording of all the vessels. Others such as Dr. Cecil Jones, Dr. Lewis and John Illsely have also been involved at one level or another on one or more of the vessels. Despite not being trained archaeologists their daily journals and notes form the primary data on the recovery of the boats. Though no fault of authors the journals at times have proved to be frustrating in their lack of recorded detail. On the whole each vessel has at least a basic account of parts recovered or an initial interim report. None of the published reports can be looked on as definitive.

The Pwll Fanog site was found in July 1976 during a marine biological survey of the Menai Straits. It consisted of a large slate mound the importance, both historically and archaeologically, of which was not recognized until the following year. Whilst the identification of the slate mound as a medieval wreck site caused much interest at the time, it only lasted two years. During this time a trial trench was excavated across the center of the site and a number of timbers identified and raised. A number of articles based on the finds from Pwll Fanog were published (Jones, 1977, 1978 and 1979; Roberts, 1979) but none are definitive. Jones, 1977, and Roberts, 1979, are the most comprehensive reports, however they do not fully explain many of the questions raised by the slate cargo and timbers recovered. These questions, such as size of cargo, type of vessel and form of vessel can only be answered through further research.

The Llyn Padarn boat was found in late 1977 by divers carrying out a survey of the lake Llyn Padarn. The remains were investigated underwater and recovered to the surface in 1979. The vessel is in the care of the National Museum of Wales and is on display at the Quarry Museum Llanberis, where it remains to this day. The Llyn Padarn boat was recorded by Mr Owain Roberts and its history researched by Mr John Illsley. Their findings were first published in the Transaction of the Caernarvonshire Historical Society (Illsley, 1979). Two further publications were produced but these do not further the research presented in the original publication apart from drawing comparisons to Irish cots (Illsley and Roberts, 1979a & b). All three publications are viewed as initial interim reports on the find, none are presented as definitive. Indeed a comparison between the archaeological remains and the reconstruction drawings shows a number of discrepancies between the two.

The Llyn Peris boat and Llyn Peris logboat were found during the construction phase of Dinorwic Power Station. They were named Llyn Peris 1 and Llyn Peris 2 respectively in anticipation of further finds. No such finds appeared. Both vessel have subsequently become known as the Llyn Peris logboat (or Peris logboat) and Llyn Peris boat (or Peris boat), and are referred to as such in this thesis. An interim report on the finds was published in the *International Journal of Nautical Archaeology* (Illsley and Roberts, 1979c) but no further publications have been forth coming. Indeed, this interim report clearly states that further work was required (Illsley and Roberts, 1980:347, 348). Caroline Caldwell recorded the remains of the Llyn Peris boat in 1987 as part of her undergraduate degree (Caldwell, 1987). Unfortunately the drawings produced were not accompanied by written descriptions and there was no understanding of the vessels hull form or cultural and economic history. An initial review of the drawings also highlighted a number of problems, least of which was repetitive drawings of the same timbers, a number of mis-identified timbers and a number of timbers not actually represented (Caldwell, 1987). A cursory reference to the Llyn Peris boat is given in McGrails *Ancient boats in North-West Europe (*McGrail, 1998:130).

The Talsarnau vessel was the last vessel to be investigated. It was brought to the attention of the University of Wales Bangor in 1988 and investigated throughout the closing months of that year. No interim report on the find has been published. The Talsarnau boat did raise awareness of a local class of boatmen, which in turn lead to the publication *Sails on the Dwyryd* (Lewis, 1989). This is an historical publication which increases awareness of this once forgotten maritime community, but does not do justice to the boat. Whilst a short description of the vessel is given there is no detailed analysis of the remains or realization of the hull form. A number of questions about the boat are raised, such as sail rig and the vessels displacement, but they are not answered. The significance of this vessel has not been fully realized.

Objectives

John Sherwood Illsley, my supervisor, was responsible for the concept of the primary objective of this thesis. It came from the realisation that the archaeological remains of the vessels under consideration are important and warranted an in-depth study. Compared to the rest of Europe, Scandinavia in particular, there are few if any articulated remains of archaeological boat finds from Britain (Crumlin-Pedersen, 1997:15). Whilst there have been a number of nautical finds from various places, such as the reused timbers in the London water front (Marsden, 1994, 1996), these are on the whole disarticulated planks and associated fastenings. Whilst such finds do warrant a study, they can tell us little compared to the articulated remains of a vessel. How well would we have understood the significance of the Caldicot plank find if the Ferriby boats and Brigg raft had not been previously discovered? It is unfortunate that there are few articulated boat finds from Britain and even fewer from Wales. It does however mean any new articulated boat find will be of significance in understanding the boats and boat building within Britain and Wales in particular.

Before the vessels in this study were found knowledge of boats and boat building in North Wales prior to the nineteenth century was limited. Indeed the vessels under consideration have an archaeological significance that is greater than just giving an understanding of boat building in North Wales. The documentary records are sparse and do not provide a coherent understanding of boat construction methods and boat usage prior to the nineteenth century (Eames,1987:23). The source material is often ambiguous and interpretation problematic; documentary sources infer and refer rather than describe. This can be true of the nineteenth century as well. Thus the archaeological record is the only real source of knowledge for descriptive detail concerning boat building prior to nineteenth century. It is this primary source that will be studied and presented in this thesis.

The five vessels presented in this study will also be used to assess the inter-reliability of coefficients and ratios of form. Their varied hull forms and methods of construction is seen as an advantage to such a study. A literature review showed there to be an acceptance of the use of coefficients of form, naval architectural terminology and lines drawing for the interpretation and analysis of nautical archaeological remains (McGrail,1978; Marsden, 1994, 1996; Mowat 1996). The analytical use of such terminology, coefficients and ratios has been shown to be of benefit for the interpretation and analysis of articulated nautical finds (Marsden, 1996:95-98; Marsden, 1993; Coates, 1994). It has however been noted that the use of such terminology and coefficients for archaeological remains can be unsatisfactory in some instances (Coates, 1994:249, 254). Furthermore, the analytical use of such ratios and coefficients has been limited to individual studies and not comparative studies across the corpus of finds. To do so the inter-reliability of the ratios and coefficients will have to be accessed. The only readily available studies into the use of such coefficients and ratios for the classification of vessels by type/usage and for hull form description are those of McKee (1983) and Wilson (1989). The inter-reliability and usability of coefficients and ratios of form generated will be accessed against Mckee's descriptive variations of form (1983:78-79) and the Great Lakes historic ships research project classification of form, termed GHLS (Wilson, 1989: 212).

A prerequisite to the principal objective of this thesis is to record the five vessels under consideration to gain a better understanding of their construction and hull form, which in turn will allow for an understanding of the boat building tradition of North Wales. The variations in date and region of the vessels is seen as a benefit to understanding boat building throughout the various historical periods and geographical areas of North Wales.

The aims of the thesis are; to set a standard level of record for each vessel, to generate coefficients and ratio's of form for comparative studies, and to assess the usability and inter-reliability of such coefficients and ratio's of form in the study of vernacular boats. A minimum standard level of record is seen as the production of a descriptive catalogue of hull timbers recovered, accompanied by illustrations where applicable. A body plan from 1st reconstruction is a necessity to produce reliable coefficients of form. Thus, the recording of constructional information for this purpose is seen to be a priority.

Therefore, the purpose of this thesis is to record and reconstruct, on paper at least, as far as is possible the five vessels previously investigated by the University of Wales Bangor (the remains of four still being in their care) in order that a fuller understanding of their construction, hull form and individual performance characteristic's can be attained. This will allow the vessels to be compared and contrasted scientifically through the use of coefficients of form, which can then be assessed against Mckee's descriptive variations of form, and the GHLS classification system.

Recording and documentation

The initial survey of recording techniques found that there were few if any archaeological publications for guidance. McGrail's publication's *Medieval boat and Ship Timbers from Dublin* (1993), *Logboats of England and Wales* (1978) and *Ancient boats in North-West Europe* (1987), McKee's *Working Boats of Britain* (1983) and Steffy's *Wooden ship building and the interpretation of ship wrecks* (1994) were all consulted on methodology and technique. All these works are comprehensive in technical detail and description. They discuss the recording of features and attributes but do not have a comprehensive chapter or appendix detailing a set of guidelines for the recording of nautical finds. It was therefore felt other sources should be referred to, giving a broader understanding of what would be required from a boat builder. *Clinker boat building* by Leather (1973) and *Boat building* by Chappelle (1969), were also used as guides.

A record of each attribute for individual pieces could be deemed necessary by some (McGrail & Denford,1982). Such a record could be extensive in its criteria and to an extent can be considered unnecessary (Crumlin-Pedersen, 1997:15).

"*... methodology and scope of the documentation must be kept within the practical limitations of prevailing administrative, operational, and environmental logistics.*" (Steffy,1994;193)

Certain details, such as angles of the scarfs and lands, are deemed extraneous to a minimum requirement as they can vary throughout the lengths due to a change in the angle of a saw cut or adze blow. If so required they can be derived from the recorded dimension of the planking.

There is however a requirement to record the scantlings, the maximum moulded and sided dimensions as well as overall length, of each piece. It is the recording of the scantlings that is considered to be the minimum requirement/standard. Each recognisable piece will have an entry giving the minimum overall length with maximum moulded and sided dimension. Variations in moulded and sided dimensions are given where applicable, as are constructional features such as fastening holes, widths of lands, length of joggles and fastenings. The general condition of a timber and certain features which have a bearing on the suitability of the wood for boat building, such as knots and straightness of the grain, are also to be noted. This allows for a greater appreciation of wood usage and construction, though it does not necessarily give us an understanding of the vessel itself. It must be remembered that little can be said of the parent vessel if the individual piece is not considered as part of the whole. The individual pieces still have to be combined into the whole that is the vessel.

Reconstruction methodology

To be able to achieve the primary research aim, that is an understanding of the vessels hull form and construction, a preliminary body plan from first reconstruction is considered a prerequisite. The term "first reconstruction" is deemed to be a reconstruction of the vessel (on paper) as it was recorded in the field with the minimum repositioning of timbers (either on paper or in the field); for example those that are obviously out of position. It is accepted that full-scale reconstruction of a vessel would give better results. This however is deemed outside the area of this thesis due to limitations on the facilities available and there being no requirement for the final display of the vessels. To allow the development of a body plan specific constructional detail will have to be recorded. This will mean the recording of sections or diagnostic timbers.

With the development of a body plan waterlines and buttock lines, in the form of the standard convention lines plans/drawings, can be developed. Lines plans/drawings are a two dimensional arrangement of lines used to define the three dimensional form of a vessel. Lines plans/drawings aid the graphical interpretation of a vessels hull form. A general criteria for lines drawings is that they are fair i.e., the lines run smoothly from one to the other in clean sweeping curves without any anomalies. This however is not a criteria for an archaeological reconstruction where such anomalies or irregularities might be actual features. If this is the case then such anomalies must be explained. However the drawings do have to be "fair" in the sense that where the lines (buttock, waterlines and diagonals) intersect in one view they must do so in the same position in the accompanying view. If this is not the case the point of intersection is a fallacy and not a three dimensional reality. There is however always some unfairness in hand drawn drawings. It is by this criteria that the lines plans/drawings are produced.

Computer aided analysis

The production of a body plan allows a table of off sets to be produced. The off sets can then be loaded directly into a computer-based hull design programme, thus allowing computer aided analysis of the hulls. The data from each vessel will be loaded into *Hullform* (Blue Peter Marine Systems, 1991, 1995,1999) a computer hull dynamics programme allowing coefficients of form to be developed and an analysis of each hull to be carried out. *Hullform* is used due to its user friendliness and ability to handle un-faired lines. Other computer hull dynamics programmes can be used. The researcher however has to be careful that which ever programme is used it can handle un-faired lines and that no redesigning or enhancement of the lines is done by the software package. The use of a computer hull dynamics programme to analis nautical archaeological remains, as opposed to long hand calculations, is not a new initiative (see Marsden, 1993), assessing its viability is.

Inter-reliability of reconstruction's

The production of a body plan is reliant on the survival of a significant amount of hull timbers or identification of timbers from a known position. It is usually the case that not all the parts of a vessel survive. Indeed, it is common that nautical archaeological finds do not survive beyond the bottom of the hull, from the turn of the bilge up. Rarely does the side of a vessel to the sheer strake survive. In other cases parts of the bows or stern might also be missing. Due to the nature of boat and ship construction it is however possible to hypothetically reconstruct the missing remains of such vessels from general construction traits and parameters. The viability of each reconstruction must be considered, as well as the viability of comparing and contrasting reconstruction's based on varying levels of evidence and confidence in using that evidence.

The hull analysis will be limited to the development of coefficients that will allow the hull to be compared to others within the study. Only two studies of boats using coefficients or ratios of form have been identified. The descriptive coefficients and ratios of form developed by McKee (1984) are used to describe the overall shape of the vessel. This will allow Mckee's ethnographical work to be analyzed against archaeological remains. The Great Lakes historic ships research project classification of form, termed GHLS will be used to access the classification of the vessels (Wilson, 1989: 212). The validity of this historical approach towards the classification of vernacular boats from the archaeological record will be accessed.

To compare load carrying ability Lloyds minimum safety requirement for freeboard, 1 inch in every 4 (75%), is used to ascertain the maximum safe working load and the displacement of the vessel at this load (Upham, 1978:1978). Other percentages of freeboard have been considered (McGrail, 1998:199) however Lloyds minimum safe working load is an industry standard and for comparative purpose is deemed just as appropriate as any other freeboard percentage. This will allow a standard to be kept throughout the thesis, an important aspect when comparing vessels of different forms, but more importantly of varying levels of survivability.

Historical significance

Whilst the documentation of nautical finds is important, it is of less significance if not accompanied by a study of the historical period relative to the find. There is no general maritime history for North

Wales. Thus, a study of the relevant economic and social history for each vessel will finalise this thesis. In many instances the real importance of a nautical find is to make us reflect as to the purpose for which it was used and thus give us a greater understanding of the period from which the vessel was found.

Chapter One.

The Llyn Peris Logboat.

(Llyn Peris II)

LLYN PERIS LOGBOAT.

Introduction.

The Llyn Peris Logboat represents the most basic form of vessel under consideration in this thesis. This does not detract from its importance. The study of logboats was considered important during the early years of archaeology. Fox, Munro and Stuart all collated and reported information on old logboats and new discoveries, often going out into the field to recover logboats that had been known about for years. In these formative years logboats were seen as important chronological indicators. Fox can be seen as the leader in the study of logboats within England and Wales (Fox, 1926). Logboats went out of fashion, being viewed as of little significance due to an inability to date unstratified and singular finds.

A resurgence of interest in the study of logboats was initiated with the birth of scientific methods of absolute dating methods. The renewed interest culminated with McGrail's study and catalogue of Welsh and English logboats (McGrail, 1978). Subsequent studies on individual finds have since been published (McGrail, 1985) as a renewed recognition of the importance of logboats as a means of transport throughout the ages.

History of the find.

On 5 December1979 Mr John Hughes, Chief Security Officer for the C.E.G.B. Pump Storage Scheme at Dinorwic, informed members of the then Welsh Institute of Maritime Archaeology (WIMA), that a number of disarticulated timbers had been discovered (Roberts, 1980). The timbers, consisting of fragments of planking, were found in a mound of detritus that developed due to a landslide that had occurred during the building of the embankment at the northern end of Llyn Peris, NGR SH581 598 (Fig. 1.1a). This was the same landslide that had revealed the timbers of the Llyn Peris boat, termed Llyn Peris 1 by Illsley (1980:346), a few months earlier in the August of the same year (See Chapter on Llyn Peris boat). The mound had been drag lined since August to remove the detritus prior to the bottom of the Llyn Peris being lined with slate waste as part of the development of Dinorwic power station. It was during the drag lining that the planking was discovered (Illsley & Roberts, 1980:347).

Though found within the same area as the Llyn Peris boat the pieces of planking recovered were not thought to be associated with the Llyn Peris boat. During the excavation of the Llyn Peris boat the area in and around the vessel had been fully excavated revealing no further timbers. These new pieces of planking were discovered some 9.14m away from the original excavation site of the Llyn Peris boat which put further doubt as to their direct association with the Llyn Peris boat (Illsley & Roberts, 1980:347). Found at the same time as the planks were the remains of a logboat which had nail fastenings evident within a land along its sheer. The remains of nails within the planking proved unequivocally to match those in the logboat at the time of their recovery, thus associating the planking with the logboat (Roberts *pers., comm.*).

The remains of the logboat were disarticulated, having been broken up by the drag line. It would appear that the bucket of the drag line caught the log boat fore and aft, the teeth cutting into it and thus randomly cutting the log boat into a number of parts. Unfortunately inspection of the timbers, even today, reveals the tooth marks of the bucket inside the side wall of the logboat, thus hinting that further damage could have been sustained. At the time of its recovery it was realised that there could be further parts of the logboat left behind in the area of the drag line. Unfortunately this area could not be inspected due to the nature of the site at that time. A large part of the drag line area was waterlogged if not actually underwater, and was therefore considered too dangerous to investigate (Fig 1.1b). The contractors who had found the timbers had also reported that they had not found any other remains (Illsley and Roberts, 1980:347)

The remains of the logboat and the planking were handed over to Owain Roberts who took them back to Amlwch for storage. Due to the problem with storage space already encountered by Owain, in what was his back garden, the logboat did not receive any first aid conservation. The make shift holding tank housing the Llyn Peris boat was already full. The logboat was therefore kept in temporary storage in an open back garden shed. An initial drawing was done with basic dimensions being taken; apart from that no further work was carried out on the logboat (Illsley and Roberts 1980:347).

Dating.

When found by the construction workers the logboat was thought to be prehistoric in date. With the realisation that the planking was directly associated with the logboat and that wrought iron nails had been utilised to fasten the planking to the side of the logboat thoughts as to its age were revised. The logboat has been assumed by some to have been early medieval in date (Roberts *pers. comm.*). No substantive evidence to establish this theory was available until a radio carbon date was commissioned as part of the present study.

Sapwood was chosen to ensure the date given would be as close as possible to the time in which the vessel was used. A sample of the pith could theoretically give a date, if the tree was old enough, that did not actually include the period in which the vessel was used. The sample was taken from a piece of wood that is known to have formed part of the logboat, but came from no identifiable area and thus, due to the destructive nature of Radio Carbon dating, was of no relative importance in reconstructing the logboat at a later date once it had been recorded. The sample piece also allowed sampling within the wood thus limiting the amount of contaminants that could possibly have been taken up by the wood during storage.

The Radiocarbon date was commissioned from the Scottish Universities Research and Reactor Centre (SURRC), East Kilbride, Scotland (See Appendix 1). The sample was prepared at SURRC, and the calibrated age ranges determined from the University of Washington, Quaternary Isotope Laboratory, Radiocarbon Dating Program, Rev. 4.0 1998 (Cook 1999). The Radiocarbon date given by the sample was 850± 50 BP (lab code GU-8428). This gives a calibrated year range to cal AD 1036-1279 at two standard deviations. Thus for the first time a date range for the period in which the log boat was used had been determined. The date range was considered to be too large, however it was within the bounds of being refined by dendrochronology. A dendrochronological study was thus commissioned to refine the *terminus post quem*. If the date had proved to have been considerably earlier or later then due to the historical period it fell within there would not have been a need to refine it.

The dendrochronological analysis was carried out by Nigel Nayling of the University of

Wales Lampeter (Nayling, 1999.b). Two samples were taken; a core sample through the base of piece **no.1** and a wedge sample from the same piece but incorporating sapwood. The sapwood taken with the core had disintegrated during coring and was therefore useless. It was also from an area that did not incorporate the greatest thickness of sapwood and would therefore not be the best area for refining the date. Though destructive it was felt that the added benefits of being able to add the largest possible sapwood sequence outweighed the destructive nature of the sampling. A hacksaw with a fine kerf was used to minimise the loss of wood and facilitate the relocation of the wedge in the parent piece. The second sample was taken in an area where there was substantial remains of sapwood.

The dendrochronological date for felling of the parent tree from which the logboat was fashioned was refined to between AD 1187 and AD1205, an eighteen year period. Theoretically, if bark had been found at the end of the sap wood sequence, the logboat could have been felled in AD 1187. No bark was discovered and therefore a sap wood estimate of a further 18 years has to be added (Hughes *et.al.,* 1981 and Tyers, 1998).

The planking was also analysed to try and achieve a date of felling. This would establish if the planking was contemporary with the logboat and therefore whether or not it was reused. The samples were taken from the ends of the planking to reduce the amount of damage done to the plank. This did not necessarily maximise the potential of data that could be recovered. Samples from the centre of the planks would have done this. A band saw with a fine kerf was used to reduce the damage to the parent plank.

The dendrochronological date for the planking is post AD 1074. That is to say the last ring in the sequence corresponds to AD 1074 and therefore the parent tree from which the planks were extracted was felled post AD1074. The largest number of measured rings (128 rings) came from the sample that gave the latest date, AD1064, (add ten sap wood rings to give 1074). Therefore if the tree from which the planks were extracted was felled at the same time as the logboat it must have been at least 277 years old, adding the extra 36 rings for maximum sap wood (Nayling 1999.a).

The dendrochronological analysis does not confirm that the planking was fashioned from a bole felled at the same time as the parent tree of the logboat. It is possible that a 277 year old tree could have been felled and part of it used to make the wash strakes. This is not outside the realms of possibility. Potentially the wood could also have been reused from another source, be it recycled from a building or another vessel. This has implications for the interpretation of the fastening holes evident within the wash strakes. The dendrochronological analysis also confirmed that plank **no.9** was part of plank **no.10**, the last date in its sequence being AD981 and the first date in **no.10**'s sequence being AD982 (Nayling 1999.b:4).

Catalogue of Timbers

Introduction

The original find consisted of a number of pieces of broken planking and a 4m disarticulated section of logboat (Fig.1.2). The planking consists of five pieces which make parts of four separate planks. The remains of the parent logboat had been broken into six main parts and twelve smaller parts, and numerous splinters. The splinters are barely identifiable and do not impart any information and are therefore not recorded as part of this study. The logboat has been dried out and the wood on the whole is of a sound and solid state. The surface exfoliates and is "crumbly" to the touch in areas due to drying. The one surviving end is crumbly, possibly due to the presence of rot that had developed in the parent tree or developed during the time of its use. Most of the original numbers assigned during recovery survived and will thus be used. Virtually all the pieces can be placed into their original position helping to reconstruct the remaining end and mid ship part of the logboat.

All length measurements are from the surviving end unless otherwise stated this being the original point from which all initial measurements were taken. There should therefore be no confusion between what was initially identified as the bow and what is now identified as the stern (see below, parent tree orientation). Side and moulded dimensions are used as all the pieces can be oriented in this respect.

Wood species and conversion.

The parent tree from which the logboat was fashioned was a large straight grained oak (*Quercus spp.*), which was at least 166 years old when felled (Nayling, 1999.b:7). The whole tree was used with little being trimmed off except the bark and some sap wood. Along both edges, sheer and chine the remains of sap wood can still be seen (Fig. 1.3). Most of the heart wood and pith were also removed throughout the length of the vessel. Only at the surviving end do we have the remains of the pith.

A minimum amount of work would be required to realise the outer hull shape e.g., four tangentially split pieces is all that is required to be taken off the outer part of the bulk. This would then be trimmed down and smoothed off as required.

The evidence as to the method used to cut out the internal part of the logboat did not remain. The floor of the inside is however covered in a pattern of elongated scallop shapes (Fig. 1.4). These represent the marks left behind by an adze. An adze is considered to be the tool used within the log boat whilst an axe would have been used on the outside of the vessel. The largest measurable adze mark has a width of 43mm. This could equate to a 2 inch wide blade as the minimum size used though any such assertion on the evidence to hand is purely supposition. No signature marks are recognisable within the collection of adze marks. The person finishing off the inside of the vessel appears to have worked along the longitudinal plane of the vessel, along the grain of the wood, working from one side to the other within 0.6m blocks. This could represent the easy working area of an adze. Narrow adze marks with a maximum width of 35mm can be seen in the corner of the logboat at the turn of the bilge. A similar size of adze was noted on the late Saxon log boat from Clapton, London (Goodburn, 1989.99).

Dendrochronological analysis has confirmed that all the planking was radially split from an oak bole (*Quercus spp.*). The dendrochronological analysis also confirmed that the two pieces of planking **no.9** and **10** are from the same plank. No sap wood or pith survived on the planks, having been trimmed off at some time prior to the planks fastening to the logboat (Nayling,1999.b:4).

A hole in the surviving end of the logboat has the remains of a holly (*Ilex aquifolium*) branch within it (Fig. 1.5). It is in a very fragile condition but was extracted for further detailed recording. It retains its central pith and appears to be an entire stem rather than a turned piece. The stem shows a moderate growth rate. This piece was a side branch with some of its bark still *in situ*. This is the only other wood species present apart from oak.

Parent tree orientation.

A number of knots evident within the logboat have helped to orientate the parent tree from which the logboat was fashioned. They are angled inward towards the surviving end suggesting they grew upwards and outwards towards the other end which would therefore be the top of the tree. The measured beam of the bottom of the logboat verifies this assumption. The beam of the floor of the logboat just behind the break of the side of **no.1** is 0.6m including the remaining sapwood. This compares to 0.64 just before the start of the up turn of the surviving end, which has no visible sapwood remaining. The thicker end should represent the butt end of the tree (McGrail, 1978:120), which in the Llyn Peris logboat is at the surviving end.

It is commonly accepted that the wider end, and therefore the butt end of the parent log, is the stern end (McGrail, 1978:87). This assumption comes from the fact that the butt is usually the place where brittle heart (a form of fungal decay) is most extensive in over mature trees (Jane, 1970:228) and therefore does not provide good wood for the termination of the end. Any defects in the bottom of the tree are easily dealt with if confined to the stern; a transom, made from a separate piece of timber, can be placed here therefore negating the need for sound heart wood.

Logboat Description (Fig. 1.6).

The logboat is made from a single piece of oak, which is now in six main pieces, twelve smaller pieces and numerous fragments and splinters. With the pieces assembled the logboat has a maximum remaining length of 4.03m. It has a maximum estimated internal beam at the surviving end of 0.55m and external beam of 0.66m. The dimensions increase to 0.56m internally and 0.675m external beam, 1.5m from the end. The maximum external depth is 0.42m and the internal depth is 0.34m along the port side. All the pieces fit together well, but have the odd irregularity. The splits in the log boat all run longitudinally along the grain, which has imparted a slight wave into the splits helping to position the pieces, and break athwartships at knots. All the splits are due to the drag line. This being obvious due to the polished marks of the teeth evident within any damaged area.

The sides moulded dimension averages between 45mm at the bottom and 40mm at the top just below the land. The bottom moulded dimension is 50mm in the centre increasing to 60mm at the sides. The remaining end has a central moulded thickness of 60mm increasing to 80mm at the sides; this is mirrored at the other remaining end, the significance of which will be discussed later. The sides appear to have a tumble home though this is probably due to shrinkage. No internal fittings can be discerned and there are no thickness gauge holes evident.

No. 1

The largest and most whole piece of the log boat is **no.1**. This consists of a 2.94m length of the bottom and side of one end of the logboat. It has a maximum width of 0.32m, 1.5m from the end. 1.58m of the side of the log boat also remains and is whole from the turn of the bilge to the sheer line. A rough rebate runs along the top edge of the side and can be interpreted as a land for the fastening of a wash strake. This land varies in height from 60 to 70mm and has an average depth of 4mm. More evidence for a wash strake comes from two 5mm nail holes, (bits of iron still being in place), 0.44m apart, running almost parallel to the sheer line, but 40mm below it. On the same line 0.35m from the end is a 20mm circular hole.

A hole, 0.22m from the end, 40mm in diameter and 108.5mm deep, is also apparent within the surviving end of the logboat. This has the crumbling remains of what was originally considered a large treenail still *in situ*. This has been identified as holly (*Ilex aquifolium*). The piece was extracted and proved to be 80mm in length. The end had been cut with an axe at least two times. Bearing in mind that half of the treenail remains it is likely three or four cuts were originally used to cut this branch from its parent tree. A minimum of trimming is evident before it was inserted into its associated hole where it made a snug fit.

No.2

Piece number 2 makes up the mid section of the surviving end of the logboat. It has a maximum length of 2.93 m and width of 0.223m. The depth of the bottom shows a slight though obvious increase toward the end. The depth of the floor being 50mm deep 2.45m from the end steadily increasing to 64mm 0.5m from the end. It then thickens considerably and curves upward to form part of the end to a height of 180mm. It is within this end piece that the pith of the parent tree can be seen.

When joined to **no.1** it does not make a snug fit, though this is most likely due to differential shrinkage between the two pieces. The main difference in fit is at the surviving end. This has been accentuated due to a loss of wood from rot. The other end starts to shape up into the side giving a good indication that this end is narrowing. This piece has no evidence of fittings of any kind.

No.3

Piece **no.3** consists of the opposite side to piece **no.1** from the surviving end. It has a maximum length of 1.75m with a maximum moulded depth of 75mm just before the turn up into the end. The moulded dimension for the side is 45mm just above the turn of the bilge reducing to 40mm just below the land. The whole piece has a remaining athwart ship dimension of 240mm, 150mm from the end. The depth of the floor is consistent with **no.2** and the two pieces fit well together. There are no tool marks or fastening holes evident. The hole evident in the surviving end of **no.1** is not evident in this piece as the end does not survive to the same height. Two unnumbered separate pieces can be directly associated with this piece. These represent part of the sides and will be designated **no.3a** and **no.3b.**

No.3a

This is part of the side of **no.3,** from the junction between the end and the side. The fact that it is not numbered and that it fits perfectly into position suggests it broke off after the initial numbering was put on the logboat pieces. It has a surviving length of 0.53m, sided dimension of 110mm and moulded of 40mm. It appears to have a 40mm land evident on its outboard top surface, which is consistent with the other side, except that it is lower down in the side. This would suggest the sheer line of the logboat was not even or symmetrical, or that there could be a second piece fitted underneath it.

No.3b

No.3b fits well to the broken side of **no.3**, it undoubtedly being the broken off side. Once fitted in place it gives the internal and external depths as previously stated for the other side but with an obvious slope down towards the surviving end. There are two nail holes (5mm square),with the remainder of the nails still inside them, 0.42 and 1.78 m from the end. A bevel 0.65 m long with an average depth of 4 to 5mm is also evident and compares to the land on the other side, and is therefore evidence for a wash strake on both sides. A circular hole 20mm in diameter is situated on the top edge 1.58m from the end. Unfortunately the adjacent side does not survive to verify if there was a parallel feature.

Two parallel lines on the inside face of **3b** do not appear to be damage, but were most likely caused by the wear and tear during the use of the log boat. If interpreted as scribe marks they could be associated with an internal fitting though the lack of such marks anywhere else could discount this theory. They could be associated with cargo damage, and as such could hint at the possibility of carrying slates. If this were the case further wear and tear associated with such a trade could be expected within the logboat. There are no references to the quarrying of slate in Llanberis prior to the mid eighteenth century. This does not mean the quarrying of slate was not carried out in Llanberis. It is however unlikely that a logboat would be used for such an activity.

No.4

Piece **no.4** has a maximum length of 1.97m and sided dimension of 0.27m. Its moulded dimension varies along its length between 50mm at the midship end and 72mm at the other end. The moulded dimension at this thicker end also varies athwart ship, being 72mm at the outboard side and 64mm at the inboard end. This is still a significant increase in moulded dimension of the floor suggesting the termination of the logboat in and around this area. There is no conclusive evidence to say that this is unequivocally the other end of the log.

No.4 fits well to the end of **no.1** with both having half of the same knot evident. Apart from being weak points the knots at both ends also help to orientate the parent tree from which the logboat was fashioned (see above). The broken end has a 30mm deep gouge in it which appears to be post depositional and is most likely to have been caused by the drag line. It does not retain the polished nature of the other drag line damage but due to it being in the longitudinal plane it is suggested that the teeth could not get a hold of the wood and thus did not leave their polished signature mark.

No.5

Piece **no.5** has a maximum length of 1.02m and sided of 0.11m. Its average moulded dimension is 40mm, though this increases through the chine. Along the bottom edge there are the remains of substantial amounts of sapwood suggesting it is from the bottom edge of the logboat. It actually fits in behind **no.3** and adjacent to **no.2**. The tell tale signature marks of the teeth of the drag line bucket can be seen in the bottom edge. There are no tool marks evident or any form of internal fitting or fastenings.

No.5b

This piece has no number but does fit perfectly to one end of **no.5** and is therefore designated **no.5b**. It shares the same overall features as no.5, there being sapwood along one edge which is rounded and two edges which are not parallel, being from the chine area of the logboat. It extends the length of **no.5** by 0.38m, giving **no.5** an over all combined length of 1.39m.

No.6

This piece forms part of the floor and bottom of the logboat side. It has a remaining length of 1.59m, a maximum sided dimension of 148mm and moulded of 50mm at the chine which decreases to 42mm at the inboard edge. There are the tell tale polished teeth marks left by the drag line at both edges. The outboard part of the piece is relatively smooth though the inboard side shows evidence for a number of longitudinal gouge marks. These are contemporary with the use of the log boat as they have the same deteriorated surface as the rest of the piece. They could be evidence for the use of a tightly curved small adze to form the internal part of the chine. If so it had a blade width of 26mm (1 inch).

No. 7

Piece **no.7** is 0.87m long and 0.075 sided with a moulded dimension of 45mm at one end and 38mm at the other. It fits neatly to the side of **no.1** and is the upper part of that side, there being a gap below it to the chine. Though there is no nail fastening evident in it, the top edge has the continuation of the land on its outboard side and a chamfer along its inboard edge. Part way along the top edge there is damage which is not consistent with post displacement damage, there being no tooth marks or the like. This could suggest damage of the upper edge during the time of its use and therefore the reason for the wash strakes being applied to the sides.

No.8

This piece is part of the side of the log boat. It has a remaining length of 0.85m, a remaining maximum sided and moulded dimension of 125mm and 38mm respectively along the bottom edge which reduces to 18mm at the top. The top edge has three nail fastenings still *in situ* 250 and 150mm apart. The outboard edge has a chamfer to it though this appears to be due to the degradation of the sapwood in this area. The amount of sapwood, 60mm sided, would suggest the piece is from near the front of the logboat.

No.14

This piece is 0.436m long has a maximum sided dimension of 40mm and moulded of 30mm. The moulded dimension would suggest that it comes form the top of the side of the log boat but this might not be the case. Looking at the cross section one can orientate the piece between inboard and outboard via the radial lines. As such it would appear that the inboard face has a crescent shaped longitudinal gouge. This runs virtually the full length of the piece and would suggest that it comes from the chine area of the parent logboat. The same feature is seen in the inboard chine area of no.6. A slight hint of sapwood on the outboard side would support this.

No.15

This is a broken piece possibly from the side of the logboat. It has a remaining length of 0.508m, with a maximum sided and moulded dimension of 58mm and 45mm respectively. The moulded dimension reduces to 36mm along one edge towards one end. This could suggest that it is part of the side but could also mean it is part of the floor. The width of the radial rays would suggest it is part of the side. There are no nail fastenings or evidence for fittings on this piece.

No. 16

This piece is part of the sheer of one side of the log boat, possibly the same side as **no.1**. It has a remaining length of 0.4m, and a remaining sided dimension of 85mm. It has a moulded dimension of 35mm which reduces to 20mm at the top. Evident along one side is a 52mm wide land between 2 and 4 mm in depth. The top edge has a slight chamfer to it.

There is a 16mm diameter hole evident at one end. This hole is in the same relative position as that on **no.3b**. It however, cannot be the hole opposite that on **no.3b** as this would be on **no.7**. It is therefore assumed that this piece represents a secondary athwart ship feature further down the logboat from that evident on **no.7**.

No. 17

Piece **no.17** is 0.061m long and 0.08 wide . It has an average depth of 53mm. This is consistent with the bottom of the logboat. One side is of a lighter colour and rounded. This is a feature noted in the turn of the bilge on number one and four. Thus pieces **no.5** and **no.17** are most likely from the bottom corner of the logboat.

No.18

A broken piece 0.40m long and 42mm sided. It has a maximum moulded dimension of 40mm which suggests it is from the side of the logboat. No sapwood is evident and there are no features suggesting fastenings or fittings evident. No definite home can be found for it.

Wash Strakes.

The wash strakes consist of five separate pieces. They are all radially split, with evidence of nail fastening along the lower edge, and treenail holes along the upper edge. The only exception to this is **no.12.** Though dealt with independently **no.9** and **no.10** do actually form the lower and upper part of the remains of a single wash strake. The wash strakes are fastened to the parent logboat in the clinker fashion using wrought iron nails driven through the wash strake and parent logboat. There is no evidence for the ends of the nails being clenched over a rove or turned back into the side of the boat.

No.9

Wash strake **no.9** is 1.54m long and narrows from 89mm to 60mm in its sided dimension at each end. The strake has a moulded dimension of 15mm at its top end and 7mm at the bottom. The narrowing to 7mm starts an average of 40mm from the bottom edge and thus forms an obvious land. There are three nail holes 450mm and 860mm apart. These run in a rough line 20-15mm from the bottom edge, within the land. The impression of a 20mm diameter round rove is evident on one side.

The nail holes in this strake do correspond to those on **no.1**, but there is no evidence for a 20mm hole as on **no.1**. The strake would, if complete, cover the hole, as it already covers half of it. The strake also sits above the bottom of the land in the side of **no.1**. The difference between the edge and the rebate is too great to be accounted for by shrinkage, but could be due to damage. The lack of a snug fit in the rebate and there being no hole in the area of the hole on **no.1** could theoretically suggest that this piece does not actually fit above **no.1**. It also hints at a loss of wood from the bottom edge.

No.10

This is the top half of **no.9** and has a remaining length of 1.41m, and a sided dimension of 116mm. It has an average moulded dimension between 14 and 12mm. There is no evidence for nail fastenings. Due to it being the top part of a wash strake these would not be expected. There is a single 22mm diameter hole evident 30mm down from the top edge. A second 8mm hole is evident in the broken end of this piece. This could represent a nail hole or small treenail/dowel hole.

No.11

This is the broken and split remains of a wash strake some 1.475m long with a remaining sided dimension of 205mm. Its average moulded dimension is 14mm which reduces to 7mm at the bottom of the land, which is 55mm wide.

There are four nail holes, 7mm in cross section, within the lap an average of 22mm from the lower edge, and 0.455, 0.37 and 0.31m apart. The fourth nail hole shows no evidence of being used and is only 40mm from one of the others. This could suggest it was a mistake, or could have been a reuse of this piece. On the top edge there are two holes 23mm in diameter and 685mm from one another. What they were used for cannot be ascertained as there are no fastenings or fittings associated with the holes.

No. 12

This is the broken and split remains of a wash strake some 1.8m long with a remaining sided dimension of 184mm and average moulded dimension of 16mm. There is evidence for a single nail along the bottom edge and a second hole in the broken end of the plank could be evidence of a further nail hole. At one end, along the bottom edge, there are two 16mm diameter holes some 210mm apart. Above these two holes is a single 24mm diameter hole just below the top edge. A second 24mm hole lies 0.71m along the top edge from the other hole. The 50mm wide land is not as pronounced in this piece as in others.

No.13

This is the broken and split remains of a wash strake with a remaining length of 1.5m, a remaining sided dimension of 160mm and moulded dimension of 16mm which reduces to 7mm at the end of the land. The remaining maximum width of the land is 30mm. There is a single counter sunk square hole, 8mm internal diameter and 19mm external with a depth of 4mm, at one end in the upper edge of the wash strake. Apart from this unusual feature there is no further evidence for fastenings or fittings within this wash strake.

Fastenings (Fig. 1.7)

A number of fastenings are evident within the remains of the logboat and wash strakes. The hole in the stern plugged with a holly branch is not a fastening. It is interpreted as one of two handles with which the logboat could have been lifted and dragged ashore. The evidence for fastenings within the logboat can be split into two categories, nails and treenails.

Nails

A number of 7.5mm, ± 0.5mm, square cross-sectioned wrought iron nails are evident along the top edge of the logboat. They are situated within the land and were used to fasten the wash strake to the logboat. There is no evidence for the use of roves on the inside of the logboat. The nails were driven through the side of logboat from outboard in and then clenched over into the side of the logboat (see figure1.7)

A number of 20mm counter sunk round holes on the wash strakes are evidence for roves being used on the outboard face. The counter sinking of the outboard roves is excessive and not required. This could support the theory of the planks being reused from elsewhere, the counter sunk holes being old holes that have been utilised for fastening purposes.

Treenails

No treenails were discovered with the logboat. A number of holes interpreted as treenail holes are evident in both the logboat and the wash strakes. The through holes are all positioned in the top of the logboat and top of the wash strakes. They cannot be directly associated with each other and must represent two different forms of fittings. The variation in size supports this.

The holes in the top of the logboat are positioned in the stern and near midships. They are represented by two 20mm diameter holes. Both holes would be hidden by the wash strakes on the outboard face, there being no corresponding holes in the wash strake. They were therefore not used to fasten the wash strakes to the side of the logboat. A plausible interpretation is that of thwarts.

The treenails in the wash strakes are of two sizes, 18 and 20mm. The 18mm holes are found as a pair along the bottom edge of the wash strake. They do not correspond to any of the other fastening holes. Their position and size could be related to a previous use if the wash strakes were reused.

The second size of treenail hole, 20mm, occurs along the top edge of the wash strakes. They are not associated with any other fastening hole or fitting. They could be associated with internal beams to help stiffen the top of the wash strake or with fastening internal frames to the wash strakes. No evidence for internal framing, apart from the inconclusive interpretation of scribe marks, has been found. The possibility exists that both sets of treenail holes are evidence left behind from the reuse of the planking.

Hull form

The Llyn Peris logboat has made maximum use of the dimensions of the parent tree. It is a rectangular shaped logboat with a square transverse cross section, rounded chines and a surviving punt end. To use McGrail's terminology (McGrail, 1978, Fig.205), the surviving end is rectangular in plan, inclined in elevation and sub rectangular in cross section, though it could be considered as rectangular in cross section with rounded chines as stated above. Tumble home has been recorded but can arguably be considered to be due to drying and not a feature imparted on the hull form by the original maker.

Though maximising the dimensions of the parent log, the logboat is not obviously tapered in its outboard shape. Where possible the original maker of the logboat has tried to keep the sides as parallel as possible. This has resulted in there being an increase in sapwood from the surviving end, whereas there is none towards the midship area of the logboat. A slight taper towards the bow end is discernible when comparing the measurements as described above.

The logboat has a remaining length of 4.03m when all the bits are put together, **no.1** and **no.4** being the two main bits for this measurement. The thickening of the floor at the end of **no.4** would suggest that it is in the vicinity of the other end. For the sake of a reconstruction it is assumed that the missing end of the logboat did not extend further then 5m. Just under an extra metre is added as this is roughly the distance that the same dimensions occur at the surviving end. For the purpose of analysis a minimum length of 4.5m, maximum length of 5.5m and an intermediary length of 5m will be used.

The external depth can be given as 0.41m, and the average internal depth is 0.33m. These depths are without the inclusion of the wash strakes. The wash strakes add between 120 and 140mm to the freeboard of the sides. Whether or not these extended around each end cannot be discerned though would seem unlikely.

Hypothetical Reconstruction

What both ends would have looked like whole cannot be known for certain. It could be assumed that if the stern is of punt form then the bow would follow suit and is either of a similar punt form, or one that is slightly rounded. In reconstructing the bow and the whole stern the estimated maximum diameter of the logboat can be used to deduce the maximum height and beam at either end. It is important to note that the pith of the parent log is not centred within the logboat but is off set towards its bottom. This could allow for a greater area of wood in the two extremities or could have just been caused by the eccentric growth of the parent tree.

Comparing the archaeological remains to other such finds in Wales can also be used when reconstructing the ends. Probably the best known logboat from Wales is the Llyn Llangorse logboat (Fig. 1.10), 1136 $\pm$ 60 BP (Q-857). Its social context, possibly Irish, means its form might not have Welsh origins (Figgis, 1995.11). The forward protrusion is a feature not seen in the other two logboats from North Wales, these being the Llyn Llydaw logboat and the Llandrindod Wells logboat (Fig. 1.9). Though similar protrusion are seen in other logboats such as Oakmere, Loose Howe and Preston 1 (McGrail, 1978) they are not necessarily of the same form. It has been suggested that the protrusion is due to loss of wood through degradation or damage (Figgis, 1995.16). This would suggest that originally the bow was of punt form with a horizontal hole through it. This shape, though not conclusive, would correspond to the evidence found on the other logboats. The horizontal hole being for the use of a painter.

The Llyn Llydaw logboat can be used in a comparative study. It is dated cal AD 1430-1525 and 1560-1630, 1 sigma (Redknap, 1999); no lab code, calibration curve or dating certificate has been provided despite being requested. It was found within 7km of the Llyn Peris logboat at the top of the Llanberis pass. Virtually the full length, 2.86m,of the vessel appears to have been recovered. Its shape in plan is rectangular but with a rounded and inclined bow. The stern section appears to be rectangular in elevation, as is its cross section. There is a hint of tumble home in the midship section though this appears to be due to not squaring off the outboard face. The bottom of the log boat has extensive rocker which is part of the original vessel, and could have been enhanced slightly due to drying.

Apart from the overall size and apparent rocker the Llyn Llydaw logboat does share a number of similar features as the Llyn Peris logboat. Its cross section is rectangular, the chine is rounded both internally and externally, no thickness gauges are used and the sides and bottom are relatively thin. The stern, though not as acute as the Llyn Peris logboat, does have an incline which ends at a right angle. It originally had two small holes through one side near the rectangular end (Barnwell, 1874) which are also a feature of the Llyn Peris boat.

A closer parallel to the Llyn Peris logboat is the logboat recovered from Llandrindod Wells. It has a remaining length of 4.78m. In general plan and elevation it looks similar to the Llyn Peris logboat. The thinner end is thought to be the bow but unfortunately did not survive (McGrail, 1978:232). The surviving end has a horizontal hole evident within it which is

40mm in diameter (McGrail, 1978:232), though was reported to have been 25mm originally (Grimes, 1931:140). In its present state it compares well with the Llyn Peris boat horizontal hole. This vessel also has a possible wash strake associated with it. If this could be confirmed beyond reasonable doubt then the Llandrindod Wells logboat would provide the best comparative study from which to reconstruct the Llyn Peris logboat.

A fifth logboat was found in north Wales at Llynbedydd, Hanmer, Flint in 1875. There is however no further information for this logboat (McGrail, 1978:232).

Using the evidence from the remains of the Llyn Peris logboat and comparing it to other finds from within Wales can enhance our understanding of the overall shape of the original parent logboat. When, however, considering features such as the holes within the sheer of the logboat and those seen in the wash strakes there is less evidence to use. Quite often an attempt at interpreting these features on other logboats has not been considered due to the non-survival of the associated fittings (Millet & McGrail, 1987:110). Despite this a number of conclusions can be reached concerning those in the Llyn Peris logboat.

The holes near the sheer line of the Llyn Peris boat do not occur often enough to be used to fasten the wash strakes to the log boat. Instead wrought iron nails were used. The location of the holes in the extremities and near the midship area could however suggest that they were strategically placed to act as fastening holes for internal ribs. If this is the case then the ribs would act more as stiffeners for the wash strakes than constructional features of the parent logboat. Similar sized holes in the wash strakes would support this except that they appear in the bottom of the wash strakes. If the above stated assumption is correct then the treenails were driven through the wash strake, logboat and rib at the same time; thus the wash strakes must have been fastened to the sides of the logboat before the fitting of the stiffening ribs.

The hole in the stern can be interpreted as some form of a handle with which to lift the logboat. This would be required as the overall size and weight of the logboat makes it awkward to lift. Another interpretation could be a method to join two logboats together, this however would not be structurally sound without further fittings or lashings.

A number of larger holes in the top edge of the wash strake (see Fig. 1.6) also represent problems for interpretation. A logical use would be for thwarts or beam ties. The first suggestion would see the seating arrangements being placed too high in the logboat, whilst the second could offer extra stiffness to the wash strakes but not necessarily the sides of the logboat. As such, without the remains of the associated fittings little more can be deduced from these features.

For the sake of the hypothetical reconstruction the logboat is considered to be of rectangular longitudinal shape with a punt shaped stern (Fig. 1.8). The bow has been reconstructed without the vertical part seen in the stern. This would allow for a more hydrodynamic bow that would ride above any chop or at least force it away from the logboat. It would also be in character with the other finds from north and mid Wales. The reconstructed maximum length is 5.5m which fits with the evidence at hand and is within the mean length of English and Welsh examples as deduced by Mowat, this being 5.16m $\pm$ 2.35m (Mowat, 1996:125). Its minimum reconstructed length is 4.5m, the minimum length allowed if a bow is added to the surviving length. A 5m long reconstruction has also been drawn. This acts as a compromise between the maximum and minimum lengths. The wash strakes have been added to the full reconstructed length. The stiffening ribs and tie beams have been left out due to there being no direct unequivocal evidence for their use.

Hull Analysis

The 5m long reconstructed Llyn Peris logboat has been used for the analysis. Either of the three reconstructed lengths or any length between would be just as viable. The 5m long reconstruction is used due to it being the best compromise between all the evidence to hand at this time. A number of simple naval architecture coefficients and ratios and hull form coefficients are used to analyse the log boat. Far from being innovative (Wilson, 1989) the use of form coefficients as an analytical tool has been in use for at least two decades, McGrail (1978) and Coates (1984) being two of its main exponents. The data is relative in most cases, and requires similar data from other logboats within Britain or Europe to be of relevance. Despite this it is important to calculate the data so it is at hand for any further comparative studies.

The nature of the archaeological find must also be considered. The logboat in its present state is sound of wood but not of shape. Apart from the obvious damage; shrinkage and distortions due to drying must be taken into account. The overall shape of the logboat is rectangular in plan and cross-section but appears to have marked tumble home. The stern, which is the most solid piece and therefore less susceptible to the effects of shrinkage does not show any pronounced tumble home. It can therefore be surmised that the recorded tumble home is due to the differential shrinkage of the wood in an area of relative weakness. Tumble home is not a required feature for this size of vessel nor is it beneficial, indeed it can be considered detrimental.

Off sets taken directly from the logboat have been loaded into *Hull Form 8*, a computer programme that analyses the hull dynamics. The 5m reconstruction is used to act as the minimal form of reconstruction. All the analysis is done assuming open ended wash strakes.

Displacement volume

This is the volume of water displaced by the immersed hull of the logboat. It is otherwise known as the vessels displacement and is standardised at the point when the water line is 75% of the total depth of the same vessel. It is an indicator of relative size and load carrying potential. The logboat has a displacement volume of 1136.36kg (see appendix 2a.3). At this displacement it has a draft of 0.3375m which is shallow for the environment within which the vessel operated. It should be noted that there is little freeboard at this displacement and the addition of wash strakes would have been welcomed.

Slenderness coefficient (CS)

McGrail (1987:194,197) defines this as what is commonly know as the length to breadth ratio (L/B) as discussed by McKee (1983:79,81). It is a definition of the overall narrowness of the boat, a narrow boat having a coefficient 3.75 or higher. The logboat has a CS of 7.14. A high slenderness coefficient, 5 or more, is considered indicative of high speed potential (Rawson and Tupper 1976:572). This last point is not necessarily applicable to medieval logboats which are man powered. A low slenderness coefficient is not indicative of directional stability as suggested by Mowat (1996:5) but indeed the opposite is the case (McGrail 1978:139). Directional stability is also reliant on the depth and area of the immersed body.

Beam/depth coefficient (B/D)

This is a definition of the general volume of the logboat. Boats with a low B/D, 2.0 or under, can be considered as deep (Mckee, 1983), or volume dominated (McGrail, 1978). A high B/D, 3.0 or over, means the boat is shallow and not volume dominated. Deep boats are good for the carrying of bulky cargos, and on the whole have good transverse stability and relative manoeuvrability. The logboat has a B/D of 1.25 which means it is deep or volume dominated. This is in part due to the limitation on the ability to increase the beam of the logboat due to the nature of the material used.

Block coefficient (CB)

This is the ratio of the immersed volume of the hull to that of a rectangular block whose sides are equal to the extreme breadth, the mean draught and the length of the hull. The larger the value the greater the area of the hull that occupies the rectangular block. It can therefore be used to compare general hull shapes, e.g. a large oil tanker would have a CB of 0.88 and a racing yacht one of 0.34 (Barnaby, 1969:19). The oil tanker, which is slab sided for most of its length, made more use of the area available within the block than the racing yacht which has fine lines fore and aft, and is not slab sided. It is also generally accepted that a low value CB, less than 0.65, indicates good speed potential. This is relative to the size of the vessel.

The wave making resistance of a displacement vessel means longer vessels naturally have a higher speed potential despite their shape (Marchaj, 1964:248). The logboat has a CB of 0.866 at its given displacement (Appendix 2a.3). This not surprising as it is in all respects a box with its corners rounded.

Prismatic Coefficient (CP)

The CP is the ratio of the immersed volume of the area of the midship section multiplied by the water line length. It gives an impression of how the hull form fills the outline formed by its maximum sectional area projected over its length. In general it exceeds 0.55 (Barnaby, 1969:25). The logboat has a CP of 0.881 at its given displacement (Appendix 2a.3). This is high due to the overall square shape of the vessel but not above 0.9 on account of the raking stem and stern.

Coefficient of Fineness of Water plane (CW)

This is the ratio between the area of the water plane (waterline length x breadth) and a rectangle formed by the waterline length and breadth. A figure of 0.7 or less indicates a fine vessel whilst one of 0.9 indicates a slab sided vessel. The Llyn Peris logboat has a CW of 0.943 due to its slab sided design (Appendix 2a.3).

Midship section coefficient

The ratio of the midship section area to the area of a rectangle whose sides are equal to maximum breadth and draught. It usually exceeds 0.85 for ships other than yachts, the fin keels of which distort the overall rectangle. A low value, less than 0.85, indicates good speed potential (McGrail, 1978:197). The Llyn Peris logboat has a midship section coefficient of 0.996 which reflects its square cross-section (Appendix 2a.3).

Drag/Speed graph

At a given displacement a drag/speed graph can be used to see the speed potential of any given vessel (Appendix 2a.7). The drag equates to the amount of effort required to propel the vessel at that given displacement. For the Llyn Peris logboat it can be seen that a speed of 4 knots is easily attainable with very little effort. The input required becomes far greater than any gain in speed after 4.25 knots. This virtual wall in the performance of the vessel is due to the shape of the bow. Such a flat raking bow would create a large bow wave which would attain a critical size and thus hinder any increase in speed.

Discussion

The Llyn Peris logboat is at its most basic level purely evidence for the use of water borne craft on the lakes of Llanberis. It could simply have been used for fishing or as a basic means of transport across the lakes. Such use of log boats has been recorded throughout Britain, continuing in some areas into the 19th century. Fox noted log boats being used in the early 19th century Lake District (Fox, 1926:128). The Llyn Peris logboat is a relatively sophisticated vessel, having wash strakes and a number of other features. As such it could be assumed that it was not used purely for fishing and that it was utilised more as a transport/ferry.

John Illsley's theory that the logboat could represent an early drag or sledge (Car-Llusg) can be discounted (Illsley, *pers. comm*). The use of sledges within Snowdonia as means of transport is well attested to (Jenkins, 1962). Sledges were used in the mid eighteenth century to carry copper ore down the mountain sides from Llyn Glaslyn to the track skirting Cawellyn and hence conveyed to Caernarvon by pack horse or cart (Beck, 1970:48). There are no wear marks on the under side of the logboat, as would be expected if it had been used as a drag in such mountainous and rocky terrain. Furthermore the survival of sapwood along the lower corners would have been almost miraculous unless the drag was lost on the lake without being used. The logboat does not fit the description of a drag either, having no skids nor any evidence for their fitting. It would be hard to envisage the logboat supporting a large bundle of hay on top of the wash strakes as described by Walter Davies (Williams, 1981:76). Though such a use can be discounted it does raise the question as to what the log boat was specifically used for.

The internal sides of the logboat do not show any form of wear. That the tool marks are still prominent could be significant. If the logboat had been engaged in a life of hard toil it is unlikely that the tool marks would remain. It would be expected that they were complemented with or actually obliterated by wear marks. It can thus be assumed that the logboat had a very short life or was engaged in a role that would not necessarily impart wear marks. Fishing and the transportation of light goods, including people but excluding animals (no hoof, claw or other marks have been diagnosed), could be likely trades for the logboat.

As stated above such a large and relatively sophisticated logboat is unlikely to have been used solely for fishing. No evidence for fishing is associated with the logboat. Despite the nature of its discovery it would be expected that if it had been used extensively for fishing then some form of evidence for such activity would be found. For fishing purposes a vessel of similar form and size to the Llyn Llydaw logboat would have been sufficient. It is however doubtful that even this vessel was used solely for fishing. Fishing is usually seen as the main function for such craft, but this need not be the case.

If fishing was not its main purpose then a form of transport or lake ferry was most likely the other main use for the logboat. If this is accepted as the case then it has implications for the social and economic history of Llanberis. A direct association with Dolbadarn castle cannot be established. The logboat predates the building of Dolbadarn. It could however be associated with the earlier settlement based at Dolbadarn. If so it could represent an important part of a communications net work. Before it must have been deemed worthwhile to fell a large oak and then fashion it into a logboat there must have been a significant need for such an undertaking.

The tree was felled between 1187 and 1205, the time of Gerald of Wales. Gerald was brought up among his father's people in a Normanized Pembrokeshire. In 1188 however he went on a tour of Wales with Baldwin the archbishop of Canterbury to recruit for the Third Crusade (Dodd, 1998:25). Gerald paints a relatively unsophisticated and poor Welsh society. Though the upper class was considered to have been well shod when going to battle, the mass of the population were less well off. A view point expressed about Anglesey by Turner in 1798 (Humphries, 1997:27). Gerald considers them a pastoral people who cared little for agriculture and nothing for commerce or shipping (Owen, 1904:77). Gerald's observations have come under scrutiny in recent years. It would appear that Gerald was not as well informed about Wales as he thought and that his writings were based more on the pattern of contemporary ethnographical writings than his own observations (Carr, 1995:52). To a degree the remains of the Llyn Peris logboat would confirm this, as it shows to the contrary, that the Welsh were well versed in the use of waterborne vessels if not shipping.

If the log boat does not represent the age of Gerald of Wales then it might be the Age of the Princes. By 1200 Gwynedd was finally emerging as the undisputed leader of Wales (Carr, 1995:54). The early to mid thirteenth century was a time of relative stability in north west Wales, albeit under a fitting Welsh Prince. It can be considered totally co-incidental that the log boat has come from the reign of Llewelyn ab Iorwerth or Llewelyn the Great (Llewelyn Fawr) but this might also be significant to its actual purpose. Any form of stability can induce a certain confidence in a populace which allows in turn commerce and communications outside the local boundaries. Llewelyn was also consolidating his power base within Snowdonia. The coastal areas of North Wales have long proved to be susceptible to attack. Llanberis represented a direct artery into the mountainous fortress.

The two lakes of Llyn Padarn and Llyn Peris form a waterway that provided easy travel through an area that was otherwise lacking in roads and tracks. The Llanberis Pass was however an important thoroughfare for penetrating the heart land of Snowdonia. Its importance is highlighted by the now picturesque castle of Dolbadarn. Dolbadarn is strategically situated at a natural choke point between the two lakes and the bottom of the Llanberis pass, guarding the main route from Caernarvon to the upper Vale of Conway, and central and Southern Wales (Reid, 1998:76). The early history of the castle is not well documented but it is thought to have been built around 1230 by Llewelyn the Great, possibly on the foundations of an earlier 6th century Welsh Prince's strong hold. For a short time Dolbadarn was possibly the seat of administration for the district of Arfon Is Gwyrfai. It is conceivable that the logboat's use was associated directly with the castle or its forerunner. The logboat and Dolbadarn are reminders of the significance of this once important waterway into the heart of Snowdonia.

In present day Llanberis it would be hard to find an oak of such dimensions and of such a straight bole as the parent oak from which the logboat was fashioned. To suggest that the parent log was transported to Llanberis would seem stubbornly to ignore the possibility that such oaks did grow in Llanberis. It must however be remembered that at the time of felling the Llanberis region was a heavily wooded area. The long straight bole from which the logboat was fashioned is indicative of a naturally grown straight wild oak (Brigham, Goodburn & Tyers, 1995:43) The wood accounts of both the Vaynol and Gwydir estates in the later sixteenth and seventeenth century testify to the extent of the then natural forests. Leland also attests to the nature of the forests in Snowdonia at this time (Evans, 1812:308). The parent log of the logboat therefore is also testament as to the great nature of the oaks from Llanberis's wooded pass.

Though a singular find within the context of Llanberis, the Llyn Peris logboat is one of five logboats that have been found within Wales. More specifically it is one of two logboats that have been recovered within the Snowdonia range. A comparison between this logboat and that from Llyn Llydaw has shown similarities in the basic morphology of the two logboats, despite their size difference. As Mowat states the recognition of regional groupings is likely to be an unsophisticated analytical tool based on the more general features of the overall form of a group of logboats as opposed to a reliance on identifying specific features (Mowat, 1996:123). In this respect this study and the publication of its main body can help to go forward towards an identifiable morphology of logboats.

The sampling of the Llyn Peris logboat for dendrochronological analysis will go a long way to helping form a master dendrochronological sequence for north Wales. The Radio carbon date though retrospectively would appear to have wasted resources will allow extra confidence in the dating of the dendrochronological samples and vis-a- versa. Both dating agencies have expressed great interest in receiving the information of the other dating method for comparative work. The dendrochronological date is a significant point in its own right. The other logboats from Wales with absolute dates are Llangorse (McGrail and Switsur, 1975) and Llyn Llydaw (Redknap, 1999) both of which have radio carbon dates. With further finds, and/or a properly managed research project the significance of the dendrochronological work that has formed a part of this study will be realised.

Conclusion.

To conclude, it can be stated that the Llyn Peris logboat represents the earliest unequivocal archaeological evidence for the use of watercraft within the Snowdonia Mountain range, being dated to the early thirteenth century. It is a rectangular punt ended logboat with sides extended by a single wash strake fastened to the sheer of the logboat by wrought iron nails.

The parent logboat has been fashioned from a single oak bole, whilst the wash strakes were radially split from another separate bole. It had a minimum load carrying potential of 596kg, and a maximum in the region of 688kg, with two paddlers and a calculated weight of 448 kg. It is a high density load carrier that could be associated with the early copper mining in Llanberis. It represents a significant reminder of an oft forgotten artery into the heartland of the power source for Llewelyn the Great, Snowdonia. The logboat represents the earliest archaeological evidence for waterborne transport upon the lakes of Llanberis and a continuity of such waterborne transport up to the mid nineteenth century and the arrival of the Padarn lakeside railway and toll roads.

Chapter two.

The Pwll Fanog Wreck.

Pwll Fanog Wreck

Introduction

The Pwll Fanog wreck was found on 28 July 1976 by Dr. D. C., Jones. It was discovered during a marine biological diver survey of the Pwll Fanog hole, just south of Britannia bridge, Menai Straits (Fig.2.1). Initially the divers were only interested in the abundance of marine life on and around the wreck. The wreck consisted of a mound of stacked slates. No timbers were visible to suggest the presence of a vessel. To study the marine growth a number of slates were recovered. After cleaning the marine growth off, the actual slates attracted interest due to their unusual shape, size and the fact that they had not been used; there was no hole to attach them to the lathe work of a roof (Jones, 1976-9).

Research into the initial find raised more questions than it answered. At first it was assumed that the slate mound represented a dumping ground for slate debris from the 19th century slate mill at Pwll Fanog on the opposite side of the Straits from the wreck. A survey of the periphery of the slate mound showed this not to be the case. The slate mound was relatively rectangular in plan, and more importantly the slates could be seen to have been stacked in rows (Jones, 1977:154). Due to the assumed early age of the slates, suggested by an analysis of the marine growth, and a paucity of information on the slate industry prior to the mid eighteenth century a survey of the wreck site mound was initiated.

Site description.

The mound of slate lies at a mean depth of 11m at low water neaps, approximately 40-50m off the Bangor side of the Menai Straits, SH535 707 (Fig. 2.1). The main mound of stacked slates covers an area 9.9 by 5.5m and is up to 1.5m high. It sits on a slope which continues down to 15-16m where there is a ledge 2-3m high. The ledge drops down into the main channel of the Menai Straits, 19m, which is covered in hard pebbles and slopes off to a maximum depth of 27m. To the east of the site the ledge increases in height. Slates washed out from the site can be found in both directions, to the north and south, up to 25m away. There are few slates in the bottom of the channel as these are swept clear, those that are noted are not usually present in subsequent dives.

A number of large boulders sit on top of the slate mound. In July 1978, a lifting bag was used to remove one of the boulders. Staked slates were found underneath the boulder proving that it came to rest on top of the slates after the vessel sank. It has been suggested that the boulders have rolled down the slope onto the site during earthquakes (Wood D., *pers., comm.*). It is unlikely that these boulders were part of the cargo.

Underwater visibility is poor, being limited to 1m though usually varying between 0.25m and 2m. This is due to a high level of turbidity and lack of light. Only on a clear summer day in the early afternoon does visibility rise above 2m. The site is swept by a predominately westward flowing current which regularly exceeds 5 knots. The local area has specific current characteristics due to a narrowing of the Straits and its topographical layout directly to the east. The steep ledge to the east creates a localised turbulence in the current around the wreck area. This is at its most obvious just after low water springs when a "front" of rough water sweeps across the area. This front of water has an onset time of minutes but lasts up to an hour. The effects of the tide are reduced during low water neaps. A slack period of up to 1

½ hours can be expected during low water neaps (M^cElvogue, 1996-99).

The site is a haven for a wide variety of marine life, both fauna and flora. This contrasts with the surrounding area which is denuded of marine life by the tide. Only in sheltered gullies can such delicate fauna such as the sponge *Haliclona oculata* be found. The off site topography is characterised by large rocks and boulders interspersed with sand overlying the bedrock. The fauna seen on site include swimming crabs, lobsters, pollock, dogfish, mullet, bass and wrasse of various types (Cuckoo, ballon and pointed). The site, in contrast to its surroundings, is over grown with sponges and soft corals, particularly *Halichondria* and *Alcyonium digitatum* (Jones,1976-79 and Smith, 1998-99).

Site Surveys

Though the site was discovered in July 1976, it was not until September of the same year that a preliminary survey of the site was completed by Dr Cecil Jones, Jeremy Carroll and David Jones. It was initially thought, wrongly, by the divers that the site represented a "flat" or "flute" transport barge (Jones, 1976-79). Due to the new interest in the slates recovered from the site, a season of diving was planned for 1977.

The survey started on July 9, 1977. The site was photographed first before survey datums were set at either end of site. An area search and pre-disturbance survey, which included a contour survey, were completed. A number of anchors and barrel hoops were found to the east of the site. These were also surveyed in to a general site area plan. Two permanent datums were positioned at either end of the site and a datum line fixed between the two, called the dorsal line (Jones, 1977). A random sample of 100 slates was recovered (August, 1977). A proposed trial trench was not opened.

Excavation

Due to the medieval/early modern date attributed to the site by the slates, see page 49, a designation order under the Protection of Wrecks Act 1973 was sought. This was granted and the site was scheduled and protected in 1978. A licence to excavate the trench was applied for and granted in May 1978. The diving season began on 2 July 1978 with the trial trench started on the 24 June 1978. The trial trench was cut 4m in from the east side/shore side of the mound. It was excavated by removing individual slates by hand from four rows of slate. These were loaded into baskets and brought to the surface for examination or transferred to a dumping ground to the west of the site (Roberts, *pers., comm.*). This area is still recognisable today, though most of the slates would appear to have been washed away (McElvogue, 1996-99). The top layer of slates was covered in marine growth whilst clean slates appeared in the second and third layers. Despite being tightly packed, sand was noted in between the slates. Below the third layer of slates the sediments became thicker. More slates were felt whilst "groping about" in this sediment. This new layer of sediment is described as a layer of grey mud and shale up to ½ an inch thick between each layer of slate (Jones, 1976-79). A small and unidentifiable piece of wood was recovered from the area near the barrel hoops. Seven layers of slates were uncovered as the trench progressed towards the middle of the mound. The trench was eventually cut to a width of 1.2m at the bottom and 1.8m at the top.

The first piece of identifiable timber was discovered on 8 July 1978. It was a short piece of framing, 0.38m long with a remaining moulded and sided dimension of 60 and 15mm. There was a single joggle evident on one side. More wood was uncovered on the subsequent dive. This extended into a layer of mud. A single piece of pottery was also discovered at this stage. It was located amongst the second and third layer of slate close to the periphery of the site (Jones, 1976-79). It is possible it was washed in and not directly associated with the site. No further information is known about this piece of pottery, nor are is its whereabouts recorded.

On Saturday 19 August, 1978, a loose plank, badly degraded, was excavated and recovered. Below this was another more substantial timber running at 90 degrees to the strake. The wood was considered to be firm to the touch (Jones, 1976-79). The above assemblage appears to represent a ceiling plank, a frame and hull planking. This was the first evidence that substantial amounts of the vessel remained underneath the slate mound (Fig. 2.2). It was estimated at the time that up to 1/3rd of the bottom of the hull could be remaining. This has not been confirmed to date.

Further bits of planking were recovered from this point onwards along with the remains of brushwood dunnage consisting of hazel twigs and field maple seedlings. The trench was cleaned up to expose as much of the wood as possible. A number of planks with rove impressions were discovered as the trench was extended towards the middle of the slate mound. On August the 8 1978 the keel was uncovered. The next dives occurred on the 15th of October 1978. Further timbers were uncovered, including a loose scarf and a number of planks (see catalogue of timbers). It was now near the end of the season so the trench was back filled with a basket full of slates to help protect the timbers. The timbers were checked on 21 April 1979 and deemed to be in good condition (Jones, 1976-79).

A second season of work was initiated in 1979. During this season the timbers excavated and surveyed previously were recovered and taken to Ynys Faelog for first aid conservation and storage. A 2m section of the keel was recovered in September. The keel was noted to have been infested with gribble plus growths of halichondria, hydroids, Tuncates (*Botryllus Schlosseri*) gold and black, brittle star (*Ophiothrix Fragelis*), barnacles (*balanuus balanoides*) the latter of recent growth. Fauna noted to have colonised parts of the site include sea-fern (*Kirchenpaueria*), and sea cypress (*Sertularia Cupressina*) (Jones, 1976-79).

The site was back filled with slate. Monitoring of the site continues but no further excavation work has been carried out. This initial trial trench proved that the lower part of the hull survives under the slate mound. Preliminary interim reports have been published (Jones, 1977 & Roberts, 1979) but no further analysis of the timbers has been carried out. To date the site has still not been fully investigated.

Dating

The site was first thought to have been associated with the industrial development of the slate industry and therefore dated to the latter part of the eighteenth century (Jones, 1978). It was only after some of the slates were recovered and analysed that an earlier date was suspected. The slates were identified as *singles* (Fig. 2.3), being on average 250 by 120 mm (10 by 5 inches), which went out of fashion by the 1740s (North, 1926:66). The *terminus* *ante quem* was further reduced when the process of manufacture was identified. The slates were knapped, as opposed to trimmed by a bench-mounted knife, called a horse, which was not used until the 1650s (Richards, 1886).

Due to this earlier than expected *terminus ante quem*, it was proposed to excavate the slate mound. The remains of a medieval or early modern vessel were deemed of importance. The excavation trench did reveal a number of timbers and constructional features (see catalogue of hull remains and analysis). The constructional features, namely clinker built shell and a heavy keel with garboard rebates, suggested that the vessel was constructed in a boat building tradition more appropriate to a medieval date than a modern one. This supported the sixteenth or seventeenth century date given to the vessel after the analysis of the slates.

During the excavation a section of the keel was raised. It was hoped that a dendrochronological date could be ascertained from it, though this has proved not to be viable. The growth pattern evident in the keel sample was asymmetric and thus, despite having a long ring sequence, proved impossible to date (Nayling, 1999.c). Samples from the planking were also taken. The samples though small had long ring sequences, suggesting the trees were grown slowly (average ring widths for the samples from 0.68 to 1.48mm). None of the ring sequences cross matched with each other nor did they significantly match any regional chronology from Britain or the north west (Nayling, 1999.c). No date was achieved but the analysis did suggest the potential of the site for dendrochronological dating.

A sample was taken for radiocarbon dating. It was sent to Oxford University Radiocarbon

Accelerator Unit and calibrated using the Oxcal computer program of C., Bronk Ramsey and the 1986 bi-decadel calibration curve (Jenkins, *Pers., com.,* February 1999). The date given is 395 ± 35 BP (OxA-7969). Within this time period there are two spikes the first giving a time range between cal AD 1440-1510 (1Ω), and cal AD 1430-1530 (2Ω); and the second between cal AD1600-1610 (1Ω) and cal AD1560-1630 (2Ω).

No explanation has been given for the two variations. The earlier range of dates is however more consistent with the rest of the evidence. As such, the century to which the Pwll Fanog wreck can be dated with confidence, both for construction and use, is the sixteenth century, though there is a possibility that it was built in the late fifteenth century or early seventeenth century.

The Slates

Slates formed the first recognisable part of the wreck site. They were also the first indicator of a late medieval to early modern date for the site. The first slates were taken for biological analysis of the marine growth. In 1977 a sample of 100 randomly selected slates were recovered for analysis. During the excavation a selection of 300 slates were recovered to the surface, the remainder of the excavated slates from the trench were dumped to the inshore side of the site.

Typology of slates recovered

The slates recovered in 1977 were measured and analysed. The slates exhibited a range of general shapes and sizes which form three individual types. The most obvious group (B) were 250 by 120mm (10 x 5 inches) and rectangular in shape, the second group (A) are the same rough size but taper more acutely towards the top (the sides have an angle 10 degrees or greater than the vertical); whilst the final type (C) classed as "Cornish" slates are smaller at 205 by 154mm (8 x 6 inches). The 300 slates recovered in 1978 fit into the same overall classification. Of the 300 slates 55% are of type B, 25% of type A, whilst type C make up the remaining 20% along with a number of broken slates. Two large slates, 12 by 12inches, were recovered near the top of the mound. These two slates could have represented a further layer of larger slates, but most probably are two random finds washed in or accidentally loaded with the other slates. The average thickness of the slates is between 6mm (1/4") and 10mm (14/32").

All the slates are classed as singles, these being the smaller type of early roofing slate (North, 1926:66). In Welsh early slates are also referred to as "ysglatus,ysglats, or sglatys" (Lindsay, 1974:14). All have tapered sides, with group A being classed as shouldered due to the tapering of the top end of the sides. This type of tapering was also noted in slates from the 13th century motte and bailey at Hen Blas, Flint, where they were used as "footings", and as roofing slates (Leach, 1960:11). It was the shape that leads to the assumption that the slates were cut specifically for a round roof. This, as previously stated, would have been easier to do at the roofing site as opposed to at the quarry. The slates also show a varied range of thicknesses. The cleavage of the slates is on the whole relatively good (Holden *pers., comm.* 1978). This however could be a reflection of the skill of the slate worker and the relative quality of the slates as opposed to evidence for the slate's final use.

The slates were noted to have been organised into different sizes within the mound. Type A and B were predominant in the top three layers, whilst type C was only found in the bottom two layers. In total 7 layers were recorded (Roberts, 1979), the top two being broken and only evident in the north part of the site.

Moss Slates

The general overall shape of the slates suggest that they are "moss slates". The term "moss slates" is a general term used to identify any roughly hewn slate used in conjunction with moss insulation and turf roofing (Lindsay, 1974:37). Such forms of roof were well known throughout the medieval period until the 19th century (Williams, 1982:101)). Moss slated roofs allowed roughly split and shaped slates to be used without any need for a close fit. Indeed the bevelled edge and tapered sides were features required of the slates so that clay or mortar could be packed between them, therefore helping to bind the slates together (Lindsay, 1974:37). The slates were laid on lath work with moss or mortar packed around them. Turfs of grass were then laid on the slates. This formed a thick insulating roof that was also water resistant. If laid well the grass would take, the roots of which helped to bond the whole roof together.

Slate Characteristics

The slates were analysed by Greaves and Son Ltd of Porthmadog. The slates are blue/gray with occasional green inclusions and carbonate scars with an average weight of 5lbs per square foot. This made them a low roof load when compared with tiles. The water content was calculated as 0.01 lb percent material weight, despite them being up to four hundred years under water. The slates had a tensile strength of 8.40 lb per square inch. The chemical analysis showed that the slates were largely Silica, 55.3%. The next largest constituent was Alumina, 24.8%, followed by iron oxide 10.0%. The final 10% is made up of magnesia, potash, soda, lime and sulphuric acid, in ascendancy of quantity. The inclusion of magnesia supports the provenance of Caernarvonshire, magnesia being present within the metal ores of the area (Rees, 1968:27).

A number of defects were noted in the collection of slates. Defects included greenish spots, *Glas Ysmotiog*, which are associated with the slates of the Llanberis/Nantle/Penrhyn area; green slate being a diagnostic feature of the upper veins of the Upper Cambrian slates of Caernarvonshire (Lewis, 1927:6 and North, 1926:42). Other defects include curved cross-sections (Fig. 2.4), as opposed to flat ones; the slate having been cut near a ripple or *Crych*. This is indicative of surface quarrying where there is less choice of material thus forcing the maximum utilisation of the slate exposed. Another common defect is inclusions of calcium carbonate. The carbonate inclusions have dissolved in the sea water thus leaving open gouge marks, easily confused with tool marks.

Establishing the provenance for slate is not as easy as might be thought. Though the slate quarries have well defined layers characterised by different colours and textures individual quarries do not. The slate beds of Penrhyn run to Llanberis and on to Nantle. It is widely accepted that it is difficult to provenance slate to a specific quarry. The endless variety in "quality, colour and texture puzzles all practical men ... when they ... attempt to account for it" (Richards, 1886:9). However, blue and purple slates are well known in Llanberis (Lewis, 1927:86), as are the inclusions of green bands. Furthermore the slates are known to be "rather hard", but are "first class, even grained and easily-split" (Lewis, 1927:80). This would easily describe the slates from Pwll Fanog. Professor Denis Wood (UWB, Geology) identified the slates as being from Llanberis due to *Glas Ysmotiog* appearing near the surface here and the lines of compression evident in the slates (Prof Denis Woods *pers., com.*).

Estimated size of cargo

No definitive answer as to the question of the original size of the slate cargo can be given. Only 400 slates were recovered from the excavation trench. This does not represent the total number of slates excavated. Initial estimates varied from 20,000- 23,000 slates (Jones, 1978:158) to between 30,000 and 40,000 (Jones, 1978:44). No method is given as to how these estimates were calculated or why there was an increase in the estimate. It is assumed that the discovery of seven layers of slates in 1978 was the basis for an increase in the estimate. Holden did however attempt to calculate the number of slates in the mound. In doing so he calculated a volume for the hold based on the slate mound, this being 1113 cubic feet. This he then divided by an estimate of the number of slates in 1 cubic foot, arriving at a total of 61,215 which equalled 20.5 tons (Holden *pers. com.*, 1978). This would appear to be a large number of slates for one shipment.

A second set of calculations has been worked out using the information from the original size of the slate mound as a comparison. Taking the overall dimensions of the slate mound, without any reductions from slippage etc, and calculating its volume (½ base x height x length) can give us an estimated maximum volume for the cargo; 26.25m^3. This can be accepted as a guestimate of displacement. Using loading calculations for both tightly packed slate (25 cubic Foot per ton) and loose slate (16-20 cubic foot per ton) the cubic metre of slate that can be carried by the displacement guestimate; 18.583 cubic metres tightly packed; 14.866425 cubic metres loosely packed; and 10.59639 cubic metres very loosely packed. These estimates can be divided by an average volume per slate, giving a total number of slates as 39,707; 31,766; 22,641.

No calculation of the number of slates in the mound can be used with confidence, there being too many variables. It would appear however that a very rough guestimate of between 40,000 and 20,000 could be applied. Though purely a guestimate a study of the size of shipments of slates would suggest the lower end of this ball park figure would not be far from reasonable. In the mid fourteenth century, "21,000 slate stones" were transported from the Ogwen to Chester castle. They were ordered by the Black Prince to roof his great stable (Lindsay, 1974:20). In 1525 Henry VIII had 1,000 slates transported to Conway from Aberogwen, whilst the Dean of Bangor was asked to transport 3,000 slates from Aberogwen to Rhyl in 1580 (Lindsay, 1974:22). The first of the two shipments was small, being used to line a well. The second however was to re-roof a house that had lost its thatch and is a good indication of the number of slates required for such a job. These are individual orders for specific jobs and would imply that the Pwll Fanog slates were not an individual order, unless for a very large building such as the great stable at Chester. As such it is assumed the loss of such an order would be noted. Instead the Pwll Fanog slates would appear to be a general order.

If it is accepted that the slate mound represents a general export order then the *Welsh Port Books 1550-1603,* can be consulted to gain an insight into what sort of order could be represented. During this period an *ad valorem* subsidy duty of 12d in the pound was paid for all merchandise imported or exported by aliens and denizens (Dodd, 1971:120).

The Port Books do not show slate being exported every year. The exports recorded are limited to the years 1583-87,89 and 92. All the exported slate recorded was destined for Ireland. This bias in the destination of the slate could be of significance in it being recorded. It is plausible that only the slates being exported beyond the shores of Wales and/or England were recorded. There are no records on the nature of the coasting trade in slates (Lewis, 1927.38). At this time the main market for Welsh slate outside of England and Wales was Ireland (Lewis, 1927.xxvi). Despite the lack of continuity in the records some important information can be gleaned from the accounts. On the whole the size of the cargos exported from Wales to Ireland was between 6,000 and 20,000 slates per shipment. The shipments were in multiples of 2,000 with 10,000 being the most common. The only exception to a multiple of 2,000 is a single shipment of 15,000 slates to Ireland by the Gallion of Beaumaris on the 14 October 1592. It is not known if this is a specific order or not.

The largest number of slates exported to Ireland in a single year was 100,000 slates in 1587 (Lewis, 1927,258). 86,000 slates were recorded as exported to Ireland in 1586 (Lewis, 1927.257). Of the 86,000 slates two shipments accounted for nearly half of the annual export, one of 20,000 slates and another of 16,000. These are still nowhere near the 40,000 plus slates initially suggested on Pwll Fanog. One other shipment of 20,000 slates is recorded, on the 6 March 1584, destined for Carlingford in Ireland and noted as "provisions for the realm of Ireland". The shipment also included other provisions such as salted butter, cheeses, hops, castle soap, and oat meal (Lewis, 1927.251).

On the whole only "slates" are referred to being shipped to Ireland. A single reference to singles (sengles) is given in 1584 but no further variations are mentioned (Lewis, 1927.254). Lewis lists a series of prices *ad valorem* based on the commodities shipped in the Port Books. Singles and doubles are priced at 1s.8d and 2s.8d per 1,000 respectively. Slates are between 1s.8d to2s.8d per 1,000 (Lewis, 1927.xlvii). Lewis does not give a reference as to where the information is taken from. No dimensions are given for the two different sizes, unfortunately we can not check the sizes present at Pwll Fanog with those from the documents.

The above is only concerned with those slates exported from the registered customs ports, these being Beaumaris and Caernarvon. The number of ports, or probably more accurately harbours or landing places, that exported slates but were not recorded within the *Welsh Port Books* is unknown. Certainly there were t4hree that probably did not have their exports registered but were known to have exported slate; Foryd Bay, Aberogwen and Abercegin. As noted above, Aberogwen had been in use since the fourteenth century, whilst all four are noted to have been in use from the sixteenth century onwards, if not before (Lindsay, 1974:27; Smith, 1906:85,86). It is possible that the Pwll Fanog slate wreck had loaded its cargo at any one of the above harbours and thus represents an unregistered cargo. If this is true, it represents a suspected but invisible untaxed trade in slate.

Stowage

No records survive concerning the stacking of slates, otherwise called "slate hobbling", within a boat. Hobbling is now a lost art as almost certainly no slate hobblers survive today. From the excavated remains of the Pwll Fanog Wreck it is possible to discern a systematic method of loading slates into the hull of a ship. The slates were loaded with the cleavage fore and aft. That the smallest slates were loaded first is no coincidence. This allowed the slates to be tightly packed in the bottom of the boat where there is less room and a greater variation in shape. The larger slates are packed on the top where they were easily fitted. To be able to differentiate between the different slates during packing implies that a stock pile was formed somewhere, be it at the quarry, a farmers house or where the slates were loaded onto the boat.

No packing (dunnage), was found between the top layer of slates, but it is likely that in this area it had rotted away as sand was found between the layers of slate. The twigs found within the bottom layers of slate (Roberts, 1979:249), in amongst the layer of clay and shale, could be the remains of brushwood dunnage (Fig 2.5). It is unlikely to have been hurdling, despite the fact that ceiling planking and hurdling were found together on the Magor Pill Medieval wreck (Nayling, 1998:17-18). Some form of dunnage could be expected between the layers of slates. This would help to limit damage. Straw was a well known form of packing in the nineteenth century, it being grown on the estates especially for such use (Lindsay, 1974:63). The sycamore "propeller" seedlings (Jones, 1978), found within the dunnage suggest the brushwood was collected in the Autumn or Winter. Analysis of the season in which slate was shipped out of North Wales between 1550-1603 would suggest that slates were shipped through out the year, including January and February regardless of season (Lewis, 1927:254, 260, 62).

Nature of the Cargo

Initially the mound of slates was thought to represent a specific order rather than a speculative cargo. Three reasons were offered to substantiate this theory. The size of the cargo was comparatively large and therefore thought to be an actual order of slates for a specific building. The different sizes of slates identified were considered to represent diminishing courses of slates. This is an aesthetically pleasing way of slating a roof. The unusual shoulders of type A were considered to represent slates used on a conical roof. It was considered that only the church, landed gentry or monarchy could have ordered such a cargo (Jones and Holden *pers., comm.* 1978). The use of conical roofs was limited to church spires and round towers. Research into state papers did reveal a number of construction projects that required slates in this number, but none that noted the loss of a whole cargo

This initial theory has been discounted. Analysis of the slates revealed that they were Moss Slates. A practical reason for diminishing course work, as opposed to the aesthetic appearance of the slates on a roof, is that it wastes less slate then when they are required to all be the same length. It would appear that the slates were produced for general use. This need not have been a speculative order cut by farmers but was more probably a general order cut for sale in Liverpool, Chester or the North of Ireland. As stated above, during the period in which the Pwll Fanog boat was in use, slate was being exported from North Wales in quantity (Lindsay, 1974:25-26).

Catalogue of Timbers

Introduction

The catalogue of hull remains is not a catalogue of all the remains recorded during the excavation, but is instead a catalogue of the remains recovered and taken to Ynys Faelog for storage, and still at Ynys Faelog over the period 1995 to 1999. Roberts recorded the timbers *in situ* but not the individual pieces (Roberts, 1979:250-253). No timber record or scaled individual drawings survive. Initial analyses should a number of discrepancies in the recording of the timbers, thus it was felt that the timbers would have to be re-recorded. The pieces did not have any labels and therefore have been given new numbers. They are organised in their identifiable type for the sake of the catalogue. It would appear from the catalogue that two important pieces, the two parts of frames have disappeared. This is most regrettable as they represented important information on the construction of the vessel. The single frame that has survived is identified as No.3 otherwise known as the long thin frame. On inspection it has revealed a number of discrepancies with the original drawings, done by Owain Roberts (Roberts,1979:250), which suggest that it is not any different in size than the other frames. This does however mean that the original drawings might not be as accurate as they could have been.

Keel (Fig. 2.6)

Part of one end of the keel was recovered during the excavation. It has a remaining length of 1.92m with maximum sided and moulded dimensions of 185 and 190mm respectively. This gives it a moulded to sided ratio of 1.027, thus making it a rabbeted beam keel (McGrail, 1998:112) The piece is badly degraded, showing extensive attack by gribble and loss of wood in the lower part. It is broken at one end but has the partial remains of a through splayed stopped scarf at the other. The scarf has a remaining length of 410mm and a depth of 40mm. A group of seven nails, 10 x 6mm square, is evident within the surviving end of the scarf. Two 26mm diameter treenail holes 90mm apart are also evident.

A land 40mm wide and 10mm deep is evident along both sides of the keel. It is 60 degrees from the horizontal. This would suggest the vessel had standing planking in the midship area. There are 15 nails on the port side and 27 on the starboard side between 200 and 20mm apart. The nails appear to have been grouped in pairs or threes. This could suggest that the garboard was re-fastened at some time in the life of the vessel.

A single nail fastening hole is evident along the top surface of the keel. It could represent a later addition to the vessel, possibly an unsophisticated fastening point. It could also represent a temporary fastening for a frame; this cannot be ascertained as the relative position of the framing was not recorded during the excavation.

The keel is made from an oak bole that has eccentric growth rings. This is the result of non uniform growth in the tree. Such growth can be the result of prevailing winds, the tree growing in a shadow or due to growing on the side of a hill. There are a number of knots evident throughout the length of the keel.

Framing (Fig. 2.7)

Only one piece of the excavated framing survives. The two other pieces were removed from the site and dried out before being sent for radiocarbon dating. (Jones *pers., coresp.* 1978). No record as to their whereabouts today is known. The two pieces of framing recovered, one in 1978 and the other in 1979, are nearly identical. They are small for a large ship. Using McGrail's identification they represent a large boat as in the case of the Magor Pill Medieval Wreck (McGrail, 1993). The frames are joggled to take clinker planking and have evidence for treenails. A rebate in both frames on the outboard face has been identified as a rebate for fastening a stringer. It is relatively low down in the hull which could suggest more stringers higher up, possibly one at or above the turn of bilge. The individual parts are labelled **PF** for Pwll Fanog, **Fr** for frame, **Pl** for planking and **mis** for miscallaneous.

PF.Fr.03

This is the badly degraded and broken remains of a frame. It shows extensive gribble attack which has resulted in the loss of surface features. The frame has a remaining length of 0.972m, with a maximum moulded and sided dimensions of 70 and 98mm respectively. It has a slight curve suggesting the rise of a floor. Its reconstructed overall cross section is rectangular. The piece has been quarter split from a small tree or more probably a side branch.

There are four treenail holes evident. An enlarged hole could be a possible fifth treenail hole. The treenail holes are 28-30mm in diameter and are spaced between 120-172mm apart. This could suggest 6-8 inch wide planks. The smallest spacing could suggest the area of a transitional plank and thus the start of the turn of the bilge. The reconstructed surfaces would also suggest this area being the start of a turn upwards. If this is so it would mean the Pwll

Fanog Wreck was larger than that at Magor Pill.

At the inboard end of the frame there is a single nail fastening 15mm square. The remains of a wrought iron fastening is evident on the outboard face. It was possibly used to hold the framing in position whilst it was augured before being treenailed. In the same general area are two tool marks. These could represent contemporary axe cuts for joggles or they might be associated with excavation damage. As they are on the outboard face, it would seem reasonable to assume they are axe marks associated with the cutting of joggles.

PF.Fr.004

This is a fragment of a frame with a single joggle. It is badly eaten by gribble, though there are two original surfaces remaining. The overall length is 0.52m with a remaining moulded and sided dimension of 54 and 48mm respectively. A single nail hole is evident 142mm above the joggle. The joggle is 15mm deep and shows evidence of being cut by an axe as opposed to being sawn.

PF.Fr.005

This is a fragmentary piece of what is thought to be a frame. It has a remaining length of 270mm and side and moulded dimensions of 25 and 105mm. This piece has been extensively attacked by gribble. There is evidence for a single knot which would have represented a side branch. The piece has a square cut out of it 90mm square which gives the impression of similar feature as seen on the missing frames. A single nail hole is evident at one end.

Planking (Fig. 2.8)

A number of pieces can be positively identified as bits of planking. Two pieces of planking are easily recognisable whilst the other pieces are less so. All the planking is radially split from oak, with a fine grain and few if any knots. The dendrochronological analysis showed that the wood was relatively slow growing with ring widths of less than 1mm (Nayling 1999c).

PF.Pl.mis.001

This is a broken and badly degraded piece of planking. It has a remaining length of 0.601m with a sided and moulded dimension of 62 and 15mm respectively. There are six large nail fastening holes, 8 by 8mm, and three small fastening holes 4 by 4mm. The fastening holes run along each surviving edge. However it is unlikely that this represents the full sided dimension of the planking.

PF.Pl.mis.002

This is a short piece of broken planking. It has a remaining length of 420mm with sided and moulded dimensions of 88 and 8mm respectively. It has two nail holes, 8mm square, and a single treenail hole, 28mm in diameter. There is an impression at one end suggesting a possible frame. No other constructional features are evident.

PF.Pl.mis.003

A short piece of a badly broken and degraded plank. It has a remaining length of 0.212m with a sided and moulded dimension of 190 and 262mm each. A single 8mm square nail hole is evident on one side. No other constructional detail can be discerned.

PF.Pl.mis.004

A relatively long piece of planking with the remains of a 45mm wide bevel along one edge. It has a remaining length of 1.004m with sided and moulded dimensions of 18 and 90mm respectively. The bevel represents the hem, it being at the top of the outboard face. There are twelve assorted nail fastening holes in the hem. Three of the holes are pegged with square wooden dowels. A further three are plugged with oak (*Quercus spp.*) dowels 20mm in diameter, which have nails driven through them, whilst the remainder are 8mm nail holes. At one end is a scarf, 100mm long with two 4mm square nail holes within it. The opposite end has an impression 172mm from the end, suggesting it is a scarf. The four nail fastenings and bevel cut at the end would support this theory. There are two 42mm long axe cuts on the outboard face. The axe cuts do not seem to have any purpose in the construction.

PF.Pl.mis.005

This represents the broken remains of a clinker plank 1.36m long with a maximum moulded and sided dimension of 26 and 108mm respectively. There is a 20mm wide bevel, interpreted as a broken land, along one edge and a 232mm scarf at one end. There is a total of 25 nail holes within the plank. All but one of the nail holes are along the edge with the land. The nails appear to be in groupings of between two and three with one group of five. A single nail fastened through a wooden dowel 20mm in diameter is similar to those in **PF.Pl.mis.004**. The overall impression is that the plank has been re-fastened on a number of occasions. The scarf has been roughly fashioned without a defined edge. There are five nail fastenings within the scarf. A single treenail hole, 28mm in diameter, is evident along the bottom edge of the land. This is assumed to have fastened the planking to a frame, there are no impressions of a frame to verify this assumption.

Unidentifiable pieces

Four small fragmentary pieces are also associated with Pwll Fanog. They are badly degraded and broken and do not to have any constructional information. They have a remaining length and sided and moulded dimensions of 350 by 60 by 8mm; 340 by 54 by 20mm; 384 by 35 by 16mm and 122 by 56 by 7mm respectively.

Fastenings

Both treenails and nails are evident as a method of fastening with each having a specific role. No treenail survives *in situ* but the treenail holes are 28-30mm in diameter. They are used to fasten the planking to the frames and the scarf together. The use of treenails and nails in the scarf is diagnostic of post ninth century boat building (McGrail, 1987:116).

Two sizes of nail holes have been noted. It cannot be discerned whether they represent two different sizes of nails or the same size of nail at different depths. The large size of nail hole is 8mm square and the smaller size is 4m square. A number of nail fastenings have been driven through a wooden dowel 20mm in diameter. This is not a general form of fastening but appears to be a repair or possibly a wedge treenail fastening. The nails are wrought iron and have been clenched over roves. The lozenge shaped roves are between 23 and 28mm per side. The nails fasten the planking of a strake to its adjacent plank and the strake above and below it.

Hull form and construction.

Not enough of the vessel has been recorded to reconstruct her full shape. Little can be said for certain concerning her hull form, hull dynamics or construction. Though the slate mound could represent the total size of the cargo carried, it cannot be used to define the hull shape, nor the overall dimensions of the vessel. Jones in 1978 estimated the vessel to be 36-40ft long with a 14ft beam (Jones, 1978:31). Spillage of the slates when the vessel broke up would lead to a flattening out of the slate mound thus giving an unrealistic and misleading size. Despite not being able to say anything definitive about the overall size of the vessel a number of features can be identified.

The overall form of construction used in the building of the Pwll Fanog Wreck was clinker, using wrought iron clenched and roved nails with the framing treenailed to the planking after it had been built. The sided dimension of the strakes recovered is relatively narrow. This could be a diagnostic feature of a building tradition, but is most probably due to the narrowing of the planking as it comes into the stern. That this is the stern has been ascertained from the direction of the scarfs. There is no definite evidence of the garboard being fastened to the framing or the framing to the keel. The use of wrought iron nails clenched over roves adds strength to the association with a Nordic boat building tradition.

The shape of the keel defines it as a rebated beam keel. The angle of the rabbet is 60 degrees to the horizontal. This is comparable to Skuldelev 2 and 3 and the Kyholm wreck i.e., dead rise above 55 degrees (McGrail, 1987:114). McGrail considered that this shows the vessel would have carried a sail, the dead rise being an attempt to stop leeway. Without evidence for associated features such as a mast step or mast beam this cannot be accepted unequivocally. Considering the size of the cargo and therefore the vessel, the use of a sail would seem plausible.

Discussion

The Pwll Fanog wreck raises broader questions than those that can be answered by the remains of the vessel or the slate mound. The find is evidence for the early slate quarrying in North Wales. The term industrialisation is not used as it has too specific a connotation with early nineteenth century industrial quarrying and mining of slate. The scientific date for the Pwll Fanog wreck is broad, late 15th century to early seventeenth century. It does however cover the early period of the recorded export of slate from Caernarvon, Beaumaris and Aberogwen.

It is assumed that this early recorded slate being exported was quarried in the Conway and Ogwen Valleys and Nantle Vale but not Llanberis (Turner, 1975:11). If it is accepted that the slates from Pwll Fanog are from Llanberis (Jones, Undated:4; Woods *pers., com.*) then they are the earliest archaeological evidence of slate quarrying from Llanberis.

The size and nature of the cargo would suggest that it was the annual output of dressed slates from a family or group of crofters/farmers. Gruffydd Ellis, Manager of the Dinorwic quarries in the nineteenth century, describes the quarrying process before the take over of the quarries by the partners in the Dinorwic Slate Company in 1787.

"They took the dug slates back home in their boats. There they would split and trim them in the evenings or on wet days."(UWB, Ms.8277)

This type of part time quarrying could be envisaged in the late medieval period. Once a stock of slate had been made they could then be transported to the nearest port. Whilst to the modern eye Caernarvon might appear to be the port of choice, the early use of the creek at present day Porth Dinorwic/Felinheli cannot be discounted. Porth Dinorwic/Felinheli, was some times known as the opposite shore of Moel-y-Don (Lindsay, 1974:109).

Of interest is Aberpwll a small pool at the North end of present day Port Dinorwic. Leland notes that it was used by boats in the mid sixteenth century (Smith, 1906:85). If this was the case, it can be envisaged that it could have acted as a small quay for loading slates from Llanberis. The reason for loading here as opposed to Caernarvon would be that the slates were dug from the Bangor side of the Afon Rhythallt. The assumption is therefore that the Pwll Fanog wreck represents a boat carrying slates dug in Llanberis and loaded at Aberpwll.

Sinking

A reason as to why the vessel sank is not given in any account of the site. The loss of a vessel carrying a cargo of slate has not been noted in the documentation of the time, nor are there folk legends to hint at the possibility of a wreck at Pwll Fanog. If it is accepted that the vessel was loaded with slates from Llanberis at either Aberpwll or Caernarvon then there are three possibilities as to why she might have sunk.

If sailing north with the tide, as would be expected, it is possible that the vessel struck the shallow bar to the south of Pwll Fanog on the Bangor side (Fig.2.1). At low tide it is possible for a vessel to ground and spring her planks. The distance between here and Pwll Fanog would easily be covered by a vessel sailing with the wind and tide. A second possibility is that the vessel was heavily loaded and had mistimed her departure, therefore having to anchor at Pwll Fanog whilst waiting for the tide to slacken. This was a common occurrence in the days of sail (Foulkes, *pers., comm.* 1977). If so it is plausible that she could have been swamped, in the same manner as the Llyn Padarn boat was, when the tide turned and the tidal front pushed past her. Even today this can be an unpleasant occurrence. A Mr Owen (1978) in his correspondence with Dr., Jones (Fig.2.9) describes a vessel foundering at Pwll Fanog due to a violent storm. This is not the same wreck, but does highlight the fact that other vessel's have sunk in the area.

Finally, without any unequivocal evidence to suggest otherwise, the vessel might just have been too old and worn, a number of secondary nail holes on the keel could support this assumption. Thus, this last voyage, with a heavy cargo combined with choppy waters, could have been enough to open the seams after leaving Aberpwll. The reason for the vessels sinking cannot be ascertained for certain without further excavation. A second slate wreck carrying similar slates has been noted half a mile away from Pwll Fanog (Jones *pers., comm.* 1999). The area of the Menai Straits is relatively un-dived and could prove, with further investigations, a potentially rich source for nautical finds.

Typology

The question as to what type of vessel the Pwll Fanog wreck represents is one that has occupied the minds of all those involved in her investigation. The little constructional detail evident cannot say what specific type of vessel she might be, but it can discount a number of late medieval forms. Little or nothing is known of the medieval Hulk. What form of construction is diagnostic of a hulk is as yet unknown, but reverse clinker and a flat keel plank are associated with the hulk (Greenhill,1995:250,252). Both features were not found on Pwll Fanog, so the hulk as a type of vessel can be discounted. No carvel bottom planks or heavy floor timbers were found, both diagnostic features of a cog (Greenhill, 1995:226), thus it can be assumed that the Pwll Fanog is not a Cog either. The heavy rabbeted keel would support this assumption. The Pwll Fanog vessel is more likely to have been a development of the Nordic/clinker tradition of boat building; what type or form is unknown though it is comparable to the Magor Pill wreck, the Aber Wrac'h vessel.

If the Pwll Fanog is considered a local vessel further iconographic evidence can be used to support a large clinker built vessel. The Beaumaris seal before the 1580's change of design (Fig. 2.10a) shows a large developed clinker built vessel propelled by a single square sail. The boat represented on the 13th /early 14th century slab at the parish church of St. Baglan, Llanfaglan, Caernarvonshire (Fig. 2.10b), though a rudimentary picture by comparison, strengthens the assumption that the predominant local form of construction is that seen in the Pwll Fanog wreck.

Conclusions

The history of the early coasting trade in North Wales is not well documented. Very little apart from the *Port Books* survive in the written records. There are occasional references to vessels, but no great detail as to how they were constructed; or even whether the basic construction technique was clinker or carvel. The survival of any vessel from this early period is therefore of importance.

The initial investigations of the slate mound have proved that there is a significant amount of hull remains under the slate mound possibly all of one side to the turn of the bilge. Whilst being recognised as an important wreck site little or no investigation of the slate mound has been carried out since the excavation of a trial trench. The information pertaining to the Pwll Fanog wreck is therefore limited. Information as to the construction of the vessel is basic, though a number of assumptions can be gleaned from it concerning the vessels overall form and shape but not its size. Despite a number of attempts at dating the vessel by both dendrochronology and radiocarbon dating, only a wide and unhelpful date can be given to the vessel. The best that can be said is that the Pwll Fanog wreck is a clinker vessel built in the general Nordic tradition dated between the fifteenth and seventeenth centuries which sank whilst carrying a cargo of slate through the Menai Straits (Fig 2.11).

Chapter Three.

Llyn Peris Boat.

(Llyn Peris I)

LLYN PERIS BOAT

Introduction

In 1972 a decision was taken to build a pump storage power station at Dinorwig, Llanberis. The site of the scheme would be Elidir Mountain on the northern side of the Llanberis valley. Elidir had the unique feature of a lake at the top, Llyn Marchllyn Mawr, and one at its base Llyn Peris. Llyn Peris is the southern most of two lakes in the Llanberis valley; the northern lake being Llyn Padarn. It is fed by the Afon Nant Peris, the run off from the northern eastern slopes of Snowdon and southern slopes of Elidir. Coupled with the disused slate quarries along its southern face this made it an ideal site for the scheme (Williams, 1984:37). To utilize these unique features however both lakes and the old quarries needed to be specially prepared.

A special access road to Marchlyn Mawr had to be built before a dam could be constructed. After the completion of the dam in 1979, Llyn Marchlyn Mawr would be able to hold 7 million cubic metres of water or 1,540 million gallons. In February 1976 the main construction work started on the caverns. These were to house the turbines, generators and ancillary equipment along with the control room and associated offices. In 1978 works started on the preparation of Llyn Peris. This entailed the draining of the lake, lining it and the building of a dam at the western end (Williams, 1984:37).

Between July 1978 and March 1979 Llyn Peris was drained and the Afon Nant Peris diverted (Fig. 3.1a). Once the lake had been drained, work started on enhancing the capacity of Llyn Peris. The lake was enlarged by removing the silt from the bottom and landscaping each end and sides of the lake. An embankment was also built at the bottom end. Slate waste was dumped into the lower end of the lake to form the embankment. Further slate was dumped behind the embankment to act as a base for the construction camp (Fig. 3.1b). The weight of this slate on top of the lake sediment caused subsidence as the sediments were pushed out from underneath the slate (see below). The collapse of slate was unexpected, especially by the security guard who lost his hut and television (Pete Murphy, *pers. comm.*). The original detritus and lake bed sediment was forced out from underneath the infill by its sheer weight. This formed a large mound at the edge of the infill (Fig.3.2a & b). It was within this mound at the edge of the infill that the remains of the boat was found by John Robert of Llanberis, an employee of C.E.G.B. (General handy man and driver). Mr Roberts was driving the foreman for the site around on the daily early morning inspection of the site when he noticed the remains of the vessel lying at the bottom of the slate infill (Roberts J., *pers. com.,* 1998) The Llyn Peris boat, termed Llyn Peris one by Illsley (Illsley and Roberts 1980:343) was initially found (NGR SH581 597) with a very small section of its bow showing (Fig. 3.3 a & b). The vessel needed to be excavated if it was to be completely recorded.

Site description.

The site of the Llyn Peris boat was 2m from the edge of the slate infill (Illsley & Roberts, 1980:343) The infilling sloped back at a steep gradient to a height of 5m (Fig. 3.4). This posed a constant danger to the archaeologists of falling slate and general subsidence. Access to the site was via abseiling down the infilling. Only a few planks were visible but during the course of excavation it was revealed that at least 75% of the original vessel had survived, with the whole vessel lying at thirty degrees from bow to stern and upside down (Illsley &

Roberts, 1980:343). This meant the stern was below the water table thus creating further problems for the site excavation. Every morning the bottom of the excavation pit had to be bailed or pumped out to allow access to it (Fig. 3.5). There was no discernible stratification of the surrounding sediments recorded (Illsley & Roberts, 1980:343).

Excavation.

The details of the excavation have been taken from Owain Roberts' unpublished site notebook and diary 1979 (Roberts, 1979b). This is a loose leafed scrapbook with no page references or standard format. Permission was granted by the C.E.G.B. for Owain Roberts and a team comprising people from the former Welsh Institute of Maritime Studies (WIMA) and Gwynedd Archaeological Trust (GAT) to recover the vessel. On Tuesday 14 August 1979, the first investigation of the vessel *in situ* was initiated. The first action was to photograph the site as it was found including the detached fragments of the vessel that lay around the site. These had been removed from their original position by previous visitors to the site and consisted of the upper portion of the stem, pieces of planking and bits of framing. They were labelled, then removed to a storage area.

On the following couple of days, due to the nature of the site, work began on clearing the outside of the hull, as it lay. This was done by digging the over burden of sediments off the timbers, then gently brushing and washing the muddy silt off the surface of the hull. In this way about two thirds of the port side outer hull, and most of the keel, was revealed. At the end of the week, Friday 17, 1979 a sample of red/orange silt was taken from under one of the strakes for identification. A sample of the luting used in the lands of the planking was also taken (Squirrell, 1979). A frame was uncovered from the area near the bows which was similar to one recovered on the 14 August. A barrel stave, with no direct association with the site, was found half a metre from the stern at the same level of the trench where the planking turned down into the mud (Roberts, 1979.b).

By Thursday 24, the hull remains had been totally exposed, labelled and photographed *in situ*. The process of dismantling the vessel could now proceed (Fig. 3.6a). Most of the planks were still held in position by their fastenings. Where possible strakes were removed in their composite state. With the help of the works manager a crane was provided so that the planks could be directly loaded onto a trailer and transported to holding tanks in Amlwch. The removal of the planking gave access to the framing and interior of the boat (Fig 3.6b).

Underneath the stern post in the detritus, and under floor **8R3,** animal droppings were found. Hay and moss were found between the planking and in the stern area. Further organic material was recovered under the keel at floor **6R.** This included leaf mould, acorns, a hazel nut and goat and horse dung. Lake bed silts were discovered between frames **8R2** and **7R2** along with samples of wool and hair. Finally two samples of a Hessian-like cloth were also discovered. Samples of everything were taken at the time for analysis (Squirrell, 1979).

With the strakes removed the framing was visible. The frames were labelled and then removed to the holding tank at Amlwch. With further excavation the stern post was extracted from the mud. It proved to be in one piece unlike the stem post. Later on the piece of stem post removed from the site was found propped against a fence (Roberts, *pers., comm.*1994*)*.

Method of recording

The nature of the site and pressure on time meant the excavation was a rescue excavation. The vessel was not recovered whole but disassembled into its component parts and transported for temporary storage to Owain Roberts in Amlwch. Due to this, a system for recording the individual parts was devised based on a colour code and individual numbering. The colour code relied on the available colours of the tags at Owain Roberts' disposal. How he came about these tags is a story in its own right but best left for him to tell to any interested party (Roberts, *pers.,com.* 1995). The colour coding was as follows:

- Grey = Central Timbers.
- Orange = Port Side Strakes.
- Green = Starboard Side Strakes.
- Purple = Frames, Floors and Futtocks.
- Yellow = Gunwale and Stringers.
- Blue = Riser.

Each piece was then given a sequence of letters to identify it. Starting with A the strakes were given a letter from the keel out, and each plank within the strake was given a number starting with 1 from the bow going aft. The frames were given individual numbers starting with five at the bow and ending with nine at the stern. It was not known whether or not there would be more frames in the bow. A number of frames were broken and thus the separate pieces were also numbered from left to right or just given the designation of left (L), or right (R) as the excavators looked at them.

The initial numbering system for the planking has been retained. Due to the awkwardness of the numbering system employed on the framing and the fact that it does not marry original pieces together and that there is no site plan to refer too new numbers have been added to the framing. The frame are now numbered 1-5 from stern to bow. The use of Left and Right, orange and green has been superseded by port and starboard in the cataloguing of the timbers. This was deemed more appropriate as virtually all the pieces can be orientated in this way.

Storage.

The timbers were cleaned before being placed in a make shift storage tank. This was built out of breeze blocks and polythene sheeting (3.7). No definite decision was made as to what should happen to the remains of the vessel. A decision to air dry the timbers was taken because their wet storage took up virtually the entire yard. They were thus taken out of the temporary tank and air dried in an outhouse.

It would be five years before the timbers could be moved to their present site at Ynys Faelog, Menai Bridge. This was done to enable the recording of the timbers by Caroline Caldwell, as part of her undergraduate dissertation, 1987. The timbers should have been recorded when first found or at least before air drying. On the whole most of the timbers were still in remarkably good condition. Most fastenings were still in place though a few iron fastenings had worked their way loose and were collected together in an ice cream tub. A number of the timbers without doubt suffered some form of shrinkage, cracking or flaking (Caldwell, 1987). The lands of the planks had suffered most and in some cases totally disappeared. This fact has been exacerbated where sapwood was present.

The timbers were dusted off, packed into polythene bags which were labelled before being placed on an open truck. They were transported to Ynys Faelog where they were to be drawn. A total of 130 pieces of timber, and a bag of "bits" and dislodged fastenings (nails, treenails, wooden pegs), were also taken. After they were recorded the timbers were stored in the sheds at Ynys Faelog where they remained until 1998. The recent cataloguing of the timbers has revealed a number of inconsistencies in the recording of the timbers by Caroline Caldwell, inadequacies of the on site recording procedures and the poor state of timbers due to the initial air drying.

Site post-depositional formation process

From the systematic investigation of the timbers a theory can be put forward as to the process by which the vessel reached its final resting place. In trying to understand this a process of working backward from the known position of the hull remains has been used. A full understanding of how sediments in flux operate is not put forward. Comparisons to other observed features as those seen in the contemporary photographs of the excavation has helped to give us an understanding of the process by which the vessel arrived in its final position.

Whether the Llyn Peris Boat was abandoned and somehow found its way onto the lake and thus sank due to its poor state of repair, suffered a catastrophic accident whilst in use on the lake or was overcome by weather conditions cannot be ascertained for certain. The fact that no cargo is associated with the wreck, its obvious bad state of repair and lack of internal fittings other than those that are fastened to the hull would suggest it had been abandoned. After being abandoned on the shore a number of situations could be envisaged to finally see the vessel resting on the lake bed.

The Llyn Peris boat's final resting place on the lake bed was not far from the northern end of Llyn Peris. Resting on its port side it slowly filled with light lake bed sediments. These light sediments were found in the vessel along the port side bilges during excavation (Roberts, 1979). Over time the Llyn Peris Boat settled into the soft sediments of the lake bed, probably up to its gunnal or over. A light current would have run in the area, as recorded for the northern end of Llyn Padarn (Author, *pers., observation.*), which helped to fill the vessel with detritus and other washed in sediments. At the time of excavation it was noted that there was a thin layer of fine grey slate dust lining the inside of the vessel (Illsley & Roberts, 1979.c:344). No stratigraphical context was recorded at the time so it cannot be discerned whether or not this layer represents an initial deposition layer or if it is associated with the industrial workings at Dinorwic.

Once buried, lying over on its port side, the Llyn Peris boat would have reached an equilibrium with its surrounds. The good state of preservation suggests burial in an anaerobic environment. A white stain noted on the outer surfaces is consistent with the light grey coloured clay of the lake bed, as found in the bottom sediments of Llyn Padarn (Author, *pers., observation*). The vessel could not have lain in the area of initial slate dumping or else it would have been destroyed entirely by the pressure of the slate above it. Instead the vessel lay hidden just outside this area.

The main factor which contributed to the resurfacing of the Peris Boat, on the night of August 4, 1979, was the sheer weight of the slate dumped on top of the lake bed sediments. This acted to compact the sediments directly underneath it but also formed an instability in forces at the perimeter, where there were only light sediments to counteract any outward forces. The weight of the slate pushed the underlying sediments out from underneath the slate pile. This suggested movement of sediment with its subsequent effect on the hull of the Llyn Peris Boat is substantiated by the cracks, breaks and pressure marks on the hull itself.

If it is accepted that the vessel was lying on its port side, buried in the sediment, the remains of the vessel would suggest a forward and upward force on the hull for it to arrive in its final position. This would agree with the movement of sediment out from underneath the slate displacing some of the sediment in front of it, but also riding up and over the same sediments into the space above it. The results of this are seen in the wave of detritus in front of the excavation area. A similar feature to that seen at Llyn Peris is also evident in Llyn Padarn where waste slate has been dumped into the lake from lake side quarries.

The movement of the sediment would impart a forward force on the Llyn Peris boat. This force was not a direct force acting on a specific point e.g. as that seen in a person fending of a boat with a pole; but more of a force acting on the vessel as a whole, though unequally, in a similar way as the thrust from a propellor in water acts upon an object. The Llyn Peris boat lay at an angle to this thrust of sediment. As such the hull was partially rolled over in the initial thrust forward and upward. As the vessel settled up side down the forces imparted on it resulted in the twist evident in the hull remains.

In the thrust forward and upward the bow buckled inward and towards the port side, the upper part of the stem post breaking off at its scarf. Both starboard and port exhibit pressure damage forward of midship. On the port side this is shown by the opening of the scarfs along strake **A**, **B**, **C** and **D** forward of midships. At the same time as the port side was pulled open the starboard side folded in on itself, along the fifth strake up, strake **E**. As the sediment slowed down its weight acted, breaking frames and flattening out the remains. Finally the sediments previously in a state of flux solidified again, with the bow of the boat in the air.

NON CONSTRUCTIONAL REMAINS

Textile fragment

A large fragment of wool twill was found in association with the Llyn Peris Boat (Fig. 3.8). The piece was found inside the boat during the excavation, though there is doubt as to its direct association with the boat and therefore whether or not it is contemporary with it. The piece of twill was sent for analysis to try and verify its date. The analysis of the twill was carried out by P. Walton and W. D. Cooke (Walton, p*ers.,com.* 1988).

The fragment of twill is trapezoid in shape, 540 by 250mm, with cut edges along the two longer sides. The edges have been cut in a slight curve. Both the short ends are slightly ragged though one appears cut. A discolouration in the twill suggests a seam along both long edges and the short edges.

The twill is made of a 2/2 twill of 18 and 16 threads per cm. The first system is a fine S-spun fawn thread, whilst the second is a two ply striped Z-twisted thread. The striped thread has a 12-row pattern of; black, blue, fawn, fawn, black, red-brown, fawn, fawn, black, red-brown, fawn and fawn with the darker threads being coarser then the fawn. The wool used, 15 to 45 microns, was of a type common in the medieval period and still in use today being of medium to fine quality and crimpy form (Walton, 1988:2).

The yarn was analysed under a twist tester and microscope to ascertain its twist distribution. It indicated a regular even spinning with variations in the widths of the twist which were too great to be have been a coincidence. This suggests the use of wheel-spun threads used in conjunction with a wind-on; a form of spinning wheel not in use till the late sixteenth century (Baines, 1977:69).

The plyed yarns, 2/2 weave, and use of stripes are an unusual feature for this type of fine spinning before the 17th century, though a number of 16th century finds from Newcastle upon Tyne can be cited as well as the single example from 14th century Baynards Castle (Walton, 1988:2). The form of weave and the use of stripes is also known from 17th century Ireland and Scotland. Such examples are however made from a coarser yarn then the Llyn Peris example. The weave and pattern would suggest a find of the 19th or 20th century. The finish of the fabric is inconclusive in being able to date the piece. The practice of fulling and raising a nap on the surface has been carried out since the medieval period onwards.

The type of dye used is unrecognisable and would therefore suggest a modern synthetic, though this is not conclusive (Walton, 1988:3). The shape and position of the seam would suggest a two part tailored sleeve of a type worn from the 14th century to the Restoration. This is also inconclusive due to a lack of further diagnostic features (Walton, 1988:4). There is no feature within the fabric that can identify it conclusively with the 16th century as all the evidence remains inconclusive (Walton, 1988:4). The piece of twill unfortunately must be looked on, without further evidence, as an intrusive find washed into the Llyn Peris boat post sinking or during the forcing of the vessel out from the detritus during the land slide.

Organic Analysis

Tallow

Adhering to a number of the planks is a whitish/yellowish substance. Samples were taken from **C4**, **C5**, **D2**,**G3** and from around the keel area. Analysis under high powered magnification revealed the bulk of the samples as being made up of a resinous material impregnated with quartz grains, silt/clay and fibrous material of vegetable origin. A single example contained no fibrous vegetable matter but 40% silt/clay. There was no animal hair evident in the samples taken (Squirrell, 1984). Chemical analysis of the resin, identified it as coming from the Birch family of trees (Squirrell, 1984).

Moss

The sample taken from the keel area had layers of moss, *Rhyditiadelphus squarrous* and *Polytrichum commune,* directly associated with it. Such mosses are found within a number of habitats but *P.commune* suggest collection from a wet acid bog. The moss from the patch at **B1** is of a different type, being *Rhyditiadelphus triquestris*, *Rhyditiadelphus squarrous*, and

Hylocomium splendens (Squirrell, 1984). These mosses are more commonly associated with open moorlands rather than acidic bog land. A third moss *Dicranella heteromalla* was also identified. It is considered a contaminant as it is not contemporary with the other mosses, having grown in the moss post excavation whilst in storage (Squirrell, 1984).

Other Organics

A number of other organics were recorded at the time of the excavation, but unfortunately they were not analysed at the time and no record of their present whereabouts is known. The samples taken at the time of excavation were bagged and tentatively identified on site.

Samples of the sediments lying in the boat were taken including; soil, stained soil (no location given), leaf mould from stringer **2R**, and peat from the bilge between **7R** and **8R** (Roberts, *Unpublished list.* August 1979). The samples of sediment and leaf mould were most likely washed in when the vessel sank. The peat however could have represented the remains of a cargo or washed in detritus.

Three types of manure were identified and samples taken for further analysis, including sheep/rabbit "muck" from behind the stern post, goat/sheep "faeces" from inside the boat next to the keel, and horse "muck" from under floor **8R3** (Roberts, *Unpublished list.* August 1979). The position of the faeces and muck would suggest they were contemporary with the vessel and not washed in post sinking. If this is the case the implication for the uses of the vessel are significant. It would suggest the vessel was used to ferry local live stock across and or up and down the lakes as well as travellers' ponies/horses.

Possibly linked with the transportation of livestock are samples identified as hay (from around land **C5**) and straw (inside stern post). Straw and hay could however represent the remains of dunnage. Further possible food stuffs are the samples of seeds (gunnel), hazel nuts (from **3R** gunnel) and acorns (**Fr 6R**).

Two other finds were recorded during the excavation. A piece of chopped bone was discovered under plank **D2**, and a sample of charcoal from near the stern post (Roberts, *Unpublished list.* August 1979). The last is the most tantalising as it could also represent the remains of a cargo. The charcoal burning industry provided an important source of fuel up until the early modern period and the industrial mining of coal.

The organic material found within the vessel is not necessarily directly associated with the vessel. Due to there being no stratigraphical record we are reliant on the original excavators impressions at the time. The possibility that the organics represent wind fallen or washed in debris cannot be discounted.

Dendrochronological analysis.

Two dendrochronological studies have been carried out on the wood from the Llyn Peris boat. The initial study was carried out by Sheffield University in 1985. Due to a lack of confidence in this initial work a second study was commissioned in 1999 and carried out by Nigel Nayling, Lampeter University.

The first set of samples taken had no sapwood evident on any of the timber. As such only a *terminus post quem* could be given (Morgan, 1985). This was initially A.D.1521, though was revised to A.D.1523 by Tyers, Sheffield University, in 1992 (Nayling, *pers. comm.*, 1998). A further minimum of 10 to 55 years for sap wood must be added to this, giving a possible date for the building of the Llyn Peris Boat in the mid to late sixteenth century.

The four samples taken provided ring records of between 54 and 78 years, with an average ring width of 2.6mm. Cross-matching of the growth patterns of A7581 and A7582 showed little variation between the ring widths, each being almost identical with a very high *t* value of 10.2, suggesting they came from the same tree (Morgan, 1985:3). The pattern of A7583 was similar with A7582 (*t* value 5.5), with both samples spanning 78 years and ending within a year of each other, 1503 and 1502 respectively. The odd plank out was A7580, despite its high *t* value of 4.4 when compared to the other timbers. A7580 compared to the other samples appears to have been split from a tree felled two decades after the others, its pattern ending 18 or 19 years later. The lack of identifiable sapwood on any of the samples only compounds the situation.

Comparison with other chronologies showed the greatest similarities with those based on building timber from the Welsh borders (Morgan 1985:4). This could suggest that the timber was of local origin and that the Llyn Peris Boat was built within Wales if not at Llanberis itself. A match with a composite British Isles chronology was also good (Morgan, 1985:4).

Useful data was derived from the initial dendrochronological analysis but it was felt that a second sampling was required to try and answer a number of outstanding questions. The difference in the age of A7580 raised more questions then it answered and raised doubts as to the age and use of the boat. The discrepancy could be due to the plank being taken from the outside of the same tree but with more of the heartwood trimmed off it. It could however suggest re-planking of the boat at a later date. Theoretically the plank could have represented a repair or the two earlier planks reused in what would then be a younger vessel. If the wood proved to be earlier it could help to substantiate the theory that the wood was reused from another vessel and was not built locally.

The whereabouts of the original sections are not known, after they were taken to The National Maritime Museum at Greenwich. The documentation does not allow us to cross reference the numbering system from the dendrochronological analysis with the original planks. Thus it was not known from which plank section A7580 came.

To help try and answer some of the discrepancy in the data a new set of dendrochronological dates was commissioned. A sampling strategy was devised to help refine the dendrochronological date, to clarify whether there had been any re-use of old timber or repairs done with new timber. A secondary purpose was to clarify whether or not the sapwood had been orientated in any specific way within the vessel. The most important aspect was therefore the identification of sapwood within the timbers.

The methodology employed by Nigel Nayling generally followed those laid out by English Heritage (1998). From initial assessment of the timbers, 15 planks were identified as retaining sapwood. Of these 15 planks, 7 were selected for analysis. Samples from the garboard, the bilge area and the sheer strake were priorities, as was an even selection from both port and starboard. This would answer whether or not there had been any major rebuilding or repair.

Slices were sawn from areas that would maximise the potential for information. A hack saw with a fine kerf was used to minimise loss of wood. The samples were prepared and analysed at the HARP laboratory, Lampeter. The results from the reassessment have vindicated the second study as well as highlighting the need to employ a specialist at the assessment stage, both in dendrochronology and nautical archaeology, to maximise the potential of the sampling strategy.

The Llyn Peris boat can now be confidently dated to between AD1547 and AD1549 taking into account the maximum range of sap wood of 95% of oak trees (Nayling, 1999a:4). The analysis also confirmed that the planks were radially split from at least two parent logs, suggesting specific felling and conversion for the building of the boat. No specific orientation of the sapwood within the boat was discerned, i.e sapwood was not always orientated to the top or bottom of the planks but varied from plank to plank. Unfortunately due to the lack of a specific North Wales master chronology, the provenance of the timber could not be established. Though there is no proof that it was felled in Llanberis or North Wales, it is also reassuring that the timber cannot be proven to have been felled out side of North Wales. The best regional chronology came from the North West England, *t* value 6.42, with the best correlation to a site master being that of Penrhos Court, near Kington, Herefordshire, *t* value 5.35 (Nayling,1999a:9).

CATALOGUE OF HULL REMAINS

The timber remains were drawn by Caroline Caldwell in 1987, without a full catalogue of the remains. There was no attempt at a description or the recording of dimensions, apart from the main scantlings (Caldwell, 1987). Thus there was still a need to look at the original timbers and record them in detail.

The overall state of the timbers was sound, though they had obviously suffered from the air drying and subsequent storage outside, which saw them open to the full effects of the elements. The fact that the wood is oak, was buried in detritus and fresh water with a low acidic level has probably helped in its preservation. An average shrinkage value (After McGrail, 1998:41) between 8-10% has been recorded for the planking. The loss of subtle surface features such as tool marks can be expected. The latter is more likely where there is obvious exfoliation due to drying out.

The removal of the timbers to Ynys Faelog did not alleviate these problems, as the sheds there are just as exposed to changes in temperature and humidity. Further more the less obvious threat to the archaeology was increased as the timbers were exposed to any inquisitive person who could be less meticulous in their handling of the timbers and replacement of loose tags. The Catalogue of Hull Remains is exact as to the timbers identified as being from the Llyn Peris Boat at Ynys Faelog at the time of recording. It is not necessarily all the timbers recovered at the time of excavation.

Wood Analysis

The wood analysis was initially carried out to verify the wood species. One sample from each component was put forward for analysis. Due to visual identification of the planks, frames, stem and stern posts plus keel it was felt that only a representative sample was required. All samples taken were positively identified as being oak (*Quercus* sp.). Most samples proved not to be unusual. It was noted that the sample taken from the stem post and frame **8R2** were both from very slow grown trees, their growth ring diameter being less than 1mm (Denam, *pers.,com.*), whilst a number of the treenails were from fast grown trees (ring diameter more that 4mm), and could have been from coppice woods.

It was noted that a number of timbers still retained a certain amount of sapwood. It is commonly believed that sapwood is readily attacked and colonised by wood borers and rot, as it is less robust then the heart wood, and is therefore removed prior to building. This practice has been noted through-out the world (McGrail, 1987:28). This generalisation does not hold true for a number of finds from varying periods through out north-west Europe; these being the Graveney boat (Fenwick, 1978:115-18), Brig raft (McGrail, 1981:84), Skuldelev 3 (Crumlin-Pedersen, 1986:139), the Magor Pill Medieval Wreck (Nayling, 1998:79) and a number of the Dublin timbers (McGrail, 1993: 89). Sapwood appears to be more prevalent on framing and knees where the shape is more complex then planking. The remains of sapwood can therefore be seen as a compromise to gain the maximum required shape from the minimum size of wood. Sapwood is evident on a number of the Llyn Peris planks as well as the stern post, keel and framing. There is no evidence of bark.

Keel (Fig. 3.9)

The keel is made from a single piece of wood 3.984m long and is "T", shaped in cross section. The sided dimension of the upper surface reduces from an average of 153 mm in the mid section, to 128 mm at the bow and 115 mm at the stern. The maximum moulded dimension is 120mm reducing to 100mm from aft forward. There are compression marks from the frames and a number of knots evident on the top surface. The grain of the wood has a number of slight waves in it where it is forced around the knots. This has imparted a twist and bend into the keel. Knots of side branches are evident throughout. The heartwood lies in the centre of the keel. It is possible that this is the reason for the hog evident in the keel.

The rabbet line for the garboard strake is evident throughout the whole length of the keel. It has a midship angle of 133 degrees which becomes more obtuse at either end. The rabbet feathers off into the stem and stern post at the junction with each scarf, both forward and aft.

There are two vertical stop-splayed scarf joints, one at each end and on opposing sides of the keel. The stern post scarf is 312mm long and 120mm moulded and 65mm sided which reduces to 35mm at its end. There is a single 26mm diameter treenail hole towards the end and two 9mm cross section countersunk, 26mm diameter, nail fastenings at the end. A further two nail fastenings are evident at the forward inboard face of the scarf.

The stem post scarf is 320mm long, 70mm moulded with a sided dimension that reduces from 65mm to 40mm at the end. There is evidence for two treenails, 26mm diameter, which are evenly spaced in the scarf. The forward treenail hole has virtually been worn away whilst the aft one has had the top worn off. There is evidence for three 9mm nail fastenings in the scarf, two at the aft end and one forward. The forward nail hole has been counter sunk, whilst the two aft ones are driven in from the stem post timber, each being evident on the inboard face of the scarf only.

The position of the frames are evident along the length of the keel (0.90, 0.90, 1.20, 1.15m from bow to stern). There are no fastenings for the frames. Between each frame there is a slight concave to the top surface of the keel which is interpreted as wear marks. When first found wear marks and possible hoof marking were evident (Illsley & Roberts, 1996 *pers., comm.*).

Stern Post (3.10b)

The stern post was fashioned from a single natural crook of timber. It is 1.55m between ends with a 1.87m long inside face and a 2.06m long outside face. It has a maximum moulded dimension of 160 mm and sided of 158mm. The foot of the stern post is 0.765m long at the end of which is a scarf joint. The grain of the wood runs straight and even, though there is evidence of a number of small knots and tool marks.

The top of the stern post is 160mm moulded which reduces to 30mm at the forward edge. There is a scooped out indentation which is a natural flaw in the actual wood at the top of the post. A rebated step,160mm from the top of the post and 175mm long, runs the full width of the inner face of the post. This forms a 12mm ledge on which the stern hook sits. This allows it to sit astride the stern post and still fit flush with the sheer strake as it runs into the stern post. There are no fastenings evident to suggest the stern hook was fastened directly to the stern post.

The scarf joint is a vertical stop-splayed scarf with the same but opposing dimension as that on the keel. The scarf is broken along a possible knot and therefore only has a remaining length of 260mm. Only one treenail hole, 26 mm diameter, and two nail holes, 9mm square cross section, remain in the scarf as evidence for the fastenings. These correspond to those on the keel.

There is a continuous rabbet line from the top of the stern post to the scarf. It starts with a definite 90 degrees rebate, 165mm from the top. The margin line of the rabbet is 74mm moulded, and 64mm sided. The back of the rebate tapers to the top of the hog at the turn of the stem post. Here the angle of the rebate becomes more obtuse to match that of the keel. This feature is evident on both sides of the stern post. At least eighteen nail fastenings are evident along the rabbet, they are without doubt for fastening the hood ends of each strake to the stern post. A grouping of six or more nail holes around the turn of the stern highlight this area of weakness.

Stem Post (Fig. 3.10a)

The stem post is made up of two separate pieces of wood scarfed to each other and directly to the keel. The first piece is the longest, scarfed directly to the keel, it carries on up to just above the turn of the stem post. The second piece is scarfed to the first and extends the stem post to the sheer strake and above. Despite the first piece being broken at the scarf, the second piece was undoubtedly scarfed to the first. The end of piece one has been reconstructed with various lengths added to the break (1m, 0.75m, 0.50m, 0.25m and 0m). The only reconstructed length that does not distort the sheer line too much is that which is the same length of the scarf on piece two. Thus it would appear that the stem broke at the scarf.

Stem post one

This is made from a single piece of wood 1.28m long. It has a maximum moulded dimension of 140mm and 95mm sided at the forward end which reduces to 110mm moulded and 75mm sided at the turn into the keel. It is made from a grown crook with the grain running along the curve of the stem post. There are no knots in this piece of wood. Evident along the inboard face of this piece are a number of tool marks. These are identified as adze marks, with possible minimum face width of 50mm. The length of the cuts suggest a short trimming action.

The forward end of the timber has broken where the forward stop-splayed scarf was located. The scarf used to join the timber to the keel still remains. It has the corresponding dimensions and fastening holes as the forward keel scarf. The remains of the treenail from the forward most treenail hole is still *in situ*.

The rebate runs from the back of the scarf to the end of the timber. The margin line is 15mm sided and 50mm moulded at the aft end. This is a continuation of the rabbet line of the keel. It increases to 60mm moulded and stays at 15mm sided at the top end. There are roughly ten nail fastenings per side of the rebate for the strakes.

Stem post two

This represents the top most part of the stern post. It is fashioned from a single piece of wood with the grain running along the curve naturally. There are a number of knots evident in the wood. It has a maximum length of 0.985m, and a maximum sided dimension of 132 mm and moulded of 155mm. At the top is a 31 mm diameter hole most probably for a painter of some form or other. When recovered, it was found to have had a triangular piece cut out of it. This was returned later by persons unknown.

There is a vertical stop splayed scarf joint at the lower end of the timber. This is 190mm long and 135mm moulded. It is 95mm sided at the top end which reduces to 75mm at the bottom end. There are four nail holes evident; one in each corner of the scarf. In the centre is a 26mm diameter treenail hole. This would suggest that the scarf was nailed in position before the treenail hole was drilled.

The margin line of the rebate is 80mm moulded and 15mm sided. It continues for 560mm then feathers into the stem post 30mm from the top. There are at least seventeen nail fastening holes evident on each side.

Framing (Fig. 3.11 &12)

There are five sets of frames in the Llyn Peris boat. Due to the orignal numbering system being confusing and not and incomplete a new set of numbers have been added to the frames. They are now numbered consecutively from the bow aft, **1** to **5** and prefixed with an **Fr.** denoting frames. Frames **1**, **3** and **5** are each made of a floor timber, thwart and knees. The floor timbers of 1 and 5 are actually “V” shaped crooks of timber. Frames 2 and 4 are made from a floor and two side timbers. The side timbers sit above the floor and continue the frame from just below the turn of the bilge to the sheer. The frames are not fastened to the keel or garboard, nor are they fastened to the inwale. The frames are fastened, by treenails, to set strakes along the length of the boat.

Fr.01

This frame is fashioned from a single crook of wood (Fig. 3.12a). There are a number of large knots evident, being residual side branches. The surfaces show extensive damage due to drying, and there is a break in one of the arms of the frame. It has a remaining curved length of 1.183m, but was undoubtedly longer. The maximum moulded dimension is 95mm at the base of the crook which reduces to 40mm at the top of the arm. The maximum sided dimension is 90mm.

The outboard side has the ubiquitous joggles for the strakes on both sides. There are at least five on the port side; being 60, 100, 80, 90, 80mm and the garboard joggle 70mm long. On the starboard side there are at least six joggles plus the garboard; these being 45, 105, 100, 90, 120 and 90 mm for the garboard. There is no rebate for the keel.

There are four treenail holes evident on the port side and three on the starboard side. They are positioned at the bottom of a rebate, and range between 25 and 30 mm in diameter. Apart from the garboard strake the third strake up on both sides does not have a treenail to fasten it to the frame. A single nail fastening is evident at the top of the port frame. This could have been used to secure the frame in position whilst it was being drilled for the treenails.

Fr.02

Originally numbered as **Fr5R** this is the floor of frame **2** (Fig. 3.12b). It was fashioned from a single piece of wood with a straight and even grain. There are a number of knots evident within it. It is now badly cracked due to drying and is broken at both ends. It has a maximum remaining length of 1.138 metres; a maximum moulded and sided dimensions of 70mm and 98mm respectively.

There are three joggles on the port side and at least four if not five on the starboard side. They are 70, 130 and 160mm and 92, 106, 115, 100, and possibly 110mm for port and starboard respectively. The central rebate for the keel is 220mm long and 25mm deep. There are no fastenings evident within this rebate. Two treenail holes are evident on the port side being 4152mm apart and 28mm in diameter. Three treenail holes are evident on the starboard side. These are spaced at intervals of 151 and 125mm from each other the treenails being positioned in the bottom of the joggles. The second joggle up from the keel rebate has a notch cut into it. These have been interpreted as being cut to accommodate the clenched nails and roves of the planking. There are no fastening holes for the garboard strake.

Fr.03

Originally numbered as 7R3, **Fr03** is the midship floor which is broken at both ends (Fig. 3.12c). It is made from a single piece of wood which has a natural wave within it. The surface of the wood is slightly damaged with obvious cracking in the bottom surface due to drying. It has a remaining length of 1.3m with a side dimension of 51mm in the centre which splays out to 80mm at the ends. Its maximum moulded dimension is 60mm.

There are a number of joggles evident on the under side of the frame. Four remain on the port side, 100, 95, 90, and 150mm long; whilst on the starboard side there are five, 95, 132, 125, 100 and 80mm each. There is a 230mm long central rebate to fit the frame over the keel. It is 20mm deep. There are three 28mm diameter treenail holes per side. These are spaced between 130 and 150mm apart on either side in the lower end of the joggle. There are no treenails in the garboard joggle or the keel rebate. There are no nail fastenings evident with in the floor.

Fr.04

Originally numbered **Fr8R3** this is the floor of the second frame from the stern (Fig.3.12d). It has been fashioned from a single piece of timber. It is the central part of a frame from the midship area. The run of the grain follows the slow upward curve of frame and there is only one knot evident. The wood itself is badly cracked due to drying. It has a maximum remaining length of 1.112m, a maximum moulded dimension of 75mm and a maximum sided dimension of 100mm.

On the outboard face of the frame there is a rebate 235mm long for the keel. There is a corresponding hump on the upper surface. There are four whole joggles on the starboard side and two evident on the port side. They are 100, 90, 145, and 125mm long and 100mm and 250mm long respectively. It is likely this last measurement actually represents two joggles though this is not conclusive. The treenail hole pattern would support this assumption.

There are five treenail holes evident in this floor. They are each 24mm in diameter. Each treenail is positioned in the bottom of the joggle. There are no fastening holes in the garboard joggle or the keel rebate. There are no nail fastenings evident in the floor.

Fr.04.star (Fig. 3.13a).

Originally identified as **Fr8R2** this is the starboard side timber from the second frame. It is fashioned from a single piece of timber with a natural curve to it. There is evidence for knots including one at the tangent of the crook; a point of weakness thus suggesting the best wood was not used but what was to hand. The wood is in sound condition though there is a deep crack running the length of the upper surface, and evidence for breakage at the lower end. The piece is 0.861m between the ends and 0.92m on the outside face. It has a maximum moulded dimension of 72mm and a maximum sided dimension of 102mm. There are four joggles for strakes. These vary between 90 and 115mm length and are between 20 and 25mm deep. For a length of 325mm from the top there are no joggles at all. This most probably corresponds to the sheer strake and gunwale.

There are five treenails holes; two of which have the remains of their treenails still *in situ*. They are spaced 115, 115, 235, and 210mm apart; with diameters varying between 28 and 30mm. There is one for each joggle apart from the fourth one from the bottom. Only one treenail hole secured the top part of the frame. Apart from treenails there is a single nail hole evident. This however most likely corresponds to the missing name tag.

Fr.05

This frame was originally numbered **9R2** (Fig. 3.12e). It is the aft most frame, the arms being acute due to the form of the stern in this area. It is fashioned from a single piece of timber that has a natural curve in it. There are a number of knots evident in the piece. The distance between the remains of the arms is 1.035m, with the port side arm being 0.74m long and the starboard 0.25m. It has a maximum moulded dimension of 100mm at the bottom though it averages 55mm along the arm. The maximum sided dimension is 100mm.

The port side arm has the remains of six rebates for the strakes. These average 90mm long and 27mm deep. There are two joggles evident on the starboard side, being an average 55mm length and 25mm deep. There is no rebate for the keel. Instead there is a step 90mm high. This would act as dead wood in the space between the garboards. There is no evidence for fastenings in this area.

The only fastenings are three treenail holes on the port side arm and the partial remains of one on the starboard side 26-28mm in diameter. The three treenail holes on the port side are spaced 100 and 110mm apart. This places them at the bottom of each rebate. They do not start until the second rebate above that for the garboard.

Fr.05.star (Fig. 3.13a)

This is the starboard piece of **Fr.05**, originally numbered **9L2**. It is badly degraded and broken though shows a definite curve in its longitudinal plane. It has a remaining length of 0.535m, and maximum remaining moulded and sided dimensions of 50 and 112mm respectively. There are at least four joggles for strakes, with a possible fifth being evident, on the outboard face. These are 100, 125, 95, and 115mm long with an average depth of between 10 and 15mm. Three treenail holes are evident, only one of which remains in its entirety, being 26mm in diameter.

Miscellaneous Pieces (Fig. 3.13b)

The pieces described below are those that can be identified as being parts of a frame but do not have an identifiable position.

No.1

This is the partial remains of a side frame. It shows extensive damage and is obviously broken at both ends but has a remaining length of 0.671m, and maximum moulded and sided dimensions of 70mm and 86mm respectively. Four joggles are evident on the outboard face. These are 150, 105, 120, and 100mm long with an average depth of 20mm. There are three treenail holes evident each 28mm in diameter. The partial remains of a fourth treenail hole is evident at the top of the piece. It is out of the vertical alignment when compared to the other treenail holes.

No.2

This is the partial remains of what is most probably the top part of a frame. The wood is in good condition though is broken at both ends. It has a remaining length of 0.504m, a maximum moulded dimension of 63mm, and sided dimension of 90mm which reduces to 60mm at the top. There is evidence for at least one joggle, 25mm deep, but unfortunately no length can be given. There are two treenail holes evident, both being 28mm in diameter.

No. 3

This is the partial remains of what most likely is the mid section of a frame. The wood is in good condition though it is broken at both ends. It has a remaining length of 0.492m, a maximum moulded dimension of 65mm, and sided dimension of 92mm. There is evidence for at least four joggles being 25mm deep and 112, 110, 110, and 110mm long respectively. There are three treenail holes evident. These are 30mm in diameter. One of the treenails is still in place.

No.4

This is the partial remains of what is most probably the mid section of a frame. The wood is in good condition, though it is broken at both ends and shows extensive cracking due to drying. It has a remaining length of 0.332 m, a maximum moulded dimension of 63mm, and sided dimension of 90mm. There is evidence of at least one joggle for a strake. This is 43mm deep and 132mm long. There are no treenail holes evident.

No.5

This is one of the sheets, not part of a frame. It is described in the sheets section under **Sh.no.5.**

No.6

This is the partial remains of what is probably the mid section of a frame. The wood is in good condition though it is broken at both ends, and shows heavy and extensive cracking on the inboard surface due to drying. It has a remaining length of 0.464 m, a maximum moulded dimension of 68mm, and sided dimension of 90mm.

There is evidence of at least two joggles for strakes. These are so badly damaged that no meaningful measurements could be taken. There are three treenail holes evident; one at each end and another 120mm from what would have been the top end. They are 27mm in diameter. The middle hole still has its treenail in place.

No.7

This is the remains of what appears to be the top part of a frame. It is broken at both ends and is heavily cracked in areas due to the process of drying. It has a remaining length of 0.535m, a maximum moulded dimension of 60mm and sided dimension of 70mm. This makes it thinner than most other frames. There are at least three whole joggles for strakes. They are 87, 87, and 100 mm long respectively; their depth is 20mm. Three treenails holes are each 28mm in diameter, and are positioned at the top of every other joggle. There is luting evident in the top part of the frame.

Inwale (Fig. 3.14)

The inwale was originally identified as the gunwale. The use fo the term gunwale is generic and therefore not wrong in this context, however inwale has a specific and diagnostic meaning and is therefore deemed the correct term to use. The inwale runs the full length of the inside of the sheer and is made up off three separate pieces per side, a breast hook and stern hook. It is fastened to the sheer strake with treenails, but is not fastened to the stern post, stem post or frames. There are a number of rebates cut into it of differing lengths to accommodate the tops of the frames. The three separate pieces are scarfed together by vertical through splayed scarfs. No fastenings are evident within the scarfs.

No.1

This piece has been fashioned from a natural crook of timber with a form of kabe evident. It has a remaining length of 1.29m, a maximum sided dimension of 71mm and a moulded dimension of 85mm. At one end there is evidence for the beginning of a through splayed vertical scarf. This is comparatively short having a 142mm long face. There is a singular treenail in the face 26mm in diameter. At the opposing end there is no scarf though the bottom of the timber has obviously been cut flush with something. There are two further treenails each 26mm in diameter and spaced 432mm between centres. They are in the horizontal plane and no doubt affix the piece to the sheer strake. Two thirds of the way along the upper surface of the piece there is a protrusion. This is 150mm high and is formed from a side branch. On the outboard face there is a 0.451m long rebate cut into the piece, underneath the kabe, to accommodate the breast hook.

No.2

The almost full length, 0.750m, remains from either of the extremities of the vessel, this piece of wood is obviously broken at one end around a treenail, and originally labelled **3R**. It has heavy and extensive cracks due to drying on all surfaces. There are a number of knots evident on the all the surfaces, some of which represent side branches. There are a number of groups of short straight edge shallow cuts on the upper surface, which are discussed later. At the opposing end from the break is a short through splayed vertical scarf joint. There is no evidence for fastenings. The most probable use for this is to fit into the forward space between the sheer strake and the stem/stern post. On the underside of the gunwale at the end nearest the scarf is a rebate. This is180mm long and extends the full width of the gunwale. It is to accommodate the top of a frame.

In the horizontal plane there are three treenail holes. These are all 26mm in diameter. They are spaced 602 and 125mm between the centres. These were used to fasten the gunwale to the sheer strake. There are a further two treenail holes in the vertical plan. These are spaced 124mm between centres and are 28mm in diameter. Due to the width of the spacing and the fact that they are in the vertical plane, they are identified as thole pins, this being a rowing position.

No.3.

This piece of wood, originally labelled **4R**, is in relatively good condition despite having a number deep cracks running along its surfaces. One end is obviously broken as well. The opposing end has been cut to form a short through-splayed scarf 140mm long. The piece has a remaining length of 0.705m, a maximum moulded dimension of 60mm and a maximum sided dimension of 85mm. There are two treenail holes each 26mm in diameter and 240mm apart. There is no evidence for any joggles. **4R** is the forward/aft part of one of the inwales.

No.4

This is either one of the extremities of the inwale or a midship join, originally labelled **1L1.** It is made from relatively straight wood which has obviously broken around a knot at one end and has a scarf joint at the other. It has a maximum length of 1.005m; a maximum moulded dimension of 65mm; and a maximum sided dimension of 90mm. One end of the timber has a through-splayed scarf. It has a 220mm long face. There appear to be two treenail holes, each 24mm in diameter, fastening the scarf together. Two further treenails, of the same diameter and in the same plane, being fastenings for the planking, being 375mm apart. Two treenail holes in the top and therefore the vertical plane are 32mm in diameter. They are larger and their relative closeness to one another would suggest a different use. The treenail holes were most likely used as bitts. At the opposing end from the scarf is evidence for a rebate. This was to accommodate a frame. It has a remaining length of 82mm and depth of 45mm. No evidence for fastenings can be found within the rebate.

No.5

This is a midship section in the inwale and was originally labelled **1L2.** It is made from relatively straight wood which is obviously broken at both ends. It has a maximum length of 1.134m; a maximum moulded dimension of 80mm; and a maximum sided dimension of 70mm. There appear to be two treenail holes, each 26mm in diameter. They are relatively widely spaced and most likely represent the fastenings for the hull planking. At the opposing end from the scarf is evidence for a rebate. This was to accommodate a frame. It has a remaining length of 80mm and depth of 30mm. No evidence for fastenings can be found within the rebate.

No.5 cont. (1L3)

This is the end part of inwale no.5. It has a natural curvature through its length. The remaining length of the timber is 0.891m, with a maximum sided dimension of 70mm and a maximum moulded dimension of 65mm. At one end it has a 125mm long through splayed scarf. The opposing end has a rebate 251mm long and 40mm deep. This has a further rebate cut into it 75mm from the edge of the broken end. The reasoning behind this is unclear though it could represent a new rebate cut into an older timber due to re-framing, or it could represent an initial misjudgement.

No.6

This is a badly degraded and broken piece of stern hook part of the inwale, originally labelled **1L5**. It has a remaining length of 0.386m, a maximum moulded dimension of 60mm, and a maximum sided dimension of 80mm. There are two treenail holes evident, each 26mm in diameter. Their centre lines are at right angles to each other. One is obviously for fixing the gunwale to the sheer strake whilst the other had another function. This could either have been for a bit or even a kabe or oarlock.

No.7

This piece is part of the midship ship section of the inwales. It is heavily and extensively cracked due to drying. There is a slight curve in its longitudinal section. The only discernible constructional detail is a single treenail hole, 28mm in diameter, half way along its length. It has a length of 1.508m, and maximum sided and moulded dimension of 118mm and 34mm.

No.8 (Fig. 3.15)

This is the broken and heavily cracked remains of part of the inwale originally labelled **3R**. It has a remaining length of 1.822m with a sided dimension of 60mm. The maximum moulded dimension is 85mm. There is a through splayed vertical scarf at one end with a 24mm in diameter treenail hole. A treenail is evident at the opposing broken end, which is also 24mm in diameter. A single treenail in the middle of the timber would have fastened it to the sheer strake. There is a 125mm wide rebate for the top of a frame. Two vertical holes 125mm between centres represents the position of the midship rowing position. There is wear evident between where the two thole pins would have been.

No.9 (Fig. 3.15)

This piece has been identified as the mid section of the stern hook. It is badly degrade and broken at both ends. There are three nail holes in the centre that would have temporarily fastened the piece to the stern post. It has a remaining length of 0.39m with a moulded and sided dimension of 70 and 90mm respectively.

Riser B1 (Fig. 3.16)

Though tagged as a riser this is most likely a piece of one of the stringers. The wood is heavily and extensively cracked along the length. It has a remaining length of 612mm; maximum moulded dimension of 27mm and sided of 90mm.

Stringer (Fig. 3.16 & 17)

St.1

The heavily and extensively cracked and broken remains of a piece of one of the stringers originally labelled **1R**. There are no constructional details evident on this piece, apart from a possible scarf at one end. This is not definite, with the feature possibly being the result of wear or breakage. It has a remaining length of 1.03m with a maximum sided dimension of 120mm, and a maximum moulded dimension of 40mm.

St.2

A heavily and extensively cracked and broken piece of wood this has been identified as part of the stringer originally labelled **2L**. It has a remaining length of 1.508m, a maximum sided dimension of 118mm and a maximum moulded dimension of 34mm. There are no constructional details evident apart from one treenail hole. This is situated in the centre of the wood towards one end. It is 24mm in diameter.

St.3

This is the substantial remains of a stringer, originally labelled **L1** (Fig. 3.17). There is a natural shallow "s" shape to the timber, which shows extensive cracking due to drying. The timber is also full of knots. These are relatively substantial with most being the actual remains of branches. It has a remaining length of 2.2m, a maximum sided dimension of 380mm which narrows to 98mm at the opposite end. The maximum moulded dimension is 32mm. There is evidence for a 26mm scarf at the thicker of the two ends. It has a face 260mm long. There are tool marks consistent with an adze on the face. The scarf is held in place with at least one nail. There are no other nails evident on the timber though there are two treenail holes. These are 26mm in diameter.

St. 4

This is the substantial remains of a stringer (Fig. 3.17), originally numbered **2R**. There is a natural pronounced "s" shape to the timber, which shows extensive cracking due to drying. There are several knots evident in the timber. It has a remaining length of 3.108m, an average sided dimension of 120mm. The maximum moulded dimension is 38mm.

There are three treenail holes evident in the timber; two of which are paired together. These are at an angle to each other and could represent a mistake with the second hole for the repositioned treenail. The single treenail is situated in the middle of a depression left by a frame. The treenails are 26mm in diameter. There is no evidence for other fastenings. A number of tool marks give evidence for the use of adzes in the fashioning of this stringer.

Thwarts (Fig. 3.18)

No.1

This is the remains of a thwart from near the stern. It has been fashioned from a single piece of straight timber which has a slight bend in it. Few knots are evident. It has a maximum length of 1.275m; a moulded dimension of 145mm at one end and 125mm at the other, and a maximum sided dimension of 66mm. The ends of the thwart are bevelled horizontally and vertically to fit the sheer of the hull.

There are three treenail holes on each side for the fastening of the standing knees. These are slightly enlarged due to degradation but were originally 28mm in diameter. A line of nail holes, some with nail shanks still *in situ* run along the forward edge of the upper surface. They are not visible on the bottom surface and therefore could have been used to affix a feature of some kind on the top edge. There are no tool marks or straight line cuts.

No.2

This is the remains of a thwart from the midship section. It has been fashioned from a single piece of straight timber which has a pronounced bend in it. Few knots are evident, though there are the remains of a number of branches evident. There are a number of adze marks visible as well. It has a maximum length of 2.112m, a moulded dimension of 150mm at each end and 140mm in the middle, with an overall sided dimension of 80mm.

There are three treenail holes on each side for the fastening of the standing knees. These are 29 or 30mm in diameter. On the port side is an extra treenail hole which is undoubtably a mistake, being out of position and only 25mm in diameter. In this side there is also a single 7mm square nail hole. There does not seem to be any significant reason for its use. There are a number of shallow straight lined cuts between 26mm and 47mm in length.

No.3

This is the remains of a thwart from near the bow. It has been fashioned from a single piece of straight timber which has a slight bend in it. There are a few knots evident. It has a maximum length of 1.38m; a moulded dimension of 160mm at one end and 150mm at the other, and a maximum sided dimension of 68mm. The ends of the thwart are bevelled horizontally and vertically to fit the side of the hull. There are two treenail holes on each side for the fastening of the standing knees. These are slightly enlarged due to degradation, but was originally roughly 28mm in diameter. A line of nail holes, some with nail shanks still evident in them, run along the of the forward edge of the upper surface. They are not visible on the bottom surface and therefore could have been used to affix a feature on the top edge of some kind. There are a number of groupings of straight line cuts on the upper surface and a number of adze marks.

Knees (Fig. 3.19)

No.1

This is a broken and badly degraded lower arm of a thwart standing knee. It has a maximum length of 0.68m with a maximum moulded and sided dimension of 64 and 76mm respectively. There are two treenail holes, one with a treenail still *in situ*, 254mm apart and 26mm in diameter. On the upper surface there is evidence for the use of an axe or adze to shape the timber.

No.2

This represents the lower part of a standing knee from one of the thwarts. The vertical arm of the knee has broken at the elbow where there appears to have been a treenail. This would have seriously weakened this area. The wood itself shows heavy cracking due to drying. It has a remaining length of 0.636m, with a maximum moulded dimension of 65mm, and a maximum sided dimension of 75mm.

There are three treenail holes evident. Two are placed 195 mm apart on the horizontal. A third was placed at roughly forty five degrees into the elbow of the knee. This is the only example of such a positioning of a treenail in the knees. The treenail holes are all 24 mm in diameter. There is a single 7 mm square nail hole in the end of the piece. This is the only example of such a fastening in use on the knees and is thus unlikely to have been used in the construction of the vessel. It is most probably a later addition.

No.3

This represents the lower part of a standing knee from one of the thwarts. The vertical arm of the knee has broken at the elbow, an obvious area of weakness. The wood itself shows heavy and extensive cracking due to drying. It has a remaining length of 0.69m, with a maximum moulded dimension of 65mm, and a maximum sided dimension of 76mm. There are two treenail holes evident, one with its treenail still *in situ.* These treenail holes are 25mm in diameter and are spaced 95 mm apart. There are no nail holes.

No.4

This is a standing knee associated with one of the thwarts, originally numbered **3L**. It is a single piece of timber, fashioned from a natural grown crook. The grain runs around the corner of the knee. There are many knots and evidence for side branches within this timber. Though smooth and relatively tight there is bad cracking due to drying near the inboard edge of the horizontal arm.

The bottom arm is 0.744 metres long whilst the vertical arm is 0.394 metres long. It has a maximum moulded dimension of 90 mm at the elbow which tapers to 45 mm at the end of the horizontal arm; and 12 mm at the top of the vertical arm. It has a maximum sided dimension of 105 mm at the elbow which tapers to 95 mm at the end of the horizontal arm; and 74 mm at the top of the vertical arm. There are three treenail holes evident in the timber. They are 26 mm in diameter. Only one is placed in the vertical arm. This would have secured the knee to the sheer strake. Two treenail holes on the horizontal arm secured it to the thwart.

Planking (Fig. 3.20).

The Llyn Peris boat was clinker built with eleven strakes per side. Each strake was made from a number of planks varying in number from 3 in strake **B** port and starboard and five in strake **F**, port and starboard. The strakes on either side are identical in the number of planks they contain, though they are not necessarily the same length. Both sides are nearly symmetrical when considering the overall strake pattern, though there are obvious differences at specific levels, i.e each plank is not identical but the same strake, on port or starboard, does contain the same number of planks which are roughly the same length.

Each plank has been cleft from an oak bole. Of the 11 planks analysed (4 by Morgan in 1985 and seven by Nayling 1999) nine were true radial splits (A7581and A7582) whilst the other two were split at a slight angle to the rays, causing a slight curvature in the plank. The widths of the planks varied as to their position in the vessel; the greatest width being evident in the midship planks of strakes **I, J, K** and the minimum at the extremities of the garboard strakes. It should be noted that the overall width of the strake **D**, is obviously thinner than the rest. The lengths of the planks also varied, the longest being the main part of the garboard and strake **B**, and the shortest at the bow or stern ends of strakes **D**, **E**, **F**, and **G**.

The thickness of each plank varies but is between 20 and 28mm, giving an average of 24mm. Thicker planks are noted at the stern between strakes **C** and **G.** The extra thickness is to accommodate the steeper lands which are required to help shape this area of the boat. The lands of the planking have an average width of 50mm (2"), and the scarfs on the whole are between 255mm (10") and 267mm (10½") long. Individual gradients vary with the angle of initial cut, the length of the scarf, and from scarf to scarf.

Port side

Pl.pt.A2

This is the partial remains of the forward plank from the garboard strake (Fig. 3.21). It has a remaining length of 1.61 metres; a maximum sided dimension of 154 mm at the forward edge, and a moulded dimension of 20 mm at the top edge which reduces to 8 mm at the bottom edge. The aft section is split and broken.

There is a 211mm long scarf at the aft end. This has a single fastening hole evident. There are five fastening holes evident on the lower edge and nine evident on the upper edge. These are spaced between 50 mm and 218 mm apart. All the fastenings are roved and clenched 7 mm square wrought iron nails. There are no treenail holes.

Pl.pt.A2 continued

This is a short plank, only 0.668m long (Fig. 3.21). It has a maximum sided and moulded dimension of 130mm and 20mm respectively. There is a 190 mm long scarf at one end, and a vertical bevel at the other, this being the hood end. There is evidence for three fastening holes in the scarf and one at the opposing end with a single nail in between. Two are in the 50 mm wide lap on the top edge and the other is half way along the lower edge.

Pl.pt.A2 continued 1

The badly broken remains of part of **Pl.pt.A2** (Fig. 3.21). It has a remaining length of 0.830m, a maximum sided dimension of 103mm and moulded of 18mm. There are six nail holes in a 40mm wide lap along one edge. The opposite edge is too broken to discern any features.

Pl.pt.A5, A4, A3 and B4 (Fig. 3.22)

This composite piece has parts of strake **A5, A4** and **B4** present. Their original position is from the stern post forward, with **A5** and **A4, A3** representing the garboard strake. The assemblage is fastened together by eleven roved and clenched wrought iron nails.

A5 is 1.22m long with a maximum sided dimension of 130mm which reduces to 95mm at the forward end, and a maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 250mm long thro5ugh splayed vertical scarf at the forward end. The aft end is feathered to fit the stern post rebate. There are three 7mm square nail holes in each scarf for fastening it to the adjacent part. A 50mm wide lap runs along the lower edge. It is fastened to **B4** by five fastenings spaced from 190 to 255 mm.

A4 is 1.558m long with a maximum sided dimension of 160mm and a maximum moulded dimension of 20mm at the top and 9mm at the bottom. A 45mm wide lap can be discerned on the lower edge. It is fastened to **A5** by a 250mm long vertical through splayed scarf, and to **A3** by a 210mm long vertical through splayed scarf. **A3** is a short piece only 0.565m long, 170mm sided and moulded dimensions of 20mm at the top and 9mm at the bottom. It is fastened to **A4** by three nail fastenings. There is a 240mm long scarf at the aft end. This makes the plank appear as a patch or butt strap. This is obviously not the case. Both **A4** and **A3** are fastened to the next strake by eight fastenings.

B4 is 1.767m long with a maximum sided dimension of 160mm which reduces to 105mm at the aft end, and has a maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 220mm long through splayed vertical scarf at the forward end. The aft end is feathered to fit the stern post rebate. There are four 7mm square nail holes in the scarf for fastening it to the adjacent part. No lap can be discerned on the upper edge. There are seven nail fastenings along the upper edge. These have a spacing ranging from 180 to 270mm.

Pl.pt.B1

This is the extensively broken remains of the ending of strake **B** (Fig. 3.23) The plank shows the twist expected in such a position. It has a surviving length of 0.965m, a maximum sided dimension of 137mm and a maximum moulded dimension of 20mm. A 45mm wide lap runs along the bottom edge and around the forward face. There are four nail holes per edge between 180 and 250mm apart.

Pl.pt.B2

This is the broken remains of a plank from the second strake and forward of midships (Fig. 3.23). The aft and top edge is broken. It has a remaining length of 1.345m, a sided dimension of 195mm and a moulded dimension of 18mm. There is a 245mm long through splayed vertical scarf at the fore end. It has four nail holes evident for fastening. There are five nail holes evident on both the top and lower edge. A single roved and clenched wrought iron nail is still in place in one of the holes. A single 26mm diameter treenail is placed 690mm from the fore edge. This was to fasten the strake to frame five. There is luting around the treenail hole and in the 50mm wide lap on the lower edge.

Pl.pt.B3

B3 represents the midship plank of the second strake between frame seven and eight (Fig. 3.23). The plank is 1.725m long with a maximum sided dimension of 180mm and moulded along the top edge of 20mm and 9mm on the bottom edge. The ends of the plank and bottom edge is extensively broken. The plank is fastened to the strake above and below as well as the other planks in its strake by wrought iron clenched and roved nails 7mm square in cross-section.

There are six fastening holes on the top edge between 280 and 210mm apart. Seven fastening holes are evident on the bottom edge 170 to 250mm apart. At least three fastening holes are evident in the 210mm long through splayed vertical scarf at the forward end, and four are evident in the 240mm long aft scarf. Two treenail holes, 26mm in diameter, are evident. These are 1.02m apart and fastened the strake to frames eight and seven.

Pl.pt.C2

This is the remains of a plank from the starboard bow (Fig. 3.24). It is extensively damaged though remains to its full length of 1.324m. The maximum sided dimension reduces from 162 to 110mm going forward. The maximum moulded dimension is 22mm. A 220mm long through splayed scarf is evident at the aft end, with three fastening holes; whilst a 200mm long scarf is placed at the opposing end and side. A lap with evidence for luting runs along each horizontal edge on opposing sides. There are five nail holes on the upper edge. These are spaced between 170 and 220mm apart. Five nail holes spaced between 182 and 260mm apart run along the bottom edge. A number of wrought iron roved and clenched 7mm square nails are still in place. A single treenail, 26mm in diameter for fastening the strake to frame six.

Pl.pt.C3

This is the remains of a plank from the third strake. It has a remaining length of 1.367 metres; a maximum sided dimension of 174 mm at the forward edge, and a moulded dimension of 20 mm at the top edge which reduces to 8 mm at the bottom edge. The aft section is split and broken. A number of holes with wooden pegs in them would suggest a re-use of this plank. There is a 240mm long scarf at the aft end and a 200mm long scarf at the forward end. There are nine fastening holes evident on the lower edge and twelve evident on the upper edge. These are spaced between 50mm and 235mm apart. All the fastenings are roved and clenched 7mm square wrought iron nails. There is a single 26mm in diameter treenail hole 0.554m from the forward edge. This was used to fasten the strake to frame seven.

Pl.pt.C5 (cont.)

This is the badly broken and degraded remains of a broken off piece of plank **C5** (Fig. 3.25) There are no discernible features apart from a number of nail holes and a lap 55mm wide on one side, and chamfering on one of the vertical edges. The piece has a remaining length of 505mm, sided dimension of 120mm, and moulded of 18mm.

Pl.pt.C5, C6

This composite piece has plank **5** and **6** from strake **C** represented (Fig. 3.25). Both bits are designated **C** and are therefore from below the turn of the bilge and about midships from the port side. The assemblage is fastened together by a number of roved and clenched wrought iron nails.

C5 is 1.19m long with a maximum sided dimension of 160mm and maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 220mm long through splayed vertical scarf at the forward end and a 251mm long scarf at the aft end. There are three 7mm square nail holes in each scarf for fastening it to its adjacent part. A 50mm wide lap can be discerned on the upper edge. It is fastened to **F3** by five fastenings, though there are another three evident on its upper edge. These have an average spacing ranging from 180 to 280mm. There is a single 26mm diameter treenail hole 57mm from the aft end. This is to affix the strake to **F5R**.

C6 runs into the stern post. It has an overall length of 1.164m with a moulded and sided dimension of 20mm and 120mm respectively. There are no treenails evident, but there are 11 nail fastenings evident. It is joined to C5 by three clenched wrought iron nails.

Pl.pt.D2, E2, F2

This composite piece has parts of strake **D2, E2** and **F2** represented (Fig. 3.26). Their original position is amidships around the turn of the bilge on the port side. The assemblage is fastened together by a 16 roved and clenched wrought iron nails.

D2 is 2.654m long with a maximum sided dimension of 190mm and a maximum moulded dimension of 18mm at the top and 9mm at the bottom. There is evidence for the remains of a scarf at the forward end with a 220mm long through splayed vertical scarf at the aft end. The aft scarf has three 7mm square nail holes for fastening it to its adjacent part. A 45mm wide lap can be discerned on the upper edge. It has eleven fastenings on its lower edge. These have an average spacing ranging from 230mm to 160 mm, with an exception of one spacing of 420mm. There are three treenail holes each 26mm in diameter and spaced 0.87m and 1.05m apart forward to aft respectively.

E2 is 2.290m long with a maximum sided dimension of 145mm; and a maximum moulded dimension of 18mm at the top and 9mm at the bottom. There is a 240mm long through splayed vertical scarf at the forward end and a 250mm long scarf at the aft end. There are no treenail holes evident. A 40mm wide lap can be discerned on both the lower and upper edge of the plank. It is fastened to **D2** by 10 fastenings and to **F2** by six fastenings.

F2 is 1.586m long with a maximum sided dimension of 190mm and a maximum moulded dimension of 18mm at the top and 9mm at the bottom. There is a 235mm long through splayed vertical scarf at the forward end and a 240mm long scarf at the aft end. There is evidence for four 7mm square nail holes in each scarf for fastening it to its adjacent part. A 55mm wide lap can be discerned on the upper edge. There are six fastenings on the upper edge. These have an average spacing ranging from 165 to 290mm. A single hole with a wooden peg is also evident. There is a single 26mm diameter treenail evident 0.71m from the forward end.

Pl.pt.D3

The badly broken remains of part of **D3** (Fig. 3.27). It has a remaining length of 0.923m, a maximum sided dimension of 130mm and moulded of 18mm. There is a 175mm long through splayed vertical scarf at one end and a 220mm long scarf at the other. There are six nail holes in a 35mm wide lap on one edge, which has the remains of luting still attached. The opposite edge is too broken to discern any features.

Pl.pt.E1,E2,F1

This composite piece has parts of strake **E1, E2** and **F1** represented (Fig. 3.28). Their original position was forward of amidships around the turn of the bilge on the port side. The assemblage is fastened together by a number of roved and clenched wrought iron nails.

E1 is 1.48m long with a maximum sided dimension of 165mm and a maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 260mm long through splayed vertical scarf at the forward end and a 251mm long scarf at the aft end. There are three 7mm square nail holes in each scarf for fastening it to its adjacent part. A 50mm wide lap can be discerned on the lower edge. It is fastened to **F1** by five fastenings. These have an average spacing ranging from 310 to 185mm.

E2 is 0.795m long with a maximum sided dimension of 145mm and a maximum moulded dimension of 20mm at the top and 9mm at the bottom. A 50mm wide lap can be discerned on the lower edge, running aft and up the aft edge of the plank. It is fastened to **E1** by two fastenings and to **F1** by one fastening though there is a further fastening evident along the top edge.

F1 is 1.971m long with a maximum sided dimension of 180mm and a maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 200mm long through splayed vertical scarf at the forward end and a 190mm long scarf at the aft end. There are two 7mm square nail holes in each scarf for fastening it to its adjacent part; it is likely there were more, though these have been lost due to damage of the ends of the planking. A 40mm wide lap can be discerned on the upper edge. There are five fastenings within this lap. A number of holes with wooden pegs in them are evidence of a reuse of this plank..These have an average spacing ranging from 200 to 290mm.

Pl.pt.E3

E3 is the second most aft plank (Fig. 3.27). The plank is 2.07m long. It has a maximum sided dimension of 115 mm and moulded dimensions of 18mm along the top edge and 9mm along the bottom edge. The whole plank is extensively broken. There are six 7mm square fastening holes on the top edge between 265mm and 185mm apart. The impressions of roves visible on the outboard face. Three fastening holes are evident in the 220mm long through splayed vertical scarf at the forward end. A single treenail hole 26mm in diameter is evident. This fastened the strake to frame eight.

Pl.pt.G3, F3

This composite piece has parts of strake **G3** and **F3** represented (Fig. 3.29). Both bits are designated **3** and are therefore from around the turn of the bilge forward of amidship on the port side. The assemblage is fastened together by a number of roved and clenched wrought iron nails.

G3 is 2.09m long with a maximum sided dimension of 160mm and maximum moulded dimension of 20mm at the top and 9mm at the bottom. There is a 220mm long through splayed vertical scarf at the forward end and a 251mm long scarf at the aft end. There are three 7mm square nail holes in each scarf for fastening it to its adjacent part. A 50mm wide lap can be discerned on the upper edge. It is fastened to **F3** by five fastenings, though there are another three evident on its upper edge. These have an average spacing ranging from 180 to 280mm. There is a single 26mm diameter treenail hole 57mm from the aft end. This is to affix the strake to **F5R.**

F3 is 1.53m long with a maximum sided dimension of 185mm and maximum moulded dimension of 19mm at the top and 9mm at the bottom. A single branch grew through the piece. There is a 185mm long through splayed vertical scarf at the forward end and a 270mm long scarf at the aft end. There are three 7mm square nail holes in each scarf for fastening it to its adjacent part. A 40mm wide lap can be discerned on the upper edge. It is fastened to **G3** by five fastenings, though there are another two evident, these most likely being old holes. There are six fastening holes evident along the upper edge a number of which have wooden pegs in them. These have an average spacing ranging from 200 to 290mm.

Pl.pt.F4

This is the very extensively broken and cracked remains of a plank from the aft section of strake **F**(Fig. 3.27). It has a remaining length of 1.313m, a maximum sided dimension of 160mm, and moulded of 22mm. There is the remains, measuring 232mm, of a through splayed vertical scarf at one end. A 55mm wide lap runs along the bottom edge. Six nail holes run along the bottom edge and evidence for two can be found on the top edge. These are spaced between 150 and 245mm. A single 26mm diameter treenail hole is positioned 350mm from the end.

Pl.pt.F1 continued

This is the badly broken and degraded remains of a broken off piece of plank **F1** (Fig. 3.30) There are no discernible feature apart from a number of nail holes. The piece has a remaining length of 355mm, with a sided and moulded dimension of 100mm and 14mm respectively.

Pl.pt.G2

This is the badly cracked and extensively broken remains of a plank from the fore quarter at the turn of the bilge (Fig. 3.30). It has a remaining length of 1.443m, a maximum sided dimension of 170mm and moulded of 20mm. There is a through splayed vertical scarf at either end of the plank; these being 220 and 180mm long. Each has evidence for two fastenings. There are six nail holes on the top edge and only three on the bottom edge. These are spaced an average 200 to 225mm apart. A 50mm wide lap runs along both horizontal edges. There are a number of tool marks evident on this plank.

Pl.pt.G4

This is the badly degraded and broken remains of a plank 0.685m long (Fig. 3.30). It has a maximum sided dimension of 140mm and a maximum moulded dimension of 20mm. There is a bevel at one end suggesting the terminal end of a strake. A 40mm wide lap runs along one horizontal edge. There are four nail holes evident.

Pl.pt.H1 and I2 (Fig. 3.31).

This composite piece has parts of strake **H** and **I** represented. Both bits are designated **2** and are therefore from the upper part of the hull and towards the bow on the port side. The assemblage is fastened together by a number of roved and clenched wrought iron nails.

H2 has a remaining length of 0.95m. It has a maximum sided dimension of 140mm and a maximum moulded dimension of 24mm. It has evidence for a hem on the upper edge of 55mm, and a land on the lower edge of 45mm edge. A 220mm long through splayed vertical scarf joint is evident at the forward end. There are four fastenings on the upper edge spaced between 230 and 240mm apart. There is evidence for three on the lower edge these being

90,130 and 135mm apart.

I2 has a remaining length of 1.985m. It has a maximum sided dimension of 185mm and a maximum moulded dimension of 24mm. It has evidence for a hem on the upper edge of 55mm, and 45mm land along the bottom edge. There is evidence for six fastenings on the upper edge spaced between 460 and 90mm apart. Due to the broken nature of this edge there was most probably more fastenings originally. The distance between spacings would support this. There is evidence for ten on the lower edge these being between 165 and 240mm on average. One fastening only 20mm from another can be explained as an old fastening. There is a single treenail hole 26mm in diameter in the middle of the plank. This was to fasten the strake to the framing.

Pl.pt.I3

I3 represents the stern most plank in strake **I** (Fig. 3.31). It runs from the stern post to just forward of frame 9, but is not fastened to it. The plank is 1.656m long, though only 1.53m between points. It has a maximum sided dimension at the fore edge of 162mm and at the aft edge of 100mm. It is 200mm moulded along the top edge and 9mm moulded on the bottom edge. The bottom edge is broken and there are a number of knots evident. There are five fastening holes on the top edge between 442 and 225mm apart. Five fastening holes are evident, within a 60mm wide lap, on the bottom edge, though it likely there were more. There are no treenail holes.

Pl.pt.J2

The badly degraded and broken remains of an end of a plank (Fig. 3.32). It has a remaining length of 0.78m a maximum sided dimension of 130mm and moulded of 20mm. There is a through splayed vertical scarf 160mm long at the forward edge. Four nail holes in a 65mm wide lap along the upper edge, are the only other constructional features.

Pl.pt.J3

This is the badly degraded remains of a plank from strake **J** (Fig. 3.32). There is extensive cracking due to drying, and each edge is broken. The only discernible features are a number of nail holes and the remains of a single treenail hole, roughly 30mm in diameter; and a lap on one side with a maximum thickness of 80mm. The piece has a remaining length of 0.628m a maximum sided dimension of 140mm and moulded of 20mm.

Pl.pt.J4

J4 represents the stern end of strake **J** (Fig. 3.32) It extends from the stern post forward to just in front of frame eight. It has a remaining length of 1.91m, though is only 1.265m between ends. It has a maximum sided dimension of 182mm at the forward edge and 90mm at the aft edge; with a moulded dimension of 19mm at the top edge which reduces to 8mm at the bottom edge. The bottom edge is split and broken.

There is a 280mm long scarf at the fore end. This has a two fastening holes evident. There are seven fastening holes evident on the lower edge and four evident on the upper edge. These are spaced between 470mm and 220mm apart. All the fastenings are roved and clenched 7mm square wrought iron nails. There is a single, 26mm diameter, treenail hole evident for fastening to frame nine.

Pl.pt.K2

This is the badly deteriorated remains of a piece of the sheer strake (Fig. 3.33). It has a remaining length of 0.668m, a maximum sided dimension of 180mm and a maximum moulded dimension of 18mm. There are three discernible nail holes 215 and 225mm apart. A single treenail hole 24mm in diameter is also evident.

Pl.pt.K3

K3 is the remains of the end of the aft most plank in the sheer strake (Fig. 3.33). It has a remaining length of 0.745m. It has a maximum sided dimension of 105mm at the fore end which reduces to 85mm at the aft end. Its maximum moulded dimension is 15mm. There is a single nail fastening at the hood end and a further nail hole on the lower edge 176mm from the fore end. Two treenail holes each 26mm in diameter and 252mm apart are evident. These are to affix the gunwale to the sheer strake.

Pl.pt.K3 continued

This is the part of the broken remains of plank K2 (Fig. 3.33). It has a remaining length of 1.12m, maximum sided dimension of 140mm and a maximum moulded dimension of 18mm. There is a through splayed vertical scarf 180mm long at one end. Two nail holes are evident along one edge 430mm apart; and there is a single 26mm diameter treenail hole along the opposing edge. A number of tool marks are also evident.

Starboard planking

Pl.st.A1

This is the broken remains of a relatively long plank from the forward area (Fig 3.34). It has a remaining length of 2.365m, a maximum sided dimension of 160mm, and a moulded dimension of 22mm. There is a through splayed vertical scarf, 235mm long, at the aft end. There are at least three nail fastening holes in the scarf. The remains of a lap, 45mm wide, can be discerned along the inboard top edge. A 45mm wide lap can be seen on the outboard top edge. A series of very close nail fastening holes are evident along the top edge; spaced between 35 and 85mm apart. Nail fastening holes, spaced between 120 and 170mm apart are evident on the bottom edge. No treenail holes are evident. No further constructional details are evident.

Pl.st.A3

This is the broken remains of a short plank from the midship area. It has a remaining length of 1.103m, a maximum sided dimension of 155mm, and a moulded dimension of 20mm. There is a through splayed vertical scarf at each end. The fore scarf is 245mm long, and the aft scarf has a remaining length of 235mm. There are at least two nail fastening holes in each scarf. The remains of a lap, 30mm wide, can be discerned along the inboard top edge but the hem does not remain. A series of nail fastening holes are evident along both edges; spaced between 135 and 210mm. No treenail holes or further constructional details are evident (Fig 3.34).

Pl.st.A4

This is the remains of a short plank from the midship area being only 0.86m long (Fig. 3.34). It is extensively broken along its bottom edge having a remaining maximum sided dimension of 165mm and moulded dimension of 17mm. There is a through splayed scarf at each end, on opposing sides. The inboard scarf is 260mm long and the out board scarf 250mm long. The inboard scarf has only two nails for fastening whilst the outboard one has four. There are a further six nail holes to fasten the plank to the strake above and below. There are no treenail holes. No further constructional details are evident.

Pl.st.A5 (Originally numbered C5)

This is the extensively broken remains of part of one of the extremities of plank **A5** (Fig. 3.34) It has a remaining length of 1.037m, a maximum sided dimension of 110mm, and a maximum moulded dimension of 17mm. There is a single scarf 235mm long at one end. The opposing end is broken around a pronounced oval shaped groove. There is a 45mm wide lap along one horizontal edge. There are a number of nail fastening holes evident; due to their degraded state nothing definitive can be said of them.

Pl.st.A5a

This is the badly broken and degraded remains of a broken off piece of plank **A5** (Fig 3.35) There are no discernible feature apart from a number of nail holes and a lap 60mm wide on one side, and a bevel to one of the vertical edges. The piece has a remaining length of 450mm, sided and moulded dimension of 100mm and 18mm respectively. No further constructional details are evident.

Pl.st.B1.Patch

B1 is a patch as opposed to an actual part of a plank (Fig. 3.35). It is 0.52m long has a sided dimension of 96mm, and a maximum moulded dimension of 19mm. The fore and aft edges are chamfered. There are a series of fastening holes around the patch. These are between 59 and 82mm apart. The inboard face still has the remains of the moss luting attached. The impression of a join between two strakes and their planks can be seen. No further constructional details are evident.

Pl.st.B1.

This is the forward plank from strake B (Fig. 3.35). It has a remaining length of 2.32m, a sided and moulded dimension of 171 and 20mm respectively. There are eight nail fastenings along the top edge. The bottom land is too degraded and does not hold any evidence for nail fastenings. A series of small nails correspond to those on patch B1. A single treenail, 22mm in diameter, is evident 0.762m from the aft end is still *in situ.*

Pl.st.B2

This is the broken remains of a short plank from the midship area (Fig 3.35). It has a remaining length of 0.791m, a maximum sided dimension of 171mm, and a moulded dimension of 16mm. There is a through splayed vertical scarf at each end. The fore scarf is 177mm long, and the aft scarf has a remaining length of 200mm. There are at least three nail fastening holes in each scarf. The remains of a lap, 35mm wide, can be discerned along the outboard bottom edge. No lap on the outboard top edge can be discerned. A series of nail fastening holes is evident along both edges; spaced between 135 and 210mm. A single treenail hole 28mm in diameter is evident. On the inboard side where the frame would have butted against the plank there is evidence for luting. No further constructional details are evident.

Pl.st.C2

This is a short plank from the midship section of strake **C** (Fig. 3.36) It has an overall length of 1.018m, a maximum sided dimension of 145mm and moulded dimension of 20mm. There is a through splayed vertical scarf at either end. The fore scarf is 190mm long whilst the aft scarf is 300mm long. There are three fastening holes in each scarf. There is a lap on the outboard top edge with a maximum width of 45mm. A series of nail holes with spacings between 135 and 95mm run along the lap. No evidence for the inboard bottom edge lap can be found. There are a few nail holes evident though. A single treenail hole, 28mm in diameter was used to fasten the strake to frame seven. On the inboard edge luting still remains where frame seven was. Here there is a roved and clenched wrought iron nail still *in situ*, as evidence of the building sequence. No further construction evidence can be found.

Pl.st.C3

C3 was sawn in half to take a dendro sample (Fig. 3.36). It will be dealt with as if whole. It is 0.996m long has a maximum sided dimension of 204mm and moulded of 20mm. There are through splayed vertical scarfs at both ends. The fore end scarf is 230mm long with two nail fastening holes in it, whilst the aft scarf is 250mm long with at least one nail fastening hole in it. There is a 50mm wide lap along one edge with two nail fastenings and luting evident. Four nail fastenings are evident on the opposing edge. No treenails are evident and there are no further constructional details evident.

Pl.st.C4

C4 is therefore the aft most plank of strake C (Fig. 3.36) It has a remaining length of 1.8m, a maximum sided dimension of 170 at the aft end, which reduces to 105mm at the fore end, and a maximum moulded dimension of 19mm . There is a 230mm long through splayed vertical scarf at the aft end and a 50mm long bevel at the fore end. There are two nail fastening holes in the scarf. A lap with a maximum width of 60mm runs the length of the inboard bottom edge; six nail fastenings are evident within the lap. There is also a lap on the outboard top edge with a maximum width of 65mm. There are five nail fastening holes in this lap and one square hole with a wooden plug. No treenail holes are evident in this plank. No further constructional details are evident.

Pl.st.D1

This is an extensively and heavily broken piece of plank (Fig. 3.37). It has a remaining length of 1.448m, a maximum sided dimension of 130mm and moulded dimension of 20mm. There is evidence of a single through splayed vertical scarf, 160mm long, at one end. Two nail holes and a single square hole with wooden peg are evident within the scarf. A number of nail holes are evident along both of the broken edges. A single treenail hole 28mm in diameter is also evident. No further constructional details are evident.

Pl.st.D3

The partial remains of a plank 0.676m long (Fig. 3.37). It has a sided dimension of 164mm and a maximum moulded dimension 16mm which reduces to 9mm along the bottom edge. There is a 210mm long through splayed vertical scarf at one end. This has two nail holes in it and one 24mm in diameter treenail hole. There is a lap along the inboard bottom edge with a maximum width of 60mm. Two nail fastening holes are evident in this lap 215mm apart. Two further nail holes are evident along the upper edge, 189mm apart. No further constructional details are evident.

Pl.st.D4

This is the broken remains of a plank (Fig. 3.37). It has a remaining length of 1.017m, a maximum sided dimension of 137mm and a maximum moulded dimension of 20mm which reduces to 9mm at the bottom edge. There are no scarfs evident on this piece. Running along each edge is a series of nails. These are spaced between 206 and 290mm apart. The nails lie in a 45mm wide lap, above which is evidence of a whitish powder. A single 28mm in diameter treenail hole is evidence for fastening the strake to a frame. No further constructional details are evident.

Pl.st.E2

This is the remains of a plank broken along its length (Fig. 3.38). It has a remaining length of 1.9m, a maximum sided dimension of 194 and moulded of 21mm. There is a 180mm long through splayed vertical scarf at the fore end, and a 186mm long similar scarf at the aft end. Two nail holes are evident in each scarf. Running along each edge is a series of nails. These are spaced between 370 mm and 205mm apart. A lap 85mm wide at it forward edge and 45mm wide at its aft edge is evident on the top outboard face. A 64mm wide lap is evident on at the bottom inboard edge. A single treenail hole, 28mm in diameter, is evidence for fastening the strake to a frame. No further constructional details are evident.

Pl.st.E3

The remains of a short piece of plank 0.827m long (Fig. 3.38). It has a maximum sided dimension of 192mm and moulded of 22mm. There is a through splayed vertical scarf at each end, these being 235 and 220mm long. At least two nail holes are evidence for fastenings within the scarfs. There are two nail holes along the top edge and one evident on the bottom edge. A 65mm wide lap is also evident along the top lap. No further constructional details are evident.

Pl.st.E4

E4 is the broken remains of a plank (Fig. 3.38). A sample has been sawn off it for dendro dating. It has a remaining length of 1.24m, a maximum sided dimension of 176mm and moulded of 20mm. There is a through splayed vertical scarf 127mm long at the aft end. This has a singe nail hole evident. The opposing end was sawn off for dendro dating. There is a single lap 50mm wide along the outboard top edge. This has a series of paired nail fastening holes evident in it. These are between 258 and 110mm apart. The paired holes represent old and new fastening holes, thus showing a re-use of the plank. There are no treenail holes evident. No further constructional details are evident.

Pl.st.E5

This is the broken remains of a plank (Fig. 3.39). It has a remaining length of 1.693m, a maximum sided dimension of 179mm and a maximum moulded dimension of 19mm which reduces to 9mm at the bottom edge. There is a 225mm long through splayed vertical scarf at one end. The opposite end does not have a scarf but does feather off to a point. A single nail hole is evident in the scarf. Running along each edge is a series of nails. These are spaced between 185 and 282mm apart. Spacings for the top edge cannot be discerned due to the broken nature of the edge. A 60mm wide lap runs along the bottom edge. A single 28mm in diameter treenail hole is evidence for fastening the strake to a frame. No further constructional details are evident.

Pl.st.F2

This is the partially broken remains of a plank from the forward quarter (Fig. 3.39). It has a remaining length of 1.991m, a maximum sided dimension of 176mm, and moulded of 20mm. There is a through splayed vertical scarf, 225mm long, at the aft end and the broken remains of a similar scarf at the other end. There is a single nail fastening evident in each scarf. A 60mm wide lap runs along both horizontal edges, but on opposite sides. A series of nail holes and wooden pegs in square holes runs along the bottom edge. The pegs show a re-use of the plank. These are spaced between 192 and 310mm. There is evidence for nail fastenings on the upper edge, though this is badly broken. A single treenail hole 28mm in diameter is evident near the aft end of the plank. No further constructional details are evident.

Pl.st.F4

This is the broken remains of a plank (Fig. 3.39). It has a remaining length of 1.034m, a maximum sided dimension of 148mm and a maximum moulded dimension of 20mm which reduces to 18mm at the bottom edge. There is a 230mm long through splayed vertical scarf at one end and the broken remains of a 240mm long similar scarf at the other. Two nail holes are evident in each scarf. Running along one edge are two nails. These are spaced between 280mm apart. A single 28mm diameter treenail for fastening the strake to a frame is evident. No further constructional details are evident.

Pl.st.G2

This is the broken remains of a plank (Fig. 3.40). It has a remaining length of 1.39m, a maximum sided dimension of 150mm and a maximum moulded dimension of 23mm which reduces to 9mm at the bottom edge. There is a 220mm long through splayed vertical scarf at the fore end and a 200mm long similar scarf at the aft end. A single nail hole is evident in the fore scarf. Running along the top edge is a series of nails in a 60mm wide lap. These are spaced between 192 and 307mm apart. No evidence for a lap or series of nails can be found on the bottom edge due to its broken nature. There is no evidence for a treenail hole. No further constructional details are evident.

Pl.st.G3

This is the heavily broken remains of a plank (Fig. 3.40). It has a remaining length of 1.89m, a maximum sided dimension of 174mm, and a maximum moulded dimension of 20mm. There is a through splayed vertical scarf evident at both end. The aft scarf has a length of 210mm whilst only 190mm of the fore scarf remains, the rest of it being broken off. A single nail fastening is evident for each scarf. A lap 60 to 70mm wide runs along the upper outboard edge of the plank; five nail holes are evident within this lap spaced between 195 and 278mm apart. No evidence for the bottom inboard lap can be discerned. There are a number of nail fastenings spaced between 185 and 94mm apart along the bottom edge. A single treenail hole 28mm in diameter is evident in the middle of the plank. The impression of a frame 90mm wide is also evident in the same area. No further constructional details are evident.

Pl.st.G3cont

This is the remains of the end of plank **G3** (Fig. 3.40) It has a remaining length of 331mm a maximum moulded dimension of 16mm and a maximum sided dimension of 80mm. There is a single nail hole evident; apart from this there are no further constructional details.

Pl.st.G4

This is the partial remains of the end of a plank (Fig. 3.40). It is basically the through splayed vertical scarf 370mm long. It has a maximum sided dimension of 137mm and moulded of 30mm. There are three nail holes evident. No further constructional evidence is discernible.

Pl.st.G5

A badly degraded and extensively cracked remains of a plank (Fig. 3.40). It has a remaining length of 1.14m, a maximum sided dimension of 175mm and moulded of 24mm. There is a 235mm long, through splayed vertical scarf at one end and a broken rebate at the other. Both features are on the out board face. A 65mm wide lap is evident on the bottom edge of the inboard face. There are two definite nail holes evident on the upper and lower edges with a possible two further holes. These are badly degraded and can therefore not be identified for certain. A single treenail 26mm in diameter is evidence for fastening this plank to a frame.

Pl.st.G5a

G5a is the extensively broken and cracked partial remains of plank **G5** (Fig. 3.40) It has a remaining length of 0.386m, a maximum sided dimension of 126mm, and a maximum moulded dimension of 26mm. There is no evidence for a scarf at either end. A 35mm lap is evident along the top outboard edge. There is a series of nail holes along the bottom edge. These are spaced between 44 and 82mm. No further constructional details are evident.

Pl.st.G6

This is the extensively broken remains of one end of a plank (Fig 3.40). It has a remaining length of 0.796m, a maximum sided dimension of 120mm, and moulded of 17mm. There is a 230mm long scarf at one end; the opposing end being broken. A 50mm wide lap is evident down one edge. There are three nail holes evident in this lap, with a further two evident on the opposite side. A thick white powder is evident above the line of the lap on the inboard face. It is some form of stopping.

Pl.pt.H1

H1 is the broken remains of a plank from the forward quarter of the starboard side (Fig. 3.41). It has a remaining length of 1.325m, a maximum sided dimension of 160mm, and a maximum moulded dimension of 22mm. There is a 205mm long through splayed vertical scarf at the forward edge and a 180mm through splayed vertical scarf at the aft edge. At least three fastening holes are evident in each scarf. A 50mm wide lap runs along both the bottom and top edge, but on opposing sides. Seven nail fastenings are evident on the top edge and four on the bottom edge. They are spaced between 80 and 120mm on the bottom edge and

130 and 280mm on the top edge. A single treenail hole 28mm in diameter is evident.

Pl.st.H1a

A short plank only 0.781m long it is badly broken (Fig. 3.41). It has a maximum sided dimension of 182mm and moulded dimension of 24mm. There is a 260mm long scarf at one end with two nail holes evident in it. The opposing end feathers off though there is no definite scarf. A 65mm wide lap runs along one edge with two nail holes evident in it. There are three further nail holes evident on the opposing edge.

Pl.st.H3

H3 is a badly degraded and extensively cracked broken piece of plank (Fig. 3.41). It has a remaining length of 1.457m, a maximum sided dimension of 160mm, and moulded of 20mm. A 280mm long through splayed vertical scarf joint is evident at one end. The opposing end is too cracked and broken to discern any features. There is a 40mm wide lap on the bottom edge. Inside this are five nail holes a maximum 268mm apart. No doubt there were other nail holes originally, which have broken off due to the damage. There are no treenail holes.

Pl.st.H4

H4 is the extensively broken and cracked remains of a plank from the stern section of the starboard side (Fig. 3.41). It has a remaining length of 1.78m, a maximum sided dimension of 180mm and a maximum moulded dimension of 18mm. There is a single, 204mm long, through splayed scarf joint at the aft end of the plank. It is badly damaged and no fastenings can be identified in it. A single lap 45mm wide runs along the top edge. There is evidence for four fastening holes in this lap. A further fastening hole is evident in the bottom lap, 40mm wide, on the inboard face. There are no treenail holes or further constructional features.

Pl.st.I2

This is the badly broken and extensively cracked remains of a plank (Fig. 3.42). It has an overall length of 1.465m, a maximum sided dimension of 202mm at one end which reduces to 184mm at the other. It has a maximum moulded dimension of 22mm. There is no evidence for scarfs at either end. On opposing sides and edges there is a lap. It has a maximum width of 70mm. There are six nail holes on the upper edge and four on the lower edge. These are spaced no greater than 348mm apart. A single treenail, 30mm in diameter, connects the strake to frame seven.

Pl.st.I4

This is the heavily broken and cracked remains of a plank (Fig. 3.42). It has a remaining length of 1.446m, a maximum sided dimension of 177mm and moulded of 20mm. There is a through splayed vertical scarf at each end. The forward scarf is 290mm long and the aft scarf is 225mm long. There is evidence for two nail fastenings in each scarf. There are three nail holes along the top edge spaced between 282 and 326mm apart. A lap 65mm runs along the outboard top edge, whilst the remains of another runs along the inboard bottom edge. Three nail holes along the bottom edge are spaced 333 and 300mm apart. There is a single treenail hole 28mm in diameter. This is to fasten the strake to a frame. No further constructional details are evident.

Pl.st.I5

This is the broken remains of a plank from the stern end of strake I (Fig. 3.42) It has a remaining length of 1.792m a maximum sided dimension of 134mm at the forward end which reduces to 120mm at the aft end. There is a 256mm long scarf at the forward end and a bevel at the other. On the inboard edge there is a lap with a maximum width of 65mm. Only one nail hole is evident within this. There are four nail holes on the upper edge. There are no treenail holes. A ghost mark from frame nine has been left by the luting on the inboard face.

Pl.st.J3

This is a badly broken and degraded piece of a plank (Fig. 3.43). It has a remaining length of 0.771m, a maximum sided dimension of 150mm, and a maximum moulded dimension of 28mm. There is a single through splayed vertical scarf , 230mm long, with at least one nail hole evident. There is a lap evident on each horizontal edge, though on opposing sides. Only two nail holes are evident on the bottom edge. A single square hole with a wooden peg still *in situ* is evidence for a re-use of this piece. A single 26mm diameter treenail hole is evident running through the back edge of the scarf.

Pl.st.J4

A badly degraded plank from the midship section, it has a maximum length of 1.271m, maximum sided dimension of 177mm and moulded of 22mm (Fig. 3.43). There are no discernible scarfs, though there is an obvious feathering of the ends of the plank. There are five nails on the bottom edge and three evident on the top edge. These average between 188mm and 330mm apart. A single treenail hole, 28mm in diameter is evident.

Pl.st.J4.cont

The remains of the last aft plank at the stern in strake **J**. It has an overall length of 1.726m, and maximum moulded dimension of 20mm. Its sided dimension reduces from 162mm at the forward end to 87mm at the aft end. There is a 230mm long scarf at the forward end and a slight bevel at the aft edge. The top edge is broken though there is enough evidence to suggest a lap. There is a definite lap on the bottom edge with a maximum width of 45mm. Four nail holes are evident in both top and bottom edges. The top nails are spaced between 355mm and 384mm apart, and the bottom ones between 556mm and 435mm apart. There is a single treenail hole 28mm in diameter. This is to fasten the strake to frame **9**.

Pl.st.K3

This is the degraded remains of a plank from the sheer strake (Fig. 3.44). It has a remaining length of 1.562m with a maximum sided and moulded dimension of 160 and 22mm respectively. It has a 262mm long through splayed scarf at one end, whilst the other end is broken. There are six nail fastening holes evident along the bottom edge. Two, 22mm in diameter, treenail holes are evident in the mid part of the frame. No further constructional details are evident.

Pl.st.K4

Originally a single piece **K4** was cut into two for dating purposes (Fig. 3.44). It will be described in its original condition. **K4** had an original length of 1.827m, a maximum sided dimension of 188mm and a maximum moulded dimension of 22mm. There is a through splayed vertical scarf at each end, these being 220mm long forward and 180mm long aft.

Each scarf has at least two fastenings each.

A single lap 45mm wide with six nail holes is evident on the lower edge. These are between 195mm and 253mm apart. No nail holes are evident on the upper edge. Four treenail holes, 24mm in diameter, are found along the upper edge. These served to fasten the gunwale and frame to the sheer strake. A number of knots and branches are evident.

Pl.st.K5

This is the partial remains of the starboard sheer strake (Fig. 3.44). It is 1.502m long, has a remaining sided dimension of 160mm and a moulded dimension of 20mm. There is a 210mm long through splayed vertical scarf at one end. Evidence for four nail holes remains along the broken lower edge. There are two 26mm diameter treenail holes on the upper edge, 585mm apart, for fastening the gunwale to the sheer strake.

Pl.st.K6

This is the remains of the stern most plank from strake **K** (Fig. 3.45) It has a remaining length of 1.66m; a maximum sided dimension of 149mm at the forward edge which reduces to 84mm at the stern edge and a moulded dimension of 20mm. There are only four nail holes along the bottom edge spaced between 382 and 358mm. Four treenail holes, between 24 and 25mm in diameter are evident throughout the plank. Three of these treenail holes correspond to fastenings for the gunwale and the fourth was to fasten the sheer strake to frame nine. No further constructional details are evident.

No coded Planking

A number of planks have no codes attached to them. They cannot be positioned in the hull of the vessel due to the state of the timbers and a lack of recorded associations at the time of their recovery. They appear to be starboard timbers which were crushed underneath the vessel and undoubtedly come from the forward part due to the stern sections being complete. They are all numbered sequentially as they were found and all have orange tags. This does not mean that they were port timbers.

Pl.no.1

The remains of a plank 1.115m long (Fig. 3.46). It is extensively broken and cracked. It has a remaining maximum sided dimension of 125mm; and a maximum remaining moulded dimension of 25mm. The forward end is feathered and has a slight twist to it. The aft end has a 250mm long through splayed vertical scarf. Clenched and roved wrought iron fastenings are evident on both top and bottom edges of the plank. The top edge has four fastening holes in a 55mm wide lap. There are a number of old fastening holes as well . The bottom edge has at least four fastening holes. There is a single treenail hole 26mm in diameter.

Pl.no.2

Originally classed as a plank from the port side with no position but numbered no.6, this plank is most probably from one of the lower strakes in the aft quarter (Fig. 3.46). It has a remaining length of 2.065m, and maximum sided and moulded dimensions of 145 and 16mm respectively. There is a 255mm long through splayed vertical scarf at one end and a possible bevel at the other. No definite evidence for a lap at either edge can be found. There are a number of nail fastening holes along each edge. These are spaced between 165 and 482mm apart. There are two 29mm diameter treenail holes towards one end. These would be for fastening to the frames, and rules out this plank being from the garboard. No further constructional details are evident.

Pl.no.3

This is the partial remains of a plank, the position of which is unknown (Fig. 3.46). It has a remaining length of 1.336m; a maximum sided dimension of 150mm at the forward edge, and a moulded dimension of 20mm at the top edge which reduces to 8mm at the bottom edge. The whole plank is split and broken.There is a 230mm long scarf at the forward end. This has two fastening holes evident. There are five fastening holes evident on the lower edge and four evident on the upper edge. These are spaced between 450mm and 135mm apart. All the fastenings are roved and clenched 7mm square wrought iron nails. There is a single 26mm diameter treenail hole at the aft edge.

Pl.no.4

This is the badly degraded and broken remains of a plank 0.994m long (Fig. 3.46). It has a maximum sided dimension of 125mm and a maximum moulded dimension of 26mm. There is the remains of a 200mm long scarf at one end and a bevel at the other. A 60mm wide lap runs along both horizontal edges on opposite sides. There are three nail holes along each edge with a number of older holes evident.

Pl.no.5

This is the badly degraded and broken remains of a plank 0.667m long (Fig. 3.47). It has a maximum sided dimension of 110mm and a maximum moulded dimension of 22mm. There is the remains of a 65mm long scarf at one end. A 60mm wide lap runs along both horizontal edges on opposite sides. There is only one nail hole evident in the piece.

Pl.no.6

This is the remains of the forward plank from strake K. It has a remaining length of 2.088m; a maximum sided dimension of 160mm at the forward edge and 223mm at the aft edge (Fig. 3.47). Its maximum moulded dimension is 20mm on the top edge which reduces to 8mm on the bottom edge. The aft section is split and broken and has a 235mm long scarf. This has a single fastening hole evident. No fastening holes can be discerned due to the lower edge being broken. There are five treenail holes. Four treenail holes, all 26mm in diameter, run along the upper edge of the plank and were for fastening the gunwale to the sheer strake. The fifth, positioned on the lower edge and also 26mm in diameter, is for fastening the strake to frame five.

Pl.no.7

This is the short and badly degraded remains of a through splayed vertical scarf from one of the planks (Fig. 3.47). It is extensively cracked and broken with a remaining length of 0.354m, a maximum remaining sided dimension of 139mm and moulded of 130mm. There are four fastening holes; one in each corner. There are no other discernible diagnostic features.

Pl.no.9

This is the partial remains of a plank from the midship section (Fig. 3.47). It has a remaining length of 1.2m; a maximum sided dimension of 140mm, and a moulded dimension of 24mm at the top edge which reduces to 9mm at the bottom edge. The aft, forward and bottom edges are split and broken.There is a 180mm long scarf at the forward end. This has at least two fastening holes evident. There are seven fastening holes evident on the upper edge. Three old nail holes, one with a wooden peg still in position, are evidence of a reuse of these planks. The fastening holes are spaced between 130 and 185mm apart. All the fastenings are roved and clenched 7mm square wrought iron nails. There are no treenail holes.

Pl.no.10

This is the badly degraded remains of a piece of planking from one of the strakes (Fig. 3.48). It has a remaining length of 0.542m a maximum remaining sided dimension of 100mm and a maximum remaining moulded dimension of 16 mm. There are no discernible diagnostic features except for two nail holes 182mm apart.

Pl.no.11

This is the badly degraded remains of part of a plank (Fig. 3.48). It is extensively broken along all edges. There is evidence for a lap with a remaining width of 40mm, and a probable scarf at one end. This has a remaining length of 170 mm. There are two nail holes 85 mm apart on the opposing side to the lap. Apart from these features there are no other discernible diagnostic features. It has a remaining length of 0.762 metres a remaining sided dimension of 120 mm and moulded of 18 mm.

Pl.no.12

This plank is extensively broken and cracked (Fig. 3.48). It has a remaining length of 1.365 metres, a maximum sided dimension of 125 mm and moulded of 23 mm. It has a 300 mm long through splayed vertical scarf at the fore end with two fastening holes evident in it. A similar scarf though only 225 mm long is evident at the aft end. No fastenings are evident in this scarf.

Only four nail holes are evident on the broken bottom edge, within the 60 mm wide lap. There are five fastening holes on the upper edge with a number of old holes one of which still retains its wooden plug. There are no treenail holes evident.

Pl.no.14

This is the remains of a part of the sheer strake (Fig. 3.49). It is 1.881 metres long, has a sided dimension of 180 mm and moulded of 20 mm along the top edge which reduces to 8 mm at the bottom. There is evidence for a thin lap along the lower edge and a 200 mm long scarf. There are six nail holes along the bottom edge between 335 mm and 512 mm apart. These were to accommodate the wrought iron roved and clenched nails. There are six treenail holes evident for 26 mm diameter treenails. Five run along the top edge spaced between 512 mm and 300 mm apart. These were to fasten the gunwale to the sheer strake. A single treenail hole near the lower edge accommodated the fastening of the strake to the frame.

Pl.no.15

This is the extensively damaged remains of a plank from the starboard side (Fig. 3.49). It has a remaining length of 1.336 metres a maximum remaining sided dimension of 127 mm and a maximum remaining moulded dimension of 20 mm. There is a 50 mm wide lap evident on both edges but on opposing sides. A 160 mm long scarf is also evident at one end. There are eight nail holes for fastenings and a number of older holes which remain as testament to a re-use of this plank. There is a single treenail hole which is badly eroded and has lost it shape and it is impossible to determine the original.

Sheets (Fig. 3.50)

All the surviving sheets are from the stern shelf. Two are made from radially split small planks, possibly off cuts, whilst the other two have been halved. They are nailed to the thwart and to the planking. They vary in length and sided dimension, but are between 16 and 45mm moulded.

Sh.no.5

Originally identified as part of the framing this is now considered to be a sheet. It is 0.35m long with moulded and sided dimensions of 45mm and 102mm respectively. A single nail fastening is evident at the forward edge to fasten the sheet to a thwart.

Sh.no.7

This sheet is virtually whole having a length of 0.63m with a moulded and sided dimensions of 20 and 120mm respectively. The forward edge is curved to follow the shape of the stern, whilst the aft edge is straight. There is a slight chamfer to the underside to fit the thwart, to which it was fastened with a single nail 7mm square. A second nail fastening is evident

220mm from the forward edge.

Sh.no.9

This is the remains of a sheet from the stern 0.524m long, with a remaining sided and moulded dimension of 98 and 16mm respectively. It is badly damaged along the inboard edge. A single nail fastening is evident 90mm from the forward edge to nail the sheet to the planking. The nail fastening for the thwart does not survive due to the damage.

Sh.no.10

This is the remains of a sheet from the outboard edge of the shelf. It is 48mm long and has sided and moulded dimensions of 140mm and 34mm respectively. There is evidence for a nail fastening to fasten the sheet to the planking and thwart. A single treenail hole, 24mm in diameter, is evident along the outboard edge. What this was used for is not known. Both the outboard edge and the forward face are chamfered to fit the planking and thwart respectively.

Fastenings (Fig. 3.51)

There are two main types of fastening used in the vessel. These are wrought iron nails and treenails. Dependent on their use a variation on each is evident. On the whole the nails were used to fasten the planking and strakes together, whilst the treenails were used to fasten the strakes and stringers to the frames and the inwale to the sheer strake. It is noted that nails were utilised in the re-fastening of the keel scarfs.

The Llyn Peris fastenings compare closely to those found during excavations in Viking

Dublin between 1962 and 1981 (McGrail, 1993:1). The Llyn Peris nails and roves are of similar form and size to those identified as coming from a boat not a ship (McGrail, 1993:24). The treenails also fall into the size category for a boat, with both shaped and wedged forms being easily identified with those from Dublin.

Nails

These have a lozenge shaped domed head. The heads were on average 20mm wide, and 6mm high, though they have left an impression in the planks 25 mm wide. The heads show the characteristic rose pattern of wrought nails. The shanks have an average square cross-section measuring 9mm a side at the top and are on average 35mm long with the maximum length found being 65mm. The measured width of the nail shank varies from that of the actual nails by up to 2mm. Thus the average size for the nail shank is given as 8 ±1mm. The width of the nail shank is comparable to the average size of nails found within the 12-17th century Port of London (Marsden, 1996:186) though slightly smaller then the Magor Pill boat, 10mm square, (Nayling, 1998:101). That the nails are square in cross section corroborates the dating of the Llyn Peris boat (Bill, 1994:60).

The patch at **B2** utilises smaller then usual nails with a cross section at the head of the shank of 5 by 6mm. The heads are 10mm in diameter. The nails are wrought iron and in all but size are identical to the larger nails. Roves are not used to fasten the patch to the side of the strakes, neither are the ends clenched over.

Roves

The roves were lozenge shaped, being an average minimum length of 25mm long on each side and 3mm thick. The roves are similar in size and shape to those off Magor Pill (Nayling, 1998:101). All examples show a pronounced rise in the centre where they had been pierced by a hole punch during their manufacturing. Some examples still have the remains of the clenched nail adhering to them, whilst others remain whole with both rove and nail head still remaining. The roves were obviously made from a strip of 1/8ths of an inch wrought iron, which had been punched then cut to form the roves. A simple but tedious task.

Treenails

A number of treenails were recovered during the excavation of the vessel. They were in excellent condition when recovered, though due to drying many are in a very deteriorated condition at present. All examples are made of oak. Their diameter varies but averages 24mm ± 2mm. This is on the large size when compared to the boat sized treenails from the Dublin collection, these being 19.8 mm ± 0.9mm (McGrail, 1993:47). The Magor Pill treenails have a diameter between 22-23mm, it is classed as a large boat (Nayling, 1998:99). The outer head of the treenails showed a definite rounding of the head, a feature noted throughout North West Europe. The inboard edge was cut at an angle to fit flush with the side of the vessel. Those that have been separated from their holes also show a discolouration either side of where the treenail was in contact with the planking.

To create a tight fit some of the treenails had a slot cut into one end. Into this was hammered a wooden wedge. None of the wedges have survived and therefore no dimensions can be given for them. Not all the treenails were fastened in this way as a number did not have wedges. The distribution of those with wedges is unknown as it was not recorded during excavation. The study of the excavation photographs does show wedged treenails *in situ* fastening the strakes to the frames. It is not known whether or not the keel scarf or the inwale treenails were wedged. All the treenails have been fashioned from radially split timber and not round wood. The oak treenails from Magor Pill (Nayling, 1998:99) and Dublin (McGrail, 1993:29) were also fashioned in this way (unlike the willow treenails recovered from Magor Pill). No caulking or luting is associated with the treenails.

Pegs

There are a number of oak pegs evident within the planking, which are not strictly fastenings. Their length varies, on average 15mm, but is exact to the width of the strakes that they plug. The pegs are found in association with fastening holes, which they plug. They either plug old nail holes which are not in use due to the re-fastening of the planking, or the drilled holes, 6mm in diameter, for nails which have not been used. McGrail notes the same form of peg in the Dublin timbers (1992:55) as does Marsden for a possibly early sixteenth century plank (1996:164) and Nayling for the Magor Pill Boat (1998:99). That some of these pegs plug nail holes which are mistakes is supported by the shallow (4mm), blind, round hole (6mm diameter), seen next to a nail fastening on **C3**.

Luting (Fig. 3.52)

A form of luting was identified by the original excavators and analysed by the National Maritime Museum, Greenwich, in 1984 (see section on organic remains). Close inspection of the lands suggests no form of luting was employed consistently throughout the vessel. The lack of any form of luting cove would support this, though one is not strictly required for its application. That the luting is made largely from moss and not a form of animal hair is unusual for this period. It is often assumed that animal hair was used in luting material from Saxon times onwards (Ryder, 1994) with the use of organic material in the form of flax and hemp, not being used till the post medieval period. The form of luting suggest it was made locally, if not on site.

The luting that has been identified has come from the outer part of the lands and the keel rebate. Such a position could represent a phase of resealing the seams of the vessel after a long period of use. The opening up and re-fastening of the lands has already been suggested. Though this could mean the forcing in of the luting it is not in the strictest sense a form of caulking as it would not lend any structural strength or integrity to the vessel (Roberts OTP., *forthcoming*). There is no discernible pattern to the application of the luting, though what remains does coincide with the areas of re-fastening. Unfortunately the luting is fragile and detaches easily, thus without the recording of its distribution at the time of excavation it is assumed that it was applied as part of the re-fastening process.

A form of luting was readily identified in the moss packed repair on the starboard side. This repair consisted of a short plank backed by moss (*Rhyditiadelphus triquestris*, *Rhyditiadelphus squarrous*, and *Hylocomium splendens*) and fastened in place by smaller than usual nails; shank cross section at the head being 5 by 6mm. It is obviously a repair of the seam between the garboard strake and the first strake. As such it is an individual feature which has not been reproduced elsewhere in the boat.

Paying

Interpreted as a form of paying is a resinous yellowish-white coating applied to the outside of the lands. The resin has been mixed with 40% quartz grit and silt. A similar yellowish-white deposit has been found on the Skuldelev planking (Crumlin-Pedersen, 1986:146) and on some of the Dublin timbers (McGrail, 1993:56). The recorded distribution of this "paying" does not conclusively suggest that it had been applied extensively to the outside of the boat. Indeed its distribution would suggest the application of paying in specific areas and therefore supporting the theory that the boat was at one time overhauled and any leaking seams stopped; either by the liberal application of a tallow and then re-fastened or by paying the seam.

Propulsion

A number of means for propelling the Llyn Peris boat can be put forward, though only rowing can be seriously accepted. Towing has been discounted due to the nature of the landscape. It is steep sided and over grown. Punting would have been of limited use due to the steep sides of the lake which has a depth in excess of 5m for the majority of the lake. It might have been advisable, to be safe, to carry a punting pole for use at the Cwm-y-Glo end of the lake, which at this time could have been more marsh then lake.

No evidence of any kind to substantiate the use of sail was found. No mast, mast step, sail or ropes were recovered. Any suggestions that an unstepped mast could have been supported by what appear to be brailing pins forward and possibly aft (Roberts, *pers., com.* 1996) can be discounted as even an unstepped mast would have left some form of wear mark on the top of the keel. Despite Llyn Peris's size i.e. big enough to sail on, it does not necessitate the use of a sail in reality.

Admittedly no identifiable rowlock, kabe, oarlock or oar was found with the boat. What was initially interpreted as a kabe, was quickly identified as a forward fair lead once more of the hull was excavated. The evidence for rowing is six pairs of vertical holes and thole pins in the inwale situated aft of forward thwart, and forward of the midship thwart, and of the aft thwart. Wear marks amidship suggests this was the preferred position for rowing.

Steering

No evidence for the hanging of a rudder was discovered. The remains of the stern post, though ideally suited for the hanging of a rudder, had no evidence on the outboard face for the pre-requisite fastening holes. If the boat was sailed one would expect a rudder but if rowed a rudder is not required, steerage can be supplied by the careful use of the oars.

The use of a steering oar cannot be discounted. The two vertical pins either side of the stern post could be associated with the use of a steering oar. No wear marks as would be expected can be seen on the stern post or inwale. It is possible that these pins had another use such as stern fair leads or mooring points. Of interest is Nicholas Pococke's painting of Caernarvon Harbour dated 1796. In this he paints two small rowing boats being steered by a man in the stern with a steering oar (Cordingly, 1986:53).

Construction sequence

The Llyn Peris boat is a clinker built vessel constructed "shell first" from the keel up. The planks are scarfed together to form strakes. The strakes are through splayed on edge, face nailed as described by McGrail (1993). The scarfs have a blunt end which does not sit flush with the outboard face of the planking. This appears to be the result of the less than careful cutting of the scarf with an axe. A similar feature is noted with the Dublin material (McGrail, 1993:43). There does not appear to have been any importance placed on the separation of scarfs from adjoining strakes. It is generally accepted as bad practice, leaving an inherent line of weakness, in modern day clinker vessels. It is however a feature noted in mediaeval finds elsewhere (McGrail, 1993:44). Each strake is fastened to its neighbour in the clinker fashion; there being eleven strakes per side. The internal frames are in turn fastened to the strakes. Planks are fastened to each other with wrought iron clenched and roved nails whilst the frames are fastened to the strakes with treenails. There is no evidence for there being a pre-fabricated frame to which the clinker planking was fastened, though the use of at least one mould if not three could be argued. Analysis of the strake construction and framing suggest four distinct phases in the building of the vessel.

Phase one

After timber conversion the keel was laid down, the keel rabbet fashioned and a stop splayed scarf cut into each end. The stem and stern post were made with appropriate scarf joints and the keel rabbet extended into the stem and stern post. It is at the keel scarfs, both stem and stern, that the rabbet line feathers-out leaving only the middle line and bearding line.

The stern post was fastened by a single treenail and two nails, whilst the stem post is fastened with two treenails. Whether or not the stem post was attached in two separate pieces or as a composite piece can not be ascertained. There is no reason why it should not have been attached as a whole piece; as is the case with the stern post. Some form of temporary shore would be needed at this stage to support the centre line structure.

Phase two

Phase two consisted of planking up the bottom part of the hull. The garboard strake was fastened first. It is made up of a number of planks, with the longest used at the extremities with wide, short planks in the midship area. The aft most plank was laid to the keel first. The garboard was fastened with a number of wrought iron nails driven through the planking into the keel rebate. The ends of the garboard were feathered into the rebate at the stem and stern, with the hood ends nailed flat onto the rebate.

Once the garboard was fastened and secured in position the first (**B**), second (**C**) and third (**D**) strakes were offered up and fastened in place. This planked the bottom of the vessel out to the start of the turn of the bilge amidships, and towards a transitional area in the stern where the hull form turns from being hollow (concave) to full (convex). The end planks of strakes **C** and **D** have extra thickness at their hood ends to accommodate the lands and the chamfer of the hood ends that is required to start to shape the fuller stern. Without the extra thickness the short but deep lands could not be cut and the hood ends would not sit tightly in the stern rabbet.

The strakes in the bow run straight into the stem post with no attempt to fair the lines by adding width to the ends or shape the planks. As such they end just above the tangent of the curve from keel to the rake of the stem post. The run of planks looking aft is concave due to the thin width of the garboard strake at the extremities. The accepted practice is to increase the sided dimension of the garboard at the extremities, thus imparting an upward sweep, so as to give the rest of the strakes a fine run upwards fore and aft.

At this stage the floors of frames two, three and four could be added to ensure the shape and form of the vessel before the rest of the strakes are added. To do so, joggles would be cut and the floors treenailed to the strakes **B, C** and **D.** Only the three midship floors would be treenailed to the planking. It is evident within the joggles that further wood had to be removed to accommodate nail heads. None of the floors are fastened to the keel or garboard. The insertion of the floors at this stage would ensure rigidity to the bottom of the vessel and its shape. It is however not a necessity.

Strake **D** represents the start of the turn of the bilge. The midship plank is, compared to the previous midship planks, relatively narrow and shaped. It has both inboard and outboard lands giving it a lozenge shaped cross section. The plank itself is banana shaped. Despite their extra thickness the aft most planks on either side have been twisted and bent to form the required shape for the bluff stern. Strake **D** varies from the previous strakes due to its shape and because it has a long plank amidship and two shorter planks at the extremities.

A transitional plank has been recognised on a number of other vessels, most notably the fifth strake on the mid thirteenth century Magor Pill boat, Gwent (Nayling, 1998:147 & 149). These planks are at the transition from the bottom of the vessel to the sides. They are recognised as being unusually heavy compared to the rest of the strakes, having a bulging cross-section, as seen in **D**. The bulge is due to the extra thickness required to accommodate the acute angle of the land in this area. McGrail notes this type of heavy strake in the Dublin timbers and identifies them as a form of *meginhufr* (McGrail, 1993:43) or transitional plank. The same thick strake is noted in the Magor Pill boat and other clinker vessels. This strake is the start of the turn of the bilge from the floor out. The extra thickness is to accommodate the greater angle of the land in this area whilst still maintaining the same average width.

Phase three

Once the strakes have been built to the start of the turn of bilge, strakes four (**E**), five (**F**), six (**G**) and seven (**H**) are added. These strakes form the turn of the bilge amidship from **E** to above the water line; the transition into a full and very bluff stern aft, and a fuller though still sharp bow forward. In all respects this completes the main part of the vessel. Strake **E** had not been fastened to any of the floors or side timbers. It is a relatively wide strake with wide lands. The ability to fashion steep lands is imperative in the ability of the boat builder to shape the turn of the bilge.

It is at strakes **G** and **H**, that the beams are added to frames one, three and five. The beams add considerable constructional strength to the vessel. This was enhanced by the addition of a stringer on either side which tied all the frames together. Frames one and five, natural crooks (with extra timbers added where the natural crook did not suffice), along with the side timbers of frames two, three and four could also be fastened in place.

Phase four

From the garboard strake, to strake **H** represents the main part of the vessel as far as the hull form is concerned. Amidship the last three strakes, still clinker, were fastened together almost slab sided. The outboard face of the lodging knee of frame three, which forms a side timber in this area, is bevelled and not joggled. A single treenail fastens these three strakes to the knee. The top of the lodging knees at frames one and five are missing. A single joggle evident on the knee of frame five is not necessarily evidence for joggles on the knees. The joggle has been sawn and is more reminiscent of a rebate, rather than a joggle.

To add further structural strength to the hull an inwale was treenailed to the top of the sheer strake. It was a composite piece, scarfed and nailed at its joints with a rebate for the top of each frame, though not fastened to each frame. Evidence for a form of stern hook is visible on the stern post where there is a rebate cut into the inboard face of the stern post to accept the stern hook. The remains of the stern hook sit comfortably in this rebate. There is no evidence for a breast hook. The ends of each inwale are feathered to a point. This would suggest they were butted and fastened to the stem post.

To complete the vessel, sheets were added at the stern and stem beams, forming a shelf at either end. The sheets were fastened with nails at each end, one end being fastened into the beam and the other into the strake it rested on. Further fittings could include floor boards and thwarts of a type common in the Northern and Western Isles. These due to their loose nature would not be expected to survive the sinking of the vessel or its abandonment. They would have either floated free or been easily salvaged for other uses.

It is of interest to note that the Conway and Menai Ferries of the Middle Ages utilised "Hirdles/Hirdels" in the bottom of the boats to stop damage when carrying horses (Davies, 1942:41). Hurdles recovered from below the iron ore cargo of the Magor Pill boat can also be interpreted as a form of ceiling. Ceiling planking was also found in the same context. Such protection would not be expected to survive but is of interest as being a different form of technology. When considering the type of technology used in boat construction in North Wales the utilisation of wattle is not surprising. Wattle is recorded as being used for the partitions inside houses and the description of the roofs of some houses could suggest its use there as well (Williams, 1982:97). Though considered as a rudimentary form of construction, wattling is a very versatile form of construction. Until recently wattle was still used as part of the fish weirs along the Menai Straits, the remains of which can still be seen at Aber Ogwen (P*ers., Observation*).

Wear and Repair

The vessel shows considerable wear and tear and evidence for repairs. The most obvious aspect of wear and tear is the loss of timber at the stem to keel scarf and the patch (tingle) along the seam between the garboard and strake **B**. Similar tingles have been found on Skuldelev 2 (Olsen and Crumlin-Pedersen, 1967:162) and the Magor Pill boat (Nayling, 1998:94). Evidence from the garboards and plank **D** would suggest that these have been opened and re-nailed at sometime in the life of the vessel.

There is an estimated 50mm of wood lost due to wear at the stem to keel scarf due to the grounding/beaching of the bow during loading and off loading. This has meant the almost complete loss of the foremost treenail hole and the top of the aft most treenail hole. The scarf has been re-fastened with four 9 by 8mm nails. The top two nails in the garboard rebate have been counter sunk so as not to affect the garboard. No such care has been taken of the bottom nails. To access the scarf the garboard would have had to have been removed. The removal and re-fastening of the garboard is evident from the extra nail shanks in the keel and the bottom of the stem and stern posts, as well as the extra holes in the garboard planking which have no nails evident within them. The nails were driven through new bits of the garboard, not the old holes.

Other planks have also been re-fastened. Of these port side **D2** is the most obvious. Out of the 24 visible nail holes in the lower land only nine were used to fasten the lower edge to strake **C**, and nine out of 27 in the upper edge. The used nail holes are identified by the staining from roves and in some cases have the remains of the nail shanks still *in situ*, a feature seen in some of the Dublin planking (McGrail, 1993:56) A number of the nail holes have been plugged with wooden plugs, which were originally square. Opening up a seam and re-fastening it after applying some form of stopping into the seam is a common occurrence on leaking clinker built vessels.

D1, **C1**,**C3** and **C4** port side, and **D2**, **E4**, **G3**, and **H1**, starboard side, also show evidence for re-fastening. The dendrochronological analysis verified that the timbers were all contemporary and not re-used from another older boat. Indeed timbers used in the bottom of the boat, port **A4** and **B3** can be considered to be from the same parent tree, *t*-value just less than 10; whilst those from the top of the boat, port **F2**, **J4** and **K2** as well as starboard **K5** have all been split from the same parent tree, *t*-value higher than 10 (Nayling, 1999a:4). These two parent trees have contemporary felling dates, and therefore the use of the wood derived from them in the Llyn Peris Boat can also be considered contemporary.

The question as to where the Llyn Peris boat was built must arise. The high free board and heavy scantlings would suggest a boat more used to an open water environment. The possibility exists that she is of a type that would have been common along the shores of the Menai Straits and coast of North West Wales. This does not mean that she was not built along the shores of Llyn Peris or Llyn Padarn. To build a boat this size needs very little infrastructure. A clear area where temporary stocks and shores could be erected would be all that was required. It would be more efficient to bring a boat builder to Llanberis than to carry a whole boat or even a dismantled one to Llanberis. The raw materials would have been available on site and boat building expertise was available at Caernarvon.

Boat Building Tradition

The construction method evident in the planking of the Llyn Peris boat has strong parallels to that considered as a Nordic/Scandinavian tradition. The use of shell first clinker construction, clenched and roved nails, internal thwarts with lodging knees, the use of treenails to fasten the framing to the planking, the fact that neither frames nor floors were fastened to the keel and the addition of comparatively thick transitional strake (**D**), compares well to the construction of vessels built in the Scandinavian tradition. Strong comparisons between the individual timbers from Llyn Peris and those found during excavations in Dublin, and considered to be Scandinavian in origin, as well as comparisons to the general features of other Scandinavian vessels supports this.

However, to form a morphology of vessels based around the specifics of a construction technique that can be considered not to be uniquely diagnostic could be flawed from the first instance. Clinker construction by the mid sixteenth century should be viewed as a ubiquitous form of construction in North West Europe which would encompass the British Isles. "Lap - Strake" construction as defined by Chapelle

> "is the favourite method of planking boats that must be very light and strong, or that must carry heavy loads in shallow, very rough water".

and that it

> "is much easier to use in some hull forms than in others; those having fairly straight keels are the most satisfactory." (Chapelle, 1969:441)

Though Chapelle is referring to modern boats, his thoughts suggest that clinker construction need not have been the preserve of the Vikings. It is increasingly recognised that there are derivatives of the standard Nordic clinker construction (Smylie, 1998:10). Medieval derivatives of the standard Nordic vessel could be considered as developments of the earlier Nordic form incorporating new technology and features from elsewhere.

The Kalmar boat, a 13th century vessel found in Sweden, is such a vessel. This vessel generally appears to be Nordic in construction with a straight stern post to hang a rudder and the unusual feature of cross beams that protrude through the side of the vessel (Bass, 1974:194-3). This last feature was possibly borrowed from the Cog to help strengthen and protect the sides. The same can be seen in the Kyholm ship, 11th -13th century, found near Samso in Denmark (Crumlin-Pedersen *et. al.,* 1980) and the so called "Copper Wreck", Gdansk, Poland (Litwin, 1980).

A clinker built vessel from a later period which shows a similar though developed form as the Kyholm and Gdansk boats is the Aber Wrac'h wreck. This vessel found off the north coast of Brittany, France has been dated to the first half of the 15th century. The vessel had a remaining length of 25m and a maximum beam of 8m. L'Hour describes the vessel as having a "rather sharp" bottom and a general section that "presents a hard bilge and straight sides" (L'Hour & Veyrat, 1994:178). Inspection of the cross section suggests a vessel with hard bilges and relatively flat floors (L'Hour & Veyrat, 1989:291). The rather sharp bottom can be seen as an overall development of the hull shape of a large sailing ship. The sharpness is contained within the first two or three strakes up from the keel. This would provide the necessary, and desirable, lateral resistance for sailing, it can be combined with any configuration of floor (McKee, 1983:81). The shape of the framing timbers at the turn of the bilge is reminiscent of the Llyn Peris boats. A floor with angled side timber fastened on top of it, is apart from size, virtually identical. The Magor Pill boat has the same form of framing with the same shape of side timber. It is "well-shaped with a flat floor and firm bilges to give good stability and load-carrying" (Nayling, 1998:139).

The Llyn Peris Boat would appear to have some direct affinities to other vessels constructed in a broad interpretation of the Nordic clinker boat building tradition. It is not outside the bounds of probability that the Llyn Peris boat represents a derivative of the standard form of Nordic/Scandinavian clinker construction. The possible survival of a developed form of clinker construction in a mountain location could be considered as surprising. The Llyn Peris boat can be regarded as over engineered for its local environment. Its overall size, extra freeboard, beam, and heavy scantlings of the framing would suggest a vessel designed to go to sea and not operate in the relatively benign conditions expected of Llyn Padarn and Llyn Peris. It must be queried as to where the form of construction seen in the Llyn Peris boat came from. One does not have to look far to be able to shed light on the question and give a plausible reason for its form of construction.

Caernarvon, Aber Ogwen, Bangor and Beaumaris were all busy ports at the time the Llyn Peris boat was built. Not only did they service an export trade in slate but also general mercantile trade and fisheries (Matheson, 1929:23). The Menai Straits, as they are today, would have abounded with small craft. Of specific interest are the Menai Straits Ferries .

The ferries might have been manned by local men, often given a farm near by to subsidise their income, but they appear in the early days to have been built by the crown or one of its officials. Whether or not these ferries were built to a local style cannot be discerned. It is possible that they were built by local carpenters to the general form of vessel required. The ferry at Beaumaris was considered to be so old and broken that it could not be used; however the local people did not build a new boat. The King's representative was to have a new boat built for them at the King's expense (Davies, 1942:28). Thus the new boat could have been built to a specific design which was not wholly of a local form. It is however likely that the "ferries", were built by local men possibly to a general design requirement, but paid for by the crown.

Very little can be found about the actual form of vessel built. A cursory description, in1685, of them as "little round sea boats" that would not hold "above three horses at a time", is the most detailed description of a ferry (Davies, 1942:188). It is possible to consider the Llyn Peris boat as a "little round sea boat", she is beamy with a rounded stern, but this would ignore the finer lines forward. To someone used to a Thames Wherry the vessel would certainly be considered as a rounded sea boat. It is of interest that many sea boats of this period are drawn as little round sea boats. These are small rowing boats as seen in Volpe's painting of Henry VIII's embarkation for the Field of the Cloth of Gold, 1520, and the boats towed at the stern of the larger warships in the Anthony Roll, 1546 (Rule, 1982:20,21,26,&39). Their shape as drawn has often been considered not to be representative due to the rounded sterns. The stern and overall shape of the Llyn Peris boat confirms the credibility of this form of vessel.

Cursory information from various periods makes interesting reading in light of the Llyn Peris Boat. In 1302 the Llanfaes ferry was overhauled. Apart from ropes, oars and several planks, a quantity of "nails of spiking" (3d per 100), "Roff nails", tallow and pitch (for smearing the boat) were also bought. This compares well to the Porthaethwy vessel of 1339 where the Sheriff was required to find half of the costs of the expenditure on the vessel. This was 20s for the boat (40s being the total), pitch and tallow 3s 4d, planks and other timbers 2s 2d, in ropes 2s 2d, oars at 14d, iron nails at 8d and "hirdles for under the feet of the animals 14d". All to a grand total of 26 shillings making the cost of buying, fitting out and repairing of the vessel cost a total of 52 shillings (Davies, 1942:41).

In the early fourteenth century the cost of oars appears to be 2d each. Small nails are bought at 1d per 100, whilst the "Rosnails" more commonly used in boat building cost 10d per 100 and larger spikes at 16d per 100. The cost of a carpenter could be between 3 and 4d a day whilst 2s 6d was given to two carpenters for keeping a ferry in repair in 1320. By 1705 the cost of a ferry has gone up to £7 2s 9d., this price include two ropes and two anchors. It is interesting to note that nails with "ruffes" or roves are still used, alongside a number of bolts in 1718 (Davies, 1942:120). The details listed above are enlightening but not as detailed as would be wished for. Nor do they deal with the mid sixteenth century.

Documentation from the late seventeenth century "Wood accounts of the Gwydir estate" is the only other source to come to light that details the actual building of a 6 to 7 ton vessel (if this is displacement then it is twice the size of the Llyn Peris boat). The timber is sawn in the March of 1685, 589 feet of ½ inch boards and 1 inch timber. The boards of oak are heated to bend them to shape and oakum, 10 lbs in total, is used presumably as a form of luting or caulking (Williams, 1980:9). Tar and pitch is used to seal the outside of the vessel. The local blacksmith commissioned to make the nails, "clenchers" (roves), spikes and rudder irons. The total expenditure for the building of the vessel, including labour, food, ale and launching came to £7 11s 3d. The Llyn Peris boat can be considered to be a 3 tonne vessel and therefore half the size of the boat discussed above, its costs could be expected to be in the region of £3 to £4.

Hull form

The Llyn Peris boat is a clinker built boat 6.32m length overall. The keel is straight, level and flanged with no defined rocker or rebate, whilst the sheer line sweeps upwards gently forward and aft from midships. Both stem and stern are straight though the stern is near plumb and the bow is raked forward. The bow is relatively sharp ended whilst the stern is bluff and semi-circular in the horizontal plane above the waterline but sharp below it. The midship section is moderately flat and straight to the turn of the bilge despite having an average deadrise at the garboard of 30 degrees. The bilge is quite hard as it turns up into the flat vertical sides. The boat is bordering on the side of being beamy and shallow.

The Llyn Peris boat's hull form fulfills a number of the attributes defined by Chapelle for a vessel clinker built out of oak; that is full ended, narrow and with numerous strakes, a mid section with flat floors, great mid section beam and relatively hard bilges (Chapelle, 1969:442). The overall shape of the boat is not significantly different in its general appearance from clinker built boats throughout the British Isles. The one area in which it does differ from the majority of clinker boats is the stern.

The stern is semi-circular in horizontal plan at the sheer and wine glass in section. This is a feature that is seen in the skiffs of the west coast of Scotland (Mckee, 1983:65) It offers a large amount of reserve buoyancy and space aft. The shape does impart certain problems when securing the ends of the planking. This is elevated when a stern hook (stammering), is used as seen in the Llyn Peris boat. The near vertical stern post is also a function of the stern's form. The Llyn Peris boat can be considered a small boat using McGrail's criteria (1993:21)

Hull Analysis (Appendix 2.b)

The nature of the archaeological find must also be considered. The Llyn Peris boat is sound of wood but not of shape. Obvious damage, shrinkage and distortions due to drying must be taken into account when reconstructing the hull shape. The overall shape of the Llyn Peris can be reconstructed with confidence as the central structure has remained virtually whole as has the midship section. Thankfully the whole of the stern remains and most of the bow along the port side (see fig. 3.20).

A quarter scale, 1/64 volume, oak model of the Llyn Peris boat has been constructed by the author with the assistance of Pete Murphy as part of the Llyn Peris Boat Reconstruction Project. This was based on 1/4 scale replica planks fastened to the same scale keel and stem and stern. Off sets were taken from the model then scaled up to 1:1. The offsets were then loaded into *Hull Form,* a hull dynamics computer program used to analysis the performance of the hull. Errors could be expected but a number of standard measurements, lengths, breadth of the midship thwart at the height given by its knee and the overall length of the inwales in set areas, were used as check measurements (Fig. 3.11). An error of 1% due to the transfer of measurements between the model, body plan and *Hull Form* off sets can be expected. The fact that the vessel was hand built means this error is negligible.

Displacement volume

This is the volume of water displaced by the immersed hull of the Llyn Peris boat. It is otherwise known as the vessel's displacement and is standardised at the point when the water line is 75% of the total depth of the same vessel amidship. It is an indicator of relative size and load carrying potential of the vessel. The Llyn Peris boat has a displacement of 4.4 tonne at a draft of 75% of her midship section, 0.640m (Appendix 2b.3). The displacement volume is therefore 4.4 cubic metres. The draught is 0.640m with a midship freeboard of 0.220m. This means that at a displacement of 4.4 tonnes the Llyn Peris boat will only need a depth of water of 0.7m, not to great when considering the depth of both Llyn Peris and Llyn Padarn. The displacement/draft graph (Appendix 4b.4) can tell use the specific draft of the vessel at a given displacement. Thus at 3 tonnes the vessel has a draft just greater than 0.5m (Appendix 2b.4).

Beam/depth coefficient (B/D)

This is a definition of the general volume of the boat. The Llyn Peris boat has a **B/D** of 2.8279 (2.432/0.86m). This means the Llyn Peris boat is tending on the shallow side of normal. Boats with a **B/D** lower then 2 are considered to be deep, or volume dominated; whilst those with a **B/D** over 3 are shallow.

Slenderness coefficient (Cs)

The length to breadth ratio (L/B) as discussed by McKee (1983:79,81). It is a definition of the overall narrowness of the boat. The Llyn Peris boat has a **Cs** of 2.618 using the overall length and maximum recorded beam, 6.368 and 2.432m respectively. The **Cs** increases slightly when using the waterline length and beam at its given displacement to 2.694 (Appendix 2b.3). A **Cs** of 2.618 or 2.694 defines the boat as beamy after Mckee, when rounded to one decimal place. This can be interpreted as a requirement for what would be a load carrier; i.e, the beam would give sufficient stability to the vessel and a greater displacement for a set length or draft.

Midship section coefficient (CMS)

The ratio of the midship section area to the area of a rectangle whose sides are equal to maximum breadth and draught. The Llyn Peris boat has a **CMS** of 0.737 (Appendix 2b.3) for its given displacement. This indicates that the vessel is relatively full in the midship area. A low value, less than 0.85, is indicative of good speed potential.

Prismatic Coefficient (CP)

The **CP** is the ratio of the immersed volume of the area of the midship section multiplied by the waterline length. The **CP** for the Llyn Peris boat at its given displacement is 0.642 (Appendix 2b.3). This puts the vessel in the region of a fast passenger ship on the GLHS variation of form. It also means the hull form is not full fore and aft, but fine.

Block coefficient (CB)

This is the ratio of the immersed volume of the hull to that of a rectangular block whose sides are equal to the extreme breadth, the mean draught and the length of the hull. The **CB** for the Llyn Peris boat at its given displacement is 0.473 (Appendix 2b.3). This indicates that the vessel has relatively fine lines. It is generally accepted that a low value **CB,** less than 0.65, indicates good speed potential. The **CB** is less than that considered by the Great Lakes Historic ships research project a factor that will be discussed in the general conclusion.

Coefficient of Fineness of Waterplane (CW)

This is the ratio between the area of the water plane and a rectangle formed by the waterline length and maximum breadth. A figure of 0.7 or less indicates a fine vessel whilst one of 0.9 indicates a slab sided vessel. The Llyn Peris boat has a **CW** of 0.724 (Appendix 2b.3) at its given displacement. Again this would define the Llyn Peris boat as a fast passenger boat on the GLHS variation of form. The CW of most pre-modern vessels is low compared to a modern day equivalent (McGrail, 1998:197). This is due to the nature and restrictions of the method, material and level of technology used in the construction of such vessels.

Speed potential

When placed into the Hull Form program at a light displacement of 2.5 tonne the Llyn Peris Boat can easily be rowed at 3 kno5ts with out creating too much drag (Appendix 2b.7). The steepness of the Drag/Speed ratio increases after 3 knots. At three knots only 6 kg of drag is required to be overcome. After this the drag to speed ratio rises exponentially, at 4 knots drag being 17 kg, and at 5 knots it is 45 kg. Thus 3 knots would be an easy speed to attain, with a ton and a half load, at a leisurely row, whilst 5 knots could be achieved by two rowers exerting a substantial amount of power.

Conclusion

The Llyn Peris boat is a shell built boat confidently dated to between AD1547 and AD1549 by dendrochronology. The vessel shows marked wear along the forward part of the keel, the re-fastening of a number of seams and patching of the bottom of the boat. The vessel was propelled by oars from three possible positions, the midship position appearing to be preferred. Its full midship section and fine under water lines forward and aft would not be a hindrance to propelling the vessel by such means whilst giving it an adequate load carrying ability.

As stated above the construction method evident in the Llyn Peris boat has strong parallels to that considered as a Nordic/Scandinavian tradition. That there is evidence for the influence of Scandinavian boat building traditions within the Llyn Peris boat is not surprising. The subtle influence of the Vikings can be seen throughout North Wales; in the names of off shore islands and place names on land with the most obvious being the Skerries and Anglesey. The Norse influence can be argued to have been purely maritime in nature. The naming of offshore Islands, head lands and inlets would have been pre-requisites to an ability to navigate the North Wales 5shores on a regular basis. As such the adoption of such Norse names illustrates their influence over the local population in matters maritime. This is not to deny the Welsh a maritime tradition, but purely to recognise the mastery of the Norse in sailing and boat building. The Norse influence extended beyond the pure maritime. The Norsemen of the Isle of Man and Dublin also had an economic and political influence in North Wales (Carr, 1995:30).

Despite being associated with the Scandinavian tradition the Llyn Peris boat was not built as a galley or trading vessel but as a day to day work horse. The vessel was evidently used on

Llyn Peris but can be assumed to have been used on Llyn Padarn as well. A draught of 0.514m is shallow enough to be floated loaded through between the two lakes. It was most probably used as a form of ferry; be it ferrying people; taking slates, copper or other commodities, agrarian or industrial, up and down or across the lake. The evidence derived from the planking tells us that the Llyn Peris boat had a long and hard life. She was used until the wear and tear had surpassed the ability to repair the boat without a major rebuild. That there is no evidence for a major rebuild would suggest she was abandoned. The Llyn Peris boat represents a significant find for evidence of boat building and use in North Wales.

The Llyn Peris boat is a very interesting and tantalising find. The nature of its discovery was coincidental as a number of situations conspired to bring the vessel to our attention, with out any one of which it could have been hidden forever. It is to the former CEGB's credit that a highly stressed construction programme allowed a lull in operations, for recovery of the vessel. Unfortunately no professional archaeologist gave up their time to direct the rescue excavation. As such the on site recording has been found lacking in its ability to stand up to inspection. This is not the fault of those involved at the time as they did the best they could with the knowledge they had in very trying conditions. Due to their efforts the vessel is now part of a permanent display in Llanberis.

Chapter Four

The Llyn Padarn Boat

Llyn Padarn Boat

Introduction

The vessel under consideration was found late in 1977 by divers from North Wales Divers Ltd (NWD) of Colwyn Bay during a perimeter survey of Llyn Padarn for the Central Electricity Generating Board (C.E.G.B.). The initial find was a pile of slates neatly stacked on their sides and covered in a fine silt near Llech y Fulfran, Cormorant Rock (NGR SH565 619). It is given as SH 567617 by Illsley (1979.65) however, this would put the boat find to the south of Cormorant Rock and some 920m up the lake and not the 650m as described by divers (Fig.4.1). Upon discovery the fine silt that overlay the slates was cleared for closer inspection of the mound. This revealed a number of partially rotted timbers. Further inspection identified these as the ribs, stem and stern post of a small vessel. Three or four slates were removed for identification at the local quarry museum. They were initially identified as early Moss slates (NWD, 1977:1).

Site Description

The Llyn Padarn boat lay at a mean depth of (30ft) 20m off-shore from the east side of Llyn Padarn and 650m from the northern end. It lay on a slope, roughly 40 degrees from the horizontal, which meant the stern was at (27ft) and the bow at (34ft). She also had a list to starboard of 45 degrees (NWD 1977:1-2). When it sank the boat had driven bow down into the lake bed sediment by up to a foot, spilling slates down the slope of the lake bed (Fig. 4.2).

Initial description of the boat.

The original finders were tasked with a pre-disturbance survey. They noted seven ribs down each side of the boat approximately 30" apart with a cross section of 2 by 1 inch. The bow and stern post were measured as 6 by 4 inches. The overall length of the vessel was 19 feet and she had a recorded beam of 5 feet 10 inches. The divers measured the contour of one side as 24 feet 3 inches (NWD, 1977:2). The divers noted the wrought iron ring at the bow, calling it a towing ring, and that the bow was fashioned from a crook of timber.

The boat was described as being "packed solid with cut slates" that were stacked athwartships in rows. There is no mention as to the number of rows in the boat, but the whole of the midship area is described as being full (NWD, 1977:1). Two sizes of slate were noted (Fig 4.3); the smallest being 16 by 9 inches and the largest 20 by 10.5 inches. These sizes are too big to be moss slates, which were not larger than 12 by 7 inches, but do correspond to Ladies and Countesses respectively (Lindsay 1974:49,63). The larger slates were packed amidships whilst the smaller slates were in the bow and stern.

The boat is described as "double clad", with both inner and outer boards. The interior planking was 12 inches wide whilst the exterior planking was recorded as 6 inches wide (NWD 1977:2). There appears to have been some confusion as to what was hull planking and what was later identified as ceiling planking.

Recovery

The significance of the boat was recognised by Mr R. Keen from the National Museum of Wales who asked for a full *in-situ* survey of the vessel and its cargo (Kemp, 1978). Due to this, and after a meeting with representatives from the National Museum of Wales the cargo of slates was removed prior to an attempt at lifting the vessel. The vessel was lifted from the lake bed on the 2nd January 1979. It was however not until the 4th of January 1979 that the vessel was actually put on a trailer in 12 feet of water and finally at 13:30 recovered to the surface (Fig. 4.4) and transported to the quarry Museum, at Llanberis, by road on the back of the trailer (Kemp, 1978). The lifting operation though a success did cause some minor damage to the external features, such as a possible rudder bar.

The vessel was kept wet by constant spraying until it was placed in a tank. It was then treated with polyethylene glycol. After this treatment it was displayed outside the museum in the fore court. In the 1980s the vessel was moved into the relative shelter of the *Baltic shed* where it is presently on display (Fig. 4.5).

Storage

The Llyn Padarn vessel had deteriorated after sinking. Its post recovery treatment, though initially good, did not inhibit further damage. When the vessel was on display outside it was exposed to the full brunt of the weather. This included a very cold winter and hot summer which undoubtably had an effect on the vessel and is most probably the cause of the warping and shrinkage that is noted. No care was taken to isolate the vessel from the public, which probably accounted for the minor damage noted since its recovery as well as the loss of some of the pieces. This should be born in mind when comparing the reconstruction drawings (Fig. 4.6) and original photos (Fig. 4.4, 4.5a&b). Conditions inside the Baltic shed, though more conducive to the preservation of the vessel, were not so for its recording. A full analysis of the outside midship section of the starboard side was virtually impossible due to the positioning of the vessel along one wall. The fact that the vessel was off the floor on a scaffolding frame allowed the bottom of the vessel, previously never seen before, to be recorded. The placement of the vessel on the scaffolding however did obscure a few of the nail holes. These were located, or their actual existence confirmed, by the use of dental tools to acquire evidence of rust or the position of the ghost holes.

Method of recording

A specific lettering and numbering sequence was used to identify each piece of the vessel. The vessel was recorded whole, by offsets from a centre line strung above the boat, with all parts recorded *in situ*. Everything to the port was denoted with a **Pt** and starboard with an **St.** The first two letters of the name of the part were then used, i.e. **Fr** for frames, **Fl** for floors, **B.Pl** for the bottom planks, **C.Pl** for ceiling planking and **Rb.St.** for rubbing strake. Numbering started from the centerline out, bow to stern, or the bilge up depending upon the piece being recorded.

Catalogue of Hull Timbers

This catalogue does not represent a list of all the timbers found, but is a list of the articulated timbers that make up the Llyn Padarn Boat and still remain in the Baltic Shed. A number of disarticulated timbers of varying sizes were found scattered around the Baltic shed. These have been collected together and are described at the end of the catalogue. The Llyn Padarn boat is still relatively intact. Whilst this is conducive to the overall display of the vessel it is not necessarily helpful to the recording of each individual part. The vessel remains whole and has been drawn as such (Fig. 4.6). Each part has been identified, labelled and given a written description.

Bottom of Hull

The bottom of the Llyn Padarn Boat is made from 7 planks. The Llyn Padarn boat does not have a keel. The centre line plank is noticeably thicker (moulded dimension) than the other bottom planks, though narrower (sided dimension), thus it can be considered a keel plank. There are three planks either side of the keel plank. Each runs the full length of the bottom and is shaped at its extremities fore and aft to fit the chine. The planks are butt joined and are therefore carvel not clinker. There is evidence for luting between the planks.

Keel Plank.

It has an overall length of 5.75m and an average sided dimension amidship of 195mm which increases to 204mm at the bows and 201mm at the stern. There is evidence for a spring in the keel plank i.e., it is curved. The maximum measured moulded dimension along the keel plank is 100mm at the stem post scarf. This decreases to 32 mm amidships then increases again to 40mm at the stern post. The forward and aft ends of the keel plank are shaped to accommodate the stem and stern post, there being a foot 130 mm long and 80mm wide for the sternpost and 130mm long and 100mm wide for the stem post. A 10mm diameter hole is evident 45mm in from the forward end of the keel plank. It is not positioned in the keel plank/stem post seam so cannot act as a stop water. There are no wear marks to suggest that it was used as some form of tying point. Its use is unknown.

Bottom Planks.

Pt.B.Pl.1 is the first bottom plank next to the keel plank. It has an inboard length of 4.384m and outboard length of 3.369m, It has an average sided and moulded dimension of 266mm and 32mm respectively. Each end of the plank is shaped and bevelled to accept the garboard plank.

Pt.B.Pl.2 is the second plank out from the keel plank. It has an inboard length of 3.364m and an outboard length of 2.6m. Its sided and moulded dimensions are 242mm and 32mm respectively. The forward and aft face of the plank are bevelled to take the garboard strake. Both ends have greater shape then PT.B.Pl.1 suggesting it came from nearer the edge of the vessel where the angle of the side becomes less acute with the centerline.

Pt.B.Pl.3 is the outermost bottom plank on the port side. It has an inboard length of 2.591m, and a maximum sided dimension of 162mm at the apex of the curve. The outboard face of the plank takes the curving form of the chine. Its moulded dimension is 32mm.

St.B.Pl.1 has an inboard sided length of 4.362m and outboard sided length of 3.643m, and has an average sided and moulded dimension of 260mm and 32mm respectively.

St.B.Pl.2 has an inboard length of 3.643m and outboard length of 2.669m, with an average moulded and sided dimension of 32mm and 254 mm respectively.

St.B.Pl.3 has an inboard length of 2.66m and an average moulded dimension of 32mm. The outboard face of the plank takes the curving form of the bilge. It has a maximum sided dimension of 154 mm at the apex of the curve.

Stem and stern posts assemblages

The stem and stern posts are made up of three pieces, the actual stem or stern post itself, a deadwood knee and a small apron above the deadwood knee. Both stem and stern post assemblages are scarfed to the keel plank and fastened to it by through bolts. The deadwood knees and aprons are fastened by spikes to the stem or stern post. Both assemblages are raked, the bow being curved and the stern straight.

Stem Post

The stem post is joined to the keel plank by a horizontal scarf which is fastened with square nails. The full length of the stem post survived being 0.91m high. It has a sided dimension of 70mm at the rabbet which tapers to 40mm at the face of the stem post. Its maximum moulded dimension is 140mm. The starboard rebate runs continuously from the bottom of the stem post to within 40mm of the top. The port side rebate is not continuous; there is a step forward, 120mm from the top.

Stem knee

The deadwood knee is made from a natural crook with a length of 0.940m, curved, and 1.004m direct between the two ends. It rises to a height of 56mm on the stem post. It has a maximum sided dimension of 107mm and a maximum moulded dimension of 50mm. There is a 391mm long rebate in the knee for the ceiling plank. Above this both edges of the knee are bevelled. The knee is fastened to the stem post by three drift bolts and to the keel plank by a further two. There is a 20mm step in the knee parallel to the keel plank to take the ceiling planking.

Stem Apron

The apron is short being only 0.37mm long. It has a maximum sided dimension of 115mm metres and a maximum moulded dimension of 55mm. The edges of the apron are chamfered. 70 mm from the top of the apron is a shoulder 18mm wide for the accommodation of the inwale. The apron is fastened to the stern post by two bolts and an eye bolt. The eye is rebated into the stem post by 6 mm and appears on the outboard side of the stem post.

Stern Post

The stern post is not scarfed to the keel plank like the stem post but sits atop the keel plank. It is fastened to the keel plank by two, 6 by 8mm spikes, and one bolt. A stop-water has been positioned 70mm from the end of the keel plank; this being 11mm in diameter and 70mm long. The full length of the stern post survives, being 0.84m high and 0.412m along its foot. It has a maximum moulded and sided dimension of 130mm and 72mm respectively. The sided dimension tapers to 56mm at the aft face. The stern post rebate is continuous, on both port and starboard sides, for the full length of the stern post.

Stern Knee

The stern post knee extends forward of the stern post by 345 mm; and continues up the stern post to a height of 0.67m; giving it a maximum sided curved length of 1.182m. The knee itself has a maximum sided and moulded dimension of 89mm and 110mm respectively. The knee is fastened through the stern post into the keel plank by a clench bolt, which goes through the knee and stern post at an angle coming out underneath the stop water. There are two more spikes with roves which fasten the knee directly to the stern post at a height of 280 and 590mm. A further spike fastens the knee to the keel plank. The knee is bevelled on its inner face to accommodate the strakes.

Stern Apron

The stern post apron has not survived. There is enough evidence to suggest that there would have been one. The apron would have had a maximum length of 0.23m with a maximum moulded and sided dimension of 110mm and 55mm respectively. It was fastened directly to the stern post by one spike at the bottom and indirectly by two spikes at the top. The two spikes at the top are driven in from outboard; this is evident by the way the holes taper inwards. Though they were used to fasten the apron to the stern post, this is most likely a secondary function (see steering). The bottommost of these spikes still remains sticking out of the stern post for a length of 28mm. A horizontal scarf was used to join the stern apron to the stern knee.

Floors

There are eight individual floors of varying lengths and cross section. Though each varies in size this is only by a few millimetres and would be expected due to the use of natural native timbers. They are relatively evenly spaced along the length of the bottom, and are numbered starting from the bow. They are measured to the forward face from the bow. Their lengths are the maximum; this means up to floor six they are measured on their aft most faces, and from floor six onwards their forward face. Measuring the maximum dimension is in keeping with the idea of measuring the scantlings of a timber, which are the maximum dimensions. Each floor is bevelled on its outer faces, the angle of which varies with its position.

Fl.no.1

Floor one is positioned immediately abaft the stem post. It crosses over the keel plank and bottom strakes one and two on both port and starboard. It has a maximum length of 0.95m and a centre line moulded dimension of 62mm and sided of 53mm. Though relatively straight, it does arc slightly towards the bow. The frame is fixed to bottom strake **Pt.B.Pl.1** and **2**, and **St.B.Pl.1** and **2** by spikes driven up from the bottom, and to the keel plank by a 12mm diameter drift bolt. There are two nail holes visible on the upper starboard surface which were used to fix the ceiling planking in place. The floor has two triangular limber holes cut into it. These are each 390mm from the ends of the floor and 20mm high.

Fl.no.2

Floor two is positioned 1.585m from the bow. It crosses over the keel plank and bottom strakes one, two and the end of three on both port and starboard. It has a length of 1.341m and a centre line moulded dimension of 74mm and sided of 55mm. The floor has a a slight curve towards the bow. The frame is fixed to bottom strake **Pt.B.Pl.1** and **2**, and **St.B.Pl.1** and **2** by spikes driven up from the bottom, and to the keel plank by a 12mm diameter drift bolt. There is evidence for eight nail holes on the upper surface which were used to fix the ceiling planking in place, one of which survives whole to a height of 24mm. There are no limber holes evident.

Fl.no.3

Floor three is positioned 2.05m from the bow. It crosses over the keel plank and bottom strakes one, two and three on both port and starboard. It has a length of 1.477m and a centre line with maximum moulded and sided dimensions of 68mm and 50mm respectively. The sides of the floor are relatively straight but taper from the centre line towards the starboard edge. The frame is fixed to **Pt.B.Pl.1, 2** and **3,** as well as **St.B.Pl.1, 2** and **3,** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There is evidence for two nail holes visible on the upper surface which were used to fix the ceiling planking in place. There are two limber holes evident on this floor. They were cut 80mm from the centre line to a height of 20mm.

Fl.no.4

Floor four is positioned 2.55m from the bow. It crosses over the keel plank and bottom strakes one, two and three on both port and starboard. It has a length of 1.59m and average moulded dimension of 68mm and sided of 46mm. Though relatively straight, it does widen slightly from the centre line to the port edge. The frame is fixed to bottom planks **Pt.B.pl.1, 2** and **3** as well as **St.B.pl.2** and **3** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There are no nail holes visible on the upper surface. There are no limber holes evident on this floor.

Fl.no. 5

Floor five is positioned 2.985m from the bow. It has a length of 1.573m and average moulded and sided dimension of 66mm and 50mm respectively. Though relatively straight, there is an evident thickening of the floor towards the port side. The frame is fixed to bottom planks **Pt.B.pl.1, 2** and **3** as well as **St.B.pl.2** and **3** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There are two nail holes visible on the upper surface which were used to fix the ceiling planking in place. Two clenched nails are also visible; these would have been driven up from the outer edge of **Pt.b.Pl.1,** and inner edge of **St.B.Pl.1**. There are two limber holes evident. These are 14mm wide and are 21mm high being triangular in shape.

Fl.no.6

Floor six is positioned 3.43m from the bow. It crosses over the keel plank and bottom strakes one, two and three on both port and starboard. It has a length of 1.69m and a maximum moulded and sided dimension of 70mm and 55mm respectively. Though relatively straight, it does taper from the port side to the starboard side. The frame is fixed to bottom planks **Pt.B.pl.1, 2** and **3** as well as **St.B.pl.2** and **3** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There are three nail holes visible on the upper surface which were used to fix the ceiling planking in place. There is no limber hole evident.

Fl.no.7

Floor seven is positioned 3.895m from the bow. It crosses over the keel plank and bottom strakes one, two and three on both port and starboard. It has a length of 1.452m and an average moulded dimension of 68mm and sided of 57mm. Though relatively straight, it does taper significantly from the port side to the starboard edge. The frame is fixed to bottom planks **Pt.B.pl.1, 2** and **3** as well as **St.B.pl.2** and **3** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There is one nail hole visible on the upper surface which was used to fix the ceiling planking in place. There are two limber holes evident on this floor. These are positioned 18mm wide at the base and 22 mm high, each being triangular in shape..

Fl.no.8

Floor 8 is positioned 4.35m from the bow. It crosses over the keel plank and bottom strakes one and two on both port and starboard. It has a length of 1.2m and a maximum moulded and sided dimension of 53mm and 60mm respectively. Though relatively straight, it does taper from the centre line to the starboard edge. The frame is fixed to bottom planks **Pt.B.pl.1, 2** and **3** as well as **St.B.pl.2** and **3** by spikes driven up from the bottom; and to the keel plank by a 12mm diameter drift bolt. There are seven nail holes visible on the upper surface which were used to fix the ceiling planking in place. There are two limber holes evident on this floor. These are 19mm along the base and 20mm high, both being triangular in shape.

Side Frames

The side frames are made from natural crooks of timber (Fig 4.7). Each side frame varies in length and cross section. There is enough evidence however to suggest that they were of a rough uniform cross section. The frames in the bow and stern are "cant frames" being laid at right angles to the side planking as opposed to the keel. There are seven side frames on the port side and evidence for eight on the starboard side. Each frame is first fastened by a single drift bolt, driven in from the top, at the inboard end. Once the sides had been built up and the boat turned over, then two nails per bottom plank were driven into the frame from below. The nail holes would be pre-drilled and countersunk so the nail heads did not protrude from the bottom planks.

Pt.Fr.no.1

Port frame no.1 is positioned forward of floor no.1. It is butted against the aft part of the stem post and floor no.1. It is a cant frame being at an angle of 40- 45 degrees to the centre line. It has an average sided and moulded dimension of 60 and 65mm respectively. It has an overall length of 0.25m and a remaining height of 0.64m, with a distance between the two points of 0.80m. There are three notches in the frame to accept the clinker planking being 145, 220 and 224mm from the bottom up. It has a remaining height above the last joggle of 115mm and a maximum moulded dimension of 60mm. It is fastened to the keel plank by a single bolt. The nail pattern on the bottom shows it is also fastened to the other planks by spikes.

Pt.Fr.no.2

Port frame no.2 is positioned immediately aft of floor no.1. It is not a cant frame and extends almost to the centerline. It has a maximum sided and moulded dimension of 54 and 50mm respectively, with an overall length of 0.5m, and a remaining height of 0.55m. The distance between the ends is 0.864m. There are three notches in the frame to accept the clinker planking. These are 85, 180 and 220mm long from the bottom up. It has a remaining height above the final joggle of 120mm and a maximum moulded dimension at the top of the frame of 70mm. It is fastened to the keel plank by a single bolt. The nail pattern on the bottom shows it is also fastened to the port side planks by spikes.

Pt.Fr.no.3

Port frame no.3 is positioned centrally between floor two and three 1.8m from the bow. It has been placed slightly off set from ninety degrees to the centre line. It has a maximum sided and moulded dimension of 60mm and 58mm; and an overall length of 0.645m with a remaining height of 0.85m, and a distance between the two ends of 0.975m. There are three notches in the frame to accept the clinker planking. These are 60, 180 and 195mm long from the bottom up. Its remaining height above the final joggle is 130mm with a maximum moulded dimension at the top of 60 mm. The frame is fastened to the keel plank by a single bolt. The nail pattern on the underside of the bottom shows it is also fastened too the other bottom planks by spikes.

Pt.Fr.no.4

Port frame four is positioned immediately aft of floor four. It is not a cant frame and extends over the keel plank to the centre line. It has an average sided and moulded dimension of 60mm and 56mm, has an overall length of 1.75m and a remaining height of 0.47m with a distance between the two ends of 1.08m. There are three notches in the frame to accept the clinker planking. These are 55, 175 and 177mm long from the bottom up. It has a remaining height above the last joggle of 124mm and a maximum moulded dimension at the top of 80mm. It is fastened to the keel plank from inboard by a single spike. The nail pattern on the bottom shows it is fastened to the bottom boards by spikes.

Pt.Fr.no.5

Port frame no.5 is positioned centrally between floor 5 and 6 being 3.21m from the bow. It has been laid at roughly 90 degrees to the centre line. Its average sided and moulded dimensions are 60 and 55mm. The overall length is 0.665m whilst the remaining height is 0.445m and the distance between the ends 0.995m. There are three joggles in the frame to fit the clinker planking. These are 55, 170 and 175mm long from the bottom up. Its remaining height above the last joggle is 110mm with a maximum moulded dimension at the top of 70mm. It is fastened to the keel plank by a single bolt at the inboard end. The frame is also fastened by a series of nails driven through from the bottom to the rest of the bottom planks.

Pt.Fr.no.6

Port frame no.6 is positioned directly aft of floor seven. It has an average sided dimension of 56mm and a moulded dimension of 55mm. It has an overall length of 0.69m and a remaining height of 0.485m, with a distance between the two ends of 1.05m. There are three joggles in the frame to accept the clinker planking; being 75, 167 and 175mm long from the bottom up. It has a remaining height above the last joggle of 100mm and a maximum moulded dimension of 65mm at the top of the frame. The inboard end is fastened to the keel plank by a single bolt. The nail pattern on the bottom shows the frame was also fastened by a series of spikes driven from outboard in.

Pt.Fr.no.7

Port frame no.7 is a cant frame positioned between floor no.8 and the end of the stern knee, 4.5m from the bow. It has an average sided dimension of 54mm and a moulded dimension of

57mm, with an overall length of 0.5m and a reconstructed remaining height of 0.66m. It is fastened to the keel plank by a single bolt driven from inboard out and by a series of spikes driven from outboard in. From the vertical remains of the frame there is evidence for four strakes. These are 65, 164, 180 and 113mm from its bottom up consecutively. Parts of the third and fourth strakes are visible. A roved nail is still *in situ* joining strakes three and four together. Four nails protrude from the side frame and were evidently used to fix the other strakes to the frame.

St.Fr.no.1

Starboard frame no.1 is positioned ahead of floor no.1. It is butted against the stem post and floor no.1. It is a cant frame being at an angle of 40 degrees to the centre line. It has an average sided dimension of 55mm, and moulded dimension of 55mm. It has an overall length of 0.19m, and a remaining height of 0.6m, with a distance between the two points of 0.72m. There are three notches in the frame to accept the clinker planking. These are 160, 218 and 205mm long from the bottom up. It has a remaining height of 40mm and a maximum moulded dimension of 70mm. It is fastened to the keel plank by a single bolt. The nail pattern on the underside of the bottom planks show that it was also fastened by a series of spikes.

St.Fr.no.2

Starboard frame no.2 is positioned directly aft of frame no.1 and at a slight acute forward angle. It has an average sided dimension of 45mm and moulded dimension of 60mm. It has an overall length of 0.44m and a remaining height of 0.545m with a distance between the two points of 0.85m. There are three joggles in the frame to accept the clinker planking. These are 85, 205 and 208mm long from the bottom up. The frame extends for a remaining height of 110mm and has a maximum moulded dimension of 60mm . It is fastened to the keel plank by a single bolt. The nail pattern on the bottom shows it is also fastened by a series of spikes.

St.Fr.no.3

Starboard frame no.3 is positioned between floors no.2 and no.3, and is badly degraded. It is 1.942m from the bow. The frame is not a cant frame being virtually at right angles to the centre line. It has an average sided and moulded dimension of 60 and 50mm respectively. It has an overall length of 0.62m and a remaining height of 0.35m, with a distance between the two points of 0.86m. There are three notches in the frame to accept clinker planking. These are 65, 205 and 190mm long. The remaining height of the frame is 130mm with a maximum sided dimension of 45mm at the top. The side frame was initially fastened in place by a single bolt through its end and the keel plank, before a series of spikes were driven in from outboard when the boat was overturned.

St.Fr.no.4

Starboard frame no.4 is positioned between floor no.3 and 4. It is 2.325m from the bow and is badly degraded. It has an average sided and moulded dimension of 50 and 55mm respectively, with an overall length of 0.47m. It has a remaining height of 0.31m. There are only two of the usual three joggles evident for clinker planking, these being 95 and 160mm long each. The first joggle has what appears to be a second smaller joggle evident, though this is actually the corner of the frame that has fallen out. It has a remaining height above the last joggle of 11mm and a maximum moulded dimension at the top of 55mm. It was initially fastened by a single bolt to the keel plank, then by a series of spikes driven in from outboard when the boat was turned over.

St.Fr.no.5

Starboard frame no.5 is 2.67m from the bow and is positioned between floor no.4 and 5. It has an average sided and moulded dimension of 60 and 65mm. Its overall length is 0.68m, and its remaining height is 0.185m, with a distance between the two ends of 0.82m. There is one joggle in the frame to accept lowest clinker plank, no.1. This is 70mm long from the bottom up. It has a remaining height of 150mm and a maximum moulded dimension of 50mm at the top. The inboard end of the frame was initially fastened to the keel plank by a single bolt then by a series of spikes driven through from outboard.

St.Fr.no.6

Starboard frame no.6 is 3.245m from the bow and is positioned between floor no.5 and 6. It has an average sided and moulded dimension of 56 and 60mm. It has an overall length of 0.7m and a remaining height of 0.12m, with a distance between the two ends of 0.8m. There is a single joggle in the frame to accept the lowest clinker planking. This is 75mm from the bottom. It has a remaining height of 85mm and a maximum moulded dimension of 55mm. It is fastened to the keel plank by a single bolt. The nail pattern on the bottom shows it is also fastened to the other keel planks by a series of spikes.

St.Fr.no.7

Starboard frame no.7 did not survive *in situ*. Evidence for it survives in the remains of 3 nails which lie in a line and would place the frame 4m from the bow. A frame was located by the divers, at the time of recovery, whose fastening holes match those of the nail patterns in this area. This frame has a maximum sided dimension of 56mm, and moulded dimension of 48mm. It has an overall length of 0.58m and a remaining height of 0.47m with a distance between the two ends of 1m. There are three joggles in the frame to accept the clinker planking being 90, 160 and 198mm long from the bottom up. It has a remaining height of 65mm above the last joggle and a maximum moulded dimension of 45mm at the top. It is fastened to the keel plank by a single bolt and to the other bottom planks by a series of spikes driven in from outboard.

St.Fr.no.8

Starboard frame no.8 is not attached. It has been identified from a number of loose timbers lying around the boat. It is positioned between port frames no.7 and the end of the stern knee, 5m from the bow. It is not a cant frame unlike its port counter part but would appear to butt against the frame. It has an average moulded and sided dimension of 50 and 67mm. It has an overall length of 0.43m and a remaining height of 0.23m, with a distance between the two points of 0.6m. There is evidence for a single joggle in the frame to accept the clinker planking, which is 85mm high. It has a remaining height of 20mm and a maximum moulded dimension of 30mm. It is fastened to the keel plank by a single bolt. The frame is also fastened by a series of spikes driven in from outboard.

Planking

There is evidence for four strakes on both the port and starboard side of the vessel. On the port side four planks of the three lowest strakes survive. Parts of the fourth are evident on the inwale. On the starboard side only the forward part of three of the planks survives. The bottom strake survives for virtually its full length. The chine plank is shaped so as its top edge follows the eventual shape of the sheer. This means it has a greater moulded dimension fore and aft. The remaining three strakes have top and bottom edges that are relatively parallel.

Pt.Pl.no.1

Plank no.1 has a width of 300mm at the bow which reduces to 100mm amidships. It has a thickness of 20mm with a land 16mm moulded and 30mm sided. Its surviving length is 3.97m. The top edge shows no sign of secondary working. The bottom edge however has been shaped flush with the bottom. There is an evident end rebate on the upper edge which starts 370mm from the stem post. It is fastened with clenched and roved nails to other strakes, and by nails to the frames.

Pt.Pl.no.2

Plank two is the forward end of the second strake with a width of 345mm at the bow which reduces to 212mm at the midships. It has a thickness of 20mm. Its full length survives being 2.196m long. Its top edge shows no sign of secondary working though it does have a land 30mm sided and 16mm moulded dimension. There is an evident end rebate which starts 460mm from the stem post. It is fastened with clenched roved nails to other strakes, and by nails to the frames.

Pt.Pl.no.3

Plank three is butted against plank two to form strake two. Plank one has an estimated width of 27mm at the bow which reduces to 220mm at the midships. It has a thickness of 20mm, with a land of 16mm moulded and 30mm sided. It has a surviving length of 2.22m. Its top edge shows no sign of secondary working. Not enough of the plank survives to be able to identify a stern end rebate. It is fastened with clenched and roved nails to other strakes, and by nails to the frames.

Pt.Pl.no.4

Plank one has an estimated width of 250mm at the bow which reduces to 224mm at midships. It has a thickness of 20mm, with a land 30mm sided and 16mm moulded. It has a remaining length of 2.78m. Its top edge shows no sign of secondary working. It is fastened with clenched and roved nails to other strakes and by nails to the frames. Not enough of the plank survives to speculate about an end rebate.

St.Pl.no.1

Plank no.1 has a sided dimension at the bow of 340mm which reduces to 120mm at midships. It has a moulded dimension of 20mm, with a land of 16mm moulded and 30mm sided. It has a remaining length of 2.78m. Its top edge shows no sign of secondary working. There is an evident end rebate which starts 370 mm from the stem post. It is fastened with clenched and roved nails to the strake above and by nails to the frames.

St.Pl.no.2

Plank no.2 has a sided dimension of 260mm at the bow which reduces to 250mm by frame two. It has a moulded dimension of 20mm, with a land of 16mm moulded and 30mm sided. It has a remaining length of 1.74m. Its top edge shows no sign of secondary working. It is fastened with clenched and roved nails to other strakes, and by nails to the frames. There is an evident end rebate which starts 450mm from the stem post.

St.Pl.no.3

Plank no.3 has a sided dimension of 250mm at the bow which reduces to 248mm by frame two. It has a maximum moulded dimension of 20mm, with a 30mm sided and 16mm moulded land. It has a remaining length of 1.45m. Its top edge shows no sign of secondary working. There is an end rebate for strake four which starts 240 mm from the stem post. The plank is fastened with clenched and roved nails to the strakes above and below, and by nails to the frames.

St.Pl.no.4

Starboard plank no.4 does not survive. Evidence for its existence comes from the stem post rebate and the end rebate on starboard plank three. It has an estimated sided dimension of 220mm, and a moulded dimension of 20mm at the bow. It was fastened by clenched and roved nails to strake no.3, and by blind nails to the inwale and the top of the frames.

Stringer

There is evidence that the vessel had an inside stringer attached to the frames. A piece of wood found by the divers corresponds to the forward port section of the stringer (Fig. 4.8). Further evidence for the use of a stringer comes from the nail holes and stringer impressions on the inside of the frames. It is assumed that the stringer is made from three pieces of wood nailed to the frame with the midship section nailed below the forward and aft sections.

Pt.String.no.1

Port stringer no.1 is 1.8m long and has a maximum sided dimension of 100mm at the forward end which tapers to 70mm at the aft end. It has a maximum moulded dimension of 22mm at the forward end, thinning to 15mm at the aft end. It is butted against the stem post with a slight bevel to the face to make a flush joint. Pairs of nails, 4 by 4mm, fasten the stringer to the frames. The nail holes are 550 and 655mm apart. This corresponds to the framing distances on the forward port side of the boat.

Pt.String.no.2

Though port side stringer no.1 is the only actual piece of the stringer remaining, there is evidence that it would have continued along the inside of the boat to the stern where it terminated, butted against the stern post. On frame three below the position of the stringer is a group of 4 by 4mm nail holes. These continue to appear on the inside faces of the frames from frame three, back. They appear 350 to 370mm above the bottom boards and between 45 and 55mm apart.

Starboard Stringer

The starboard stringer has not survived but evidence for it does in the form of 4mm square holes positioned between 45 and 60mm apart on the inside faces of the starboard side framing. In the bow they correspond to the same height as the port side. Due to the lack of survival of the starboard side frames the midship section cannot be projected. However, the survival of frame seven allows us to project the height at the stern which corresponds to the aft part of the port side stringer. It would be reasonable to assume that the starboard stringer was also made of three pieces as is the port side.

Inwale

The inwale survives in a number of pieces. The best preserved comes from the forward port side. A further two pieces, each in different stages of disintegration, make up the port side inwale. Further bits which can be identified as parts of the inwale, but cannot necessarily be positioned accurately within the vessel, are parts of the starboard inwale. The reconstructed inwale extends from the stem post to the stern post in three separate pieces, forward, midship and aft sections, that are scarfed and fastened together. The inwale is fastened to the sheer plank by nails, and is notched to accept the tops of the frames. There are two vertical wooden pins evident in the forward and aft sections of the inwale. These are identified as bits or belaying pins used to tie up the boat. An oar lock is evident in the midship section of the inwale.

Pt.Inwale.no.1

Port inwale no.1 has a maximum length of 2.31m. It has a maximum moulded and sided dimension of 54 and 42mm at its forward end. This tapers to an average moulded and sided dimension of 50 and 42mm respectively. Its forward edge is bevelled to butt against the stem post neatly. The aft part ends in a vertical scarf joint and is fastened with two nails. On the bottom surface are three sloping rebates to accept the tops of the frames. These are 0.58, 1.3 and 1.92m from the forward end. On the upper surface there are three circular holes 25 mm in diameter, two of which penetrate all the way through the inwale. These two are 0.91 and 1.71m from the forward end of the inwale. The third is 14mm deep and has been drilled just in front of hole no.1. It appears to have been the initial place for hole no.1 but is positioned over a nail and thus could not be drilled all the way through. The remains of a 94mm long pin are still *in situ* in hole no.1.

Pt.Inwale.no.2

Port inwale no.2 has a length of 1.75m and a maximum moulded and sided dimensions of 65mm and 44mm respectively amidship. This tapers down to an average moulded and sided dimension of 55 and 40mm respectively. The forward edge has a 204mm long vertical splayed scarf with a single nail fastening evident in it. The aft end appears to represent an horizontal scarf but is actually a break. There are 11 nail holes, between 65 and 170mm apart, evident along the outboard face. Two chamfered rebates, 65mm wide at their tops, are positioned to accept frames 4 and 5.

Evident on the upper surface of the inwale are the remains of an oarlock. It is made up of two separate tholes. There is evidence for an iron bar, at least 60mm long (roughly 2 feet), between the bottom of the thole and the inwale. It is fastened down by two nails at either end. The inwale obviously thickens in this area by 10 mm. Immediately forward of and 500mm aft of the oar locks are single rebates, 55 mm wide and 9 mm deep. They are both suspected to have accepted hanging knees for thwarts. Aft of the oar lock , 160mm, and along the outboard edge is a 20mm diameter hole which has no discernible function. It is plausible that it formed a thole pin, a bit, or is a mistake.

Pt.inwale.no.2.

It has a remaining length of 1.88m, and a sided and maximum moulded dimension of 35 and 52mm respectively. On its underside there are two sloping open rebates that fit the position of frames six and seven on the port side. As on **Pt.inwale.no.1** there are two holes 25mm in diameters. These are 0.27 and 1.17m from the forward end of the inwale. The aft most hole still has the remains of a wooden pin *in situ.* This has a cylindrical shaped pin at the bottom and a squarer shaped point at the top, being 30mm moulded and 24 mm sided with a height of 100 mm. Both ends are badly degraded and the original shape of the top can not be discerned.

St.inwale.no.1

Starboard inwale no.1 is badly degraded but identifiable as part of the starboard inwale. It cannot however be positioned on the boat. It has a maximum remaining length of 0.93m, with a maximum sided and moulded dimension of 20 and 45mm respectively. Evident on the outer face are nine nail holes. These are 5mm by 7mm and appear in pairs. They were used to fasten the inwale to the inside of the sheer plank. There are no other discernible constructional features.

St.inwale.no.2

Starboard inwale no.2 is badly degraded and cannot be positioned in the boat. It has a maximum remaining length of 0.385m with a maximum sided and moulded dimension of 35 and 58mm respectively. Evident on the outer face are five nail holes. These are 5mm by 6mm and appear in pairs. A single nail hole evident on the inner face, adjacent to a set of nail holes on the outer face, would suggest the fastening of an internal feature. Due to this and because the angle at which the nails have been driven in is more acute then those in **St.inwale.no.1** it is considered to come from either the forward or aft part of the vessel. There are no further constructional features.

St.inwale.no.3 and 4

These pieces of wood are very badly degraded, but identifiable as part of the starboard inwale and were at one point joined to each other, hence describing both at the same time. They have a maximum combined remaining length of 0.284m, with a maximum sided and moulded dimension of 37 and 20mm respectively. There are no fastening holes evident on either of the pieces, but on piece no.4 there is evidence for what could be an underside open rebate for the top of a frame. This is 40mm wide with a remaining depth of 5mm. Despite this they cannot be positioned directly on the boat.

Stem post breast hook.

The breast hook in sequence of construction is added after the inwale. The stem post breast hook is badly deteriorated. It is "v" shaped to fit into the bow and is fastened to the stem post apron by a single spike, 11mm by 8mm. This was driven from the inside out. Two nails were used on either arm to fix it to the inwale. Each arm of the breast hook was fastened to the inwale and sheer strake by clenched and roved nails driven in from outboard. The length of the port side arm measures 260 mm, whilst the starboard arm is 210 mm long. The distance between the two ends of the arms is 355 mm. The face which butts against the stem post apron is 110 mm wide. The whole piece has a maximum sided dimension of 46 mm.

Stern post transom knee

The transom knee in sequence of construction would have been added after the inwale. The knee has deteriorated along its port side whilst the starboard side has remained largely intact. It is "v", shaped with the port arm being 181mm long and the starboard arm 257mm on the outboard faces. No fastenings are evident on the port side though there are two nail holes evident on the starboard side. These are 7 by 5 mm nail holes and show evidence of roves on their inboard faces, again suggesting fastening from the outside in. There is a central spike 8 by 11mm which fastened it to the stern post through the stern post apron. The piece has a maximum sided dimension of 38mm.

Bow Thwart

A piece of wood which was recovered by divers can be identified as a forward thwart. It has a forward face length of 451mm and an aft face length of 606mm. It has a maximum sided and moulded dimension of 117 and 38mm respectively. Along either side of its upper surface a line has been scribed. These are 10 mm in from the edge and are purely decorative. There are two nail holes evident at either end of the thwart. The nails have been driven in at an angle from outboard in. There are matching holes on the third strake of the starboard side.

The edges of the thwart are bevelled so as to lie flat against the strake. This also allows it to wedge itself in and therefore not rely on the nails for vertical support, only lateral support. There is no evidence for a stern thwart.

Ceiling Plank

There is evidence to suggest the entire bottom of the boat was covered in ceiling planking (C.Pl.). Only the port side ceiling planking survives virtually intact and is made from long planks amidship with smaller pieces situated in the bow.

C.Pl.no.1

This is situated in the port side of the bows of the vessel. It has a maximum length of 700mm, sided and moulded dimensions of 145 and 15mm respectively. It is basically lozenge shaped with a square cut out of one face to fit around a frame. This allows the piece to sit flush against the side planking. Its aft most edge is damaged and would extended a further 100mm. This would have allowed it to sit flush against the main ceiling planks.

C.Pl.no.2

This is situated in the forward starboard section of the vessel. It does not actually sit flush against the side of the vessel. It is of a rectangular shape, but with its forward edge sloping aft on the starboard side. It has an over all length of 1.242m; a maximum sided and moulded dimension of 310 and 14mm respectively. There appears to be a step in the aft part of the plank, but this is actually recent damage. A 24mm step has been cut out of the forward starboard edge.

C.Pl.no.3

Ceiling plank no.3 is 1.86m long with a maximum moulded and sided dimension of 15 and 204mm respectively. The plank has a rectangular piece, 445 mm long by 164 mm wide, cut out of its forward starboard side so it can fit between ceiling planks no.2 and no.3.

C.Pl.no.4

Ceiling planking no. 4 is situated to the port side of midships and between frame two and six. It has a remaining length of 2.96m with a sided dimension of 230mm at its forward end which tapers to 315mm aft. It has a maximum moulded dimension of 12mm. Its aft end is damaged and thus the full length of the plank could have been greater.

C.Pl.no.5

Ceiling plank five is butted against four to the port side of it. It has a remaining length of 3.185m, and a sided dimension of 225mm at the forward and 230mm aft. The moulded dimension is 12mm. It is damaged at the stern end and thus could have extended to the side of the vessel as ceiling plank no.6 does.

C.Pl.no.6

Ceiling plank no.6 is butted against ceiling plank no.5 and the side of the vessel. The plank has an overall length of 2.715m with a maximum sided and moulded dimension of 213mm and 12mm respectively. It extends from frame no.2 past frame no.6. It is curved along its outer edge 350mm from the forward face and 335mm from the aft face. Along its outer face are three rebates for frames no.3, 4 and 5. These are 135, 70 and 65mm wide respectively.

C.Pl.no.7

This is really a fillet to fit in between frames no.3 and no.4. It is 680mm long, with a maximum sided dimension of 45mm forward and 105mm aft. Its maximum moulded dimension is 12mm.

C.Pl.no.8

This is also a fillet to fit in between frames no.4 and no.5. It has a maximum length of 540mm, with a sided dimension at the forward end of 105mm and at its aft end of 85mm. The moulded dimension is 12mm.

C.Pl.no.9

This is a fillet that fits in between frames no.5 and no.6. It is 715mm long, with a sided dimension of 95mm at its forward end and 55mm at aft. Its moulded dimension is 12mm.

Rubbing strakes

The boat is equipped with a number of protective features. Rubbing strakes **(Rb.St.)** are evident along the bottom of strakes one and two. The bottom of the boat is protected by skids whilst there is an iron stem strap and evidence for a possible stern strap. These will be discussed in this section.

Pt.chine.Rb.St.no.1

Along the chine at the bilge is a rubbing strake. It is made up of three pieces of wood with the first having a maximum length of 1.395m, sided dimension of 125mm at the bow which reduces to 60mm amidship. Its moulded dimension is 25mm. It is fastened to the garboard strake by 12 nails with nail heads of 8 by 8mm.

Pt.chine.Rb.St.no.2

This is scarfed onto **Pt.chine.Rb.St.no.1** with a vertical scarf. It has a maximum length of 2.25m, with a sided dimension of 41mm and a moulded dimension of 24mm. It ends just aft of frame no.6 in a vertical scarf. It is fastened to the garboard strake by two spikes at its extremities each with a head 11.2 mm by 13.4 mm, and by two 8 by 8mm nails through out its length. The need for less nailing on this piece is most likely due to the less acute curvature in the hull form here.

Pt.chine.Rb.St.no.3

This does not survive but there is evidence for it being in place. The evidence appears in the nail holes along the outside edge of the port side bottom planks. There are no discernible features to give an idea of its over all dimensions though one would expect it to correspond to those of **Pt.chine.Rb.St.no.1.** The exact amount of widening at the end however is not known.

Pt.Rb.St.no.1

This rubbing strake is a single piece of wood and is positioned directly under the bottom edge of **Pt.Pl.no.3.** It has a maximum remaining length of 2.36m with a sided and moulded dimension of 30mm and 34mm respectively. It has evidence for being fastened by four nails throughout its length, though there is a possibility that it extended to **Pt.Fr.no.6** and therefore was fastened by five nails. This would increase its original length.

St.chineRb.St.no.1

Though this has not survived evidence for its existence comes from ghost marks left by it and four nails, which are still *in situ*. These would have been used to fasten it to the bottom of the boat. It has an estimated maximum length of 1.4m with an estimated sided dimension of 125mm at the bow which would reduce to 60mm amidship. Its moulded dimension was probably 25mm.

St.chine.Rb.St.no.2

When originally surveyed the starboard side chine rubbing strake two was shoved under the bottom of the boat. Analysis of its nail pattern showed its original position. It has a remaining maximum length of 2.35m, with a sided dimension of 42mm and a moulded dimension of 25mm. It ends aft of frame no.6 in a vertical scarf. It is fastened to the garboard strake by two spikes at the forward and aft ends, and throughout its length by 8mm square nails.

St.chine.Rb.St.no.3

Though this has not actually survived there are fastening holes evident in the starboard garboard strake as evidence for it being there.

St.Rb.St.no.1

The starboard side rubbing strake is made of iron. It has a maximum remaining length of 1.25m with a sided and moulded dimension of 50 and 25mm respectively. It is fastened to strake no.1 by eight nails. It is undoubtedly a repair to what would have originally been a wooden rubbing strake. Evidence for the original wooden rubbing strake comes from a number of nail fastening holes along the bottom edge of the second strake. This must have been damaged at some stage in the boat's history.

St.Rb.St.no.2

It has a maximum remaining length of 1.272m, and a sided and moulded dimension of 30 and 21mm respectively. It is fastened below strake no.3 by two nails which are positioned in the same area as frames one and two on the starboard side. It undoubtedly extended further aft but is broken and therefore its full length cannot be discerned.

Skids

The bottom of the boat is equipped with a set of skids, one each side. The skids are made from three separate pieces of wood all of which are nailed to the bottom of the boat. The pieces are scarfed together though there are no fastenings in the scarf joint. The ends of the skids are angled in towards bow and stern and keyed in (fitted into rebates). This would help to strengthen the skids, which could otherwise shear off or pull the nails from the bottom of the vessel.

Pt.Skid.no.1

Though this is actually missing there is evidence for its existence. This appears as a rebate for the piece of wood and in the nail holes that would have held it in place. It would have had a maximum length of 0.57metres; sided 51mm, and an estimated thickness of at least 10mm if not 32mm; the same as port side bottom rubbing strake two which it was scarfed to. There are no fastenings in the scarf.

Pt.Skid.no.2

This exists in its full length being 3.534m long, with a sided dimension of 52mm, and a thickness of 32mm. It is curved in its horizontal plane to fit the out side curvature of the bottom. It is fastened to port side bottom strakes one, two and three by nails.

Pt.Skid.no.3

This is the stern most piece. It does not actually survive but evidence for its existence does. This is in the nail fastenings and the rebate where it would have terminated. It therefore would have had a maximum length of 0.62m, with a 4 sided dimension of at least 52 mm, and a moulded dimension of 32mm to fit **PR 2.** It would have been butted against **PR 2.**

St.Skid.no.1

The bottom rubbing strake is made up of three bits as is the port equivalent. The first piece is that in the bow. Though it does not survive, its ghost marks allow us to reconstruct its estimated dimensions. These are maximum length 0.66m, an estimated sided dimension of 60mm and a moulded dimension of 25mm.

St.Skid.no.2

This survives for its full length in two pieces. It is curved in its horizontal plane to fit the shape of the bottom. It has a maximum reconstructed length of 3.54m, a sided dimension of

85mm and a moulded dimension of 35mm. The broken piece is 0.75m long with a sided dimension of 64mm and a moulded dimension of 40mm.

St.Skid.no.3

This does not survive but evidence of its existence does in the remains of its rebate. It would have had a maximum length of 570mm, a sided dimension of 70mm, and a moulded dimension of 50mm.

Fore foot Strap.

The fore foot of the stem post and keel plank is protected by an iron strap. This is fastened by nails. It has a maximum length of 0.26m with a sided dimension of 60mm which tapers quickly to an average of 50mm towards the bow. It has a moulded dimension of 5mm. There are a number of holes in the strap which were not used for fastening it to the fore foot. They are larger than any other fastening used on the boat and would suggest that the iron strap is re-used. Indeed the whole look of the strap is that of a re-used door hinge.

Miscellaneous bits

When first investigated there were a number of pieces of wood lying in and around the vessel totalling 82 pieces. Initially most were unidentifiable and thus labelled as miscellaneous. However once the preliminary survey was done, it was realised certain features could identify their origin. Due to their initial labelling and the fact that they cannot be directly placed on the vessel they are described here.

Twenty pieces were identified as bits of ceiling planking. These range from small fillets to what are obviously the remaining parts of starboard ceiling planks. Eleven pieces are bits of planking from the strakes. These can be identified due to their greater thickness and the marks left by the roves. These do not appear anywhere else but in association with the side planking. One further piece of bottom strake can be identified. This is 75mm sided, 26mm moulded, with a remaining length of 404mm, with one side being convex. There is an obvious break at both ends of the piece of wood. Though it is most likely from the bow or stern area of the bottom strake, it is too degraded to locate precisely. There remain a further fifty pieces of unidentifiable wood. Though they are associated with the vessel, from which part is indiscernible. In all respects they are just large splinters ranging from 470mm to 100mm long and of various thicknesses and widths. No orientation can be give to them. There are no discernible features such as fastening holes, rebates, or chamfers.

Wood Species

Two main types of wood have been used in the construction of the Llyn Padarn vessel, oak and Spruce. Oak (*Quercus* sp.) has been used for all side frames, floors, the stem and stern posts and the stem apron. The skids on the bottom of the vessel are also made from oak. The bottom boards, side planking and rubbing strakes are all made from Spruce (*Picea abies*). The only other type of wood species used in the construction of the vessel is the Scots pine (*Pinus sylvestris*). This was used to make the stop water in the stern.

Wood Conversion

A number of tool marks have been noticed during the analysis of the vessel allowing for an understanding of the process of wood conversion. All the bottom boards and planking have been tangentially and radially converted. There is no specific pattern as to the placement of radially or tangentially converted planks to any position. There is no saw kerf join scar evident, as would be expected on planks cut on trestles (Goodburn 1997:35) suggesting a continuous cut and therefore possibly the use of a band saw or large circular saw. The floors would appear to have been cut in a similar fashion with the ends being hand sawn to the appropriate angle of the garboard as required.

Each side frame has been fashioned from a crook of timber. This timber has been half converted along the bottom of the frame and quarter converted along the top. The inboard face has not been squared off leaving a rough face. The bark and sapwood had been removed. The joggles have been cut using a hand saw.

Fastenings

There are a number of different types of fastening used in the building of the Llyn Padarn boat. No treenails are evident though nails, spikes and bolts of various kinds are.

Nails

Throughout the vessel wrought iron nails have been used for various jobs. The nails have largely been used to fasten down certain features such as the ceiling planking or forward thwart. Apart from this, the nails were also used to fasten the strakes to the frames. Their overall average length is 70mm. They had an average cross section of 6mm at the top of the shaft and taper down to their point. The heads of the nails are square with a slight dome, and are between 10 and 11mm in cross section, and up to 5mm high.

Clenched and roved nails

Clenched and roved nails are the most prevalent of the fastenings numerically being used to fasten the strakes together. Roves are also used with nails to fasten the breast hook, stern hook and the inwale. The clenched and roved nails are specifically used to fasten the planking together or to fasten the planking to the top longitudinal strengthening parts. The roves are made from a 19mm (3/4 of an inch) wide strip of metal, and are roughly rhomboid in shape. The nails have the same average dimensions as the ordinary nails described above.

Spikes

Spikes are classed as large nails and in general are the same size as the bolts. They are however square in cross section and taper to a point unlike a bolt which is round and does not taper to a point. A number of spikes have been recorded on the vessel, having an average 9mm cross section at the top of the shaft then taper down to a point. The shaft has a maximum length of 130mm (5 inches). Spikes are used in the same fashion as the nails, but being more substantial are found in high stress areas or where the nails would be too small. Spikes are found in the fastening of the stern post, stem post, floors, frames, breast hook and transom knee. In the latter two examples they are used to fasten the piece through the respective apron and into the respective post. The length of a normal nail is not adequate.

Clench Bolt

A number of clench bolts have been recorded in the vessel. They are directly associated with the stern and stem post. They are used to fasten the stem and stern post dead wood knees to the keel plank and the stem or stern post. In the stem it is a blind fastening whilst in the stern post it is through fastening. The bolts are 19mm in diameter (3/4 of an inch), and a head 34mm (1 3/8ths of an inch) in diameter. They are all wrought iron.

Drift Bolts

Eight drift bolts have been used to fasten the floors to the keel plank. They are 12mm (½ an inch) in diameter. There is no evidence for a head, the tops of the bolts being left flush with the tops of the frame. They are blind fastenings and therefore are considered to be drift bolts, i.e. a hole is drilled slightly smaller than the diameter of the bolt and the bolt is then hammered into this. No evidence for the bolts being ragged can be discerned.

Eye/ring Bolt

Only one eye bolt is evident, stationed in the bow. The eye is 45mm in diameter. It has been made from a 10mm square bar, the end of which has been turned back on itself in a circle to form the eye. There is no evidence that the end of the bar has been welded onto itself. Instead it would appear that the bar has been hammered into a recess 15mm deep and 35mm wide thus holding the ends together. The bolt has been hammered in from outboard and the inboard end clinched over a 35mm diameter washer/rove to stop it pulling out. The eye bolt is dual purpose, being used to fasten the bow apron to the stem post and as a method to moor the boat.

Propulsion

Initially it was suggested that the Llyn Padarn boat was towed as a means of propulsion (NWD 1977). The ring bolt in the bow was used as evidence for this. This might at first have seemed a reasonable assumption but this method of propulsion can be discounted. A ring bolt in the bows would only be of use if the Llyn Padarn boat was towed astern of another vessel. This cannot be discounted if the vessel was empty or lightly loaded but is not plausible if fully loaded as found, the force on the eye bolt could pull it out. Towing from the side of the lake is not feasible due to the terrain. If this had been the method of propulsion then a samson post forward of midships would be expected as this is best position to be towed from. Towing can be discounted as the primary means of propulsion due to a lack of archaeological evidence and the local terrain.

No mast step was found in association with the Llyn Padarn boat. The ceiling planking covers the bottom of the boat where one would expect a mast step to be. Indeed sailing on Llyn Padarn is considered only for the foolhardy, due to the erratic nature of the winds, by those who have attempted it (Murphy *per., com*). It should be noted that there is a down stream current on the lakes, flowing from the top to the bottom. This would have assisted the vessel when loaded thus in some respects negating the need for a sail.

Evident on the inwale (**Pt.Inwale.no.2**), are the remains of an oarlock (Fig. 4.9). It is made of two separate tholes. The top half of the tholes are 90mm wide, 50mm thick with a maximum height of 14mm. The tholes had two integral dowels protruding from their bottoms which fit into holes in the top of the inwale. There is evidence for an iron bar between the bottom of the thole and the inwale. It had an estimated thickness of 3mm (1/4 inch) and a length of 710mm. This served to strengthen this area of stress as well as to protect the inwale from wear incurred by the use of the oars.

The remaining length of the dowels could suggest a form of stiffening pad underneath the inwale as suggested by Roberts (Illsley and Roberts, 1979a.64). This is unlikely as the forward pad would have had to have been cut in half to facilitate frame four; therefore negating the extra stiffening the full length pad would have provided. The extra length instead could have allowed the use of a hammer to help knock the tholes out. Even today they are obviously held quite firm in their holes. Forward of the oarlock on the underside of the inwale is a notch. This has been interpreted as being for a hanging knee to support a thwart from which an oarsman could row the vessel. No evidence of the actual oars themselves has come to light.

If it is accepted that the Llyn Padarn boat was rowed, the question as to how must arise. The rowing position is amid ship, but no thwart or seat has been recovered and the area amid ship was full of slates. It is therefore likely that the oarsman either, sat on the slates and rowed or stood between the slates and the side of the boat. It is highly unlikely that the oarsman would stand on the slates and row due to the effect on stability. Whether or not the vessel was rowed by one person or two can not be discerned.

Steering

Roberts (Illsley and Roberts, 1979a.62, 64) has put forward a theory for the addition of a rudder to the Llyn Padarn boat. Evidence for this came from ghost marks on the stern foot, an iron bar and a number of concretions. Only part of the iron bar survives, and one of the concretions. The iron bar has a remaining length of 442 mm; maximum cross-section of 16 mm by 20 mm. A square washer, 9 mm thick and 12 mm wide, is evident 92mm from one end. There is also a defined butt join in the bar which appears to have been welded together. Such a join cannot be deemed to be a strong joint. The concretion shows that it was also from a square bar of the same dimensions. From the original finds report it is suggested that these bits were originally connected to the stern post and are part of the rudder/steering.

A method to hang a vertically adjustable rudder was devised by Roberts (Illsley and Roberts, 1979a.64) using the remains of the above described pieces. The square cross section bar is fastened to the stern post and the rudder gudgeons fixed to this. The rudder was hung from the gudgeons in the usual manner, except that bolts are used as opposed to pintles. This method of fastening was put forward so as the rudder could ride up when the vessel grounded. There are no parallels to this method of hanging a rudder. It is a very complex method which is not actually required.

A rudder is also not a necessity for the Llyn Padarn boat. The iron bar does not fit the stern post. Only the top pair of fastenings penetrate the outboard face of the stern post as described by Roberts, whilst the next pair down do not and therefore could not be used as rudder fastenings. It is possible that the second set of fastenings are staples that limit the movement of the rudder. If this is the case there is no need to have a washer on the bar. Either of the two methods give the rudder an upward movement in the region of 6-8 inches, a factor that would not appear to be that significant if an extended rudder as found in sharpies and cobles is envisaged. Such a rudder would only be required to counter leeway on a sailing vessel and not a rowed vessel. This form of rudder would, due to its forward rake underwater, have a tendency to catch and plough into the bottom and not ride up as Roberts suggests (Illsley and Roberts, 1979b.63). Even if such a rudder was used, a far simpler method for fastening it was known (Chapelle, 1969.161,162).

The NWD report (1977) does not mention the rudder fittings nor any evidence for a rudder. With out wishing to totally discount Roberts over complicated theory, it would appear that no rudder was actually used on the Llyn Padarn Boat, instead she was directed by the subtle use of the oars. Her shallow draft would not be a hindrance in this respect. The two through fastenings evident at the top of the stern post are just that, fastenings. They fasten the top of the apron to the stern post, the bottom of which is wedged in place by the chamfer of the stern knee. The iron shoe at the aft end of the keel plank need not be the bottom pintle but is more likely a protective shoe carrying out the same functions as the fore foot strap.

Construction sequence

From an analysis of the hull remains a construction sequence can be discerned and described in phases. The Padarn boat is a bottom (after Hocker, 1991) or raft based (after Mckee, 1983) boat in its philosophy of construction. It shares many of the same characteristics of numerous other flat bottomed vessels of the bateau/flatty type of vessel.

Phase one

After the selection of the appropriate wood the keel plank was fashioned and laid down. The floors were then laid on top and the centre line holes drilled for drift bolts. There is no evidence for the centre line drift bolts on the outboard surface of the keel plank, the bolts therefore having to have been drilled and hammered into position from inboard. With the floors fixed it is an easy process to turn the vessel over onto its back. The rest of the bottom planks can be placed on and nailed to the floors. Each plank is butted against the other and its edges painted with a form of luting. The nail holes were pre-drilled and counter sunk before the nails themselves were hammered into place, from outboard in as is evident from the nail patterning along the underside of the vessel. Once the bottom planks were secured in place the vessel could be turned over and laid up on trestles or supports of some kind.

Phase two

With the vessel turned upright the stem and stern posts were fashioned and fastened into position using bolts driven in from inboard then clinched over washers on the outboard face. The dead wood knees and aprons of both stem and stern post were then laid to the stem and stern post and fastened in position. Both were through fastened into the stem and stern post using through bolts driven from outboard in. Once securely in place the stop water could be drilled and plugged.

Phase three

With the stem and stern posts in position the first strake could be fastened to the bottom after a chamfer had been cut along the outer edge of the bottom planks. The first strake (garboard) was nailed directly to the outer edge of the bottom and stem and stern post; the nails passing through both stem and stern post and into the aprons and dead wood knees. In the midship area the garboard was sawn flush with the bottom, if not pre-shaped before being fastened. The second, third and fourth strakes were fastened in sequence after this by clenched and roved nails. The nails are driven from the outboard in, with the roves on the inner surface. Once the planking was positioned and fastened together, the frames could be fashioned and fastened in place. Three joggles have been cut into each frame so they can fit over the planking. The end of each frame is nailed to the floor planking. At least two nails were used to fasten the strake to the frames. Although the frames are inserted after the planking, the nails are driven from outboard in and thus fasten the strakes to the planking.

Phase four

Once the fourth strake was nailed onto the top of the frames the inwale could be fastened in position. The inwale clamped the top of the frames together, thus a rebate had to be cut for the top of each frame. The inwale was fastened to the sheer strake, not the tops of the frames, by wrought nails. With the inwales fastened in position the breast hook and transom knee was then fastened in position. These were fastened to the fourth strake and the inwale by two nails on either side. A spike was also used to fasten the breast hook to the stem post; and the stern hook to the stern post. It would seem viable that the stringers were now put in place.

Phase five

With the main structural part of the vessel complete the additional constructional features could be added. These are in some respects superfluous to the actual primary capabilities of the vessel i.e., an ability to stay afloat. The vessel was inverted for a second time. This allowed the fastening of the frames from below, now they were in their final position using counter-sunk nails so that the heads lay flush with the bottom. Whilst inverted the skids were fastened in place.

In the inverted state it would also be easier to fasten the rubbing strakes and the chine strake in position. The rubbing strakes are only fastened to the frames; where they extend past the frames no attempt has been made to fasten the ends to the strakes. The chine rubbing strake was fastened along the full length of the Llyn Padarn Boat. It was made in three pieces to accommodate the curvature of the forward and aft ends. Due to being in an area of greater stress the forward piece of the chine rubbing strake had the greater number of fastenings. The fore foot strap would be fastened whilst the boat was inverted.

Phase six.

With all the structural features, both primary and secondary, fastened in position the remaining elements of the vessel could be added, once the vessel was righted. These are concerned with the propulsion, steering and general use of the vessel. Along the upper edge of the inwale, forward and aft, are a number of pairs of 28mm diameter holes were drilled. These acted as a form of bit or fairlead from which breast lines or forward lines could be attached when along side a quay or if beaching. A hole on port inwale 1 has been partially drilled, having had to be stopped due to coming across a nail. Thus, a new hole was drilled a few inches aft in between nail fastenings. This is evidence that the holes were not pre-drilled before the inwale was fastened.

Evident in the mid part of the inwale are two tholes that make up an oarlock. These are each made from a single piece of wood (See hull catalogue for description.). Though it has been suggested that there was a stiffening pad underneath the inwale no evidence for this can be found (Illsley & Roberts, 1979). The remains of an iron bar along the top of the inwale is evident. This would have been cut to size, then holes drilled into it, to accommodate the thole pins and then nailed in place. Evidence for a single nail at each end of the bar has been found to support this. Once the iron bar was in place the tholes could be hammered down into the holes. I use the term hammered as they are still a tight fit.

Just forward of the oarlock on the inwale is a rebate and two fastenings. This feature has been interpreted as a means to fasten the hanging knees for a thwart. Their position in relation to the oarlock makes this assumption more credible, suggesting they are for a rowing thwart. It would seem logical to place this forward of the oar locks position and after they had been placed. A second thwart appears to have been positioned just aft of the oar locks. Its position is further away from the oarlock in relation to the rowing thwart. It would have been fitted in the same way as the rowing thwart. This thwart could have been multi functional. It is too far forward for the steering man to use and therefore could have been an extra thwart for passengers. It should be noted that the remains of the thwarts or hanging knees have not survived. It is of interest that the boat was described as being full of slates. It could be suggested that the thwarts were therefore removed to allow more slates to be loaded.

Phase seven

The evidence from the ceiling pattern shows that a number of relatively long and whole planks were laid in the central part of the vessel. These cover the bottom from the keel plank to each side. Once the midship section, up to frames two and seven, had been planked the forward and aft sections could be planked over. Due to the nature of these areas it appears that a more jigsaw like approach was taken. Straight planks were used to cover the greatest area, then fillets of mainly triangular shape, were used to fill in the gaps. All the ceiling planks which butted against the side of the vessel were shaped to fit. To finalise the construction of the vessel the rudder, if indeed it had one, would be fitted.

Hull Form

The Llyn Padarn boat has an overall length of 5.85m and a maximum beam of 2.05m at the sheer line the maximum beam along the floor of 1.6m, and draft amidship of 0.602m. She is a flat bottomed keel-less vessel with a carvel bottom and clinker sides. The bottom is made from seven planks laid longitudinally, with rocker fore and aft, whilst the sheer line runs smoothly up from midship creating lines pleasing to the eye. The lower freeboard amidship, is possibly a practical consideration for the loading and unloading of slates. The bows of the vessel are fuller than the stern; they get fuller towards the sheer providing considerable reserve buoyancy forward. The stem is curved and raked forward whilst the stern is straight and raked aft. The sides of the boat meet the bottom in a hard chine and have a 15 degree flare. The boat is bordering on the side of being shallow and can be considered to be on the beamier side of normal. All in all the Llyn Padarn boat would have been a pleasant little boat when first launched.

Boat Building tradition.

When the Llyn Padarn boat was lifted out of the water it became immediately clear that she was a flat-bottomed keel-less type of boat generally identified as a bateau. There are a number of types of flat-bottomed keel-less boats (termed rafted by McKee) which are commonly known by other names e.g., flatner, dory, keels, trow, punts or cots. Flat-bottomed, double ended hulls are a style of construction known to have existed for a long time throughout Britain, Europe and most parts of eighteenth and nineteenth century North America.

Frederick Hocker has argued that the "Celtic" tradition of boat building and the form of construction seen in the Medieval Cog constitute a third classification of boat building tradition when seen in comparison to the two traditionally identified forms of construction; these being shell-built and skeleton-built (Hocker, 1991.249-250). In this bottom-based tradition of building Hocker identifies what he sees as a distinct third family based around the building of the bottom first utilising aspects of both the shell-built and skeleton-built traditions of boat building. To quote Hocker the tradition

> *"...is easily distinguished in its earlier stages from the shell-based technologies of the ancient Mediterranean and Scandinavia by its reliance on the bottom of the boat as a structurally distinct component that is assembled first (often in a different manner than the sides) and defines the essential shape of the rest of the hull."* (Hocker,1991.250)

Hocker goes on to describe the framing as neither representing

> *"... the alternating floor timbers and half-frames of Mediterranean construction, nor the continuous ribs of Scandinavian craft."* (Hocker, 1991.250)

As such the bottom-based constructional tradition as a concept formulates a third tradition in the broader sense of things. Within such a broad tradition there could be seen a number of regional variations. The extent of such regional variations are unknown, though the potential for variability can be extensive depending on the variables considered (See Mckee,1989). There is a dearth of known finds, or more specifically fully recorded and published finds from which a typology of the different regional forms could be made (Hocker, 1991.253, 259). There are however a number of modern types of vessel thought to have been broadly based on this tradition (Greenhill, 1995 chapter 18). The Llyn Padarn boat is an example of the bottom based theory of boat construction.

In Europe such flat bottomed keel-less vessels with sides fastened to the bottom at a hard angle and joined to it by side frames that are separate from the floors, are considered to have had a long history of development. Early examples of the lineage of such vessels are the second or third century Bruges boat from Belgium, the second century Blackfriars wreck 1 from London (Marsden, 1976) and the Gallo-Roman river barges found at Druten in the Netherlands (Lehmann, 1978) and Bevaix in Switzerland (Egloff, 1974). Hocker sees these vessel as being part of the same design concept, that of a bottom based building type, and as such would include the early examples of cogs within the group (Hocker, 1991; Greenhill, 1995.230). Vessels built to the same basic design concept and nearly contemporary with the Llyn Padarn boat were raised from Lake George, New York, and are well known as trappers and lumber men's bateaux (Chapelle, 1951.86). An example of the size to which such a vessel can be made, is the large bateau style gun boat, the Philadelphia, sunk on Lake Champlain in 1776 (Greenhill, 1995.238). Other examples but of earlier date would be such boats as the sturdy and sea worthy Grand Banks fishing dories which set nets and lines off the Newfoundland coast (Chapelle, 1951.86), to the far less sophisticated turf boats of the Somerset Levels (Mannering, 1997.181). The Somerset Levels have a number of variations of the flat bottomed boat and form an interesting study in their own right.

Larger, more sophisticated flat bottom vessels are also known from various parts of the Britain and North America. In Britain the Flat bottomed Severn Trow and Bridgewater barge represents a large flat bottomed vessel of relative sophistication whilst the Glamorganshire canal barge is a less sophisticated version of a large flat bottomed vessel (Mannering, 1997.183,191). In North America modern examples of the sophisticated flat bottomed vessels can be seen in the shape of the St. Lawrence goelette, a large motorised fishing vessel (Greenhill, 1995.244). An earlier example of a sophisticated form of flat bottomed vessel more contemporary with the Llyn Padarn boat is the Browns Ferry boat. This vessel is flat bottomed, but its overall construction and form is not akin to the bateau form of vessel (Steffy, 1994.168).

The Llyn Padarn boat is undoubtedly a form of bateau. Chapelle gives the main defining characteristics of the bateau as "fore and aft bottom planking (as opposed to athwartship for a skiff), combined with a transverse framing system"(Chapelle, 1951.80). He goes further to give a general description as flat bottom, double ended with straight or curved flaring sides, raking bow and stern with a marked sheer and fore and aft rocker. The overall form of the bateau varied being light and sleek for a lumber man's bateau for use on river rapids; to the more sturdy St.Lawrence River bateau, which is more a hybrid of bateau and skiff (Chapelle, 1951.83). The Llyn Padarn boat is however sturdier in construction and appearance then the usual type of bateau. Using Mckee's classification she is considered to be a sprung bateau (McKee, 1983.83).

The Llyn Padarn boat is more akin, in overall form, to a dory than a lumber man's bateau, though it does not have the specific features of the developed Banks Dory such as the dory lap or tombstone stern. The dory is in all respects a form of bateau in the broadest sense of the word (Chapelle, 1951.85). The early history of the dory is unknown though it would seem certain that some form of early European bateau was in use as a form of coastal fishing vessel in certain areas of Europe as well as North America. It is not until the introduction of dory fishing in the Gloucester fishing schooners about 1850 that the characteristic's of the Banks Dory was formed.

The Llyn Padarn boat, though considered to represent a more ancient form of construction and one that is virtually ubiquitous through out Europe, is not deemed to be indicative of the form of boat building tradition of North Wales; the clinker sides hint at this. The predominant form of boat construction in North Wales is clinker, built around a central framing system, with internal frames added later; the Llyn Peris boat is a good example of this. Such a vessel is similar in form and construction to the small double ended skiffs and yoles of the western seaboard of England, Scotland and the Isle of Man (Mannering, 1997,17,24,25,32; Smylie, 1999.78-9,86) The Llyn Padarn boat must therefore be considered an intrusive form of vessel to North Wales. Its direct association with the early development of the Dinorwig Quarry under the direction of Messrs Wright and company does however hint at a plausible suggestion for such an intrusive form.

One of the partners, William Bridge, had a one-eighth share in a brig called Elizabeth and the sloop Dinorwic, both of Caernarvon (Lindsay, 1974.60). Caernarvon was at this time a busy port. The passing of private legislation to procure authorisation for improvements to the harbour and the local navigation in 1793 tells us of the increasing importance of the harbour and its need to expand due to the increase in trade (Lloyd, 1989.1). Port Penrhyn shipped slates to Flanders, Ireland, and the West Indies whilst Caernarvon appears to have connections with Ireland and North America (Dodd, 1971.208). The partners would therefore be open to outside influences that might at first seem unusual in what is commonly thought to be a backwater of Britain. We do not have to look across the Atlantic for such influences. Caernarvon has a long history of trading with Ireland, from the late sixteenth century to the present day. Such forms of vessel are to be found in Ireland as well in the shape of "cots", such as the Rosslare and Wexford Cots (Roberts, 1985).

Hull Analysis (Appendix 2.c)

Obvious damage, shrinkage and distortions due to drying must be taken into account when reconstructing the hull shape. The overall shape of the Llyn Padarn boat can be reconstructed with confidence as the main structure has remained virtually whole from the bottom to the sheer line. Most of the bow remains, though the aft planking is missing. Thankfully the stern post was recovered thus alleviating the problem of reconstructing the stern without it. A large percentage of the side frames survived though some have obviously bent out from their original position.

Displacement volume

This is the volume of water displaced by the immersed hull of the Llyn Padarn boat. It is otherwise known as the vessels displacement and is standardised at the point where the water line is 75% of the total depth of the same vessel amidship. The Llyn Padarn boat has a displacement of 2782 kg at 75% of her midship draft (Appendix 2c.3). This means it is a smaller vessel than the Llyn Peris boat, which has a displacement of 4400 kg (Appendix 2b.3), with less load carrying potential than that vessel, but a greater load carrying potential than the logboat, 1060.498 kg (Appendix 2a.3)

Beam/depth coefficient (B/D)

This is a definition of the general volume of the boat. The Llyn Padarn boat has a **B/D** of 3.405 (2.05/0.602) (Appendix 2c.3). The Llyn Padarn boat is on the shallow side of normal, having a **B/D** over 3.

Slenderness coefficient (Cs)

The length to breadth ratio (L/B) as discussed by McKee (1983:79,81). It is a definition of the overall narrowness of the boat. The Llyn Padarn boat has a **Cs** of 2.853 using the overall length and maximum recorded beam, 5.85 and 2.05m respectively. A **Cs** of 2.853 defines the boat as normal after McKee, between 2.6 and 3.75. If we use the waterline beam and length at its given displacement the Cs changes to 2.986. this is not excessive but does show a change in the overall shape of boat as she sits down in the water. The fact that the Cs increases is significant as it means the shape is becoming less full and thus the reserve buoyancy is less.

Midship section coefficient (CMS)

The ratio of the midship section area, to the area of a rectangle whose sides are equal to maximum breadth and draught. The Llyn Padarn boat has a **CMS** of 0.923 (Appendix 2c.3) for its given displacement. This indicates that the vessel is relatively full in the midship area and has good speed potential.

Prismatic Coefficient (CP)

The **CP** is the ratio of the immersed volume of the area of the midship section multiplied by the water line length. The **CP** for the Llyn Padarn boat at its given displacement is 0.637 (Appendix 2c.3). This puts the vessel in the region of a fast passenger ship on the GLHS variation of form. It also means the hull form is not full fore and aft, but fine.

Block coefficient (CB)

The **CB** for the Llyn Padarn boat at its given displacement is 0.587. This indicates that the vessel has relatively fine lines. It is generally accepted that a low value **CB**, less than 0.65, indicates good speed potential. The **CB** of the Llyn Padarn Boat is less than that considered by the Great Lakes Historic ships research project variation of form.

Coefficient of Fineness of Water plane (CW)

This is the ratio between the area of the water plane and a rectangle formed by the waterline length and maximum breadth. The Llyn Padarn boat has a **CW** of 0.675 at its given displacement, making it a fine vessel (Appendix 2c.3). Again this would define the Llyn Padarn boat as a fast passenger boat on the GLHS variation of form. The CW of most pre-modern vessels is low compared to a modern day equivalent (McGrail, 1998:197). This is due to the nature of the construction of the vessels, and is more pronounced in clinker built vessels.

Speed potential

When placed into the Hull Form program at a light displacement of 2.7 tonne the Llyn Padarn Boat can easily be rowed at 3 knots without creating too much drag. The steepness of the Drag/Speed ratio increases exponentially after 3 knots (Appendix 2c.6). Thus, 3 knots would be an easy speed to attain with a 1.8 ton load.

Historical Discussion

The Llanberis slate quarries are in the Parish of Llanddeiniolen which formed part of the old manor of Dinorwic. The manor had been alienated by William III and was subject to nominal rent and other reservations. It was under these conditions that it was let to John Smith of Hampshire and hence inherited from him by Thomas Assheton-Smith. The general development of Dinorwic quarries and its rivals in Nantle and Penrhyn have been extensively researched by Lindsay (1974) North (1926), Lewis (1927) and Pritchard (1935). More specific studies into the aspects of early transport have also been carried out by Boyd (1985 & 1986) and Carrington (1994). The studies have in common a considerable lack of understanding of the importance of the ships and shipping in the success of the quarries, pre and post industrial revolution. The lack of interest in the role of waterborne transport in the development and success of the Dinorwic Quarry is even more surprising considering its importance to the overall success of the quarry.

Statements such as "shipping expanded as the slate industry developed" (Lindsay, 1974:102) belie the importance of shipping and the ability of the slate merchants to seek larger and more diverse markets. It could be said that the slate industry expanded as shipping, or more precisely transport systems developed. Illsley (1979) is the first to look at the transport system from a maritime perspective. Lindsay acknowledges the use of boats (1974:61) but shows no depth in understanding the importance of the boats to the development of the Dinorwic Quarries. Illsley recognised that the boats represented an important and integral part of the initial improvements to the transport system, which made the expansion of slate industry viable. Despite this, there was still a requirement to re-assess the documentation pertaining to the development of the early slate industry as a number of details were not fully explored.

Quarrying in Llanberis is usually considered to have started in the mid eighteenth century. Large pieces of slate known as "stone slates" were "dug" in the Llanberis district as the rock was easily obtainable (Hughes, 1908:28). Not to accept a minimal level of local extraction of slate prior to this would appear stubborn considering its availability. Indeed Griffith Ellis (UWB Ms 8277) tells us that Chwarel Fawr (SH 589 616) was working by 1700, suggesting that it was being worked in the seventeenth century. Quarrying was initially a part time occupation for tenant farmers who "dug" for slate in return for a small consideration (Turner, 1975:18). This would have acted as a welcome cash income, for what would otherwise be a meagre existence. The need for cash, even by farmers, cannot be dismissed. Certain items, such as tools, clothing, salt and luxuries such as tea or sugar, as well as some services like tool sharpening, cobbling and blacksmithing could fall outside the arena of bartering and would therefore need cash as a payment.

The nature of such cottage industries in North Wales was thus limited in size and relatively unsophisticated. By 1748 however, on average 4 million slates were being exported from Caernarvon to Ireland and other places every year. Despite the large number of exported slates the quarries were still dug by partnerships of two or three farmers who worked the quarries to demand (Dodd, 1971:16). This limited the long term commercial viability of any given quarry. Copper and lead mines in Llanberis could also have been viable propositions for the farmers. The commercially backed copper mining of the late eighteenth century above Nant Peris employed at least forty men from the local farming community. Boats were utilised in the transport of the ore from Dol Ithel, or thereabouts, as seen in John Warick Smith's painting, 1792, of the loading chutes here (Williams, 1980). Pennant in his "tours" tells us of Margaret ferch Evans of Penllyn. He describes her as a "stout rower" and a "boat builder", she was said to have built two boats in her time. Margaret used the boats to transport copper ore down from Nant Peris. Pennant put her age at 90 years when he met her at Penllyn in 1781. Even if her age is exaggerated Margaret is testimony to the use of boats on the lakes before the industrialisation of the slate industry.

The increased demand for slate throughout the eighteenth century ensured a growing interest in the commercialisation of the industry. The defining year for the development of the Dinorwic Quarry was 1787. Land in the parishes of Llanddeiniolen and Dinorwic was leased by Assheton Smith to Thomas Wright, Hugh Ellis and William Bridge. The partnership leased a number of small quarry workings for the sum of £12 per annum for twenty one years

(Lindsay, 1974:43). They immediately set about consolidating their position by concentrating their efforts around Allt Wen and Bryn Glas (possibly a virgin quarry) and by discouraging the practise of open quarrying on the commons (Lindsay, 1974:57). The main inhibitor to the success of the quarrying was not local opposition or competition but the transport network.

The roads of the day were poor and unsuitable for the passage of slate carts. Initially slates were taken by pack horse through Clwt y Bont where there would appear to have been an early trail. The Vaynol estate map of 1777 shows a road from Glan y Bala to the quarries more or less where the present drag is sited (CRO Vaynol 4056). In the late 18th century William Bridge implies in a letter to Hugh Ellis, dated 26 September 1788, that carts could not make it to the site of the workings. In the letter he complains of the problems with transporting the slates "down the Hill from Brynglas", stating that there were no cart roads within 3 miles of the quarry and describing the precarious use of drags and that "few will undertake it (transporting the slate by drag), at any price". He therefore asks for permission to build a "Rail Road" to "where carts can take them up", to ease the problem of transporting large quantities and, a point often missed by others, more varied sizes of slates away from the quarries (Porth yr Aur 29080).

Though Hugh Ellis does not mention an incline his letter asks for balks of timber to build the Rail Road, two small wagons a windlass and three labourers. A rope 200 fathoms long and 3/4 of an inch in diameter was also requested. The above description has long been assumed to be an incline of one type or another which is a reasonable assumption. No record for the building of this incline can be found in the building accounts for 1787-1792 despite

Lindsay's and Illsley's assertion to the contrary (Lindsay, 1974:61; Illsley, 1979:50); though a Mr Howard, Engineer is mentioned (Porth yr Aur). The building accounts for the period 15 August 1787 to 4 February 1788 do include the cost of a road from Bryn Glas to the common and a road from the quarry to the "Poolside", cost £200 (Porth yr Aur 29093). This road is probably an improvement of the old drag route/trail described above by Hugh Ellis, by simply widening it. Pococks painting c.1795, "loading slates with Dolbadarn Castle and Snowdon in the background" supports this assumption (Fig 4.10). A "new quay" was built at the head of Llyn Padarn where boats were loaded with slates and sent to Cwm y Glo or Penllyn. Again this is most probably an improvement of an already existing quay. At Cwm y Glo or Penllyn the slates were unloaded and stock piled before being carted to Caernarvon or Porth Dinorwic (Porth yr Aur 29089).

Further steps were taken to improve the transport system from Dinorwic to what appears to have been the preferred export route at Felinheli/Moel y Don. Permission to build a new road from Llanddeniniolen to Porth Dinorwic was given in 1788, whilst at the same time the Highway surveyors were asked to repair the road from Llidiart Rhos y Wylfa in the Parishes of Llanddeiniolen and Llanfair Isgaer to Craig y Cefn Gwyn in the parishes of Bangor and Llanfair Isgaer (Port yr Aur 29087). This would appear to be a road from Penllyn through Pen isa'r Waun and Llanddeiniolen to Felinheli. The loading point at Felinheli was also being improved. In 1793 John Bryne writes to Hugh Ellis, 24 March, mentioning that a new quay at Moel y Don was nearly ready (Porth yr Aur 29084). This was to become Porth Dinorwic.

Between February 1788 and February 1789 the Company built a number of boats for the sum of "about £50". The Llyn Padarn boat is almost certainly one of these boats. By 1793 the company reported six carts at Allt Wen "pretty constant", whilst the boats managed to keep the Quay "quite clear"(Lindsay, 1974:62). The Company boats were not the only ones plying trade on Llyn Padarn. It is not stated that only the company boats were being used, and it should not be assumed that only the Company boats were referred to. The Company had employed boats to transport slate along Llyn Padarn since its first year of trading. In 1787 a number of payments were made to boatmen W. Griffiths, W. Thomas, R Williams, and R. Griffiths. Even when the new company fleet was on the water bargains were made with the independent boatmen to carry slate down the Lake. The independent boatmen were paid at a higher rate than the Company boatmen (Illsley, 1979:72).

The Company undoubtedly used their own boats as well as those belonging to independent boatmen. A close parallel to this dual use of company and independent transport is the carting of copper ore from Llyn Llydaw to Caernarvon. Here the Britannia Copper Mining Company paid the local farmers to cart the copper ore from Llyn Llydaw to Caernarvon. The company did build its own carts, but these were only used to transport the ore to Pen-y-Pass where it was stock piled until the farmers could cart the ore from there to Caernarvon. Farmers would not be available during the certain times of year, such as planting, harvesting or lambing (Beck, 1970:51). The same system could be envisaged for the Llyn Padarn boatmen. It is probable that the company would utilise the independent boatmen to supplement their own boats as and when the need arose. What cannot be stated for certain is that the Companys' boatmen were utilised only when the independant boatmen were not available.

The use of boats as a means of transporting slate along Llyn Padarn continued until the building of the Llyn Padarn Railway in 1841-42. A horse drawn tramway from the top of Dinorwig quarry to Porth Dinorwig, 1824-5 (Lindsay, 1974,172), served the top of the quarry but not necessarily the bottom. This could still be served by the boat's. It is no co-incidence that the Llyn Padarn Railway terminated at the old boat quay. This can be seen as a statement of closure for the use of boats as a means of transporting slate from the Dinorwig quarry.

Discussion on use

The use of boats on Llyn Padarn and Llyn Peris was not reliant on the success of the Dinorwic Slate mine. Waterborne craft were used on the lake prior to the take over of the slate mines by Messrs Ellis, Wright and Bridge and they were used after Messrs Ellis Wright and Bridge lease had ceased and the railway been built. On the15 March 1827, John Jones, a carpenter, is recorded as drowned whilst crossing Llyn Peris on his way to work (Anon, 1879:1). The term "crossing" undoubtably implies the use of a boat. A more specific incident after the building of the Llyn Padarn Railway is the loss of eight men when their boat capsized on June 23, 1848. David Jones, Griffith Griffith, his son, Owen Evans, William Evans, his brother, John Williams and Thomas Parry drowned when their boat capsized in a strong wind whilst travelling to work from Cym-y-glo (Anon, 1879:6). Their colleagues could do nothing but watch as all but one of the men perished. Boats were still used as a means of passenger ferry on the lakes after the building of the railway.

The use of the company boats as passenger ferries is a factor that has not been considered. No description is given as to the type of vessel built by the company, nor is their size given.

If the carrying of slates was the Llyn Padarn boat's original purpose, it would appear that the two thwarts would have been superfluous. The positions of the rebate for thwart knees would suggest a midship thwart and a thwart further aft. Both were taken out to accommodate the loading of more slates in the boat. It can be surmised that the vessel could have had a secondary role, that of ferrying workers/people about, or as a return load form Cwm-y-Glo.. If this was the case, it is plausible that the thwarts were added for the ferrying of people then taken out afterwards to accommodate slate carrying.

The size of the Llyn Padarn boat's load has been estimated at between 1.75 and 1.85 tons (Illsley and Roberts, 1979:54) The normal weight of slate carried by a cart was 18cwt from Nantle and up to 2 ½ tons from the Penrhyn quarries (Lindsay, 1974:108,170). It could be expected that a boat built specifically for the carrying of slates would carry at least the equivalent of a cart load if not more, possibly double. If 18cwt (0.9 tons) is taken as the minimum size of load for Llanberis then it is easy to see that the Llyn Padarn boat could transport in one trip the equivalent of two carts. This however could not be done comfortably and required a certain faith in her not being swamped, as undoubtedly happened on her final journey. The boat was designed on the limit of a safe working load. Crammed full to the gunwales, possibly in an attempt to carry the standard 1.8 tons (2 x 18cwt) of slate, she sank at a point where she was finally overwhelmed by the conditions and burden that she was carrying. If she was specifically designed for slate carrying, the Llyn Padarn boat was the bare minimum size required to carry the equivalent of two 18cwt cart loads of slate.

Evidence for Quays

It has long been assumed that the boats used by the company and possibly those of the local boat men had utilised quays for loading and off loading the slate. Roberts put forward the theory that the rubbing strakes are evidence for this, suggesting they help to protect the sides of the boat when she came along side the quay (Illsely and Roberts, 1979:62). This is a misconception as to the purpose and position of the rubbing strakes. The rubbing strakes are placed below the lands in the midship area and do not project out beyond the planking. They do not offer longitudinal strength as a wale would, nor do they protect the side planking. If the Llyn Padarn boat was consistently brought up against a quay it would be expected that the rubbing strakes be positioned on the outside of the land, not underneath it, and at the top of each strake not the bottom.

The rubbing strakes would however offer protection to the bottom two strakes in the vulnerable area of the lands. This would be deemed as an important feature if pushing through a rocky or marshy area. Such a marshy area can be recognised in the lower end of Llyn Peris and Cwm-y-glo. Here the Lake shallows allowing reeds and marsh land to grow. It is through this that the Llyn Padarn boat could be expected to pass and possibly cause some damage by doing so. Boulders could also be encountered in the shallows. The skids and fore foot strap on the bottom of the boat would support this theory. The skids certainly would have no function if ample depth of water and proper quays were available in Llyn Padarn and Llyn Peris.

The assumption is that there were quays in Llyn Padarn and Llyn Peris (Illsley and Roberts, 1979:62; Carrington, 1994:25). No unequivocal archaeological evidence to support this assumption exists. Much has been made in the recent past of the so called "underwater quays" at the top of Llyn Padarn (1994, unpublished survey. *UWB*). These however are not quays but are the remains of built up tracks used to dump slate into Llyn Padarn. Subsidence and redevelopment has subsequently seen the walls submerged under 1 metre of water. This subsidence still continues today (First Hydro internal report 1999). The same walls can be seen within the quarries themselves, and more specifically the underwater quays can be seen in a photo of the Dinorwig Quarry Workshop at Gilfach Ddu soon after its erection in 1870, now on sale as a post card at Gwynedd Archives, Caernarvon (Fig 4.11).

The "New Quay" at the head of Llyn Padarn is also put forward as evidence for the building of quays on the Lake. It is however more likely that the name "New Quay" refers to the building on the shores of the top of Llyn Padarn and not actually a quay (CRO Vaynol 7142). The same can be said of the possible quay at the top of Llyn Peris (Carrington, 1994:25). Evidence for a quay at the northern end of Llyn Padarn is also scant. There are no visible quays at Cwm-y-glo or Penllyn. Reverand P.B. Williams does describe a small harbour for boats at Cwm-y-glo (Williams, 1821) but no further information is given. The use of the term "harbour", implying a sheltered area behind walls, might suggest that Reverend Williams did not actually known what he was looking at and therefore used a general maritime term for an area where a group of vessels were gathered. A map dated 1807, does describe a "wharf" at Cwm-y-glo but does not show any installations (CRO, X/Plans/RD/1.1809). It is unlikely that a specific quay, wharf or harbour ever existed at Cwm-y-glo, but that as depicted by Pocock the boats unloaded and loaded at a specific part of the lake edge where a boat could easily come alongside. This does not necessitate the building of a wharf or quay but just a hard area to land the cargo. It is possible that a rudimentary lakeside wall was built, as is hinted in Pocock's "unloading slates at Llanberis" (Fig 4.12). This however cannot be considered a developed "Quay" but at best a just a "landing place".

It is interesting to note that there are no recognisable quays associated with the other industries in the area. The copper mines at Nant Peris had associated "loading chutes"; these are shown in J.,Warwick Smiths painting titled "Llanberis mine", 1792 (Williams, 1980). The loading chutes are shown in good detail, but there is no hint of there being a quay or wharf for the boats to lie alongside. The position of the site is known; the old bridge at the head of Llyn Peris is shown indicating the mines at the top of Llyn Peris on the opposite side form Nant Peris. The copper mines were known to have been in use throughout the eighteenth century and early nineteenth century (Dodd,1971:154) and had utilised boats in the transportation of the ore to the furnaces in North and South Wales.

Conclusions

The archaeological remains of the Llyn Peris Boat and Llyn Peris Logboat are the true testimony to water borne traffic on Llyn Peris and Padarn prior to the coming of Messrs Ellis Wright and Bridge. Though not considered to be an indigenous design the Llyn Padarn Boat is as important as the last two mentioned vessels. When found she was the only archaeological evidence for the use of waterborne craft on the lakes of Llanberis. In the context of the development of the Dinorwic quarries, and as evidence of the importance of the utilisation of waterborne means of transport during that period, the Llyn Padarn Boat is of great importance.

Chapter Five

The Talsarnau Boat

Talsarnau

Introduction

In August 1988 it came to the attention of Mr Merfyn Williams, the then Principal of the Snowdonia National Park Study Centre at Plas Tan-y-Bwlch, Maentwrog that a vessel long assumed to be an ordinary abandoned boat could actually be a vessel of archaeological value. During a lecture by Mr Williams on the transport of slate from *Blaenau Ffestiniog* a Mr Hefin Jones realised the vessel he had taken for an abandoned and insignificant boat could be one of the historic vessels discussed in this lecture (Williams, 1988).

An initial appraisal of the vessel was done by Mr Williams and Michael Lewis of *Hull University*, an expert on the local maritime, economic and social history of the area. From the initial appraisal it was decided that the vessel warranted further investigation. During the August and December of 1988 an archaeological investigation of the site was carried out. This included the excavation and recovery of all but the bottom half and most of the starboard side of the vessel. The pre-disturbance survey and excavation was overseen by *Plas Tan y Bwlch,* under the direction of Owain Roberts.

Site description

The boat lay at SH 605 367 on a direct transit line (050° magnetic), between the middle of the bridge and Ynys Gifftan farm (Fig. 5.1). It lay roughly half way between the sea bank and the island of Ynys Gifftan. The initial condition of the boat proved to be sound. It had an overall length of 7.92m (26 ft), a maximum beam of 2.9m (9ft 6 inches), and a depth of hold of 1m (3 ft). The vessel appeared to have settled by the stern, with no confirmable list to either side. Drawing up the survey has revealed a slight list aft of 3 degrees (Roberts, 1988 Field Journal).

The forward section of the vessel was embedded in the bank of the water course, though the outer planking of the starboard side was exposed along with the framing. The aft part stuck out into the channel (Fig. 5.2). The remains of the vessel in the bank (grall) proved to be well preserved, being covered by at least 0.7m of sand and mud. Degradation could be seen on the parts within the channel itself which was exacerbated by their drying out during low tide (Roberts, Field Journal. 1988).

Part of the stern post and stern section, gunwales and a number of the top strakes had washed away completely, whilst the tops of the exposed frames of the port bow showed evidence of decay. It would appear that the vessel dried out and the grall was submerged during spring tides (range 6.3m) and that during neap tides the vessel was constantly submerged (range 2.7m). This factor could help or impede excavation and conversely helped or impeded preservation. Talsarnau Low Water is 3 hours before Liverpool.

Excavation

After the initial investigation and pre-disturbance survey it was decided to excavate the vessel. A number of research questions concerning the vessel's construction needed to be answered. After gaining permission from the local land owner it was decided to carry out the excavation at the end of the year. On Saturday 22 October the prerequisite base line was set up (5.2b). All timbers in view were labelled and their positions fixed from the base line.

Initial measurements of the main timbers evident were taken. Though not a rescue excavation the overall feel of the "dig" was one of haste due to the environmental conditions i.e. "all hands to dig frantically down centre line to loosen sand" (Roberts, Field Journal. 1988).

The initial excavation removed the over burden from the forward section to the sheer line. This gave the first indication of the bluff bows and fine stem. A channel was dug behind the boat to aid drainage. The next day sand bag dams were added to the channel and a pump was used to remove the majority of the water from inside the boat; despite this the bottom of the vessel remained under water. It proved virtually impossible to pump the vessel dry, thus the recovery of the bottom planks and the keel was not achieved.

The second stage was to remove the top layer of sediment from the forward section of the boat. This revealed the whole of the mast beam, deck beam, lodging knees and elements of the stem post. The aft section, which did not have such an over burden, was dug out to reveal the constructional details of the bottom part of the vessel. The vessel was flat bottomed with carvel planking which turned into clinker at the turn of the bilge. The keel at the stern was found to be flat and the presence of a stern apron was confirmed. The presence of a keelson and a mast step was also revealed along with a number of samples of coal beneath the keelson. All artefacts that were detached and removed from the vessel were stored temporarily at Ynys GifftEn.

During the excavation most of the port side frames were removed. Due to the sand it proved almost impossible to remove the starboard frames. A concerted effort allowed the keelson and mast step to be detached. The ceiling planking was also recovered, though not in one piece. The continued problems with the ingress of sand and the shorter days meant new priorities had to be made. Sufficient parts of the vessel were to be removed to further study its shape and construction. The stern post, stern apron, parts of the stem, as well as half the clinker strakes from the port side and some of the carvel planking from the stern were removed on the 26 October. Measurements of the stem and stern post curvature and rake were also recorded. A number of environmental finds were recovered from the site. These included heather, lamp glass, a wheat stone, leather, a pewter bottle, samples of the sediments and short bits of nondescript timber.

Post excavation treatment

Initially timbers and artefacts were removed to Penrallt, Amlwch, but all timbers and artefacts would eventually be deposited at Ynys Faelog by the 27 October where they were kept in fresh water tanks. Some initial cleaning and recording was carried out, but no detailed constructional drawings of individual timbers or the vessel as a whole was done. The timbers have lain in the holding tanks since first being placed there. Periodically the water has been changed but there has been no attempt at long term conservation or display. Evidence for drying out can be seen on some of the timbers.

The timbers investigated have been in relatively good condition considering their treatment, or lack of it. Most of the damage, loss of wood and evidence of degradation would appear to be due to burial environment. The timbers presented within the catalogue are those recovered from the site and stored at Ynnes Faelog. The catalogue is a full record of the timber present at Ynys Faelog in the summer and winter of 1997/8.

Dating

The vessel has been associated with the Dwyryd boats due to the place and estimated time of abandonment. The area in which it was found, Traeth Bach, has long been part of the seaward end of the Dwyryd rivers. It is an intertidal area between Port Merion and Talsarnau. The vessel was found partly buried in an area of the inter tidal zone described as the Saltings. It is known that the saltings have not always been so prominent. The growth of the Saltings gives us a clue as to the date of the resting up and abandonment of the boat.

Two surveys of the area gives us a *Terminus post Quem* for the laying up of the boat. The 1836 ordnance survey 1 inch map of the area shows the Saltings as virtually non existent. By 1887, and the production of the first 6 inch ordnance survey maps, the Saltings had advanced by over a third of a mile (540m), out into Traeth Bach (Lewis 1989: 89). The site of the boat was at the interface of the then sand and Saltings. It is therefore surmised that the boat was laid up and abandoned around the 1880's, as it was not buried in the sand but enveloped by the onward march of the Saltings.

An 1880's date for the vessel is late in the context of the Dywryd boats. By the 1860's the Ffestiniog railway (opened in 1836), had superseded the boats as a means of transporting slates down to the new harbour of Porth Madoc. It is likely that the boats had some use after their slate carrying life had finished. The transport of local produce up and down the Dwyryd and even out along the coast could have prolonged the life of some boats. Eventually the boats upkeep would become too much, or the winters laying up saw the demise of the owner, and the vessel was abandoned at its moorings alongside the saltings sometime in the 1880's.

No scientific method of dating has been applied to the boat's timbers. The date is too recent for radiocarbon dating to be meaningful. A date range of a hundred years either side of 1800 would not be useful. Though a large selection of the boats timbers are made from oak a dendrochronological analysis has not been commissioned. Initial inspection of the timbers suggest that there are not enough rings surviving to provide an adequate date (less than 40 rings). Those sections that could possibly provide sufficient rings to warrant dendrochronological analysis have associated features, such as side branches that would distort the ring sequence and therefore lessen the possibility of recovering a datable sequence. No sapwood or bark has survived either making any date less precise. Dendrochronological dating could be a possibility if the keel was raised.

Recording system

Each piece recovered during excavation was tagged and given an individual colour coded number.

The colour coding system was as follows

- Red = port frames with odd numbers, and port planking odd numbers 151-199.
- Green = starboard frames with even numbers, and starboard planking even numbers 152-198.

- Brown = Structure other than framing and planking numbers 101-125.
- Blue = Finds, numbers 202-225.
- Yellow = Environmental finds 251-270.

Unfortunately most of the tags have not survived their stay at Ynnes Faelog. A new system of tagging the individual piece has thus been put in place for the purpose of this thesis. Each piece has been given an individual number from 1 upward with the pieces being numbered consecutively as they were processed. The individual pieces have then been arranged into their relative groups for the sake of the catalogue.

CATALOGUE OF HULL REMAINS

The catalogue is of the remains of the vessel recovered in 1988. No timbers have been recovered since 1988, despite a number of visits to the site (Fig. 5.3). Though not a full catalogue of the timber remains of the vessel, it is a full catalogue of the remains removed to, and at Ynys Faelog during the period 1995 to 1999. A large part of the vessel was recovered, though a number of significant parts were left behind including virtually all the planks, the stem assemblage and most of the starboard framing (Fig. 5.4). The most important parts left behind were the keel/keel plank and stem post. Investigations at the time did hint at what the keel might have been like. The port framing makes the bulk of the catalogue. Most of the port frames are half frames from the mid section with the exception of a number of futtocks and top timbers with floors from the extremities. A number of starboard frames were also recovered but only from the bow and stern areas.

At Ynys Faelog many of the tags fell off (a large bucket of tags at Ynys Faelog was at first thought to be extra unused tags but have since been identified as the lost tags) or their numbers have faded beyond recognition and totally disappeared. This has meant two things; one a need to give a new set of numbers to the timbers, and two an inability to associate most of the timbers with their original position on what is termed the site plan (this is not a site plan but the surveyed ends of each frame and thus a seris of dots with no identification). The latter aspect has necessitated a broader description of the position of the frames within the vessel. Due to there being no proper site plan, sections or any form of drawing made on site, the positioning and identity of the timbers has had to be deduced from any diagnostic features evident. To a large extent the hardness of the turn of the bilge and the enclosed angle of the frame has allowed a rudimentary position to be attained for each frame. The timbers have been catalogued in identifiable groups and where possible given a starboard or port designation. Where the original tags have survived their numbers are given in brackets to the side of the new number.

Centreline structure.

The Talsarnau boat, though considered to be flat bottomed vessel, has a defined centreline structure consisting of keel/keel plank, keelson, stem post assemblage and stern post assemblage. Due to the keel/keel plank not being recovered and the inability to carry out enough *in situ* recording of the relevant details it is not known how the stem and stern post assemblages were fastened to the keel/keel plank. This will be discussed later in the building sequence section.

Keel Plank

No keel was excavated or retrieved. Blind hand investigation of the bottom of the boat during excavation did hint at there being a keel plank though this could not be verified conclusively (Roberts., *pers., correspondence* 1997). It could have been possible for there to have been a thicker keel plank with a false keel fastened to it underneath though such a conclusion is purely speculative with the present knowledge of the sites. To verify the nature and form of the keel or keel plank would be reason enough to revisit the site with excavation in mind.

Keelson (Fig. 5.5a)

The keelson is made from a single piece of wood and survives for its full length, being 5.17m long. It has a maximum moulded and sided dimension of 110mm and 130mm respectively at the forward end which tapers to a sided and moulded dimension of 85mm and 100mm respectively. The keelson has a notch cut into its forward end. This notch is 400mm long and 60mm deep. It is assumed that it was used to hook onto the after part of the stem post acting as a form of key scarf. A single nail fastening is evident in the apex of the notch. Tool marks show that the forward notch was made using a saw and an axe or adze. The keelson is damaged around the area of the mast step, but enough evidence survives of the original forward face of the mast step to allow us to identify this badly degraded area as being that of the lower part of the mast step.

The Keelson does not appear to have been fastened directly to the keel plank. Instead it was fastened to the top of the frames by a series of 16mm diameter bolts and then into the keel plank. Evidence for these bolt fastening are seen along the top of the keelson as a series of concretions and as vacant holes on the under side. It is plausible that the keelson was fastened to the keel through the ends of the frames, but this was not ascertained at the time of excavation.

Mast step (Fig. 5.5b)

The mast step is fashioned from a single piece of timber with the inner part of the original bole at the top. There are two side branches growing out of the timber just ahead of the mast step. It has an overall length of 2.765m, a maximum moulded dimension of 80mm amidship which reduces to 40mm forward and 30mm aft. Its sided dimension is 110mm throughout its length except in the forward part where there is a lot of damage and loss of wood. The aft part of the mast step is chamfered along one side.

There are six nail fastenings with large, 50mm by 30mm, roves evenly spaced along the top face. A number of cut marks are evident, but these are considered to be damage caused whilst digging out the over burden of sand rather then damage done during stowage of slates. The aft face is fastened down with two nails without roves. There is too much damage along the forward edge to verify the use of fastenings here.

The actual mast step is situated 1.25m from the forward end being a rectangular mortise which has been cut into the keelson. It is 144mm long with a top sided dimension of 55mm and a 50mm moulded depth. The bottom of the mortise has a length of 125mm and sided dimension of 45mm.

Stern Post (Fig. 5.6a)

The remains of the badly degraded stern post was recovered during the excavation. It survives to a length of 1.12m and has a maximum moulded dimension of 170mm. The maximum sided dimension is 100mm inboard tapering to 74mm outboard. A 25mm wide chamfer runs the length of the inboard face and would have acted as an open rabbet for ends of the planking to sit against. At least two fillets, 100mm long, have been nailed into this rabbet, most probably as a form of repair. The bottom of the stern post has a 140mm long tenon, 33mm thick, with two 20mm diameter treenail holes evident in it. It is assumed this tenon fastened the stern post to the keel plank, but this was not verified at the time it was removed.

Along the inboard face there are 4 spike holes with a cross section of 16mm per side. The spikes continue through the stern post and appear on the outboard face. Here they are 10mm per side suggesting they are driven from inboard out. One large concretion which wraps around the whole stern post is identified as part of a gudgeon and its holding strap. The estimated size of the strap is 35mm by 13mm. Evidence for another strap at the top is directly associated with a rectangular rebate. It has a remaining length of 150mm and depth of 23mm and is for a pintle.

Stern Post Apron (Fig. 5.6b)

The stern apron has survived for a length of 0.78m, the top half of which is very badly degraded and has lost wood. The apron is roughly diamond shaped and has a maximum sided and moulded dimension of 156mm and 80mm respectively. The bottom has been cut flat at an angle of 50-60 degrees to the horizontal. The outboard faces make a rebate angle of 50 to55 degrees. The outboard face has the remains of four treenails 20mm in diameter still *in situ.* The purpose of these treenails is unknown and the fact that they only appear down one side further complicates our understanding of them. A number of nails are evident on the inboard face. The apron has been fashioned from half a bole and has evidence for a large side branch. Due to the poor state of the timber no further constructional details could be deduced from the remains of the stern apron.

Stem Post

The top part of the stem post was excavated but due to the nature of the sediments covering it, it could not be recovered. The stem post would appear to have been fashioned from a single piece of wood. How it was connected to the keel plank is unknown. No written records, drawings or photographs were taken of the stem post to keel plank joint.

Stem post Apron

Aft of the stem post was a stem post apron. Roberts initially described this as the stem piece. It was not recovered at the time of excavation. It is assumed that the stem post apron was fastened to the stem post, deck hook and king post by through bolts. No further information as to its form or method of fastening to the keel plank is known.

King Post (Fig. 5.7a)

Aft of the deck hook and breast hook is the king post. The king post sandwiches both deck hook and breast hook between itself and the stem post tying the whole stem assemblage together. The king post has a remaining length of 0.8m with a maximum sided and moulded dimension of 87 and 102mm respectively at the top. The king post tapers towards the bottom being only 63mm moulded before a bevel takes it to a 38mm wide base. This area has two concretions 400mm apart. The concretions correspond to the position of the breast hook and deck hook. There are single bolt holes on the inboard face which correspond to the through bolts that held the assemblage together. Each inboard edge is chamfered.

Knight Heads (Fig. 5.7b)

There were two knight heads posts either side of the stem post. Only the port knight head post appears to have been recovered. The port knight head post is heavily damage towards the top with a substantial loss of wood. It is fashioned from a single piece of curved wood which had a slight wave through it and evidence for a side branch. The post is straight at the top but is curved in the fore and aft direction in the lower quarter. There is a single bolt hole 310mm from the top of the post. This fastened the knight heads post to the deck beam. The forward face has 5at least thirteen nail holes evident. These were used to fasten the forward planking to the knight head post.

Deck hook (Fig. 5.8a)

A single deck hook was recovered being fashioned from a single piece of quarter sawn timber. It has a length between ends of 1.46m with a maximum sided and moulded dimension of 110 and 130mm respectively. The top surface has 32 nails 10 by 10mm square evident. These nails were used to fasten the deck planking to the top of the deck hook. There are six 18mm diameter through bolts evident in the horizontal plane. Two bolts fasten the deck hook to the stem post and king post. Two bolts either side of this pair fasten the deck hook to the knight heads either side of the stem post. At the end of each arm is a single bolt which fastened the end of the deck hook to a frame. There is a lozenge shaped rove evident for each bolt, with the outer two being the largest.

Breast Hook (Fig. 5.8b)

The breast hook is smaller than the deck hook and positioned lower down in the bows then the deck hook. The port end of the breast hook is damaged and has considerable loss of wood. It has a maximum remaining length between ends of 1.04m with a maximum sided and moulded dimension of 80 and 90mm respectively. There is a 20mm step 200mm from the centre of the breast hook. This is interpreted as a joggle to fit around a frame. Two through bolts 18mm in diameter fastening the breast hook to the stem post and bottom of the knights head. A single through bolt fastens each end of the breast hook to a frame. There are no nail fastenings evident.

Framing

The framing can be split into three main areas within the boat and three components. The three components are floors, side timbers and top timbers, with the three areas being the stern, amidship (the largest part), and the bows (forward of the deck beam). The two extremities are characterised by the use of cant frames and whole side timbers not requiring the use of top timbers. There were up to 29 athwartship frames per side recorded. It is however more probable that there were only 20 actual full frames, with the remainder representing dislodged top timbers or intermediary top timbers placed in areas requiring greater strength, such as the bows or the area around the mast beams. The frames are flat on the underside, to accept the carvel bottom planking, or joggled to take the clinker side planking. Treenails are used to fasten the framing to the keel plank, bottom planks and upper clinker strakes. Wrought iron nails are used to temporarily fasten the bottom planks to the frame and permanently fasten the clinker planks.

Floors

Fl.001 (133)

This is a floor that ran the full width of the bottom of the boat (Fig. 5.9). It has a maximum length between ends of 2.075m with a maximum sided and moulded dimension of 85 and 90mm respectively in the centre. The moulded dimension decreases to 70mm at the turn of the bilge and again to 65mm at the either end of the floor. In the centre of the floor is a 15mm diameter bolt used to fasten the floor to the keel plank. A 150mm wide rebate on the underside of the floor is for the top of the keel plank. There are two square limber holes 25 by 8mm either side of the rebate. The floor has a slight rise which increases at the turn of the bilge 0.83m from the centre bolt. No nail holes are evident though there are 13 treenails on the port side and 15 on the starboard side, all are between 55 and 105mm apart.

Fl.002

Described as a floor for want of a better description **Fr 002** is 0.52m in length with a sided dimension of 72mm and moulded of 70mm (Fig. 5.9b). There is extensive and heavy damage to the top outboard face with a considerable loss of wood. The floor has a dead rise of 10 degrees 140mm from the end. There are eight treenail holes, six of which have their treenail still *in situ.* The treenails would have fastened the floor to the top of the bottom half of side timber **Fr 0059**. The purpose of this timber is not fully understood though its position could define the limit of the cargo hold.

Fl.003 (Starboard 74)

The starboard half of a floor from the bows. Fr.003 forms part of a composite frame around **Fr 0066**. It has broken at the rebate for the keelson, 50mm deep, around a number of through bolts which fastened it to the keelson (Fig. 5.9c). The piece has been fashioned from a natural crook of timber the grain imparting a wave through its length. There is a single knot and a change in the run of the grain which signifies the position of side branches. It is 0.925m between ends, the arm being 0.842m long from the rebate out, with a height of 250mm. The floor has a dead rise of 15°. It has a moulded dimension of 142mm at the keelson rebate, which reduces to 85mm at the top. It has a sided dimension of 90mm which reduces to 82mm towards midships. There are no joggles evident through out the floor. A single limber hole, 25 by17mm, is positioned next to the keelson.

Seven treenails are still *in situ* within the floor. They appear to be in pairs and would therefore be used to fasten the edges of the planks. Ten nail holes are evident along the underside, grouped at either end of the frame. A single vertical wrought iron through bolt fastened the floor to the keelson and keel/keel plank. A treenail fastened the garboard to the keel/keel plank at an angle of 60°.

Fl.003.cont (Fr 0050)

The port side of **Fr 003** has broken at the keelson rebate, which is 50mm moulded and 180mm sided. The floor has a dead rise of 17 degrees with a distance between ends of 0.960m and a length of the arm of 0.785m. It has a height of 0.225m. Its maximum sided dimension is 90mm which reduces to 83mm a midship. The moulded dimension reduces from 125mm at the keelson rebate, to 75mm at the top end of the floor. There are no joggles evident, thought there is a slight step into the keelson. A single limber hole 25 by 16mm, is evident next to the keelson rebate. There are no side branches evident in this piece.

Eight treenails are evident and still *in situ* through the length of the floor. Sixteen nail holes are also evident along the middle part of the floor where there is no treenail. Twelve of the nails are clustered in an area, 200mm wide, between two well spaced treenails. A single treenail, which fastens the garboard strake at 60° to the horizontal, partially blocks the limber hole.

Fl.004

A floor from a midship area 0.860m between ends and a maximum sided dimension of 80mm (Fig. 5.9d). The floor has half a single joggle, 75mm long, evident with a single nail fastening in the middle. The rest of the outboard face of the floor is flat to allow the carvel strakes to butt up against it, though through the turn of the bilge there is a marked change in angle. The dead rise of the floor starts 0.485m form the inboard face with an angle of 3 degrees and steadily increases through the turn of the bilge to 45 degrees. There are five treenails that fasten the floor to the bottom boards in conjunction with nine nails. There are no nail fastenings evident on the inboard face of the floor. A slight chamfer runs the length of the horizontal part of the floor. The floor has been constructed from a whole side branch with the pith evident throughout the floor.

Fl.005

A floor of similar function as **Fr 002** (Fig. 5.10a). It has an overall length of 0.570m, with a maximum sided dimension of 94mm and moulded of 85mm. Each end has been chamfered to a point. There are nine treenail holes along which the floor has split. None of the treenails are *in situ*. There are eight nail fastening on the underside, their function is unknown. The piece has been converted from a whole timber, the pith of which is evident.

Fl.006

A floor from the midship section, 0.904m long, it has extensive damage at its inboard end (Fig. 5.10b). Its sided dimension is 80mm. The maximum moulded dimension at the turn of the bilge is 80mm but reduces to 75mm towards amidship. The turn of the bilge has a dead rise of 12 degrees starting 190mm in from the end of the floor. There are no joggles or rebate for the keelson.

There are eleven treenail holes, all but two with a treenail still *in situ*. Two smaller holes are positioned either side of the second inboard treenails. These two holes are 18mm in diameter compared to the 20mm diameter treenails. Both holes are plugged with wooden treenails which are flush with both surfaces of the frame. They represent plugs to fill badly positioned pilot holes for treenails that were not used. Five nail holes are evident along the bottom of the floor with two pairs being spaced between the second and third treenail from amidships out. The seams of the second carvel plank are evident, giving it a width of 210mm.

Side Frames

The Talsarnau boat has been constructed using a number of side frames. The side frames vary in length and height but run from the flat at the bottom of the boat to the near vertical sides taking in the turn of the bilge. As such the side timbers also take into account the transition from carvel to clinker at the turn of the bilge. Three groups of side frame are evident each corresponding to one of three relative positions in the boat, be it midship, aft or forward. The midship frames are the tallest, plus 0.5m, and the stern frames the shortest, minus 0.4m. On the whole the carvel planking is temporarily held to the frames by 9mm section nails and then treenailed. The clinker planking is fastened to the frames by nails.

All the side frames have been fashioned from natural crooks of timber, which usually have a straight and even grain running up and around the turn of the bilge. There are a few side branches evident within the wood but they are few and far between. This shows that the boat builder had the luxury of carefully picked timber at his disposal and did not have to make do with whatever was at hand.

There are no tool marks to suggest the method of conversion, but none of the side frames show evidence of being radially split. The edges are straight and there is a relative continuity between the sided dimensions which would suggest the use of a band saw or circular saw for the conversion. The top timber **Fr.0059** has the tool marks left by a circular saw along its bottom edge. A number of saw kerfs are evident in the face of the joggles which suggest the use of a hand saw to fashion the joggle. First the required depth of the face was cut then wedge shaped wood of the joggle cut using an axe or possibly adze.

Port Side Frames

Pt.Sd.Fr.0030

A side frame from the stern most part of the vessel (Fig. 5.10c). It has a length between ends of 0.82m with a sided dimension of 70mm. The maximum moulded dimension is 80mm at the turn of the bilge which reduce to 60mm at the top and 75mm at the bottom of the frame. There are two shallow joggles at the top of the frame 120mm and 115mm in length, each with evidence for a single nail fastening. The rest of the frame is flat to allow for the carvel strakes which have been fastened using single nails, six in all. Along the bottom edges there is a 5mm chamfer 340mm long. This frame probably represents the fifth side frame from the stern, though this cannot be discerned for certain, due to the broken and damaged nature of the top of the frame.

Pt.Sd.Fr.0034

A side frame from the aft most quarter, most likely the fourth from the stern, 0.8m between ends (Fig. 5.10d). The maximum sided dimension is 68mm and moulded 70mm. There is a single joggle 140mm long, with a treenail hole 17mm in diameter in the middle of it. An extra piece has been chopped off the end of the joggle to fit the frame properly, as is evident from the axe marks. The rest of the frame is flat to butt against the carvel strakes. Six nail fastenings are evident along the bottom to fasten the frame to the carvel strakes. There is slight damage to the top and bottom of the frame and a shallow chamfer along the forward edge at the bottom.

Pt.Sd.Fr.0043

The stern most port side frame just 0.39m in length with a sided dimension of 65mm at the top which increases to 75mm at the bottom (Fig. 5.10e). The frame is unusually thin with a moulded dimension of 42mm through most of its length, though the single joggle evident gives it a maximum moulded dimension of 52mm. The joggle is 115mm long with no fastenings evident within it. The majority of the outboard face of the timber is flat to butt against the carvel bottom boards. There are three pairs of nails along the outboard face, with a single nail in the bottom aft corner. The size and use of nails is consistent with a frame from the stern most area.

Fr 0053

A side frame from the aft part of the boat 1.075m between ends and 0.442m high (Fig. 5.11a). The frame has been fashioned from a natural crook of timber, though the grain does not run all the way through the turn of the bilge. The frame has a maximum sided dimension of 80mm throughout its length and a maximum moulded dimension of 90mm at the turn of the bilge which reduces to 86mm at the inboard end, and feathers off to 51mm at the top end. The inboard end is chamfered, 100mm long, to a height of 25mm. A 5mm chamfer runs along the aft edge of the upper face. The end has been badly damaged with extensive loss of wood.

There are seven joggles from the turn of the bilge up, between 100 and 125mm long. There is at least one nail fastening evident in the top of each joggle, though all but two have two or more. There are no treenails evident through out the length of the frame. The carvel planking has been fastened using eight nails, five of which are spaced in two groups near the turn of the bilge.

Pt.Sd.Fr.0056

A side frame from the stern quarter, most probably the second from the stern, it has an overall length between ends of 0.692m and a maximum sided dimension of 70mm at the bottom (Fig. 5.11b). The maximum moulded dimension is 85mm at the top of the joggle. The frame is for the most part only 56mm moulded due to the flat surface required for the carvel planking. Four single nails fasten the carvel strakes to the frame, and a single nail the clinker strake. There is a small chamfer to the bottom end of the frame with slight damage to the top of the frame.

Pt.Sd.Fr.0057

This is one of the aft most side timbers, most likely the third forward from the stern post, with a length between ends of 0.740m and slight damage to the top of the timber (Fig. 5.11c). It has a maximum sided dimension of 80mm and moulded of 84mm which reduces to 67mm at the top. There are two joggles, 100 and 120mm in length, both with faces 92 degrees to the vertical with the bottom most having a single nail fastening evident within it. Below the joggles the frame is flat to butt against the carvel strakes. All but the highest carvel strake, which is fastened with two nails, are fastened to the frame with a single nail. The top edges are chamfered as is the top of end face.

Pt.Sd.Fr.0059

A frame from forward of the midship area 0.514m high and 0.885m between ends (Fig. 5.11d). It has a maximum sided dimension of 80mm at the top which increases to 90mm at the bottom. Its maximum moulded dimension is 80mm at the turn of the bilge but reduces to 75mm at each end of the frame. The aft face of the top side has a 5mm chamfer along its length. This side frame has been fashioned from a natural crook of timber with no evidence for side branches. It has suffered extensive and heavy damage throughout its length, with a split occurring along the length of the bottom between the treenails.

There are six joggles between 112 and 134mm long. There is no evidence for any fastening in any of the joggles apart from the bottom joggle. The damage evident in the outboard face could have destroyed the evidence for the nail fastenings. A small piece of concretion is evident in the top of each joggle and could be the only evidence for nail fastenings. The bottom joggle has two large concreted holes at either end of the joggle. There are seven treenail holes in the bottom part of the side frame for fastening the carvel planking to the frame. Three of the treenails are still *in situ*.

Pt.Sd.Fr.0063

The shortest of all the frames, with a height of 0.242m, from the aft most part of the vessel it has a distance between ends of 1.130m (Fig. 5.11e). Its maximum moulded dimension is 80mm, and its sided dimension 80mm. It has been fashioned from a natural crook of timber with the grain running through the turn of the bilge. It has heavy damage along the under side of the top of the frame from the turn of the bilge up, with extensive loss of wood. The bottom aft end has been chamfered in by 35mm.

There are seven joggles evident between 72 and 141mm in length. The first joggle is 520mm in from the bottom of the frame. The faces of the joggles vary in their angle between 68 and 110 degrees from the bottom up to accommodate the run of the planks into the stern post. The first two joggles have a cluster of five nails in them, there being no further evidence for nail fastenings in any of the other joggles. Two treenails are still *in situ* near the bottom end of the frame. There are two sets of three nails and a single nail along the bottom of the frame to fasten the carvel planking. The impression of two planks, 130 and 200mm wide, are evident along the bottom face.

Pt.Sd.Fr.0064

A short frame 0.384m high, from the aft most area of the vessel (Fig. 5.12a). It is 1.1m between ends with a maximum moulded dimension of 85mm at its top. Its sided dimension is 75mm at the top which reduces to 55mm at the bottom. The frame is fashioned from a natural crook of timber with the grain running through the turn of the bilge. There is extensive damage to the frame with a large loss of wood at the turn of the bilge. There are four joggles evident with the possibility of a fifth. There is at least one nail fastening situated in the top of the joggle and further nail fastenings along the bottom of the frame. A total of six treenail holes are evident, with the bottom four still *in situ.*

Pt.Sd.Fr.0065

A very short frame, only 0.396m high, from the stern of the vessel (Fig. 5.12b). It is 1.16m between ends with a maximum moulded dimension of 100mm at the bottom end which reduces to 75mm at the turn of the bilge. Its sided dimension is 80mm at the top reducing to 75mm at the bottom. The frame has been fashioned from a natural crook of timber with the grain running through the turn of the bilge. There is extensive damage in the area of the turn of the bilge due to degradation of the timber, as the result of there being a side branch.

There are four joggles evident. Each joggle has had the top of its face adzed off to accommodate the planking. A single nail fastening is evident in each joggle with the second joggle up having an extra nail. Five treenail holes are evident along the base of the frame with four treenails remaining *in situ*. Three nail holes are also evident. On the upper surface of the frame there is a group of three nails and a single nail hole above the turn of the bilge.

Pt.Sd.Fr.0066

A frame from the aft port quarter 1.21m between ends, 1.152m long and 0.534m high (Fig. 5.12c). It has a maximum moulded dimension of 80mm which reduces to 75 mm at the turn of the bilge. Its sided dimension is 75mm at the bottom end and 80mm at the top end. The frame is fashioned from a natural crook of timber which has been quarter sawn, and is badly degraded on the upper surface due to the effects of exposure. There is a single knot on the upper surface.There are only four joggles evident with a nail fastening in each. Four treenails are evident 0.55m in from the end of the frame. A series of double fastening holes span the bottom from the last treenail to the first joggle. Two nail holes fasten the end of the frame to the keel plank. A series of nail holes on the upper surface are evidence for the fastening of the ceiling planking. There is a single treenail hole evident in the upper part of the frame for the fastening of a possible stringer.

Pt.Sd.Fr.0067

A medium sized frame, 0.581m in height, and 1.18m between ends from the midship area (Fig. 5.13a). It has been fashioned from a natural crook of timber with the grain running through the turn of the bilge. It has a maximum moulded dimension of 82mm and sided of 78mm at the bottom of the frame which reduces to 70mm at the top. Four joggles are evident though there is a possibility of a fifth. They vary between 125 and 140mm long. The top surface has been badly degraded with the loss of substantial timber in some areas. The bottom is 0.726m long before it turns into the bilge. There are four treenails *in situ* and a single treenail hole in the bottom of the frame. There are a further two treenail holes, one each in the bottom of the third and fourth joggles. The remainder of the joggles have at least one nail fastening evident in each joggle. There are a further eight nail holes evident in the base of the frame to fasten the bottom planks to it. Five nail holes are evident on the top surface for the facing of the ceiling planking to the frame.

Pt.Sd.Fr.0068

A short frame, 0.554m high, from the aft quarter of the port side, which retains a red tag number 123 (there is no number 123 on the site plan), fashioned from a single crook (Fig. 5.13b). It is 1.356m between ends, 0.554 high and 1.284m long. It has a maximum moulded dimension of 92mm at the inboard end which reduces to 70mm at the turn of the bilge then increasing slightly to 75mm before tapering to a point 170mm from the top. It has a maximum sided dimension of 80mm.

There are two joggles in the upper part of the frame 90mm and 220mm from the top. The outboard face is badly degraded though there are three nail holes which are evidence for a further three clinker planks. A single nail is evident in the lowest of the two surviving joggles. The bottom of the frame is flat to take carvel planking, with the remains of four treenails still *in situ* to fasten the planking to it.

Pt.Sd.Fr.0069

A short frame 0.479m high and 1.250m between ends (Fig. 5.13c). It is fashioned from a natural crook of timber with the grain running through the turn of the bilge. It has been converted by being half sawn. The frame has a maximum moulded dimension of 90mm at the end of the frame which reduces to 82mm at the turn of the bilge. Its sided dimension is 80mm throughout its length. There is slight damage at the top of the timber and the turn of the bilge.

There are six joggles evident, between 92mm and 142mm long, with the bottom joggle being more of a bevel then a joggle. The face of the joggles vary in angle from 103 to 90 degrees from the bottom up. This is to accommodate the run of the planking aft. There are three treenails, still *in situ*, along the bottom of the frame. At least eight nail fastenings are evident between the inner most two treenails. There is evidence for a single nail fastening at the top of each joggle for fastening the clinker planking.

Pt.Sd.Fr.0070

A short frame, 0.389m high, from the aft part of the vessel (Fig. 5.14a). It is 1.1m between ends, has a maximum moulded dimension of 82mm and a sided dimension of 80mm. The frame has been fashioned from a natural crook of timber with the grain running through the turn of the bilge. Both ends have been chamfered with the bottom chamfer being longer and deeper that the top chamfer. There is extensive and heavy damage along the outboard face from the turn of the bilge up.

There is evidence for six joggles these being between 80 and 120mm. The lower two have been virtually shaved flat. Both have the remains of a saw kerf between 1.5mm and 2mm wide. The bottom of the frame is flat for 0.36m before it starts the turn of the bilge. There are three treenails still *in situ* and a single nail hole for fastening the bottom planking to the frame. Two nail holes are evident at either end of the first joggle. There are no further fastening holes evident on the under side. A single fastening is evident on the top side of the frame. The single seam of a plank can be seen below the lowest joggle giving the plank a maximum width at the frame of 118mm.

Pt.Sd.Fr.0071

A side frame that is probably a cant frame from the bow area (Fig. 5.14b). It has an overall length between ends of 0.930m, a maximum sided dimension of 65mm and moulded of 75mm. The piece has been fashioned from a natural crook of timber with the grain following the curve of the frame. There are eight joggles between 80 and 111mm long, each with a single nail fastening in the top of it. There are five treenails still *in situ*, two being in the top quarter of the frame and the other three in the bottom third. A chamfer runs along both top edges for the full length of the frame, and both ends terminate with a chamfer. The bottom outboard part of the frame is extensively damaged with some loss of timber.

Pt.Sd.Fr.0073 (Red 124)

A short side frame, 0.598m in height, from the aft quarter (Fig. 5.14c). It is 1.07m between ends, has a maximum moulded dimension of 90mm at the top which reduces steadily to 74mm at the bottom end. Its maximum sided dimension is 90mm at the top which reduces to 75mm at the bottom. The bottom is flat for 0.45m before it starts into the turn of the bilge, with the first joggle evident 0.72m out form the inboard end. The top of the frame has been chamfered into a point. The piece has been fashioned from a side branch and is quarter sawn. A single knot is evidence for a side branch. Both the top and bottom show extensive degradation due to exposure.

There are five joggles, each with between 2 and 3 nails evident, along the upper part of the frame. The bottom is flat for the flush fitting carvel planking. A single treenail is evident in the top of the fourth joggle down from the top of the frame. There are a further four treenails in the bottom of the frame for the fastening of the carvel planking. No nail holes are evident in the bottom though there are two concretions that could represent nail fastenings. Two nail holes are evident for the fastening of the ceiling planking.

Pt.Sd.Fr.0074

Fashioned from a natural crook of timber, 1.145m between ends and 0.322m high, this frame is from the aft part of the vessel (Fig. 5.15a). It has a maximum sided dimension of 90mm and a moulded dimension of 100mm at the turn of the bilge which reduces to 85mm at the bottom end and 70mm at the top. There is heavy damage along the top surface at the turn of the bilge. In the same area is spade damage from the excavation of the frame. There are four joggles evident between 51mm and 135mm in length. A single nail fastening is evident in the top of each joggle. The base is 0.65m long before it turns up into the bilge. There are three treenails along the bottom, a single treenail in from the end and another two 0.4m in from that. Two sets of two nails lie in the middle of the intervening space, with a further three nails in between the two outer most treenails.

Pt.Sd.F.0075

A frame from the forward section of the vessel, possibly a cant frame, 0.762m between ends and a height of 0.58m (Fig. 5.15b). The frame has a maximum moulded dimension of 90mm at the turn of the bilge which reduces to 50mm at the top of the frame and 70mm at the bottom. It has a maximum sided dimension of 80mm. The frame has been fashioned from a side branch, the grain of which runs through the turn of the bilge naturally. There is evidence for six joggles between 118mm and 155mm in length. The outboard face is extensively damaged and therefore evidence for nail fastenings within the joggles is hard to find. Three treenails are evident in the bottom 220mm of the frame with a single blind treenail fastening in the second joggle from the top.

Pt.Sd.Fr.0076

A relatively short frame, 0.467m in height and 1.202m between ends, fashioned from a natural crook of timber (Fig. 5.15c). The grain has imparted a natural longitudinal wave in the frame. There are three side branches evident through the length of the frame. The top underside and end of the top side have suffered extensive damage. The top has been chamfered, 55m long, to a point 12mm wide. There are six joggles between 72 and 128mm long from the turn of the bilge up. There is evidence for a single nail fastening in the top of each joggle apart from the top two. There are three treenails evident along the bottom for fastening the carvel planking. Two nail holes are evident at the end of the frame spaced 270mm apart. The frame would appear to be from the forward part of the aft quarter. This is evident by the hardening up of the bilge and length of the bottom needed to accommodate the carvel planking.

Pt.Sd.Fr.0077

A short side frame 0.587m high and 1.164m between ends from the aft port quarter of the vessel (Fig. 5.16a). It has a maximum moulded dimension of 80mm at the turn of the bilge which reduces to 70mm at the top of the frame, which has been chamfered to 40mm. The maximum sided dimension is 100mm at the bottom which reduces to 70mm at the top. The frame has been fashioned from a natural crook of timber with the grain running through the turn of the bilge. There are five joggles between 92 and 142mm long. The bottom of the frame is 0.580m long before it turns up into the bilge. The top of the frame has been chamfered at the end. There is extensive damage with considerable loss of wood at the turn of the bilge. There are five treenails still *in situ* for fastening the bottom planking to the frame. A single treenail is situated in the top of the fifth joggle. Along the bottom at the turn of the bilge are three nail holes for temporally fastening the ceiling planking to the frame. Six nails were used to fasten the ceiling planking to the top of the frame.

Pt.Sd.Fr.0078

A short frame, 0.547m in height, from the after part of the midship section of the hull (Fig. 5.16b). It has a distance between ends of 1.032m, maximum sided dimension of 80mm. The moulded dimension is 93mm at the bottom end which reduces to 78mm at the top of the frame. Each end has a chamfer being 96mm long at the top and 119mm long at the bottom. The base is 0.474m long before it turns up into the bilge. There are only three joggles evident though a further two are suspected but are not evident due to the degradation of the upper part of the timber. The frame is fashioned from a crook of timber. The run of the grain has imparted a natural longitudinal wave in the frame. There are two knots evident in the side of the frame. Three treenail holes fastened the first two or three carvel planks to the frame whilst the rest were nailed. There is a single nail hole evident in the first joggle only. There are twelve nails in the top face for the fastening of the ceiling planking.

Pt.Sd.Fr.0079

A large frame from midships; 1.470m between ends 0.866m high and 1.252m along the base (Fig. 5.17a). It has a maximum moulded dimension of 90mm reducing to 75mm at the bilge and 60mm at the top. The frame is a natural crook of timber, the run of the grain imparting a longitudinal wave through the timber coinciding with the turn of the bilge. It is fashioned from a half timber. There are two knots and a side branch evident along the aft face. The frame is badly degraded at the turn of the bilge and along the forward face of the floor of the timber. Seven joggles between 110mm and 138mm long, with at least a single nail fastening in each, are evident from the turn of the bilge up. The bottom has four treenails and five nail holes fastening the carvel planking to the frame. The dead rise starts 0.68m from the end. There are two pairs of nail holes on the top as evidence for fastening the ceiling planking.

Pt.Sd.Fr.0080

A side frame from the midship area 1.35m between ends, 0.734 high and 1.207m along the base (Fig. 5.17b). It has a maximum moulded dimension of 85mm at the inboard end reducing to 75mm at the turn of the bilge and 70mm at the top. The frame is fashioned from a natural crook of wood representing a quarter of the converted timber and imparting a longitudinal wave into the frame. The top half of the frame is badly damaged from the turn of the bilge up. There are a number of knots evident through out the frame. Four joggles are evident from the turn of the bilge up. A further two joggles have possibly been lost to degradation. The bottom two joggles have a single nail hole each. The base of the frame has five treenails and six nails evident. There are no joggles, the bottom being carvel planked. A 15mm dead rise starts 0.28m along the bottom with a further increase 0.742m from the end as it rounds into the turn of the bilge.

Pt.Sd.Fr.0081

A side frame 1.370m between ends, 0.735 high and 0.980m long (Fig. 5.18a). It has a maximum moulded dimension of 92mm. Its sided dimension is 80mm at the bottom end reducing to 75mm at the top of the frame, which has been cut to a point. The frame is fashioned from a natural crook of timber. The piece has no knot evident. The grain is straight longitudinally through the length of the timber with a slight wave at the top. This wave does not affect the shape of the frame. The frame is a quarter timber.

There are four whole joggles evident with a further two possible joggles which have been lost due to degradation. There is a nail evident in each joggle to fasten the clinker planking to the frame. Five treenails fasten the carvel bottom planking to the frame. Five nail holes are evidence of further fastenings. Iron concretion and staining has left the impression of the two outer most carvel planks. These are 250mm wide at the turn of the bilge and 180mm inside of that.

Pt.Sd.Fr.0082

A side frame from forward of the midship area on the starboard side (Fig. 5.18b). It is 1.440m between ends, 0.780m high and 0.98m long. It has a maximum sided dimension of 78mm and moulded of 82mm at the inboard end, this reduces to 70mm at the turn of the bilge. The frame is fashioned from a natural crook of timber with the run of the grain following the turn of the bilge. A slight wave is imparted in the frame from the run of the grain. The frame is quarter sawn.

Seven joggles are evident being between 28 and 129mm long, the shortest at the top and the longest at the turn of the bilge. Each joggle has a nail in the top part as evidence for fastening the clinker planking. The bottom has five treenail holes still *in situ*. The frame is 654mm long before the start of the dead rise and the turn of the bilge. There are three nail holes on the bottom and four on the top for fastening the ceiling planking.

Pt.Sd.Fr.0083

A unnumbered side frame from the midship area, 1.15m between ends, 0.66m high and 0.55m along the bottom before the turn of the bilge (Fig. 5.19a). The maximum sided dimension is 80mm. The inboard end is 80mm moulded decreasing to 74mm at the turn of the bilge and increasing again to 80mm at the top. The upper and lower sides are badly degraded in areas with extensive iron staining throughout the timber, and isolated areas of concretions. The wood is a natural crook with a number of knots and branches evident. It has a longitudinal wave through its length. The frame has been fashioned from quarter of a branch with the side extremities removed.

The bottom has four treenails *in-situ* and eight nail holes for fastening the carvel planking. There is evidence for five joggles between 190 and 110mm long. Two treenails are evident in the top two joggles with a single nail in the second lowest joggle to fasten the clinker planking to the frame. Ten nail holes are evident on the upper surface of the frame as evidence for fastening the ceiling planking.

Pt.Sd.Fr.0084

An unnumbered side frame from the midship area of the vessel (Fig. 5.19b). It is 1.38m between ends, 1.015m long with a height of 0.748m. It has a maximum sided dimension of 98mm at the inboard end which reduces to 88mm before increasing again at the turn of the bilge to 96mm then tapering down to 88mm at the top. The frame made from a naturally grown crook, the run of the grain follows the turn of the bilge but has a slight wave longitudinally. The grain pattern would suggest the frame is made from a side branch, being a half timber at the top and only a quarter at the bottom. There are a number of small knots, left by branches, evident. The timber is in sound condition, though there is staining and localised damage on the top surface.

The bottom of the frame is 0.895m long before it gives way to the turn of the bilge. Its underside has 13 nail holes for the initial fastening of the carvel-built bottom planking; six treenails also fasten the bottom planking to this frame. Six nail holes on the upper side are evidence for ceiling planking. After the turn of the bilge the carvel planking gives way to clinker-built sides. There are five joggles evident with a nail hole in all but the fourth joggle; the first joggle has an extra two nails at its base.

Futtocks

Fut.0042

A heavily and extensively damaged bottom piece of a futtock 0.396m long (Fig. 5.20a). It has a maximum sided dimension of 80mm and moulded of 65mm. A 5mm chamfer runs along each edge of the top surface. There are three joggles between 90 and 115mm in length. They are so badly degraded that no further information can be determined. A single nail hole and treenail hole are evident at the base of the timber. The base of the futtock has been cut flat to butt against the bottom boards. The futtock has a 25 degree angle of dead rise at the bottom which increases to 45 degrees at the top.

Fut.0044

A heavily and extensively damaged piece of a futtock 0.563m long (Fig. 5.20b). It has a maximum moulded dimension of 72mm and sided of 63mm. There are four joggles evident between 25mm and 160mm long. At the top of each joggle is a nail fastening for fastening the clinker strake to the frame, except for the third joggle up which has two. A 5mm chamfer runs along the aft edge of the inboard face. A single nail fastening is evident on the inboard face, possibly for the fastening of a stringer. The futtock has been fashioned from a whole branch with the pith being evident in the centre. There are a number of side branches evident at the bottom of the futtock.

Fut.0072

A futtock from the stern section of the vessel (Fig. 5.20c). It has a remaining length between ends of 0.890m with a maximum moulded dimension of 75mm and sided of 76mm. There are five joggles evident between 82 and 100mm in length. The joggle faces vary in angle, from 90 degrees to 64 degrees, to fit the run of the planking aft. There is a single nail fastening positioned at the top of each joggle. Two treenails are evident in the first and fourth joggle from the top. The bottom is flat, 0.330m in length, to accept the carvel planking of the floor boards. There is a single nail hole on the inboard face. There is a rebate, 20mm deep to accommodate the floor boards. This gives the futtock a dead rise of 15 degrees. This suggests it is the same type of futtock as **Fr 0058** but would lie in front of it where there is less dead rise. The angles of the joggles would also suggest this is one of the few starboard frames recovered. The top part of the bottom face has been chamfered down to 25mm. The top end has extensive damage and has broken off around the top treenail.

Fut.0058

A futtock with little or no damage 0.852m long (Fig. 5.20d). It has a sided dimension of 75mm at the top which increases to 80mm at the bottom. Its maximum moulded dimension is 75mm. There is a chamfer on either side of the inboard face and one at either end. The bottom end face has a 10mm deep rebate cut into to it. This gives the futtock a 30 degree angle of dead rise to the bottom boards. There are seven joggles between 107 and 125mm in length. All but two have at least a single nail fastening evident in the top of the joggle. The faces of the joggles vary in angle between 92 to 96 degrees to accept the run of the planks aft. The bottom rebate has an angle of 124 degrees to the horizontal so that it can butt against the floor boards. Two joggles have a 1.9mm saw kerf evident whilst another has the marks left by an axe. A 25 by 15mm rebate has been cut into one joggle to allow for the nail head from one of the strakes.

Fut.0055 (Starboard 68 originally)

A starboard futtock from the stern area with slight damage on the underside and broken at the top (Fig. 5.20e). It has an original tag numbered **Starboard 68,** but unfortunately this cannot be relied on as it was not a number used in the original excavation. It has a remaining length of 0.895m between ends, with a maximum moulded dimension of 85mm and sided of 70mm at the bottom which decreases to 60mm at the top. There are six joggles evident between 80 and 100mm in length. The angle of the face of the joggle varies between 86 degrees and 106 degrees to accept the run of the planking into the stern. There is evidence for at least one nail fastening the top of each joggle. Three treenails are also evident from the turn of the bilge up. The bottom part of the futtock, 0.345m long, is flat to accept the carvel bottom planking.

There is a 5mm chamfer along the top edges and the aft face.

Fut.0051

A top timber 0.776m long from the stern (Fig.5.20f). There is heavy damage at the top of the frame with considerable loss of timber. Its sided dimension is 104mm at the top which reduces to 95mm at the bottom. The maximum moulded dimension is 80mm. There are six joggles between 115 and 80mm in length. The top joggle is 225mm in length. The faces of the joggles vary in angle, from 103 degrees at the top to 118 degrees at the bottom, to accept the run up of the stern planking. There is at least a single nail fastening in the top of each joggle and a single wrought iron bolt at the bottom.

Top timbers

T.T.Fr.0031

A top timber with a length of 0.635m and slight damage (Fig. 5.21a). A 4mm crack runs 3/4 of the length of the timber. There are five joggles between 80 and 120mm in length. There is a single nail fastening in the first, second and fourth joggles from the bottom. No other fastenings are evident. In comparison to other top timbers this timber is relatively straight.

T.T.Fr.0032

A whole top timber with little or no damage 0.520m long (Fig. 5.21b). It has a maximum moulded dimension of 70mm and sided of 70mm at its top which reduces to 40mm at the bottom. There are four joggles between 115 and 130mm in length along the outboard face. In the top of each joggle is one or more nail fastening to secure the top timber to the clinker strakes. Three nail holes are evident on the inboard face for fastening internal planking.

T.T.Fr.0035

A whole top timber with little or no damage 0.610m long (Fig. 5.21c). It has a maximum moulded dimension of 70mm and sided of 70mm at the bottom which reduces to 60mm at the top. There are four joggles between 90 and 135mm in length. Each joggle has two nail fastenings evident apart from the second joggle from the bottom. There are two nails evident in the top of the inboard face along with two knots from dead side branches. A 2mm kerf is evidence at the top of each joggle for the use of a hand saw in the cutting of the face of the joggle.

T.T.Fr.0036

A top timber, 0.455m long, with a maximum sided dimension of 70mm and a maximum moulded dimension of 80mm (Fig. 5.21d). A single side branch is evident half way along the timber. There are three joggles, between 50 and 145mm long, with at least one nail fastening evident in each. A total of eight nail fastenings are evident on the outboard side with a further two evident on the inboard side.

T.T.Fr.0037

A top timber with a remaining length of 0.440m (Fig. 5.21e). The bottom end has split and broken from the rest of the timber. It has a maximum sided dimension of 71mm and moulded of 60mm. There are three joggles evident between 130 and 90mm in length. The top end of the inboard face has a 140mm long chamfer which is 15mm deep. Two through bolt holes and a single blind bolt hole are evident in the bottom two joggles. The blind bolt hole is 17mm in diameter and the through bolt holes are 20mm in diameter, suggesting that the blind hole could be an unused pilot hole. A single nail hole is evident in the top of the bottom joggle.

T.T.Fr.0038

A top timber, 0.395m long, with the remains of a wrought iron bolt still *in situ* at the top (Fig. 5.21f). The top has split and decayed around the iron bolt. It has a maximum moulded dimension of 60mm and sided of 74mm at the top which reduces to 52mm at the bottom. There are three joggles evident between 35 and 120mm in length. In the top of each joggle is a single nail fastening. Four small side branches are evident on the inboard face.

T.T.Fr.0041

A top timber 0.389m long, with a maximum sided dimension of 89mm and moulded of 75mm (Fig. 5.22a). There are two joggles between 110 and125mm long with the top of the outboard face being chamfered into a point. There are twelve nail holes on the outboard side and three on the inboard side. A number of the outboard nail holes represent re-nailing. There are a number of score marks on the timber though these represent damage caused by digging and not tool marks.

T.T.Fr.0054

A badly damaged top timber 0.561m in length with a maximum moulded dimension of 65mm which reduces to 45mm at the top of the timber (Fig. 5.22b). The sided dimension is

90mm at the top of the timber reducing to 80mm at the bottom. There are four joggles between 60 and 150mm in length. The outboard face is too badly damaged to be able to discern whether or not there was a fastening in each joggle. There are two treenail holes, the uppermost one still having its treenail *in situ,* at the bottom of the base two joggles.

T.T.Fr.0055

A long top timber 0.729m in length with slight damage on the top inboard surface (Fig. 5.22c). It has a maximum moulded dimension of 75mm and sided of 71mm. The top end has been chamfered, and there is a chamfer along both of the inboard edges. There are six joggles, 68 to 130mm in length, on the outboard face. The joggles vary in the angle of the face from 95 degrees at the bottom to 92 degrees at the top. This is in response to the run of the planks in the stern. There is a single nail fastening in all but the top and bottom joggles. Four nail fastenings are evident along the in board face. There are no treenails evident.

T.T.Fr.0060

The remains of a top timber 0.615m long with a maximum sided dimension of 80mm and moulded of 60mm. The top has lost a substantial amount of wood and there is further damage along the outboard face. The top timber has four joggles between 110 and 135mm in length. There is at least a single nail in the top of each joggle. From the top of the second lowest joggle to the bottom of the top timber is a 25mm rebate 230mm long. This would have allowed the top timber to butt against the top and side of the side timber it was associated with.

Beams (Fig. 5.23)

Two beams situated along the sheer were found *in situ* when the forward part of the vessel was excavated. No evidence for any other beams either in the bows or the stern has come to light. The beams can be directly associated with supporting the mast. The forward of the two beams is the deck beam whilst the aft beam is the mast beam. They are connected to each other by a system of horizontal knees.

Deck Beam

The deck beam is a single piece of timber which has suffered heavy, though not extensive damage at the port end and along the aft face. The beam was situated between the fifth and sixth frames from the bows. It has an overall length of 2.715m, and a sided dimension of 71mm on the starboard side which tapers to 132mm at the port end. The moulded dimension is 85mm on the starboard side, tapering to 78mm at the port end with a maximum dimension of 110mm in the mid part of the beam. The starboard side is chamfered along the top edge and there is further chamfering along the midship bottom edges.

There are a number of fastenings evident long the top face of the beam. These are evidence for the fastening of the forward deck planks to the deck beam. They appear to be grouped in pairs with an average distance between the pairs of 80mm. There are no fastening holes evident along the bottom face. The fore and aft faces have the remains of the deck beam knee fastenings. These are 13mm diameter dumb bolts. A single 17mm bolt with trapezoid rove is evident on the forward face of the beam. There is no indication as to what this bolt was used for

Mast Beam

The mast beam is made from a single piece of wood 2.815m long, with a maximum sided and moulded dimension of 180 and 108mm respectively. The forward edge is straight with three bolt holes evident on the starboard side and five evident on the port side. These fastened the forward lodging knees to the beam. The aft edge is slightly concave between the outboard face and the mast bracket. It is heavily damaged along the port face, though evidence for two through bolts can still be discerned. These through bolts fastened the aft lodging knees to the mast beam.

The mast bracket is of a composite design incorporating a wrought iron bracket around three wooden chokes. Only the basic design of the bracket is described here because the finer detail of the bracket is hidden by concretion. No radiographic investigation of the concretion could be carried out due to size of the timber. It was deemed inappropriate to break open the concretion due to a lack of facilities.

The bracket consists of two 50mm (2 inch) straps folded around the beam and a single choke on the forward face, and a 127mm (5 inch) strap which held the mast to the mast beam. The mast beam choke was wedge shaped, being 45mm deep at the top and 30mm at the bottom end, and was used to tighten the strap around the mast. The beam itself has been shaped with shoulders, each with a single fillet of wood between it and the strap, where the straps cross the aft face either side of the mast. It is suspected that a simple pin, fastened through holes in the top of the mast beam straps, fixed the mast strap to the bracket. This whole system would have been easy to manufacture and maintain whilst still providing the necessary support the mast required.

Knees (Fig 5.24)

The deck and mast beams were fastened to each other and the side of the boat by a system of horizontally fastened knees. The knees were fastened together by tapered through bolts with rounded heads. The bolts were 20mm in diameter at the head and 18mm where they came out at the other side. The system of knees supports the mast beam, directing the forces forward and aft onto the sides of the boat. The forward knees, the outboard arms of which are tied to each other, also tie the deck beam to the mast beam. The deck beam is therefore an important and integral part of the mast support. Such an arrangement would be expected for a shroud-less mast. The knees are fastened through the internal side planking into the side frames. Only the starboard knees survive.

Aft mast beam knee

The aft mast beam knee survives for its full length along both arms, but is badly degraded and damaged at the outboard part of the corner. It is made from a single piece of wood, the grain of which runs through the turn of the knee, but is wavy along the horizontal plane. The inboard face, which sits flush against the mast beam, is 1.105m long, whilst the outboard face is 0.522m long. The length between the ends is 1.12m. The knee has a maximum sided dimension of 95mm along the forward and outboard faces, and 90mm along the inboard face. The moulded dimension varies through its length from 121mm inboard to 154mm at the turn of the corner and 107mm at the outboard end. Both ends are chamfered down to a point.

The knee is bolted from the aft face through the mast beam once at the end, and twice from the mast beam through into the knee. It is fastened to the side frames by two bolts from inboard out. There are no further fastenings evident. No tool marks are evident, but it would seem reasonable to assume that the knee was sawn to shape.

Forward mast beam knee

This knee is fastened to the forward face of the mast beam and between the sides of the boat and the deck beam knee. It is fashioned from a crook of timber whose grain runs through the corner of the knee. The knee has slight damage and loss of wood. Its aft facing arm has a length of 0.45m whilst the side arm is 0.605m long and the distance between the ends is 0.71m. The maximum sided dimension is 80mm whilst the moulded dimension varies between 45mm at the ends to 75mm just before the turn of the corner.

The aft facing arm is fastened to the mast beam by a single bolt from inboard out. The side arm is fastened to the deck beam knee and the side of the boat by two through bolts. There are no further fastenings evident in the knee.

Starboard deck beam knee

There is only evidence for one knee fastened to the aft face of the deck beam. This is heavier than the forward facing mast beam knee which it is fastened to. The knee has an outboard face 0.541m long with the face fastened to the deck beam being 0.46m long. The distance between ends is 0.66m. Its sided dimension is 85mm whilst the moulded dimension is 85mm at the aft end of the side arm increasing to 134mm at the turn of the corner and then reduces to 30mm at the end of the beam arm.

The knee is fastened to the deck beam by three bolts fastened from through the knee and into the beam. Two through bolts fasten the deck beam knee through the forward mast beam knee and the internal side planking into the side timbers. There is no further evidence for fastenings. There is a 3mm saw kerf evident at the apex of the internal face of the knee. This is evidence for the knee being fashioned by being sawn as opposed to the use of an axe or adze.

Planking

There are two types of planking evident within the construction of the Talsarnau boat. The bottom is made from carvel planks butted against each other and fastened to the floors. From the turn of the bilge there are seven clinker planks per side. This sequence of planking can be seen on Fr0082. The number of carvel planks is unknown. The majority of the planking did not survive. The only clinker planks to have survived were in the bows (Fig. 5.25a). The run of carvel planking into the stern and the carvel bottom planks also survived ((Fig 5.25b). The planks recovered and in store at Ynys Faelog are disarticulated with no original numbering. As the main purpose of the thesis was to try and attain a set of hull lines from first reconstruction, to gain an understanding of the vessels hull form, the main emphasis of recording was aimed towards the framing and centerline structure. These held more information than the planking to understand the hull form. The planking was not ignored, despite time being limited. The planking was recorded 1:1 for quickness, and due to time limits has not be reduced for presentation here. A full descriptive catalogue is presented.

Clinker Planking

Pl.cl.017.

This is the remains of a clinker plank from the forward port side. The curved nature of the plank suggests it is from the lower part of the boat. It has an overall length of 3.334m with a maximum sided and moulded dimension of 160 and 20mm respectively. The sided dimension decrease to 80mm towards the forward end. The inboard face has the impressions of 7 frames along its length. The hem has an average sided dimension of 50mm through its length, decreasing to 35mm towards the forward end. There are 22 nail holes evident in the hem, between 280 and 100mm apart. A single trapezoid rove impression remains which has 15mm long sides.

The outboard face has a land with a maximum sided dimension of 45mm but average 40mm and reduces to 15mm at the hood end. There is a lap rebate 45mm long. This would support the theory that the plank is from one of the lower clinker strakes, possibly the second strake up. There are 17 nail holes evident between 120 and 260mm apart. Three holes with wooden plugs *in situ* are also evident. They do not have any discernible pattern nor are they linked to any other feature.

Pl.cl.108

This is the remains of a port plank which is broken at both ends and has a crack running the length of its mid-section. The two end pieces could not be found. The plank curves inward at the forward quarter suggesting it is from the forward port area. It has a remaining length of 3.254m with a maximum moulded and sided dimension of 23 and 170mm respectively but thins towards the stern. The outboard face has a lap with a maximum sided dimension of 50mm which reduces to 35mm forwards. There are 19 nail holes between 65 and 310mm apart. Three round holes are the remains of the drilled pilot holes for the nails, two of which still have their wooden plugs *in situ*. There is a slight chamfer along the lower edge of the plank The inboard side has the impression of 6 frames along its length. There is no hem suggesting it is from the top part of the vessel. There are 24 nails along the lower edge a number of which have the impression of diamond shaped roves evident. There is no evidence for treenails.

Pl.cl.018

The remains of virtually the full length of a plank. It is flush at one end suggesting it was butt joined to the next plank in the strake. The forward end has the remains of a lap rebate 57mm long. It has a remaining length of 3.094m and a moulded and sided dimension of 24 and 175mm respectively. The moulded dimension increase to 28mm and the sided dimension decreases to 95mm at the forward end. The lap has an average width of 40mm which reduces to 35mm at the start of the lap rebate. The hem is 15mm wide and there are seven impressions of frames on the inboard face. There are 20 nail fastening holes evident in the top edge plus one in the hood end and two at the butt joint. A further 21 nail fastening holes are evident in the hem, both sets of nails being between100 and 210mm apart. There is a group of four nail holes which are repairs, having no evidence for wooden plugs in them. A single 16mm in diameter hole 1.1m from the butt join is possibly evidence for a bolt fastening. This would suggest that the plank is from the top part of the boat if not actually the sheer plank. This is supported by the lack of twist in the plank. The bolt hole being for the mast beam knee.

Pl.cl.020

This is the complete remains of a plank 3.316m overall length. The piece has a slow bend inward starting from 1/3 of length. There is no evident twist in the plank nor a land rebate suggesting it is from the stern. This is supported by the fact the piece is caked in black mud and is rotten and has split along its top edge, a feature associated with the exposed stern pieces. It has a sided dimension of 170mm in the mid section which reduces to 141mm at the butt end. It has a moulded dimension of 24mm. The lap has a maximum width of 45mm which reduces to 35mm at the end. There are 34 nail holes in the lap, some in clusters of 3. The nails are between 120 and 180mm apart, the clusters of three nails are in line with the seven frame impressions on the inboard face. There are two nails at the butt join. The outboard face of the plank has chamfer along its edge but no hem on the inboard face. There are 22 nails evident along the bottom edge.

Pl.cl.144

This is a short piece of plank which is wedged shaped in both elevation and side elevation. It has a maximum length 0.463m with a maximum moulded sided dimension of 42 and 120mm respectively, which reduce to 27 and 85mm respectively. The moulded dimension is thicker than expected which could indicate that it is a stealer or part of the ceiling planking. This is supported by the thinner end having a butt join whilst the thicker aft end is chamfered to a point. There are six nail holes evident along the bottom edge, between 90 and 100mm apart. The top edge is broken and degraded, suggesting it is from the exposed stern quarter.

Pl.cl.025

This is a broken clinker plank with a remaining length of 0.454m and a maximum sided and moulded dimension of 26 and 172mm respectively. The butt join survives at one end. The top edge has a single nail fastening evident 20mm in from the top edge. The lap is 45mm wide. There are 7 nail holes along the lower edge between 20 and 25mm apart. A single 40mm wide crescent shaped cut on the inner surface suggests the use of an adze but could represent damage sustained when the boat was dug out.

Pl.cl.024

This is a broken piece of clinker planking from the bow area. It has a remaining length of 0.635m. It has a maximum sided dimension of 105mm and moulded dimension of 22mm. The piece has a single lap evident running along one edge and a butt join at one end. There are three nail holes evident along the top edge, two in the lap 215mm apart and one at the butt end. The lap is 34mm wide and broken along the top edge, but there is evidence of a 560mm lap rebate. It ends at a width of 8mm where it is broken. Two single nail are evident in the bottom edge. Two 4mm kerfs are evident on the inboard edge. There is no further constructional evidence discernable.

Carvel Planking

Pl.car.022

This is a short piece that has survived to an overall length of 0.782m. It has a sided dimension of 128mm and a moulded dimension of 44m which reduces to 28mm forwards. There is a slight twist along its length from the forward butt join towards the aft angled and chamfered hood end. Two nails fastened the butt join and two nails are evident in the hood end. There are only two nail fastening holes along the top edge, 135mm apart, and one along the bottom edge. There is no evidence for there being a land along either edge, suggesting it is one of the carvel planks from the stern quarter.

Pl.car.023

This is a short carvel plank that survives for its full length of 0.9m. It has slight damage along both the top and bottom edges with the remains of tar/pitch along the bottom edge. It has a maximum sided dimension of 140mm and a maximum moulded dimension of 27mm which reduces to 23mm at the stern. It has a slight twist through its length, with a butt join at the forward end and an angled and chamfered hood end at the stern. There are four frame impressions along the inboard face with an average moulded dimension 160mm. The second frame impression from the forward edge has a single treenail evident within it. The other frames have a single nail fastening associated with them. A single nail fastens the hood end to the stern post.

Pl.car.029

This is the short broken remains of a piece of the bottom planking most probably from the stern area. One end has broken away whilst the other appears to be a butt join with a split through it. The butt join has a 225mm long step in, suggesting a stop splayed scarf. The outboard face a has a slight chamfer to it along one edge and a 40mm land along the other. There are 8 nails along the top edge, 75-150mm apart, and 6 along the bottom edge, 80-180mm apart. A single treenail, 19mm in diameter, is evident 222mm from the butt join and

72mm down from the top edge. On the inboard face there is a 60mm wide frame impression verifying that the treenail was used to fasten the plank to a floor or frame. This plank represents the transition from carvel to clinker.

Pl.car.030

A length of planking broken and split at both ends but with evidence for a butt join at one end. It has an overall length of 1.294m with a moulded and sided dimension of 24 and 165mm respectively with a slight bend and curve through its length. On the outboard edge there is a 40mm wide lap with 6 nail holes evident in it, between 145 and 180mm apart. There is a single wooden plugged hole evident in the plank. There are 9 nail fastenings in the bottom edge, between 160 and 65mm apart. The bottom edge does not have a land but does have a slight rounded chamfer along one edge. There is a single frame impression on the inboard face with a nail fastening the plank to the frame along the top and bottom edge.

Pl.car.039

A short, 0.443m long, broken piece of bottom planking with a sided and moulded dimension of 85 and33mm respectively. There are four treenail holes 40-100mm apart and 22mm in diameter. These would have fastened the piece to the bottom of a floor. There are no further constructional features evident.

Pl.car.036

This is the broken remains of a bottom plank. It has a remaining length of 0.802m and a sided and moulded dimension of 91 and 33mm respectively. There are three 21mm diameter treenail holes evident 225 and 230mm apart, and a single nail hole along the broken bottom edge. The top edge appears to be shaped in a slight curve, which could indicate that it is from the side of the bottom in the stern area where such a shape would occur. There are no further constructional features evident.

Pl.car.197

A long piece of carvel planking 1.068m in length with a maximum sided dimension of 80mm. The moulded dimension has a maximum of 30mm at one end but averages 28mm throughout most of its length. The piece is broken at both ends and there are no lands along either edge. On the inboard edge there is a single frame impression 125mm from the edge. It is fastened by 2 nails 10 by 6mm. A second frame impression 170mm distance from the first is fastened by a single nail and two treenails. There are two treenails still *in situ* 22mm in diameter 300mm apart, and a single empty treenail hole 21mm in diameter at the forward end.

Ceiling Planking

The ceiling planking did not cover the full length of the boat, it finished 1.5m from each end. The midship area covered by the ceiling planking can be taken to define the area of cargo hold. The ceiling planking did not extend to the sheer line either. It was capped between the frames at the roughly the third strake down from the sheer.

Pl.ce.021

This is the broken remains of the butt end of a plank, possibly from the starboard side. It has a remaining length of 1.06m, with a maximum sided and moulded dimension of 183 and 24mm respectively. There are two nail fastenings evident along the bottom edge, which has a slight chamfer to it. The top edge is broken. The inboard face is smooth with no evidence of damage whilst the outboard face is rough and has evidence for scuffing and gouging.

Pl.ce.026

A relatively short length of planking, 0.597m long with a maximum sided dimension of 110mm and moulded of 20mm. The plank is notable for having two rectangular holes cut out of it, being 256mm apart and 76 by 88mm. They were cut by a saw the 4mm kerf of which is still evident. A single nail is evident at each hole. These are driven in at an angle possibly into a frame. A 47mm saw cut is evident along the bottom edge, and there is a chamfer along both top and bottom edges. This piece is thought to represent the internal planking around the deck or mast beam.

Pl.ce.027

The remains of a whole plank 1.425m long with a maximum moulded and sided dimension of 31 and 140mm respectively. It is butt edged at both ends and slab sided along one edge with a chamfer along the other. No laps are evident on either face. There is a single nail fastening evident at each end, both slightly off centre. Four nails are evident along the top edge with the middle two only 35mm apart. The nails were probably used to fasten this piece of ceiling planking to the frames. Along one face is a series of gouges, most probably damage done during excavation. This does however identify the top face. On the bottom face are a pair of saw marks with a 2mm step in them. No obvious reason for their being there can be given apart from the plank being used underneath something else that had been sawn.

Pl.ce.028

This is the full remains of a piece of ceiling planking. The plank has an overall length of 1.327m with a moulded dimension of 30mm and a maximum sided dimension of 202mm at one end and 120mm at the other. There are three nail holes evident along one edge and a single nail fastening in the other. Each end is butt joined and fastened with a single nail. No laps are evident.

Pl.ce.031

A broken and split piece of ceiling planking, 1.105m long with a sided and moulded dimension of 140 and 22mm. The bottom side is smooth with no damage whilst the top side has a number of cuts evident in it. There are no nail fastenings or other constructional features evident.

Pl.ce.032

This is the broken and damaged remains of a piece of ceiling planking 1.105m long with a maximum sided and moulded dimension of 196 and 25mm respectively. There is a single nail fastening evident 40mm in from the edge. A mass of concretion represents part of a chain. There are no further constructional details evident.

Pl.ce.038

A relatively short piece of plank, 0.554m long, broken at both ends but with a possible butt join surviving at one end. It has a sided dimension of 120mm and a moulded dimension of 29mm. There are three nail fastenings through its length 20-30mm in from the edge. These fastened the ceiling plank to the floors. An 85 by 100mm square has been cut out of the plank. This would accommodate some form of feature such as a frame or the mast step. There are no further constructional details evident.

Pl.ce.034

A piece of ceiling planking 0.67m long with a maximum side and moulded dimension of 66 and 24mm respectively. This makes it a relatively short and narrow piece of planking. One end is split and broken whilst the other has a butt join with an angled step in it. This would accommodate a frame. There are only two nail holes evident to fasten this piece to the floor. There are no further constructional details evident.

Pl.ce.035

A piece of ceiling planking broken at one end with a butt join at the other and split along both edges. It has a remaining length of 0.794m with a sided and moulded dimension of 130 and 24mm respectively. There is a single nail fastening evident, 284mm from the butt join, for fastening the plank down. There is considerable excavation damage along the top face and none on the bottom face. There are no further constructional details evident.

Pl.ce.032

This is the remains of what appears to be a whole plank 1.92m long. It has a maximum moulded and sided dimension of 53 and 152mm respectively. At one end is an angled butt join from which the plank runs straight, for 1.64m, to a step 40mm wide. There is a rectangular hole 1.07m from the end 80 by 54mm. There are 6 nail fastenings evident along each edge between 510 and 175mm apart. There is a single nail fastening in the rectangular hole. The inboard face is flat and smooth with 75mm wide chamfer at the butt join. There is also evidence for a 4mm saw kerf. No further constructional details could be discerned.

Land Rubbing Strake

A land rubbing strake has been noted on the table of constructional pieces. No evidence for its survival at Ynys Faelog could be found. There are no pictures or drawings of the rubbing strake nor is it mentioned in the field diary. It can only be assumed that the rubbing strake has gone missing or that it is an uncorrected mistake in the table of constructional pieces.

Caulking and luting

At the time of excavation tar or pitch was noted in some areas (Lewis, 1989.89). The water of the holding tank at Ynys Ffaelog if not changed at least twice a week would have an oily film over its surface and a number of the timbers also emitted an odour similar to creosote. No samples could be taken for analysis though undoubtedly the timber were impregnated with some form of oily pitch or tar. Lewis notes the supplying of pitch for use on the boats by a Robert Lloyd of the Talsarnau shop and a Sarah Francis of Maentwrog (Lewis, 1989.89). This was clearly a form of water proofing be it painted on or used as luting between the carvel planking or in conjunction with fibrous materials to form caulking. Apart from a pitch/creosote covering, waterproofing between the joints of the planks was provided by a caulking or luting made of horse hair (Lewis, 1989.89). There is no record as to whether or not the horse hair was mixed with a pitch or tar, though this can be assumed as horse hair alone would not make a good form of caulking or luting.

Fastenings

Three types of fastenings are evident in the construction of the Talsarnau boat, treenails, iron bolts and wrought iron nails.

Treenails

The treenails are used to fasten the framing to the planking. Treenails are not used in the fastening of the planking or the keel plank/keel to the keelson. The treenails are 20.5 $\pm$ 1mm in diameter. They are hammered through pre-drilled holes 17mm in diameter. There is no evidence for the use of wedges inboard or outboard on any of the treenails. The average overall difference between the treenail and its hole is 3mm, making for a tight fit without a requirement for wedges. The treenails have been driven from outboard in.

Bolts

Treenails were not used to secure the deck and mast beam knees. Tapered bolts with round heads fasten these features to each other and the side frames. They are 20mm in diameter at the top of the bolt and taper to 16mm at the base. The use of bolts in this area is not surprising as it is high stress. It is not known whether or not the bolts are clenched or round headed on the outside.

Nails

The third type of fastening is that of wrought iron nails, sometimes used in conjunction with roves. The nails have a maximum cross section of 8 by 9mm at the top and taper to a point. The heads are rounded or rose shaped. They appear to have a maximum length of 75mm (3 inch) though this can not be verified as no whole nail has been recovered. The roves used in conjunction with the nails vary considerably, being trapezoid in shape or oval. The trapezoid roves have a length of each side between 15 and 25mm. The largest roves are of the rhomboid form with an overall maximum length of 45mm.

Wooden plugs

Not strictly a fastening but associated with the nail fastenings are a number of wooden plugs. These are directly associated with the nail fastening pilot holes. They can be split into two types, either those plugging holes that were drilled as a mistake, or plugging old nail holes. The latter type are of interest as they denote re-fastening of the planking and therefore possibly a repair.

Propulsion

A number of different types of propulsion could be put forward for the Talsarnau boat. We are lucky that the mast step and mast beam have survived so we can state with confidence that she was primarily propelled by sail. What form of sail is the main question?

Sail

The vessel was undoubtedly sailed despite no sail, mast, bits of standing or running rigging being found. There are plenty of references to the making and repairing of sails for boats on the Dwyryd during this period in the Diffwys accounts (Lewis, 1989.81). The mast step and mast beam are the two pieces of archaeological evidence that verifies the use of a sail. Further information about the mast, its position and the probable rig utilised can be derived from these two pieces of evidence.

The mast step has a maximum length of 144mm and width of 55mm at the top tapering to 125 and 45mm respectively at the bottom. This meant the base of the mast had a tapered tenon 500mm deep which was stepped into the top of the keelson, providing support for the lower end of the mast. Once stepped the mast could have stood up on its own. Boats are known without standing rigging in Britain (Finch, 1976.70,90). It is however unlikely to have stood up to the stress of being under press of sail. No standing rigging or associated fittings were found with the vessel, though arguably light stays could have been used to support the mast and be fastened into the eye bolts at either end of the mast beam. The angle of the stay if this was the case would be abeam of the mast, if not slightly forward of it, and thus not raking aft as would be expected, even by a few degrees. This is important as single stays abeam of the mast would not prevent it from toppling if fore and aft pressure was applied, only stays raking aft or forward would do so. The only other apparent support for the mast came from the actual mast beam itself.

The mast beam supported the mast at deck height. The mast was positioned aft of the centre line of the beam and held in place by a wrought iron bracket. The bracket was held in place by driving a chock into the gap between the mast beam and the two bracket straps forward.

Such a system allowed for the easy removal of the chock thus loosening the bracket around the mast and allowing the mast to be unshipped when the need arose.

The beam itself was supported at either end by a system of lodging knees fore and aft; the forward knees connecting with the deck beam forward of the mast beam. This gave the mast immense support athwart ship and helped to transmit the forces imparted on the mast to the hull of the boat. The mast step in conjunction with the mast beam are enough to support the mast.

The mast now acted like a cantilever with its foot anchored in the mast step and a pivot point against the mast beam. As such the forces from the sail would be well supported forward and athwartships but with less support aft. The mast at deck level had a diameter of 171mm (6 3/4 inches), assuming there was no rebate, implying that the mast was quite slender. This is what would be expected for a mast without standing rigging as it would be more resilient and transmit less loading to the hull than a thicker mast (McGrail, 1998.224).

Using Mckee's ratio for the thickness of a lug sail mast on a ballasted beamy boat (D= L/45) the diameter of the mast at deck height would give a mast length of 7.695m (McKee, 1983.150). This is 0.3m more than the proposed headroom under Pont Briwat at high springs (Lewis, 1989.83). This discrepancy could be accounted for by the draft of the boat and therefore the amount the mast sat under the waterline. It is only an average and should not be taken as the definitive answer. The height suggested by McKeee's formula does correspond closely to that of the head room at Pont Briwat, suggesting that it is within the "ball park".

A number of single mast rigs could be proposed. The position of the mast and the fact that the Cat rig was not found in Britain during this period discount it as a possible form of rig. A form of lug sail would however be the most appropriate type of rig to use. The use of a basic lug sail would have negated the need for a complicated and heavy system of running rigging, and subsequently the standing rigging needed to support the system for any form of gaff rig. A lug sail on the contrary could be supported and handled quite adequately without a complex system of running rigging and therefore no need for heavy standing rigging. All that would be required was a halyard and basic fastening points for the sheet and guy.

The lug sail is a basic type of fore and aft sail which comes in a number of forms; the dipping lug, standing lug and balance lug. Small lug sails are easily handled, with their relatively short yards being easily stowed in the boat (Harvey, 1997.73). They are easy to manufacture and therefore maintain. The lug sail in its different forms, though a relatively simple sail, has a surprisingly good performance and scope for adjustment.

Of the three main types of lug sail the dipping lug would seem to be the most appropriate for the archaeological evidence at hand. A balanced lug can be dismissed due to it never having been favoured by working boatmen, and by the mere fact that it was introduced after the boat under consideration was out of use; the balanced lug was introduced into Britain in the1870's (Harvey, 1997.76). The standing lug is the same form of rig as the dipping lug but with the tack brought into the mast. This gives it a better windward performance, makes the rig more handy, and with the mast positioned up in the bow leaves greater room for working and rowing (Harvey, 1997.78) That the mast is usually positioned up forward in the bows does not correspond to the positioning of the mast in the Talsarnau boat, this being further aft.

The position of the mast in the vessel plus the lack of shrouds suggest the use of a dipping lug. The dipping lug was in effect a square sail swung fore and aft and peaked up. The sail was laced to a yard which extended beyond the mast, with the tack pulled down tight at the stem head and the clew sheeted aft. The yard usually extended beyond the mast by a third in Britain (McKee, 1983.151). The bottom of the sail was boom less, which made it easy to handle. To set the sail, it was raised with a single halyard to the lee side of the mast; the halyard also doubling up as a stay when set. To tack the vessel the sail has to be lowered (dipped) and the whole assemblage transferred to the other side. Though considered a hard and hazardous operation in foul weather and at night, it must be remembered that it is unlikely that slates would be transferred at sea in such conditions, and therefore the only disadvantage of the dipping lug is negated. Indeed with a certain amount of familiarisation the whole operation is not as hazardous and awkward as is usually considered (Author's personal experience).

Apart from the archaeological evidence a number of illustrations of boats on the Dwyryd though unhelpful in being able to confirm the use of the dipping lug for certain do not deny it. Lewis's analysis points to the use of a number of rigs on the Dwyryd without confirming one type as the predominant rig (Lewis, 1989.87). A number of the vessels shown do however show a lug sail in use. It is also of interest, as Lewis points out, that the most accurate and reliable of the artists, Williams, does show a lug sail (Lewis, 1989.87).

Considered a basic form of sail, the dipping lug is nevertheless a powerful sail which was arguably better than the other lug sails for driving to windward in a straight line (Marchaj, 1996.161). This in part was due to the leverage exerted by the after part of the yard which kept the luff taut and helped to maintain the sails overall efficiency when beating to windward; and partly due to a greater area forward of the mast and therefore outside its turbulent air flow. Compared to other rigs the lug sail imparts its driving force lower down thus reducing the amount of heeling force exerted on the boat (Marchaj, 1996.157), a feature that is also preferable for a heavily laden working boat. Though not as efficient off the wind as other rigs, its lifting characteristic can be considered desirable in a heavily laden working boat (Harvey, 1997.73). Such a lifting effect would help to heave the bows over any swell and suppress a tendency for the bows to dig in, in a following sea. A certain degree of weather helm imparted by the large sail area aft would also be a desirable characteristic of the sail (Mckee, 1983.141). This would give the rudder some feeling and naturally bring the head of the boat into the wind, eventually stopping it, if the rudder was let go.

Oars

Despite the lack of archaeological evidence the use of oars cannot be discounted as they appear in the Diffwys account books (Lewis, 1989.81). It is highly unlikely that oars were meant to provide the main power source for this vessel, though the carrying of at least a pair could have provide an ability to manouevre in confined waters and light airs. The shape of the vessel (bluff bows) would suggest that the use of oars was looked on as purely auxiliary in nature.

Steering

The remains of wrought iron bolts and straps are evident on the stern post. These are the fastenings for the gudgeons or pintles from which the rudder was hung. The rudder itself was not excavated. It would appear to have been hung off the stern post by two gudgeons or pintles. This would have made it easy to ship when required in the shallow waters, if being beached or for repair. The accounts for the boats give several references to the making of rudders for Dwyryd boats and repairing of the rudders of the boats (Lewis, 1989.81). No sizes or other details are given but some aspects of the rudder and steering system can be suggested from the archaeological remains.

The Talsarnau boat is small enough for the rudder to have been steered by a tiller, either fastened into the head of the rudder or slotted over the top. The rudder would have followed the rake of the stern post and possibly have sat on a bottom pintle. It is unlikely that the rudder was balanced, an unbalanced rudder being the most common form. The relatively fine underwater lines aft on the Talsarnau boat would not necessitate the need to have had the large immersed area seen in many other flat bottomed boats such as barges and keels. A relatively light but efficient rudder would have sufficed. The use of poling poles, or more likely oars, to assist the rudder would have helped when sailing down stream where the rate of the apparent water flow over the rudder would have been less.

Wood species

The wood used in the boat has come from a number of species. Representative samples were taken from the main constructional parts represented in the catalogue. Samples of anything unusual were also taken. All samples were analysed by Dr. Pat Denham, UWB.

The samples from the framing (floors, futtocks, top timbers, and side timbers), all proved to be made of Oak (*Quercus* spp.). The oak had ring widths between 2 and 3mm except for the keelson which had wide rings over 5mm wide indicating it was from a fast grown tree. It could not be ascertained whether or not the oak was locally grown. By the late nineteenth century most of the wood used for the building of ships and boats in North Wales was actually imported (Eames, 1987.26). Other constructional features that were made of oak are the stern post, the mast beam (also from relatively fast grown oak of ring widths 3-4mm), breast and deck hook, king post, knights heads and one of the hull planks sampled. All treenails sampled were also fashioned from oak.

The next commonest species found in the vessel was Weymouth pine (*Pinus strobus*), otherwise known as yellow pine or white pine (Desch and Dinwoodie, 1981.390). It is an imported wood. Weymouth pine is used within the Dwyryd boat on pieces that are interpreted as repairs; these include the fillets found in the stern post and wooden plugs found with in the planking. A single piece of ceiling planking was also made from Weymouth pine. Scots pine (*Pinus sylvestris*) has also been used for nail hole plugs. There are other species noted within the ceiling planking, these being Larch (*Larix*), Spruce (*Picea abies*) and Elm (*Ulmus procera*). The mixture of wood species shows the secondary nature of the ceiling planking suggesting that the type of wood used to provide the ceiling planking was selected from that at hand and not selected specifically for the job.

Wood conversion

Analysis showed evidence for a number of tools being used in the conversion of the timber. The timber on the whole was converted using a large circular saw, the saw marks of which can be seen on a number of the frames. The even sided dimensions along the length of the frames suggest the use of a bench and large machine saw. The consistency in the sided dimensions, on average around 82mm, would support this theory. The planks can also be expected to have been cut on a large circular machine saw. Secondary cutting of the timbers to the required lengths was done by a large hand saw with a 4mm kerf. The hand saw was also used to cut the joggles in the frames. It could be expected that an axe and a adze were used in some areas though no evidence for this has been found. The shaping of the lands and chamfers could have been done by plane.

Non-constructional remains

A number of organic and non organic remains were discovered within the vessel that had no constructional purpose. They were bagged and tagged at the time of discovery though no formal analysis of the finds was done. The badly degraded condition of the remains has prevented the analysis of the samples for this thesis. The list of organic material found is from a list titled "Dywryd boat" and the home address of Owain Roberts stamped onto it.

Organics

A number of none constructional artefacts and organic remains were found in and around the boat. Of the organic remains recovered, these included a number of twigs, stalks and leaves found behind and under the planking, thus ruling out the option that they were washed in.

Large lumps of organic matter and heather were recovered from aft of the stem. Such an organic mat can easily be interpreted as dunnage, though this need not be the case (Fig. 5.26). Individual leaves found under the planking and in between the ceiling planking and bottom boards are evidence of the vessel sailing inland, as would be expected for a Dywryd boat. Individual sweet chestnuts (*Castanea sativa*), can also be evidence of such voyages, but could actually represent a seasonal addition to the crew's meals.

Lumps of loose pieces of coal were recovered from the stern area and from pitch under framing or the keelson. A number of pieces have been identified as coke as opposed to coal. Coal dust was evident aft of the stem post. A number of small chips of slate, found lying on the ceiling planking or embedded in frames along with the coal and coke are testament to the cargo carried by the Dywryd boat. Evidence recovered for a more unusual possible cargo are the horse droppings.

Non organic

Non organic remains were also recovered. Most of these were loose concretions of a number of the ships fastenings; these included roves, bits of iron fastenings, and parts of a chain. Individual items of a personal nature included a pewter bottle (Fig. 5.27a), lamp glass (Fig. 5.27b), part of a sharpening stone and what can only be described as a "wooden pebble". The pewter bottle is too concreted to allow analysis for datable feature. The fact that lamp glass has been found within the vessel does however allow us to give a *terminous post quem* for the site of 1800 (Bathurst, 1999.48).

Construction sequence

Though the full vessel was not recovered enough of her remains were excavated to be able to reconstruct the construction sequence. The most important factor is the lack of a keel or evidence for it. Verbal confirmation that a flat keel plank of greater thickness than the bottom boards was used came from a non visual inspection of the keel by Owain Roberts (Owain Roberts, *pers.com.*1996). Such a form of keel would not be inconsistent with the evidence from the rest of the remains and it has been assumed to be the case for the purpose of reconstruction. A false keel could have been added for lateral stability if required.

Phase 1

The initial phase of construction is the laying down and building of the bottom. The whole centre line structure would need to be suspended at either end if the bottom was to be sprung, though this is unlikely as the keelson is straight. The bottom was made from at least seven bottom planks, including the keel plank, butt joined and laid from stem to stern. The planks are not fastened to each other but are temporarily fastened to a number of floors by wrought iron nails. When the floors have been positioned and temporarily fastened down they can be permanently treenailed in position. Before the treenail is hammered into place the plank and floor had to be drilled.

Once the bottom of the boat has been constructed the stem and stern post can be fastened in place. The method of fastening the stem post is unknown though it would seem reasonable to assume that it was horizontally scarfed to the keel plank. The stern post would appear to have been fastened to the keel plank by a tenon 55m long which is secured in place by two treenails. There is no dead wood knee but there is a stern apron, this however was not fastened in place till the strakes had been laid up and temporally nailed to the stern post. At the same time the keelson and mast step could be fastened in place.

Phase 2

Once the bottom had been constructed and the stem and stern post fastened the run of strakes from the turn of the bilge up could be laid to the side, shaped and fastened in place. These strakes were clinker built and therefore built up one after the other and fastened to the strake below by wrought iron clenched and roved nails.

Phase 3

Once the side of the hull had been constructed the rest of the internal framing could been fastened in place. Thus the side frames, futtocks and top timbers would be fashioned and the joggles cut before finally being fastened into position. This stage would see the basic hull of the vessel completed. If only designed for light use then no further constructional timber would be required apart from a light breast and stern hook, and possibly a gunwale. The builders of the boat however did not envisage an easy life for the Talsarnau boat.

At this stage a heavy deck hook and breast hook were fashioned and fastened into place. These two constructional features were designed to tie the sides together and help to support and reinforce the bow. The heavy nature of the scantlings suggest the bow were expected to take a considerable amount of stress. The knights heads were also fastened into position at this stage, helping to reinforce the bow area further. Due to the heavy construction of these fittings it would also be expected that the boat had a stern hook and a sheer line inwale or gunnal of some form. If a gunnal was present it would be fastened into place once the planking had been built up. This would help to protect the sheer line as well as offering lateral strength to the sides of the boat.

It is probable that the bow and the rest of the boat was heavily reinforced in this way so she could come along side a quay or nudge up to a ship with a heavy load and with a considerable amount of way on without stoving in the bow or sides. Though the crew would have undoubtedly been skilled sailors, in an age without motor power it would be preferable to have too much way than too little. The latter could result in an undesirable need to go about and try again.

Phase 4

The inside of the Talsarnau boat has been planked over with a ceiling planking. The bottom is planked up to 5 foot from either end. There is no evidence that the stern or bow area were planked. This could denote an area for the crew or a half deck in the stern at a higher level as can be discerned for the bow. The ceiling planking extends up to the third strake below the sheer line in the midship area. That the ceiling planking was laid after the frames were fastened is evident by the fact they overlie the nail fastenings on the frames.

Phase 5

With the main parts of the boat constructed, all that remained was for the associated sailing parts to be fitted. The aft mast beam knees were fastened in position first then the mast beam was fastened to it. The forward knees were fastened to the beam but not the side of the boat. The deck beam knees could then be fastened to the side of the boat through the forward mast beam knees. Finally the deck beam was fastened to its knees.

With the mast beam in position the mast could be stepped and what rigging required, rigged. The forward decking could also now be nailed down and any further possible decking (aft), fastened in position. The rudder was also hung before the boat would be ready to set sail, and start plying her trade.

Hull Form (Fig. 5.28)

The Talsarnau boat is a flat bottomed keel-less vessel with rounded bilges. The stem is curved and raked forwards and the stern post is straight and raked aft. The bows are bluff whilst the stern remains relatively sharp as the run of planks aft of midship is fine. The midship section is flat having a dead rise less than 5 degrees, but becomes sharper aft of midship with increased dead rise and finer lines into the stern post. The sides are plumb with relatively hard though still rounded bilges. The boat errs on the beamy side and has a relatively shallow draught.

The Talsarnau boat uses both clinker and carvel planking in its construction. The bottom is constructed using stepped butt joined planking running fore and aft. There are no fastenings between the planks which are nailed and treenailed to floors. From the turn of the bilge up the Talsarnau boat is clinker built. The planks in each run of strakes are butted together and each strake is fastened to its neighbour with wrought iron nails. The strakes are fastened to the frames by wrought iron nails. In all there are 8 clinker strakes per side from the sheer down, and evidence for at least 7 carvel strakes of varying sided dimension either side of the keel plank out to the turn of the bilge. She is heavily framed having 18 to 20 frames per side. The frames are supported in the midship area by top timbers that help to reinforce the sheer.

Hull dynamics (Appendix 2.d)

When found it would have been very easy to have reconstructed the Talsarnau boat on paper and then in 3 dimensions on computer. The excavation and subsequent loss of information in storage has meant that its reconstruction is not that straight forward. The individual parts of the boat, though representing the whole of one side no longer retain their individual numbers. The reconstruction of all the pieces was beyond the scope of this thesis. It has been fortuitous that the overall shape of the Talsarnau boat can be reconstructed with confidence as a number of frames could be identified. Thankfully the frames are not all from one area but span the full length of the vessel. Unfortunately the keel plank could not be reconstructed with confidence. Instead a best guess using the depth of the stern post tenon and an extrapolated width from the remains of the floors has been used.

From the known position and dimensions of identifiable frames and floors a body plan was drawn. Waterlines, buttock lines and diagonals were then projected onto an elevation and plan. The lines were faired and a new body plan drawn, scale 1:20. The body plan was checked against scaled drawings of the frames to ensure it had not deviated significantly from the original shape of the frames. No significant differences were noted, apart from areas where there was a loss of wood on the original frames. Once checks had been made and a satisfactory set of lines had been produced offsets were loaded into *Hull Form*, a hull dynamics computer programme used to analyse the performance of boats. Errors could be expected but a number of standard measurements, lengths, beam at known set points, the deck beam width and height were used as check measurements. An error of 2% due to the transfer of measurements between the body plan and *Hull Form* off sets can be expected. The fact that the vessel was hand built means this error is negligible.

Beam/depth coefficient (B/D)

This is a definition of the general volume of the boat. The Talsarnau boat has a **B/D** of 2.222 (3/1.35). This means it is tending on the deep side of normal (after Mckee, 1983). Boats with a **B/D** lower then 2 are considered to be deep, or volume dominated; whilst those with a **B/D** over 3 are shallow.

Slenderness coefficient (CS)

This is a definition of the overall narrowness of the boat. The Talsarnau boat has a **CS** of 2.9 (8.634/3). This defines the boat as beamy.

Displacement volume

This is the volume of water displaced by the immersed hull of the Talsarnau boat. It is otherwise known as the vessels displacement and is standardised at the point when the water line is 75% of the total depth of the same vessel amidship. It is an indicator of relative size and load carrying potential of the vessel. The Talsarnau boat has a displacement of 14.996 tonne at a draft of 75% of her midship section (Appendix 2d.3). The displacement volume is therefore 14.997 cubic metres. This makes the Talsarnau boat one of the larger of the Dwyryd boats. The Dwyryd boats are known to have been between 2-8 tons, whether this is burden or displacement is not known. This fact supports the theory that the Talsarnau boat is possibly one of the boats introduced from the Mersey and Dee Estuaries.

Midship section coefficient

The ratio of the midship section area to the area of a rectangle whose sides are equal to maximum breadth and draught. The Talsarnau boat has a **CMS** of 0.787 for its given displacement (Appendix 2d.3). This indicates that the vessel is relatively full in the midship area. A low value, less than 0.85, is indicative of good speed potential.

Prismatic Coefficient (CP)

The **CP** is the ratio of the immersed volume of the area of the midship section multiplied by the water line length. The **CP** for the Talsarnau boat at its given displacement is 0.702 (Appendix 2d.3). This puts the vessel in the region of a fast passenger ship on the GLHS variation of form. It also means the hull form is not full fore and aft, but fine.

Block coefficient (CB)

This is the ratio of the immersed volume of the hull to that of a rectangular block whose sides are equal to the extreme breadth, the mean draught and the length of the hull. The **CB** for the Talsarnau boat at its given displacement is 0.553 (Appendix 2d.3). This indicates that the vessel has relatively fine lines. The **CB** is less than that considered for the Great Lakes Historic ships research project variation of form.

Coefficient of Fineness of Water plane (CW)

This is the ratio between the area of the water plane and a rectangle formed by the waterline length and maximum breadth. A figure of 0.7 or less indicates a fine vessel whilst one of 0.9 indicates a slab sided vessel. The Talsarnau boat has a **CW** of 0.786 at its given displacement (Appendix 2d.3). Again this would define the Talsarnau boat as a fast passenger boat on the GLHS variation of form. The CW of most pre-modern vessels is low compared to a modern day equivalent (McGrail, 1998.197). This is due to the nature and restrictions of the method, material and level of technology used in the construction of such vessels.

Speed potential

When placed into the Hull Form programme at its given displacement it is shown that the Talsarnau Boat can be easily rowed at 2.5 knots without creating too much drag. The steepness of the Drag/Speed ratio increases after this (Appendix 2d.7). At three knots only 4.2 kg of drag is required to be overcome. After this the drag to speed ratio rises exponentially, at 4 knots the drag is 25.3 kg, and at 5 knots is 75 kg. Thus 3 knots would be an easy speed to attain fully loaded at a leisurely row or in light airs, whilst 5 knots could be achieved by two rowers exerting a substantial amount of power, or with full canvas up and a stiff breeze.

Boat Building Tradition

The constructional detail seen in the Talsarnau boat is unusual. The use of carvel bottom planks and clinker sides is not uncommon (see page, 231-235), however the use of clinker and carvel in this form of hull shape, rounded but hard bilge as opposed to chine, is uncommon. It could be argued that the Dywryd boats were built to a design not indigenous to North Wales, and therefore considered an intrusive type of vessel; but the fact that a number of local boats and boatmen were hired for the trade up and down the Dywryd cannot be ignored. As such the constructional details seen in the Talsarnau boat are of interest.

The use of clinker and carvel strakes in conjunction with heavy framing is reminiscent of constructional features seen in medieval cogs and are general diagnostic features of the "Celtic tradition" of boat building (Greenhill, 1995.186; Steffy, 1994.100). Initially Roberts suggested that it could have been the remnants of a "Celtic" boat building tradition that had survived unnoticed in a backwater of Wales (Roberts *pers. comm.*, 1988). This however is unlikely for two reasons. First, the Dwyryd estuary was not a backwater at this time. On the contrary it was a lively port with a flourishing export trade in slate and other commodities (see Davies, 1913; Hughes and Eames ,1975; Morris, 1856). Ships from the area visited ports all round the world, bringing imports as return cargos. One of these imports was timber. This aspect is highlighted by the wood species used in the Talsarnau boat. Second, the predominant tradition of boat building in the area is a light, clinker built boat as typified by the Aberdaron fishing boats (Smylie, 1999,46). Though the construction technique evident in the Talsarnau boat is similar to that of the early "cogs", it need not be a direct descendant.

A common form of lighter along the Northwest coast of England and Wales was the Flat. The Flat is commonly associated with the Mersey and Weaver Rivers (Mannering, 1997.210) but was known to have travelled as far as the North Wales coast (Jones, 1973.147) whilst others were registered, if not actually built, locally in North Wales (Jones, 1973.189,190,194,204). This is not surprising as North Wales had extensive coastal traffic with Chester on the Dee and Liverpool on the Mersey. Flats were essentially heavy bulk cargo carriers, carrying such commodities as timber, metal ores, stone, slate linen yarn and agricultural produce. Indeed, Owen in recollections of his fathers business at Porth Fanog tells us that:

> "Coal was brought from Parlar Du in barges and lighters - long flat-bottomed boats. These originally came from Liverpool and were used to carry coal, slate and sand ex Beaumaris flats and Caernarvon Bay sand banks." (Owen C., 1978).

Though much is known of the larger late nineteenth century flats little is known of their smaller contemporary sisters or the earlier boats from which they undoubtedly developed. The earliest use of the term Flat to describe a specific vessel is 1702. The flat described was a distinctive type of craft that could be used up river and for lightering (Stammers, 1993.12).

Unlike Severn Trows or Thames Barges, Flats were not actually flat bottomed but had a noticeable deadrise and rounded bilges. Flats were all carvel built except for some built on the Yorkshire side of the Leeds and Liverpool canal which were clinker (Stammers, 1993.25). Stammers describes the overall hull form and construction of a Flat as

> "A curved stem and raked stern post and their bows were rounded but not as a bluff and square as in the Humber keel. They could be described as "apple cheeked" and they had a distinct hollow at the base of the stem and a good run aft, particularly in the round-sterned flats. The shape hints at an older origin, possibly medieval, and within the overall pattern lies a range of subtle variations of fineness and bluffness." (Stammers, 1993.23).

The above description all but describes the Talsarnau boat. Indeed the "plan of a Flat" dated 12th November 1782 and the small flats seen in the painting of the salvage of the barque *Valparaiso* published by Stammers (1993.22,183). It is easy to see the Talsarnau boat as a localised form of Flat that was specifically designed for the environment of the Dwyryd but not called a Flat. It is known that new boats were built in Liverpool in 1820 because the original boats were not considered good enough for the job (Lewis, 1989.80). It would seem plausible considering the documentary and archaeological evidence to hand that the Talsarnau boat is a derivative of the Flat.

Historical Discussion

The period for the employment of the Talsarnau boat is confidently dated to the nineteenth century. Its abandonment is considered to predate the development of the Dwyryd Saltings, c.1887. During this time the Dwyryd was a thriving maritime community, with schooners, brigs, sloops and ships visiting the area carrying cargos from around the world. The reason for such activity was the success of the slate quarries of Ffestiniog and Blaenau Ffestiniog. The population of the Parish of Ynys Cynhaiarn grew from 525 in 1801 to 5506 in 1881 (Lindsay, 121) due to the success of the slate industry.

The first recorded evidence for slate quarrying in the area comes in the form of a reference to slated roofs between 1575 and 1580 (JMHRS 1969 134-6). The early slate industry was localised and sporadic by nature. It was not until Methusalem Jones' involvement in the industry that slate quarrying in Merionethshire developed into a viable commercial enterprise. The first commercially viable slate quarry was Diffwys. When exactly it was developed is unknown, but it was working before 1771. Further quarries were developed at the being of the nineteenth century, but not until the 1820's did the slate industry in Merionethshire really expand. By this time Madoc had carried out most of his improvements to the area. A new town at Tremadoc and harbour at Portmadoc had been built, whilst the cob across Traeth Mawr was closed and permission was being sought for a tramway along the cob. Eventually the Ffestiniog Railway was opened in 1836, signifying the beginning of the end for the use of boats on the Dwyryd. The final end did not come till the 1860s.

Initially slates were transported first by pack horse and cart to a suitable loading place along the Dwyryd, then loaded into small boats which took the slates onwards to ships waiting for the load at Ynys Cyngar. The Dwyryd was navigable up to Maentwrog, the limit of tidal influences. It can be expected that the Dwyryd was used for the transport of goods other than slate prior to the 1800's despite there being no corroborative material to support this. Many of the Dywryd boats carried return loads of coal, beans, onions, salt, ale, porter, guano, and rails for the quarries; they even carried rails for the Ffestiniog Railway (Lewis, 1989.97). Quays were built at the main loading points from Cei Newydd up the river to Cemlyn (Lewis, 1989.26-57).

The boats were crewed by two boatmen. The boatmen were called "Philistines", the meaning of which is unknown. Most of the men came from Talsarnau or Penrhyn in Traeth Bach at the mouth of the Dywryd. The boatmen were either casual workers or had a second income to supplement their wages (Lewis, 1989. 92). It is likely that the otherness of the world of the Dwyryd boat men meant that they were seen as separate from the rest of the community.

The boats are described as being between five and seven tons burden (PYR 30218) with a maximum recorded size of ten tons (PRO MT 19/115/591), though this last statement did not define whether it was burden or displacement. It would seem that various sizes of boats were employed at any one time being between 2 and 8 tons burden with at least half being in the 5-6 tons bracket, approximately (Lewis, 1989. 78). No mention as to the hull type or form is given. Of interest, in this respect, are the observations of Samuel Holland (1952.10). He states that his father did not consider the Dywryd boats then in use (1820) to have been, "of a good construction". Holland tells us that his father had two new boats built in Liverpool to an unknown design and specification as replacements. It might not be too much supposition to suggest that Holland had two "Flats" built. Flats would have been ideally suited to the Dywryd, both its environment and the trade plied. Although as Lewis rightly states, it would appear that the overall size of these new boats was not copied, it could be feasible that their constructional features were. Stronger boats would lead longer lives and need less repairs. Overall the Dywryd boats appear to have been small shallow and flat bottomed (Lewis, 1989.98), an apt description for the Talsarnau boat.

Conclusion

The boat found at Talsarnau has proved to be an important find in its own right. The vessel can be directly associated with the Dwyryd boats and boat men by virtue of its date and the finds found within the boat. It is therefore directly associated with the development of the slate quarrying at Blaenaufestiniog. A lot is known about the Dwyryd boatmen and the logistics of running slates out to waiting schooners (Lewis, 1989) but, as is often the case nothing was known of the vessel themselves.

The excavation and subsequent basic analysis of the hull timbers instigated a study into the understanding of the Dwyryd boat men (Lewis, 1989). The cataloguing and more in depth analysis of the timber remains held at Ynys Faelog has furthered our understanding of the vessel, its capabilities, and the overall hull form. As the only find directly associated with the Dwyryd it can not be considered as "the type of vessel used" along the Dwyryd but can be considered as "a type" of vessel used on the Dwyryd. This last point does not detract from its importance.

The transition from carvel to clinker, in and around the turn of the bilge, seen in the Talsarnau boat complies in general with Hocker's bottom-based building tradition. It is feasible that the Talsarnau boat represents a late though local form of "Flat", built specifically for the slate trade of the Dwyryd. Even though this cannot be confirmed without further boat finds the Talsarnau boat represents an important find in its own right. It represents a type of boat that traded on the Dywryd, the coastal regions of Tremadog Bay and possibly further afield; as well as showing the level of boat building technology in the eighteenth century.

General Conclusion

General Conclusion

"In the first place, one must be aware of what is in sight. Secondly, it may be physically or economically impossible to record everything," (Steffy,1994;192).

This thesis set out to fully record and document the remains of each of the vessels in the care of the University of Wales, Bangor. It then proposed to use the results to assess; the inter-reliability of using coefficients of form for comparative studies, the Great Lakes Historical Study classification of form and Mckee's descriptive variations in form. The remains of each vessel had to be recorded and documented first before they could be reconstructed on paper and a body plan and table of off-sets produced. The results of which were then loaded into a computer hull dynamic's programme, *Hull form 8*. This process allowed for the final production of coefficients of form. The conclusions and lessons learnt from this study are presented below.

Documentation

The documentation of each vessel is an essential and important part of the thesis. This has meant the production of a written catalogue of all timbers associated with the five individual vessels. Each identifiable piece of articulated or dis-articulated timber has a written description, even if only to state its overall dimensions. A full list of attributes for each piece has not been recorded, this is theoretically non-exhaustive, but the main attributes (scantlings) and a general description of each constituent piece has been documented. The production of a descriptive catalogue of each find is an important and essential part of the primary archaeological data. For the first time this data will be available for the interested researcher.

The written description of each part of each vessel can be deemed tedious, but was necessary to ensure a standard level of record for each vessel. This has been attained and a number of lessons learnt from its production. No set format for the description of each part or component parts was chosen, instead a narrative format is utilised to describe the individual parts. However the description of component parts does lend itself to the development of a standard descriptive format. Though this might make reading the catalogue of hull timbers in its entirety more tedious, it would allow for the greater accessibility of the data. Indeed the next stage would be to accompany each description with a standard pro-forma data sheet. This would contain the minimum required information that would be accessible at a glance; for example, the scantlings, number and type of fastenings present, wood species and type of joints or other features deemed of interest.

The adoption of the terms "moulded" and "sided" has proved to be of importance when recording individual timbers. This eliminated the confusion between thickness, width and height that can arise when recording separate pieces of a vessel. The use of both terms gives an immediate orientation to each piece if other features such as scarfs and lands are present, allowing the identification of inboard and outboard faces as well as fore and aft ends. The correct and proper use of terms is essential when recording nautical finds so confusion between dimensions that can be found in different planes is not caused. This is an aspect that has unfortunately been missed in other publications on nautical finds, as pointed out by Burningham (1999:300).

The documentation of the individual vessels has highlighted the need to consider a general format for such documentation. This format should be based on the minimum requirements deemed necessary for an understanding of the vessels constructional particulars and not the requirements of an archaeologist who wishes to pursue a full reconstruction of the vessel through what ever medium. This, realistically will require further recording and the ability to access the timbers throughout the reconstruction of the vessel, which can be classed as a different level of record. This thesis has highlighted a requirement for a clear and concise standard/format/guidelines for the recording of nautical remains that is easily accessible to both the well informed nautical archaeologist and the less informed field archaeologist.

Recording

Though a written description of each part recovered was completed it was not deemed necessary to have an individual illustration of each component part. This was a practical decision, due to time constraints, partly forced onto the author by the articulated nature of the Llyn Padarn boat and the requirement to attain a body plan for the Talsarnau boat from its disarticulated timbers.

The Llyn Peris logboat and Llyn Peris boat received the "full treatment". This meant having each piece; recorded at 1:1, to a scale of 1:10 or 1:5, an illustration for each part, a constructional drawing of the vessel, a body plan from 1st reconstruction and a lines plan all of which accompanied the descriptive catalogue. The pieces of the Llyn Peris boat were dis-articulated with little or no information as to the overall hull form. Therefore, to understand the overall shape and general construction of the vessel a comprehensive study was required.

The logboat being smaller and less complex leant itself to being recorded quickly and thus receiving the "full treatment".

This was not the case for the Llyn Padarn boat. A different approach was taken to recording this vessel. The surviving parts of the Llyn Padarn boat are still articulated. The planks, except for the garboards and the fore part of each plank, did not survive. The vessel was thus recorded as it stood without separating each part. This was a necessity as permission was not granted to dis-assemble the vessel and there were no facilities to do so. The survival of most of one side of the vessel up to and including the sheer strake did allow a body plan from first reconstruction to be made. Indeed the Llyn Padarn boat proved to be the easiest to record a body plan for due to its articulated nature.

The remains of the Talsarnau boat represented a separate problem. With limited time, and the fact that not all parts of the vessel were recovered, it was deemed more important to record and illustrate the main constructional parts of the vessel that would allow the vessels hull shape to be reconstructed. All parts recovered have been drawn 1:1, but only the main constructional pieces and the recovered framing have been reduced for production in the thesis due to time limits. The framing held the main information on the overall shape of the vessel, whilst the planking which held little or no ability to reconstruct the vessel was omitted. The body plan from first reconstruction has shown that this is viable if time is of the essence and there are conservation, storage or financial considerations. As such a sampling strategy based on the selection of key diagnostic parts is essential. The inability to reproduce 1:1 drawings also highlighted the uselessness of such drawings for publication if a reduction facility is not available.

The reduction of 1:1 drawings requires an in-line rolling scanner for direct reduction of the drawing or preferably to digitise the drawing. A digitised drawing can then be enhanced and reduced to the required parameters, with a basic graphic's package and computer knowledge/hardware. It must be noted that in-line scanners are not readily available and are expensive tools. Scaled drawings 1:5, 1:10, 1:20 are more useful as they are easily reduced on a standard photocopier or A3 scanner. The choice of either process is reliant on the capabilities of the person required to do the reductions. It should be noted that despite the problems with reduction for publication 1:1 drawings are irreplaceable if the timbers cannot be inspected directly due to conservation or storage requirements. They also act as a check for variations in the size and distortion of the timbers due to conservation or storage. As such they should always be carried out sooner rather than later.

Few constructional parts of the Pwll Fanog wreck were recovered, thus each piece received attention. It has proved to be impossible to reconstruct a body plan and therefore understand the overall shape of this vessel. Little can be said of this vessel except very generalised statements about its construction and possible comparisons of individual parts to other vessels. This does not lessen the importance of the vessel but does leave the archaeologist wishing for further information. The real importance of the site is the collection of dressed roofing slates from an early historical period. Pwll Fanog is an important site type for pre-industrial slate due to having an absolute date.

Three-dimensional reconstruction

As Steffy states, we should be trying to achieve a representation of the original vessel no matter how incomplete that might be (Steffy, 1994;6). This would require the ability to reconstruct each vessel in three dimensions, at least on paper. To be able to develop a body plan which would allow us to understand the form of the vessel itself information was gathered and sought. Construction drawings alone do not allow us to understand the hull form. More often than not constructional drawings are two-dimensional and lack the essential third dimension. Constructional sections can be recorded, however these are not necessary if a body plan is presented along with the construction drawings. The three-dimensional hull shape can be extrapolated from the body plan without the need for constructional sections. At first it might seem that the production of a basic body plan would be simple. A reliable body plan is however the culmination of a protracted and developed procedure of reconstruction. The production of reliable body plans has allowed the hull form of the vessels to be studied for the first time.

An archaeologist must question the reliability of a reconstruction. Whilst Steffy's view, as stated above, is admirable and should be borne in mind during all nautical archaeological investigations it can not be taken literally in all cases. This has been highlighted by the study of the remains of the Pwll Fanog wreck. In this case too much would be asked of the available archaeology if a full reconstruction of the vessel was presented. The archaeologist must state clearly the level of archaeological evidence at hand when attempting a reconstruction. This will depend on the source material, the variability of which is highlighted in this thesis, and must be considered in each individual case. The validity of each reconstruction must be stated. The validity of an individual reconstruction will depend on the "controls" used to attain the reconstruction. These have to be taken from the archaeological source and not from elsewhere. To have full confidence in a reconstruction the archaeological controls must fit back into the construction or lines drawings, as is the case for each of the reconstructions in this thesis.

The archaeological controls used for the reconstruction of the Llyn Padarn boat were easy to define. The vessel has all the main dimensional timbers (stem and stern post, keel plank, framing amidship and fore and aft) still *in situ*. Thus the process of recording a body plan, and the archaeological confidence in that process, can be stated as very high. The final lines drawing conform to all the main constructional dimensions. The same can be stated for the Llyn Peris logboat, apart from its overall length. An educated guess based on the evidence to hand had to be given. Confidence can also be given for the recording of the Llyn Peris boats body plan. The main dimensional parts were recovered and the final lined drawing conforms to their dimensions. The size of the keel, stem and stern posts, midship thwart and height of the sheer line at the five frames were used as archaeological controls for this reconstruction. It also proved to be viable to reconstruct a body plan for the Talsarnau vessel. Again, archaeological controls could be defined from the known overall length of the vessel, the surveyed positions of known framing timbers, the known beam at set positions and the known depth to the top and bottom of frames. The archaeological controls do fit the lines drawing, thus giving confidence to it. The remains from the Pwll Fanog site could not be used to reconstruct a body plan. Too much would be being asked of the archaeological record if such a body plan was produced.

The procedure of reconstruction for each vessel highlighted areas where the original records were inadequate. This might have been the lack of a simple depth measurement as in the case of the Talsarnau boat, or a few sections of the hull for the Llyn Peris boat as it sat *in situ*. The lack of photographs or measured drawings from the time of recovery of important features such as, the Llyn Padarn boats rudder bar or the wash strakes from the Llyn Peris boat *in situ*, is of equal importance. These few oversights might now seem trivial but if achieved at the time of the initial investigations the boats could have been fully reconstructed on paper without a re-investigation of the remains.

Three-dimensional computer based analysis

The production of body plans from first reconstruction for four of the vessels meant they could be loaded into a computer program, *Hullform 8* (Blue Peter Marine, 1999). This meant each vessels hull form could be studied through the production of a set of coefficients of form and three dimensional graphic representation. The use of a computer program allowed the coefficients to be calculated quickly. The data should be inputted direct from the body plan from first reconstruction. It should not be enhanced or developed from that. Obvious discrepancies in transferring data should be corrected, but no further developments or enhancement of the lines should be done. If it is, then it should be clearly stated that the lines are a second reconstruction i.e., a second stage of development has taken place and therefore it is two full development stages away from the original archaeological source. Naval architecture computer programmes should be used as analytical tools and not design or development tools.

The use of computer software for the analysis of archaeological remains has proved to be a success if done with care and honesty. It allows calculations, the development of coefficients and varied analysis to be done quickly. It is not, however a short cut. A high level of recording has to be maintained to make the computer based work relevant. It is too easy to allow the software to drive the recording and research. Caution must be expressed at the use of such computer software and the results must always be archaeologically questioned. It is too easy to re-design a vessel based on a body plan from first reconstruction on the computer.

Hull dynamics data and coefficients of form are not readily available for most historic vessels or archaeological finds. No study of the corpus of archaeological finds has been carried out nor is there a comprehensive review or readily available list of coefficients of hull form from which to carry out a comparative study. It was beyond the scope of this thesis to produce such a list, though the coefficients of form given within the thesis could easily be added to any such list. Further coefficients can be developed from the computer program as and when required by further research. The development and use of the coefficients of hull form within the thesis has shown the relevance to the study of boats and ships alike. The presentation of such coefficients should become standard in any nautical investigation, either as an appendix or as a separate section.

Observations on the use of coefficients of form.

The Great Lakes Historic ship's research project (GLHS) set out to establish a methodology which would be applicable to the study of hull forms from varied regions and eras (Wilson, 1989:201). As part of the methodology a table of variation in form was constructed. Most of the vessels analysed for the GLHS were large vessels and boats. No general description is given of their hull form but due to their nineteenth and twentieth century dates it can be assumed that they had transom sterns and on the whole were not constructed from clinker planking Only 1/8th of the total of vessels recorded in the GHLS were classed as small craft (Wilson, 1989:212). This does not mean the vessels were small double ended boats.

In this thesis the GHLS table of variation in form has been used for comparative purposes only. Its use does not help to understand the vessels in this study. Double ended vessels inherently have relatively fine lines, due to the nature and restrictions of the method, material and level of technology used in their construction. Sir John Scott Russel noted this when considering the optimum shape for a boat (Emmerson, 1977:19) For further analysis to be relevant it will be necessary to produce a different set of ratios. This will require further research into the use of such coefficients on archaeological remains.

Of further interest in the study of nautical finds is the inter-reliability of coefficients and ratios. As discussed above further research has to be carried out into the inter-reliability of coefficients of form and the use of tables of variations in form. However this thesis has proved that using a standard ratio for calculating displacement is viable for comparative studies; in this case Lloyds minimum safety requirement for freeboard, 1 inch in every 4, or 75%, (Upham, 1978:1978). It should be noted that it was felt that for boats this should be seen as a maximum and not necessarily the working displacement due to the freeboard, or lack of it, at a ratio of 1:4. For boats a ratio of 1:3 or 1:2 might be more appropriate for working displacement.

A study of the coefficients of hull forms for the vessels in the thesis shows similarities due to the generic hull shape of the vessels. This could be indicative of the fact that all the vessels are load carriers, the GLHS defines them as fast ferries, but this need not be the case. Whilst undoubtedly form can follow function, it is also influenced by the constructional material used and the environment within which it is used. Thus the relative fineness of the water plane is indicative of this form of construction as noted by Sir John Scott Russel (Emmerson, 1977:19). Furthermore, the main coefficients and ratios of form tell us that the boats are beamy or erring on the side of beamy. They are also relatively shallow of draft. This can be seen as an effect of the environment in which the vessels were used. All the vessels were used in an environment where a premium would be set on draft. There are only three main dimensions in the design of a vessel, length, breadth and depth (draft), a compromise must be made if one cannot be exceeded. The working draft of the vessel was obviously important. It can thus be assumed that to gain the required displacement (load carrying ability), beam was increased so that the maximum draft was not exceeded. Thus it can be seen that coefficients of form can be used to highlight certain constructional restrictions.

The standard data sheet produced by Hull form 8 is presented in this thesis. It should be noted that not all the data is used in comparative studies. All the data is however relevant if a more in-depth study of each vessel is required. Such a study could consider the carrying capacity, sailing, rowing, stability and seaworthiness of each vessel. Therefore the data is presented for further research by the interested researcher.

This thesis has thus shown a flaw in the general application of hull form coefficients as a method of comparing vessels remains from different periods and generic constructional principles. Further research to establish proper coefficients or ratios of the coefficients is needed before they can be used with real confidence. In recent years an attempt at research into this problem has been carried out (Jensen,1999). Unfortunately the study only became available after the main body of research in this thesis had been concluded. It however only serves to highlight some of the problems encountered in this type of research and highlighted in this thesis. Coefficients are used to try and categories the type of vessels in the study (Jensen, 1999:51). However using coefficients in a preconceived way neglects the need to analysis what is actually being expressed by the coefficients. It is unlikely that coefficients of form will help to answer specific questions. They are more likely to be of help in generalisations and descriptive comparisons of hull form. They are unlikely to help categories usage, for example whether or not a vessel is a fast ferry, cargo vessel or warship.

It is in this respect that McKee's more descriptive use of coefficients of form has proved to be of worth. The five different vessels under consideration have been described using McKees descriptive form. Using a standard form for description allows for a comparison between the vessels. This thesis shows that they can be used despite different generic constructional principles and are thus inter-reliable, which is a necessity if a standard is to be achieved in comparative research.

Historical significance

The technical documentation of nautical finds is of importance, but there is also a requirement to have a wider understanding of what the vessels tell us about the economic and cultural background (Westrdahl, 1998:364). Before the vessels were found knowledge of nineteenth century boat building and the general use of boats in north Wales was limited. The vessels have shown that during certain periods there was a need to build and maintain a relatively sophisticated transport system which utilised water craft. The question as to what this transport system was for must arise. A common theme in this thesis is the development of the local industries, especially but not exclusively the slate industry. Another industry highlighted by the study of the vessels is the early copper mining in Snowdonia (the logboat is not suitable for the carrying of slates but would be for copper ore, a low volume but expensive commodity). When trying to understand the role of each vessel, communications or more specifically the use of water courses as means of transport and communication, prior to the building of roads is also another common theme. Thus this thesis has highlighted and enhanced our knowledge of the history of the early industries and economic infrastructure of north Wales.

When considering the social history of the industrialisation of north Wales certain generalisations can be expressed about the boat building influences in the area. The main tradition would appear to be that of the clinker built, shell first, light internal framing and a fully developed keel, as seen in the Pwll Ffanog vessel and Llyn Peris Boat. This is supported by iconographic and documentary evidence (see pages 71, 169-172). This form of boat building is considered to be evidence for Scandinavian, or more generally North European, influences (Greenhill, 1995:191). This should not be considered unusual as throughout the early medieval period there was a strong Scandinavian influence in Welsh politics. It is not surprising that there can be seen comparisons to the Scandinavian form of boat building with well-established Viking settlements at Dublin, Wexford and the Isle of Man encircling north Wales. Also of interest are the external localised influences evident in north Wales and highlighted by the Llyn Padarn boat and Talsarnau boat.

The Talsarnau and Llyn Padarn boats cannot be considered as representative examples. The Llyn Padarn vessel was without doubt built specifically for the Dinorwic slate quarry. It is not a developed form of local craft but an intrusion. No other examples of a Llyn Padarn form of vessel have been found in north Wales. It was a specific one off design, built for a specific job. The same can generally be said for the Talsarnau boat. It can also be considered as intrusive, though not as a one off design. The Talsarnau boat has constructional details and a hull form that suggest an influence on its design from the Mersey Flat. This is not surprising as Flats were known to have been used in north Wales, and indeed two Liverpool built boats (probably Flats), were employed on the Dwyryd.

It is of significance that both vessels appear in what has been termed the "expansionist phase" of the economic history of north Wales (Pritchard, 1942:30). The expansionist period, c.1790-1877 (representative dates rather than specific ones), saw the replacement of the independant quarrymen by capital-intensive organisations under the control of a new social elite. It was a period of continuously accelerating demand for slate fuelled by the need to house an ever increasing industrial work force. The increase in demand for welsh slate was bolstered by a low price on delivery when compared to other roofing materials (Pritchard, 1944:319). This was secured by the development of a specialised local maritime industry characterised by strong internal competition which saw a continued reduction in cost of freight from the late eighteenth century to the end of the nineteenth century (Pritchard, 1944:320). An integral part of this maritime industry was the use of boats to transport the slates on inland waters. The usurpation of the local independant quarrymen by financially motivated businessmen was however the most significant development. These men were not interested in tradition but in financial viability and costs. They would not think twice about introducing new forms of vessels to the area if it suited their purpose. The Llyn Padarn and Talsarnau boats are evidence that in the commercial world "tradition" can be a luxury.

Conclusion

It can be concluded that whilst this thesis is not a complete in-depth study of each vessel (the bottom of the Talsarnau boat still needs to be recorded and the rest the Pwll Fanog slate mound requires investigation) due to set limitations on time and resources, it is a study of the timbers recovered, and in store, and an analysis of the first reconstructions of the vessels under consideration. The research potential of each vessel has not been exhausted but the presentation of the primary data pertaining to each vessel allows it to be added to the growing corpus of nautical material. Only with a general study of this corpus can a sufficient understanding of the broader issues of boat building traditions and their localised adaptation be considered.

The thesis illustrates both the quantity of material associated with the archaeological remains of boats and the limitations of understanding such remains, which is dependant on the totality of the vessel, the quality of the initial recording and the time needed to study such evidence fully. The thesis has highlighted areas of weakness in the general application and inter-reliability of specific coefficients of form to small craft in comparative studies. It has however shown that McKee's pioneering work is still a sound basis from which to work. From an historical perspective the vessels themselves reflect external influences on North Wales as the industrialisation of local industries progressed. The thesis has increased our knowledge of an otherwise unknown part of the maritime heritage of north Wales.

GLOSSARY

The glossary of terms is derived from a number of sources. Dixon and Kemp, The Oxford English Dictionary and The Oxford Companion to the Ships and the Sea (Kemp1993), formed the basis of the terms within the glossary. Mckee (1976 a&b), Leather (1973), Steffy (1994) and Chapelle (1969), March (1970) and Ansted (1898) were the main cross reference. Every book in the bibliography that had a glossary was also consulted. The main notable area of discrepancy in the use of nomenclature was that of caulking and luting. Though there is an obvious difference between the two forms of waterproofing, which is still recognised today in modern boat yards, many archaeologists do not differentiate between the two. This is even more surprising as both are readily identifiable in the archaeological record. A number of references to caulking in archaeological reports actually refer to luting (Marsden 1994 and 1998, McGrail 1993, Nayling 1998). All naval architecture terms are derived from the *Hull form 8* glossary (Blue Peter Marine Systems, 1999).

Abaft- Aft- a relative term used to denote the position of an object relative to another, it being further towards the stern than the other object.

Athwartship- running from one side to other. Also classed as Abreast.

Afore- fore-forward- the opposite of abaft.

After- the state of being aft i.e., towards the stern of something else.

After most- the stern most part.

After part- the stern extremities of a vessel or anything else.

Amidships- the middle part of a vessel

Apron- A piece of timber fixed behind the stem post in much the same way as dead wood.

Astern- towards the stern.

Baulk- A hewn tree, or more specifically a piece of timber for masts.

Batten- see ribband.

Bearding- the surface of the stem or stern rabbet that is in contact with the inside of the plank.

Bearding line- the line that forms the aft or fore-most part of the bearding.

Beam- A timber that crosses a vessel athwartships, usually used to support decking.

Bevel - a surface that is angled to fit to its opposing surface. An oblique edge of a plank or piece of timber.

Bilge/turn of the bilge- The transitional area of the hull, from the bottom of the boat to the sides.

Bit-Bits- Pins for fastening ropes to.

Blind hole- a hole that ends within the wood and does not break through to the other side.

Blind fastening- a fastening that doe not penetrate through the opposite surface from which it has been hammered.

Block coefficient- the ratio of the volume displaced by the product of waterline length, waterline beam and draught.

Body plan- the two dimensional representation of athwartship sections through a vessels hull.

Bolt- a large square or circular cross-sectioned pin, of various lengths and made from metal, used in the fastening of ships timbers. They can be threaded with nuts and washers or just plain.

Brailing pin- a pin used to fasten a rope around. Usually comes in pairs.

Breasthook- a "U" shaped timber used to bind the stem to the shelf, frames, inwales, sheer or other parts of internal framing forward thus holding the sides together.

Butt- as in butt joined. To place two pieces of wood together squarely.

Butt strap- a piece of wood fastened over a butt join.

Buttock line- a vertical fore and aft section of a vessel.

Bulkhead- a transverse athwartship wall.

Brails- ropes that draw the leech of a loose footed sail up so as to stow it or to reduce the sail area.

Carvel- method of ship construction where by the strakes are butted together.

Cant frame- a frame that is plumb to the keel but comes off it at an angle and not at ninety degrees as most other frames do. Cant frames are usually found in the stem or stern area to avoid excessive twist, bend or bevel.

Caulk-caulking-caulked- a method of making planking, etc, water-tight by forcing caulking materials into the seam after assembly. Unlike luting caulking is an integral part of the construction of the vessel.

Caulking material- in the modern sense long stranded cotton, though in other periods it could be made from any type of available material i.e., organic matter, horses hair, cattle hair, old rope and was commonly termed oakum.

Caulking tools- at its most basic this comprises a mallet and a blunt chisel called an iron. More complex tools can comprise a mallet, hawsing tool, reamer, wheel, and a number of irons; such as a common or making, deck or dumb, bent, spike, sharp or butt, reefing or clearing irons.

Ceiling- planking/boards placed or fastened along the inside of the hull, usually on the frames, to protect the framing and hull planking from the cargo.

Centre of buoyancy-LCB- the fore and aft location where the buoyant forces acting on the hull have no rotational force. It expressed here as a percentage between the fore and aft most extent of the waterline.

Centre of floatation-LCF- the geometric centre of the area enclosed by the vessel's waterline. It is important for defining pitching motions.

Chine- the area of the hull where there is a direct acute change in angle from the bottom to the sides. Vessels can be described as multi-chined though never as multi-bilged.

Clinch/clench- to turn or bend over a nail so as it is hammered back onto the face of the wood; or to beat to the head of a bolt to deform it

Clinch/clench ring- a washer fastened to the end of a bolt to secure it.

Clinker-clincher- a method of boat building where the top and bottom edge of the strakes over lap.

Clench bolt- a bolt with a ring (clench ring) fastened to an end to stop it from pulling out.

Deadwood- timber fastened above the keel and behind the stem or stern post to fill in the space in such areas.

Dead rise- the angle that the bottom of the boat rises from the horizontal, usually refers to that angle seen on the floors.

Deck beam- a beam that is laid athwartship to support the deck planking.

Deck hook- a breast hook laid below the deck in the bows to help support it.

Diagonal- a fore and aft sectional line coming down at an angle from the centre line being neither horizontal or vertical.

Dowel- a wooden peg used when edge fastening, locating planking or to plug holes.

Draught- distance between bottom of the keel and waterline.

Drag- a proto-road used to pull sledges down from the top of a hill.

Drift bolt- a bolt larger in diameter than the hole it is to be driven into.

Dumb fastening- a method of fastening where by the end of the fastening does not go all the way through both pieces of wood. It usually refers to bolts as opposed to nails.

Dunnage- material used to pack and protect a cargo.

Eye bolt- a bolt with a metal ring at its head, which can be used to tie into.

Fashion Pieces- the aft most pieces of timber/framing that form the stern.

Fairing- when the buttock, waterlines and diagonals all correspond.

Fastenings- the bolts, nails, etc which hold the framing and planking together.

Faying- to fit surface closely. Faying surfaces are usually coated in luting before being fastened together.

Feathered- tapering to nothing.

Flare- the increase in width of the hull from the bottom up.

Floors- Floor timber- the lowest part of a frame, which crosses the keel. A half floor might cross the keel but does not extend to the other bilge.

Fore- towards the bow relative to another piece.

Forelock- a wedge shaped piece of iron driven into a slot at the end of a bolt to secure it.

Frame- the athwartship timbers that form the skeleton of the vessel. A frame can be a single timber or made up of component parts i.e. floor, futtocks and top timbers.

Futtocks- a component part of a frame, being those timbers between the floor and the top timber, numbered from the bottom up.

Full-fullness- rounded section that shows a vessel has ample bouyancy.

Garboard strake- the first strake after the keel on the port and starboard side of a vessel.

Gudgeon- fitting used to support the rudder in conjunction with a pintle.

Gunwale-gunnel The top edge of the hull. Also refers to a longitudinal member that adds strength to the top edge/sheer of a boat locking over the timber heads.

GZ- or the horizontal lever arm. It is the distance between the centre of mass and the metacentre of the hull.

Half-breadth plan- a graphical representation of a vessel hull shape in plan form from the centreline out to one side.

Halse-hoodend plank. The terminal plank of the garboard. The term halsen is still in use in present day Shetland.

Hem- bevel on the upper edge of a clinker plank formed to take the upper plank.

Hog- the sagging at the extremities of the ends of the keel or keel plank. The opposite of spring.

Hoodend- the end of a plank that fits into the stem or stern post. See Halse.

Humbling band- A term used specifically for the leather grommet that holds an oar to a kabe.

Inboard- strictly speaking inside a vessels bulwarks as opposed to outboard. Used to define the sides of planking and timbers relative to its position in the vessel.

Inwale- generally termed gunwale.

Joggle- to cut out a notch so as the member can fit into the given space. The term is usually given in reference to frames being notched to fit clinker planking.

Kabe- a protrusion from the gunnal that acts as a pivot against which an oar can be used. Usually used in conjunction with a humbling band/grommet.

Keel- lowest and main longitudinal centre line strength timber.

Keel plank- the centreline plank, sometimes thicker than the other bottom planks, of a flat bottomed boat.

Keelson- longitudinal member fitted over the keel and floor timbers to help distribute the stress from the mast.

King post- a strong post behind the breast hook and deck hook fastened through to the stem post, which serves as a means of tying the whole structure together. A king post on a merchant ship is also used to help work the small cargo derrick.

Knights head- strong pieces of timber fitted inboard at the bows to bear the strain of a bowsprit.

Knee- a right angle member used to strengthen beams.

Land- the amount one plank overlaps another. Lands are usually bevelled.

Lap- the area of contact between two clinker planks.

Lines- waterlines- buttock lines- diagonals- the graphical representation of a vessel expressed as sectional cuts through the 3 dimensional shape of a vessel. Lines consist of, water lines (plan), buttock lines (elevation) and diagonals (diagonal to the vertical).

Luting- stopping placed in a joint before closing it. This is opposed to caulking which is forced in after the planking has been assembled.

Luting cove- a term coined to describe a channel cut into a plank to hold luting material.

Limber hole- a hole of any form that is cut or drilled into the lower part of a frame to allow water in the bilge to flow to the lowest part of the bilge.

Margin line- the internal corner of a rebate, be it on the keel, stem or stern post. It is the depth (sided) and height (moulded) dimension of this line that forms the internal angle of the rebate.

Mass per unit immersion- the increase of hull displacement required to increase the draught by a given unit of distance, in this case cm.

Mast partner- timbers or framing at deck level that support the mast as it passes through the deck.

Mast beam- athwartship timber that supports the mast.

Mast step- a rebate in the keel or keelson which the mast foot sits in.

Meginhufr- a strake that is larger then the rest and acts as the transition point for the change in hull shape from the bottom to the sides.

Metacentre- the intersection of the vertical line from the centre of buoyancy and the centre plane of the hull. It is a measurement of the inherent stability of a vessel and can be thought of as an expression of its dynamic stability. See also GZ.

Midsection coefficient-Cm- a ratio of the largest immersed area of any section of the hull to the product of the waterline beam and draught.

Moment of change of trim- MCT- the pitching moment applied to change the difference between the bow and stern heights by a unit of distance, in this case a cm.

Moulded- the dimension of a timber at right angle to the shell. The moulded dimension of the stem and stern post is that which is fore and aft. In the keel it is the vertical dimension, and in a frame it is the athwartship dimension.

Nail- a small metallic fastening; pointed at one end, with a flat head and either a square or circular cross-section. They can be described by cost, weight, size, the material they are made from or their purpose.

Nail sickness- a condition of the hull resulting from lost nails or nails that are working loose.

Nail spacing- average distance between the land nails

Oarlock- the area between two thole pins/bits in which an oar is placed. The oar acts against the pins in both fore and aft strokes.

Painter- mooring rope tied to the bow.

Pay-Paying- to cover a plank seam with a layer of water proof "paint" usually hot pitch.

Pintle- the male part of the rudder hinge which the gudgeon slides over and pivots around.

Plank- a component part of a strake.

Prismatic coefficient-Cp- the ratio of volume displaced and the product of the waterline length and the largest immersed area of any section.

Rag bolt- a bolt, usually a dumb bolt, that has been hit by a sharp tool to make a series of barbs along the shaft.

Rabbet- A groove cut into a timber so as another piece can fit into it; usually refers to the keel, stem and stern post rabbet for the garboard strake and hood ends.

Raking- the deposition of a mast, stem post or stern post, be they leaning forward or aft.

Rebate- a groove cut into a piece of timber. The common term for rabbet.

Rivet- A metal through fastening pin where the end has been hammered down so as to secure it.

Righting moment-GM- the distance from the centre of mass of the hull to the metacentre.

Rove- an iron washer used in the process of clenching a nail. Sometimes called a ruff.

Rocker- a curve upwards in the keel. This is a feature that has been formed as part of the constructional process and not due to drying or hogging of the midships.

Rubbing strake- a timber running fore and aft on the outside of the hull and projecting out, used to protect the hull.

Rudder- the piece of timber, or pieces of timber, by which the vessel is steered. This can be a stern hung rudder or a side mounted rudder.

Rudder bar- a bar fastened to the stern post, to which the gudgeons and pintles of the rudder are hung.

Scarf- a tapered joint used to fasten two pieces of timber of identical cross-section.

Scantlings- the size of a timber when reduced to its standard size before trimming for fitting. The maximum sided and moulded dimensions of a timber thus make up the original scantlings.

Seam- the longitudinal joint between strakes or planking.

Sheer- the rise of the upper most edge.

Sheer line- the line of the top most edge of the hull. This does not include the superstructure.

Sheer plan- the graphical representation of a vessel's side view. The elevation of a vessel.

Sheer strake- the top most strake on any wooden vessel

Sheets- constructionally, boards used to form a small deck in the forward (head sheets) or aft (stern sheets) part of a vessel sometimes nailed together by a strip of wood; also the rope attached to the lower corner of a sail for control.

Shell built- a method of construction whereby the hull planking is constructed first and the internal framing erected afterward.

Shore- a strut to temporarily hold timbers or the actual vessel whilst building.

Side frames- frames that support the side of vessel, as opposed to futtocks which are a continuation of a frame.

Sided- the dimension of an unmoulded surface or parallel to the shell of the vessel. The fore and aft measurement of a frame, and athwartship measurement on the stem and stern post as well as the horizontal surface of the keel.

Skeleton built- a method of construction where by the internal framing is constructed first and the hull planking fastened to it afterwards.

Spike- a large square-sectioned nail

Spring- an upward curve formed into the keel or keel plank. The opposite of a hog.

Standing strake- a garboard which is more vertical amidship then the outer strakes.

Stays- part of the standing rigging. Stays are ropes that support the mast. They run fore and aft and athwart ships.

Stopwater- a dowel placed in a keel scarf or in the join between the keel and stem post or stern post to stop water seeping into the vessel.

Stopping- material put into a seam or gaps to make it waterproof.

Stealer- a short plank inserted between two strakes so as they do not have to be made to wide. Stealers are usually found in the lower part of the bow or stern where the shape of the hull changes considerably.

Steering oar- an oar, usually hung off the stern, used to steer the vessel.

Stern frames- the assembly of timbers that make the framing of the stern, usually the sternpost, transom, and fashion pieces.

Stern post- the aft central upright timber or timbers of the central supporting timbers into which the two sides are joined. It is usually fixed to the keel or a keel plank, and it is to this timber that the rudder is usually mounted.

Stem knee- a dead wood knee place aft of the stem post to help support it.

Stem post- the forward central upright timber or timbers of the central supporting timbers into which the two sides are joined. It is usually fixed to the keel or a keel plank.

Strake- a plank or series of planks running from one end of a vessel to the other.

Stringer- a longitudinal timber fixed on the inside of the frames to give the hull longitudinal strength.

Superstructure- Parts of a boat above the sheerline including such parts as the wheelhouse but not masts and spars.

Tack- a small nail with relatively large head.

Tallow- the harder kinds of fat melted down, be it derived from animal or vegetable (trees). Commonly used to make candles, soap and in the nautical sense stopping.

Thief- a piece of timber which is inserted to replace part of a damaged or defective timber.

Through bolt- as opposed to a dumb bolt a through bolt, or fastening, is that which passes completely through the materials to be fastened together. The end is secured by clenching, a clench ring, nut or forelock

Thole-thole pin- thole bitt- at its most basic it is a pin that stands proud of the sheer line against which an oar is rowed. Tholes can have more complex shapes and cna be classed as pins or bitts, bitts being more substantial. Two thole pins/bitts can be combined to make an oarlock.

Treenail-trenails-trunnels- a cylindrical pin made of a hard wood and used to fasten planks or timbers. Treenails can be of the wedged form, which means a slit is cut in the end of the treenail and a wedge hammered in.

Tumble home- the coming in of the sides of hull. A feature commonly seen in large medieval ships.

Una Rig- a sailing rig that utilise a single sail.

Wale- a thicker than usual strake for reinforcement.

Waterplane area- the area of the hull enclosed by the waterline.

Wetted surface- the total area of the curved surfaces of the hull below the waterline.

Wrought iron- Iron which has been shaped by hand and not cast. It leaves a tell-tale grain and if badly degraded looks like wood.

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Abbreviations.

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ARCUS	Archaeological Research and Consultancy University of Sheffield.
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CRO	Caernarvon Records Office
F.H.S.P.	Flintshire Historical Society Publications.
H.A.R.P.	Heritage and Archaeological Research Practice University of Wales Lampeter.
I.J.N.A.	International Journal of Nautical Archaeology.
I.J.M.H.	International Journal of Maritime History.
M.M.	Mariners Mirror.
PRO	Public Records Office.
PYR	Porth yr Aur
R.C.H.M.E.	Royal Commission on the Historical Monuments of England.
SURRC	Scottish Universities Research and Reactor Centre.
T.C.H.S.	Transactions of the Carnarvon Historical Society.
T.A.A.S.	Transactions of the Anglesey Antiquarian Society.
U.W.B.	University of Wales Bangor.

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Appendices

List of Appendices

Appendix I

North Wales Diver Survey, 1978.

NORTH WALES DIVERS SURVEY OF SLATE BOAT WRECK

discoveredin Llyn Padarn while completing a survey for the C.E.G.B. re the Dinorwic Power Station.

Please find attached plans and profiles which should be referred to during the reading of the following report.

The wreck is situated some 650 metres along the railway shore of Llyn Padarn, from the Caernarfon end of the Lake and some 20 metres out from the shore.

She is lying at approximately 45° from true on her latitudinal axis and the bottom of the lake forms the angle along the longitudinal axis and is approximately 40° from horizontal. Which shows she is lying with her longitudinal axis at approximately 90° to the shore and is precariously close to a considerably steeper angle of lake bed at her deepest point. As can be appreciated by consulting the associated drawings these angles at which the vessel lies are causing considerable stress on the remaining sides of the boat by the solid packed slates. This would appear to be a real cause for concern should this be a significant find.

The end of the vessel nearest the shore is in approximately 27 feet of water and the other end in approximately 34 feet. It has been assumed for ease of reference that the end of the boat nearest the shore is the stern. This is not, however, just supposition, but is based on the fact that a metal ring has been discovered in the upper section of the keel post at the deeper end of the vessel. This is assumed to be a tow ring. A general description of the wreck follows, followed by a number of measured details which can be used in direct association with the enclosed sketches :

The wreck, upon close examination, appears to have no nails, screws or bolts. There are a number of wooden dowls and holes which appear to have been the main method of construction.

The boat is packed solid with cut slates. These are almost certainly Moss slates. Please notemethod of packing and position shown on the associated sketches.

The ribs of the boat above the level of the packed slates stand proud as the side planks and gunwales are now missing off the wreck, and a number of these side planks are to be found in the silt on both sides of the wreck. Because of this damage it can be clearly seen that the vessel was double clad having both outer boards and inner boards which formed a deck which seems to have continued right up to the gunwales.

The bow stanchion has a metal ring through it (possibly wrought iron). This ring appears to have been riveted over on the inner side and may have been pinned as there is a hole some 2" from the inside edge of the riveted ring and shows signs that this may have been a locking pin.

Much of the bow of the vessel is bedded into the surrounding silt, and from preliminary checks it would appear below the silt, the wood forming the vessel is in very good condition and is still very solid.

During our survey it was noted that a number of the cargo slates had become dislodged from the wreck and have fallen down the slope. This movement is still continuing as on a subsequent day more slates were noted to have fallen. While checking the cargo it was noted that the slates were packed side to side very tightly across the vessel. The whole of the vessel appears to have been filled. In our opinion the whole of the deck space was filled leaving no room for a passenger or oarsman unless he worked from on top of the cargo.

The following are the measurements taken throughout the wreck:

There are seven ribs down each side of the vessel each approximately 30" apart. The bow post stands 39" above the silt, though without a more complete check it is impossible to know how much of the wreck is under the silt. The stern post stands 27" above the silt.

The overall length of the boat is 19' and the widest beam measurement is 5' 10". The overall length around the contour of one side is 24' 3".

The interior planking is 12" wide and the exterior boards seem to have been 6" though this is not easily confirmed as the best examples are under the silt.

The ribs at the upper ends are apprximately 2" x 1" and at their lower end as far as can be seen 4" x 1". The bow and stern posts are approximately 4" x 6" at the upper end widening towards its lower end. On the bow post at the lower section it appears not to have been planed and is still noticably tree shaped.

The dimensions of the slates are shown on the accompanying sketches.

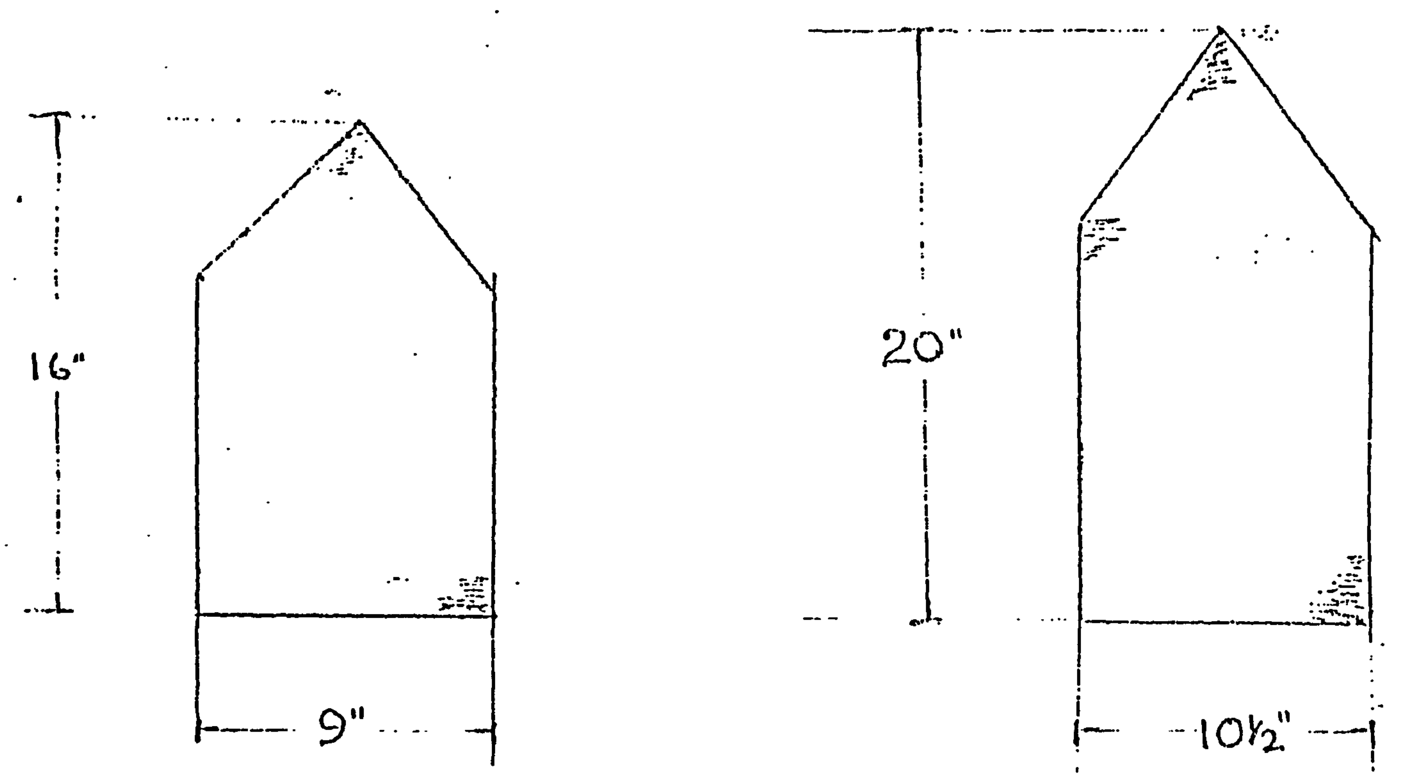
Addendum : 3 Drawings
1 Map.

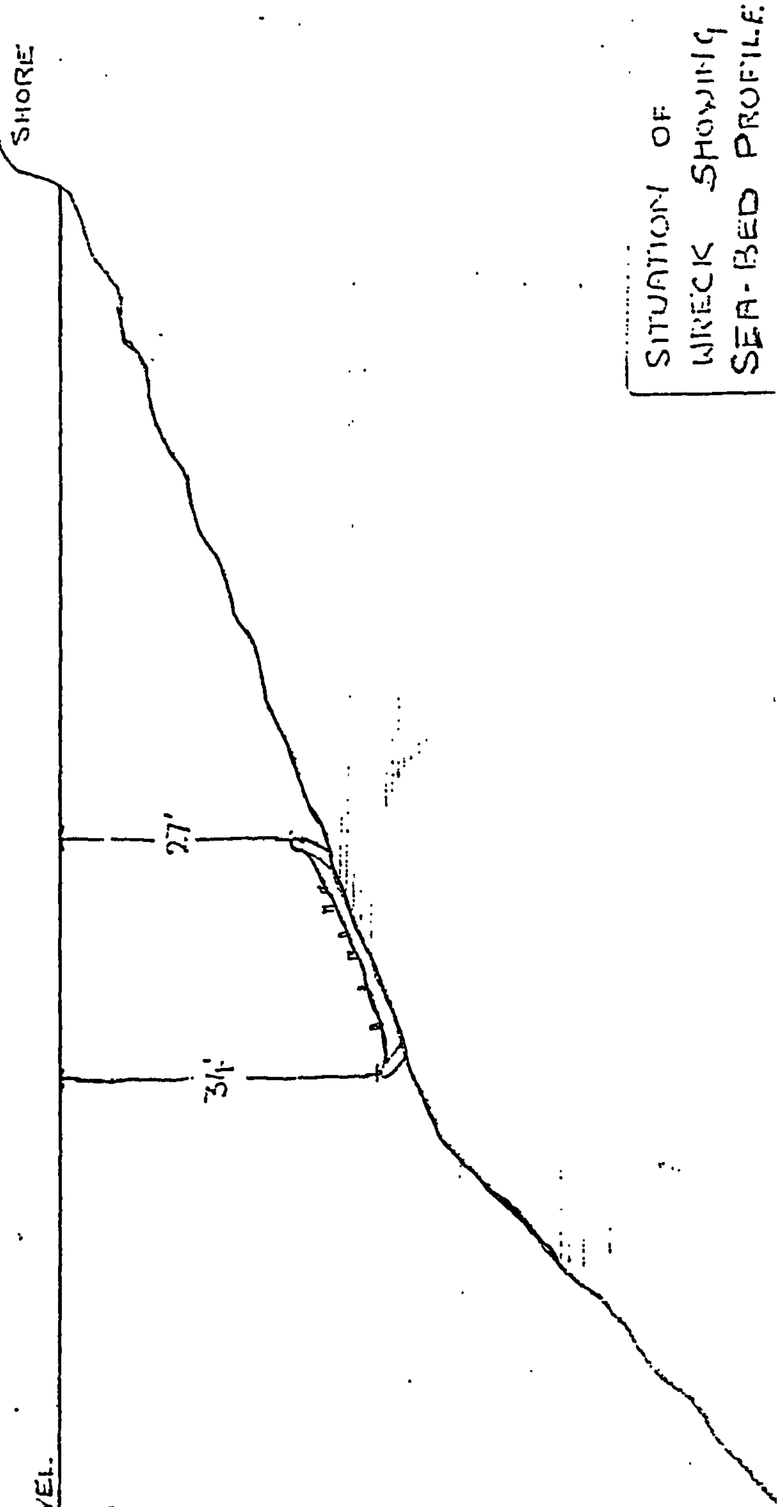
Dated this 13th day of November 1977

NORTH WALES DIVERS COMMERCIAL DIVISION

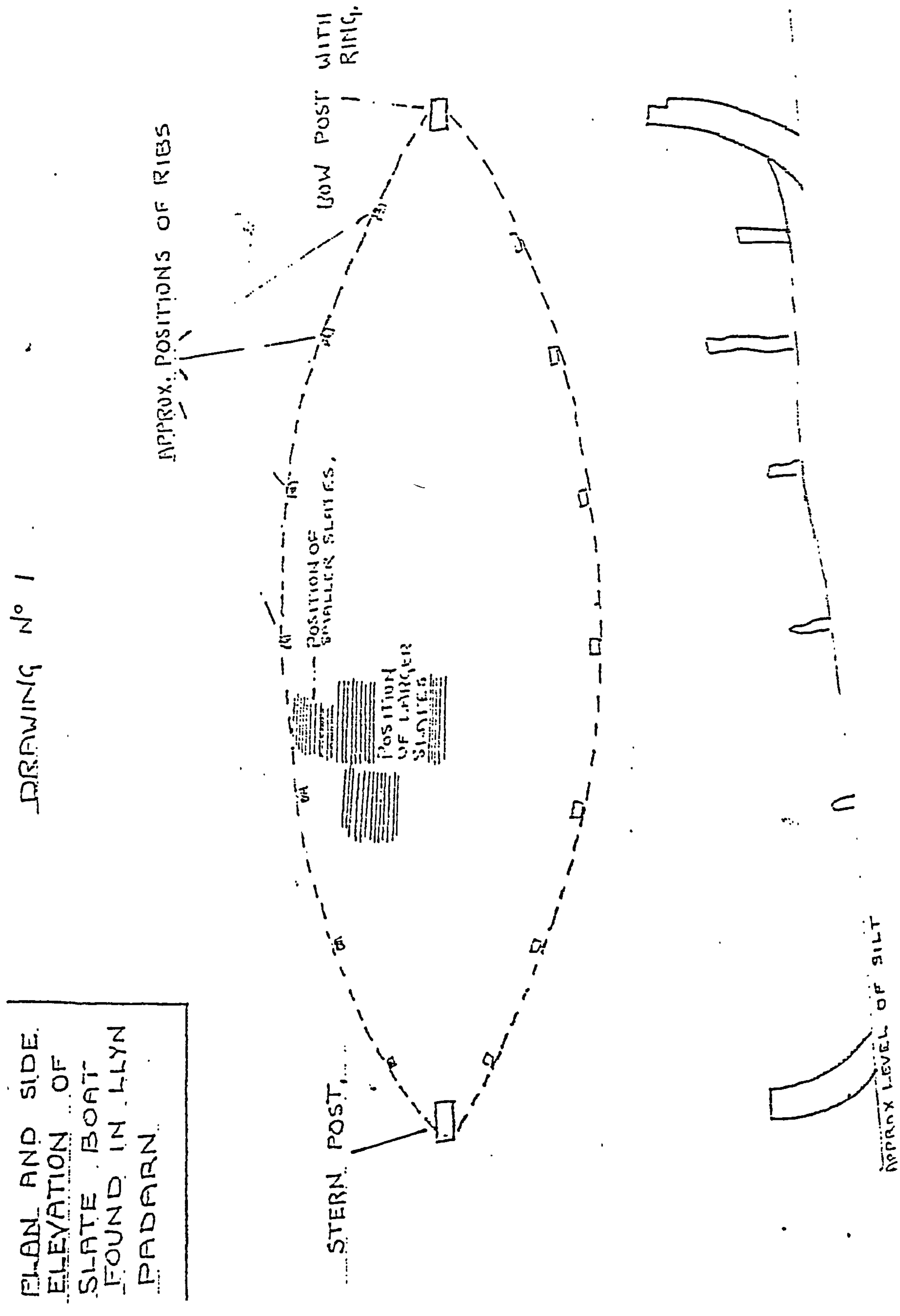
SIZE AND SHAPE OF MOSS SLATES FOUND IN SLATE BOAT WRECK.

DRAWING No. 2




SITUATION OF
WRECK SHOWING
SEA-BED PROFILE
SHORE
27'
31'
WATER LEVEL.

DRAWING N°. 3.


PLAN AND SIDE ELEVATION OF SLATE BOAT FOUND IN LLYN PADARN
DRAWING No 1
APPROX. POSITIONS OF RIBS
BOW POST WITH RING.
STERN POST
POSITION OF SMALLER SLATES
POSITION OF LARGER SLATES
APPROX LEVEL OF SILT

Appendix II

Hull Form data.

Hull form data Introduction

This appendix consists of the hull form data generated by the computer soft ware package *Hull Form 8.* It is presented here in its standard format for the interested researcher. Each section consists of; computer generated lines drawing, isometric view, standard hull form data sheet, draft/displacement curve, GZ/heel curve, and a Drag/speed curve. The relevance of each form of data is discussed below. All curves and data sheets have been calculated to the required 1 in 4 freeboard.

Computer generated hull lines

These are generate as part of the process of entering the off-sets. They are presented here to illustrate the hull form of each vessel in three dimensions. The scale is in metres.

Isometric view

The isometric view is one of an infinite number that can be generated by *Hull Form 8*. It is included to illustrate the variations in hull form of each vessel when viewed from a different angle. This allows the researcher to gain a better indication of the vessels overall hull form. This is easily shown by comparing the isometric of the Llyn Padarn boat with that of the Talsarnau boat. It is useful for visual comparisons. The use of a computer software package enables such views to be quickly produced. They can be produced as standard wire frame isometric's or textured as presented for the Llyn Peris boat. The usefulness of such visual aids cannot be under estimated, especially if there are restrictions on access/viewing of the timbers and/or vessel.

Standard Hull Form data sheet

Hull Form creates a standard data sheet. This is presented in this thesis. The full meaning of each part of the data sheet is adequately explained in *Hull Form 8* reference book (Blue Peter

Marine Systems, 1999:110-120). A basic explanation is given here for the reader. Only the first two sets of data have relevance to the work carried out in the thesis. The rest of the data is presented for the interested researcher, thus saving them time if they require such data.

The first set of data summarises the hull's state, with no angle of heel, at a given draft (3/4 of mid section freeboard). An angle of heel can be inputted if required. Of importance here is; the displacement, waterplane area, waterline beam, waterline length and draught. All of these are used to calculate length to beam ratios. Of interest for further research are; wetted surface (required for drag calculations), righting moment (required for stability calculations and analysis) and mass per unit immersion (required for displacement/MPI graph).

The second set of data gives the coefficients of hull form. These are used throughout the thesis in the relevant sections. It should be noted that *Hull Form 8* separates the prismatic coefficient into fore and aft coefficients. Though not used within the thesis this separation can be used to assess sailing and seaworthiness characteristic's.

The third set of data expresses the positions of the hull centres in a range of terminology. They can be calculated for a balanced vessel at any given freeboard (and thus displacement or load), angle of heel and/or angle of pitch. Though not used in the analysis carried out by this thesis, they are a prerequisite if further analysis into sailing characteristic's and seaworthiness is required.

Draft/displacement curve

This curve shows the relative draft at a given displacement. Draft is given in metres and displacement in kg.

Displacement/MPI

This is an indication of the mass per unit of immersion (1 cm) required at a given displacement. It is of interest for load carrying potential at different displacements and reserve buoyancy. It is presented here to show the possibilities for further analysis beyond the usual parameters of coefficients and ratios of form.

GZ/heel curve

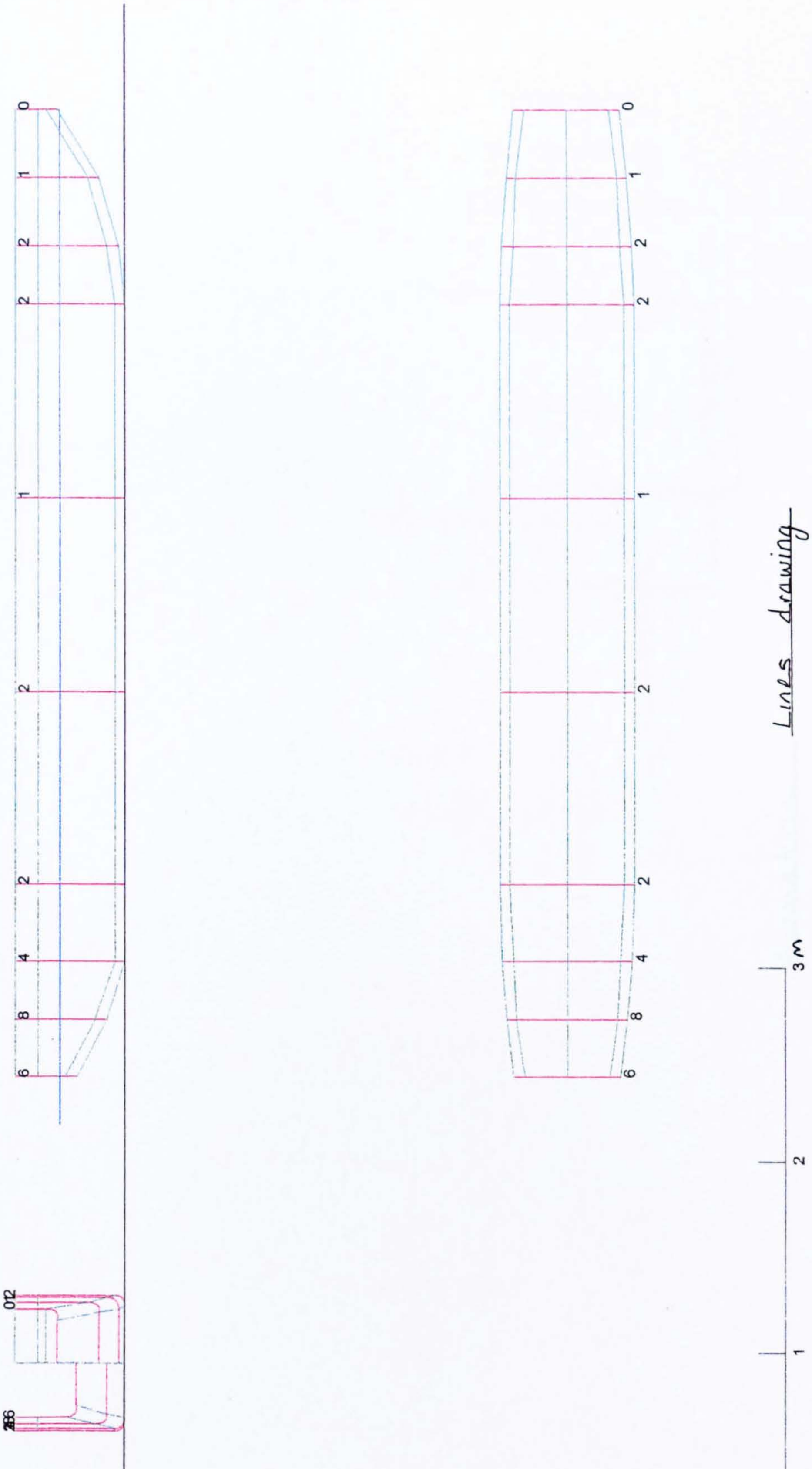
This is an indication of relative stability and stiffness of the vessel. The greater the heel the greater the GZ or not as the case might be. Of interest is the decrease in the Llyn Peris boats GZ at an angle of heel greater than 40 degrees. This means it is losing stability. If this was carried on to its conclusion the vessel would turn over, flood and sink.

Drag/speed curve

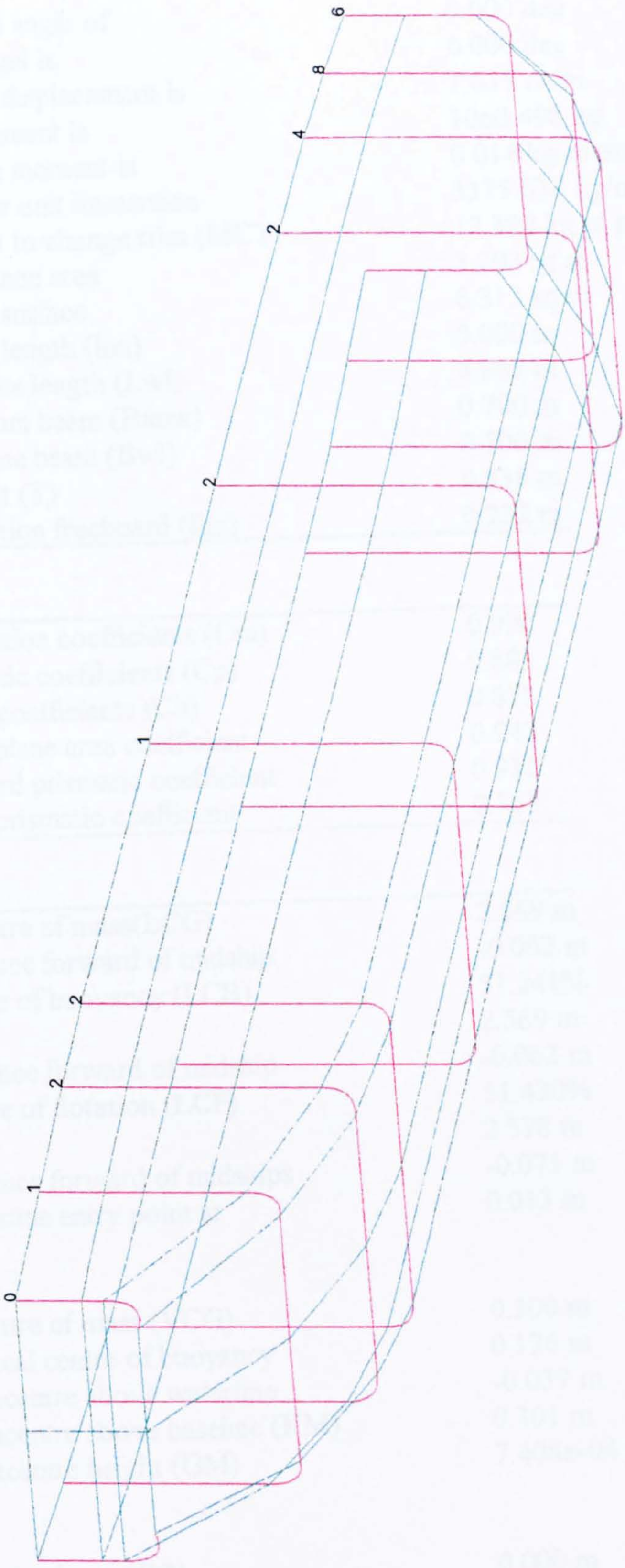
An indication of drag at a given speed. From this it is relatively easy to calculate the required power input to attain the required speed. For the purpose of this thesis it shows what speed can be attained before drag becomes to great. All the drag/speed curves are calculated at the relative draft (3/4 freeboard) for the relative displacement.

It should be remembered the data sheets presented here are just a few of the sum that could be generated. It should be stressed that the information is useless if stringent archaeological control is not kept throughout the recording and reconstruction phase. Once the offsets have been entered they should not be enhanced or tampered with except for obvious errors. The software should be used to analysis the vessel and not enhance or re-design it.

2.a- Llyn Peris Logboat.



Appendix 2a.1



Isometric

Appendix 2a.2

C:\HULSEVEN\HULLDATA\DOUGLOGPERIS.HUD

At a heel angle of	0.000 deg
Pitch angel is	0.000 deg
Volume displacement is	1.035 cu m
Displacement is	1060.498 kg.
Righting moment is	0.014 kg m per deg.
Mass per unit immersion	3375.638 kg/m
Moment to change trim (MCT)	12.382 kg m per cm
Waterplane area	3.293 sq m
Wetted surface	6.313 sq m
Overall length (loa)	5.000 m
Waterline length (Lwl)	4.987 m
Maximum beam (Bmax)	0.700 m
Waterline beam (Bwl)	0.700 m
Draught (T)	0.338 m
Midsection freeboard (Fm)	0.232 m

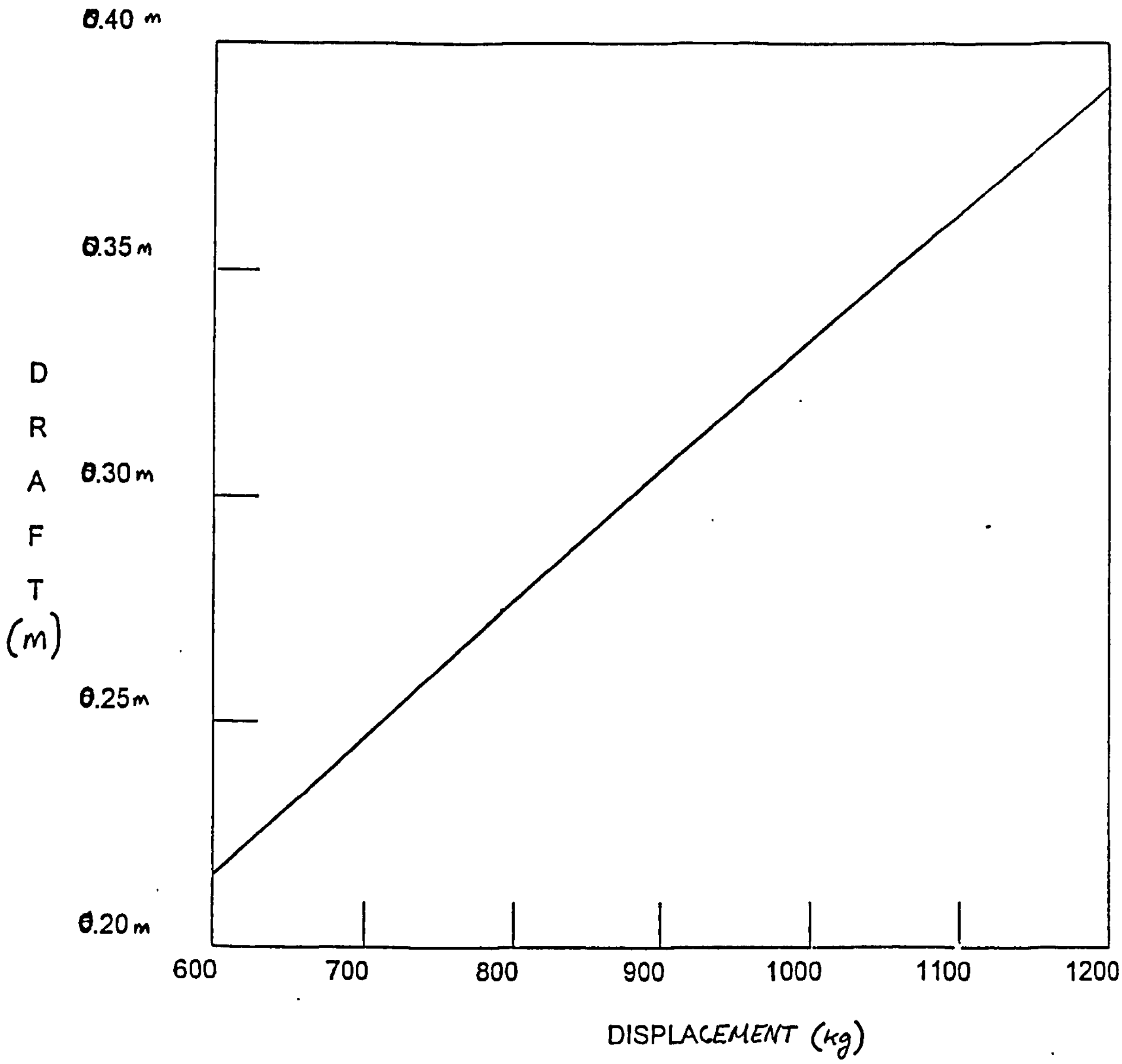
Midsection coefficients (Cm)	0.996
Prismatic coefficients (Cp)	0.881
Block coefficients (Cb)	0.878
Waterplane area coefficient	0.943
Forward prismatic coefficient	0.910
Stern prismatic coefficient	0.768

X-centre of mass(LCG)	2.569 m
-distance forward of midship	-0.062 m
Centre of buoyancy (LCB)	51.241%
-at	2.569 m
-distance forward of midship	-0.062 m
Centre of flotation (LCF)	51.430%
-at	2.578 m
-distance forward of midships	-0.071 m
Waterline entry point at	0.013 m

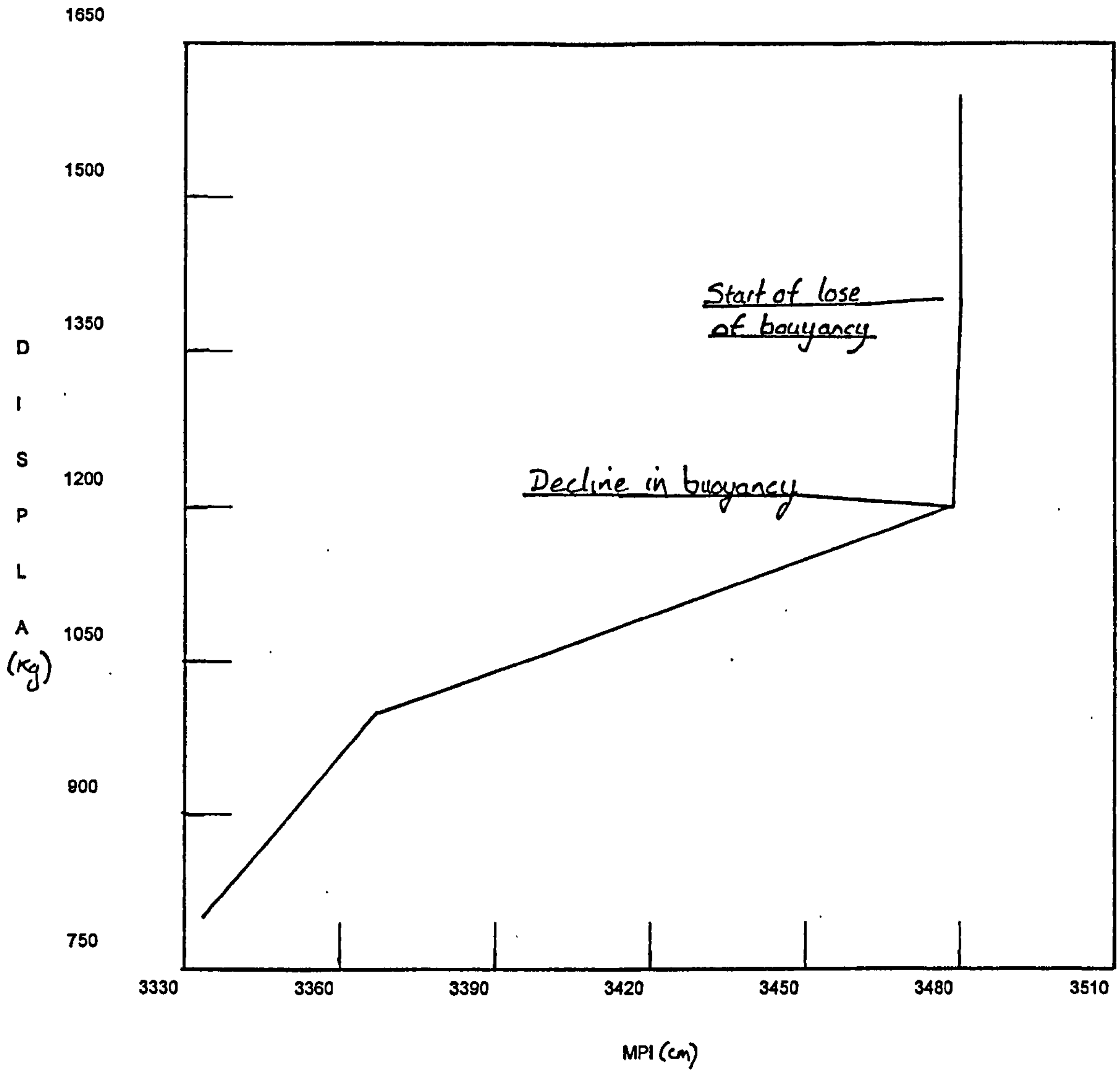
Z-centre of mass (VCG)	0.300 m
Vertical centre of buoyancy	0.176 m
Metacentre above waterline	-0.037 m
Metacentre above baseline (KM)	0.301 m
Metacentre height (GM)	7.408e-04 m

Righting lever (GZ)	0.000 m
KN	0.000 m

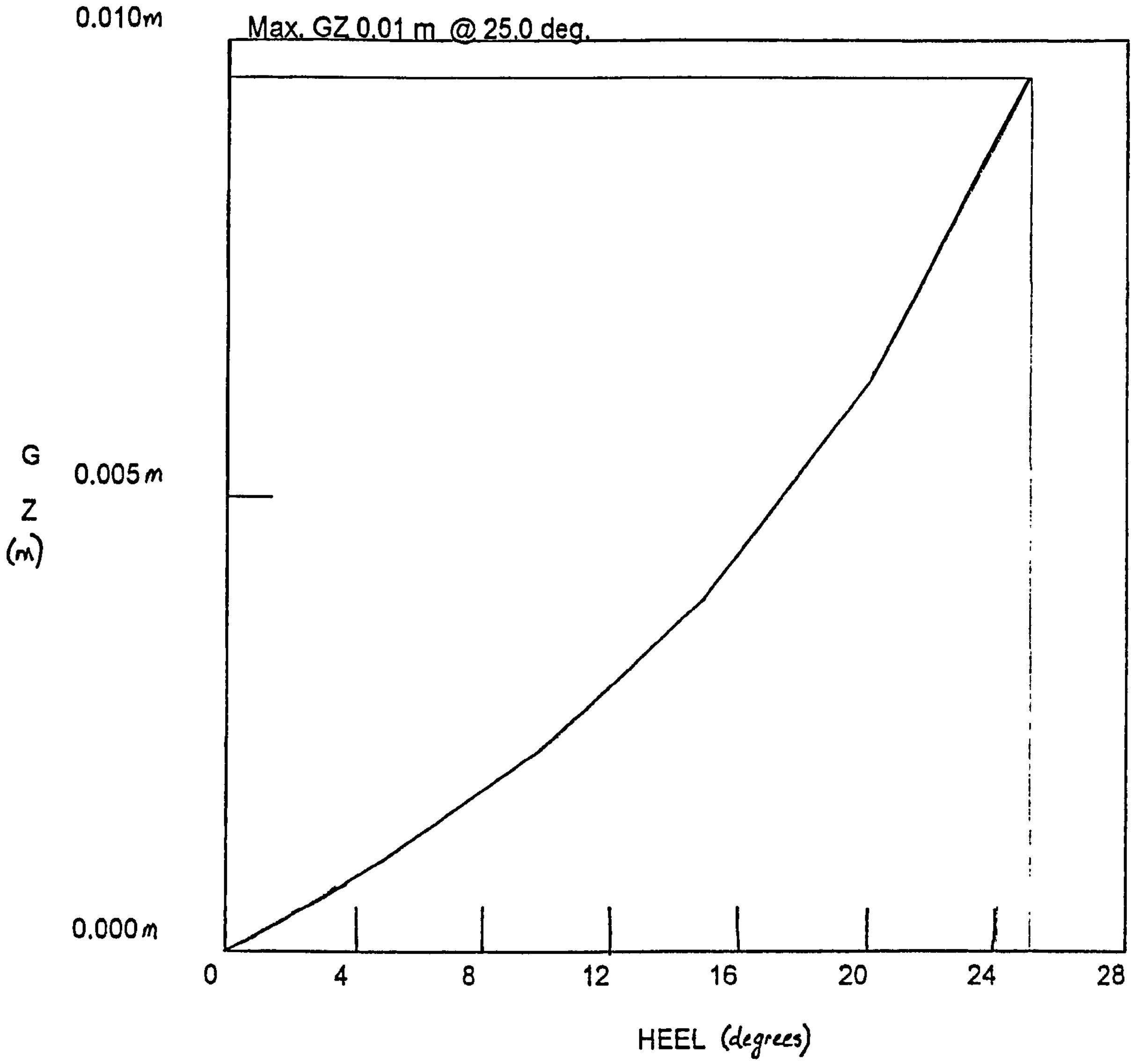
Appendix 2a.3- Hull form data sheet.



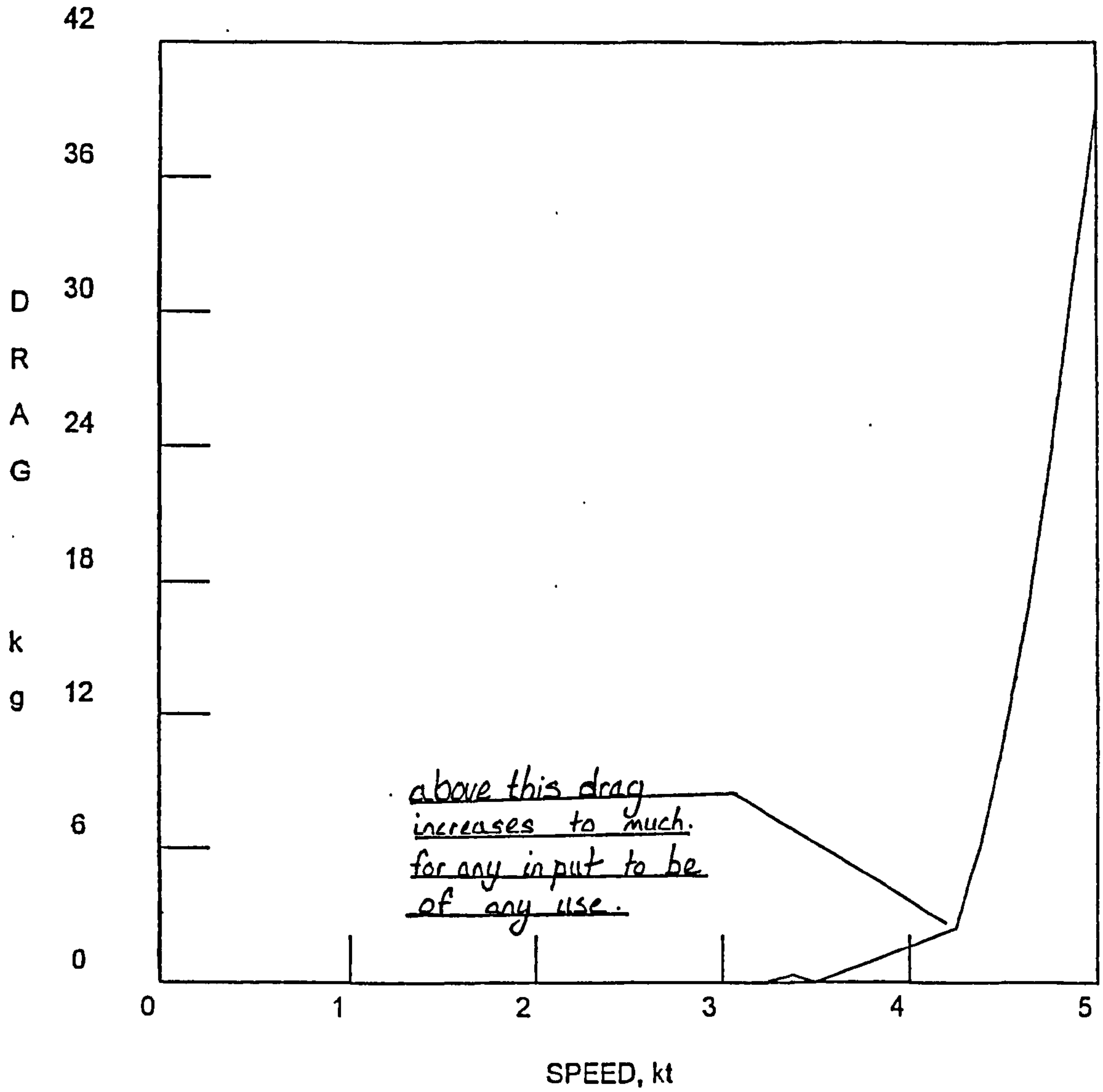
Appendix 2a.4- Draft/Displacement curve.



Appendix 2a.5-Displacement/MPI curve.

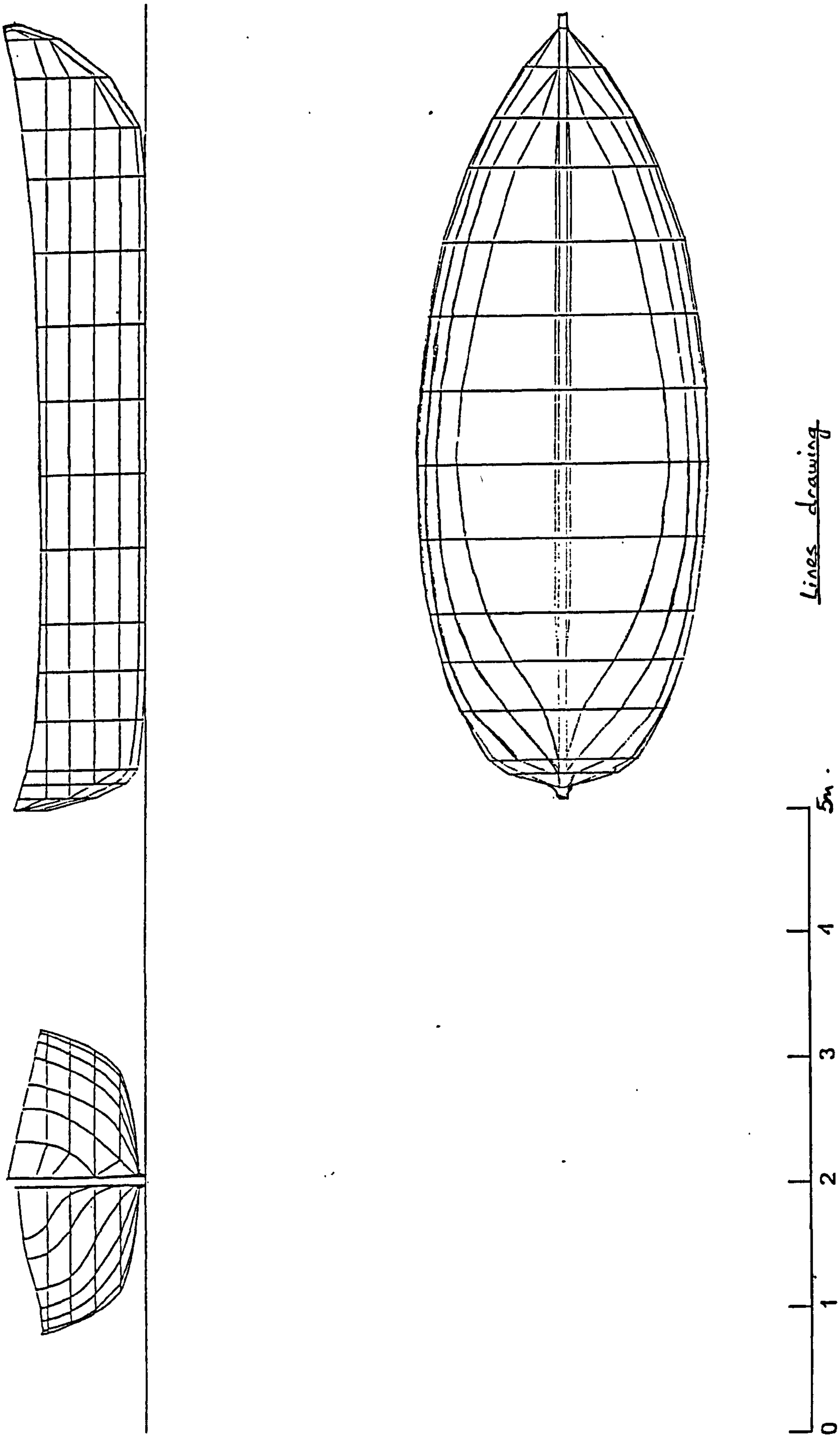


Appendix 2a.6- GZ/Heel curve.

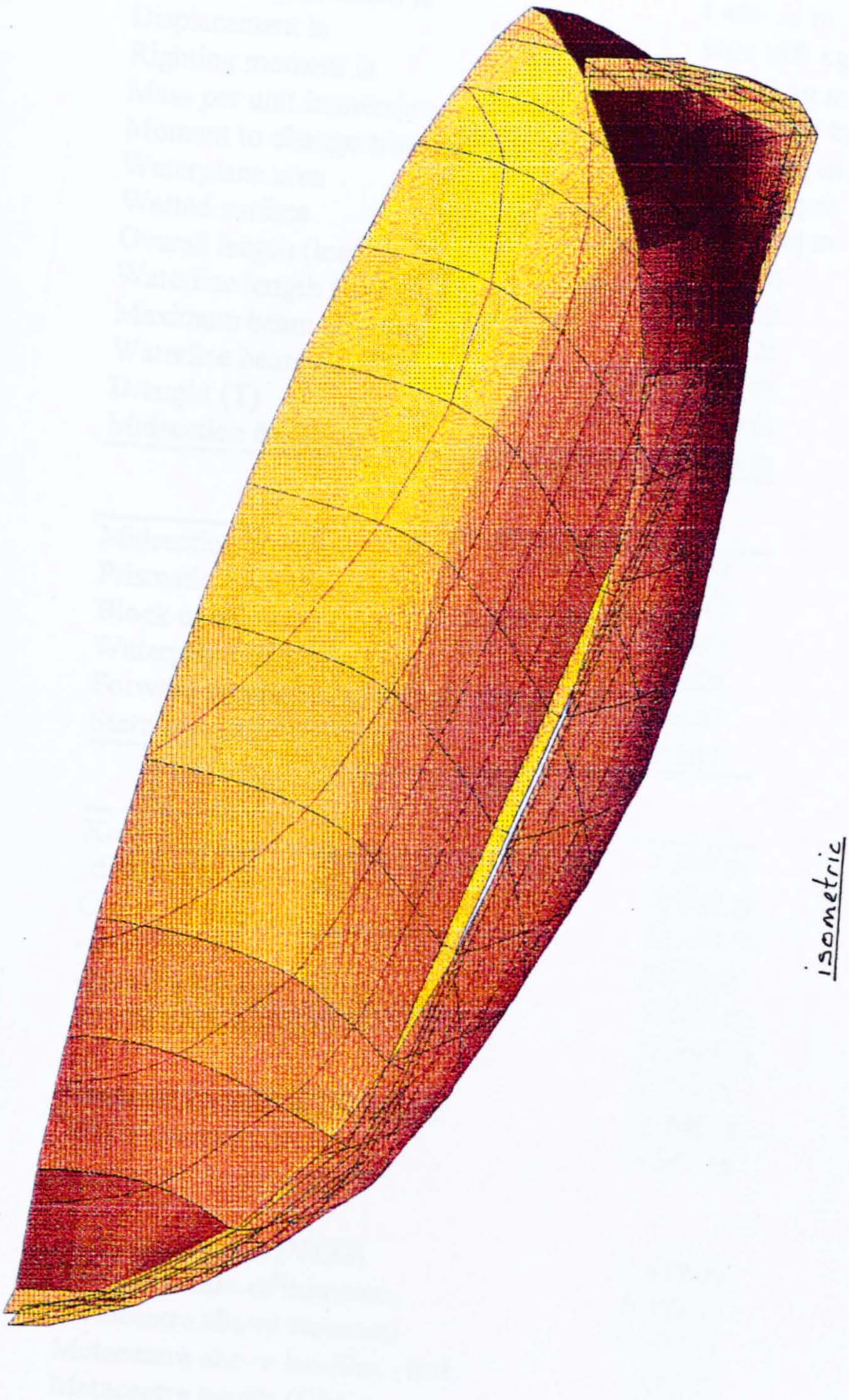


Appendix 2a.7- Drag/Speed curve.

2.b- Llyn Peris Boat.



Appendix 2b.1



Appendix 2b.2

C:\HULSEVEN\HULLDATA\DOUGPERIS.HUD

At a heel angle of	0.000 deg
Pitch angel is	-0.306 deg
Volume displacement is	4.400 cu m
Displacement is	4400.000 kg.
Righting moment is	58.493 kg m per deg.
Mass per unit immersion	1.037e+04 kg/m
Moment to change trim (MCT)	34.780 kg m per cm
Waterplane area	10.375 sq m
Wetted surface	14.217 sq m
Overall length (loa)	6.368 m
Waterline length (Lwl)	6.215 m
Maximum beam (Bmax)	2.432 m
Waterline beam (Bwl)	2.307 m
Draught (T)	0.640 m
Midsection freeboard (Fm)	0.220 m

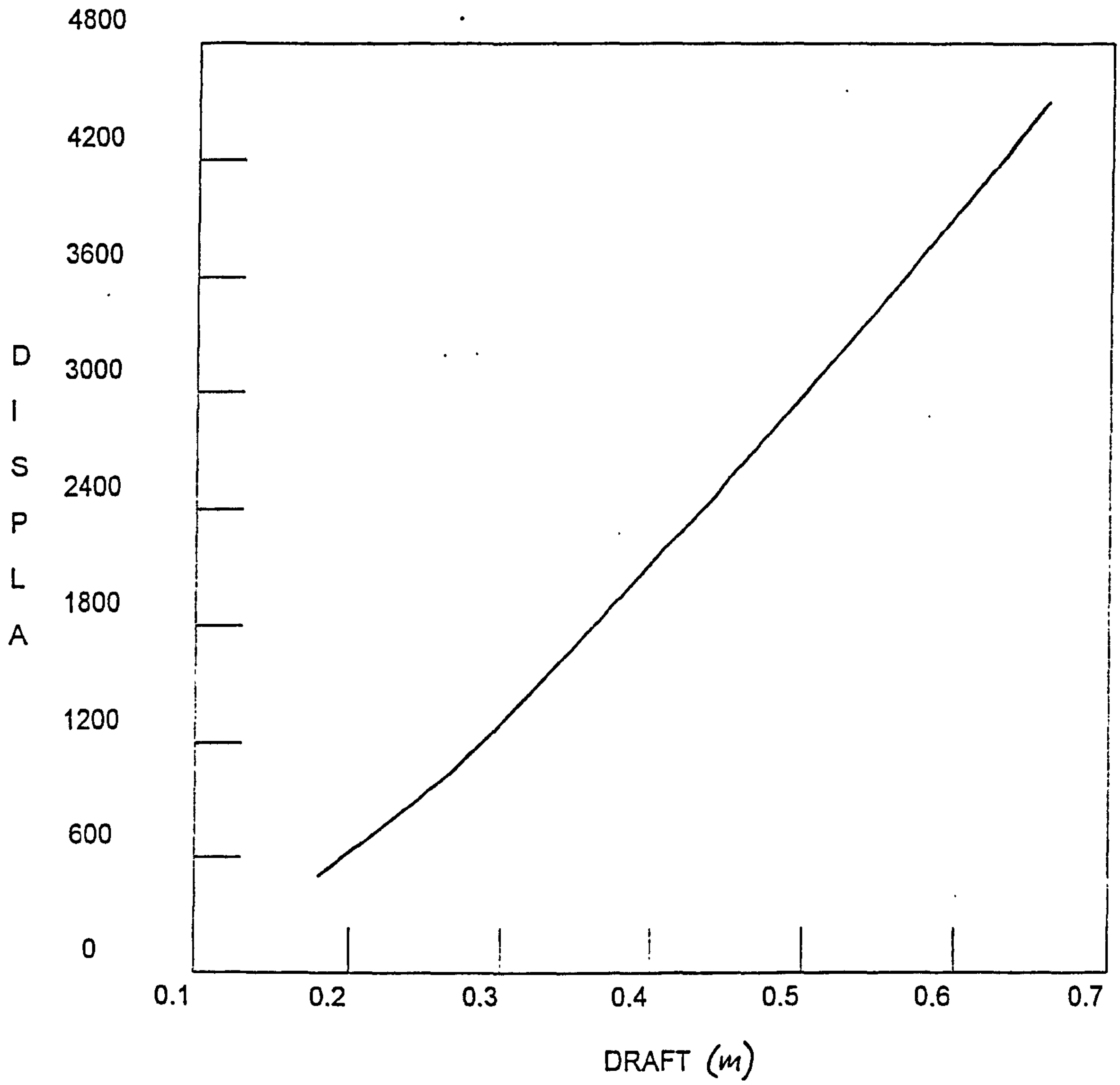
Midsection coefficients (Cm)	0.737
Prismatic coefficients (Cp)	0.642
Block coefficients (Cb)	0.473
Waterplane area coefficient	0.724
Forward prismatic coefficient	0.647
Stern prismatic coefficient	0.635

X-centre of mass(LCG)	3.300 m
-distance forward of midship	-0.092 m
Centre of buoyancy (LCB)	51.478 %
-at	3.300 m
-distance forward of midship	-0.092 m
Centre of flotation (LCF)	52.394 %
-at	3.357 m
-distance forward of midships	-0.149 m
Waterline entry point at	0.101 m

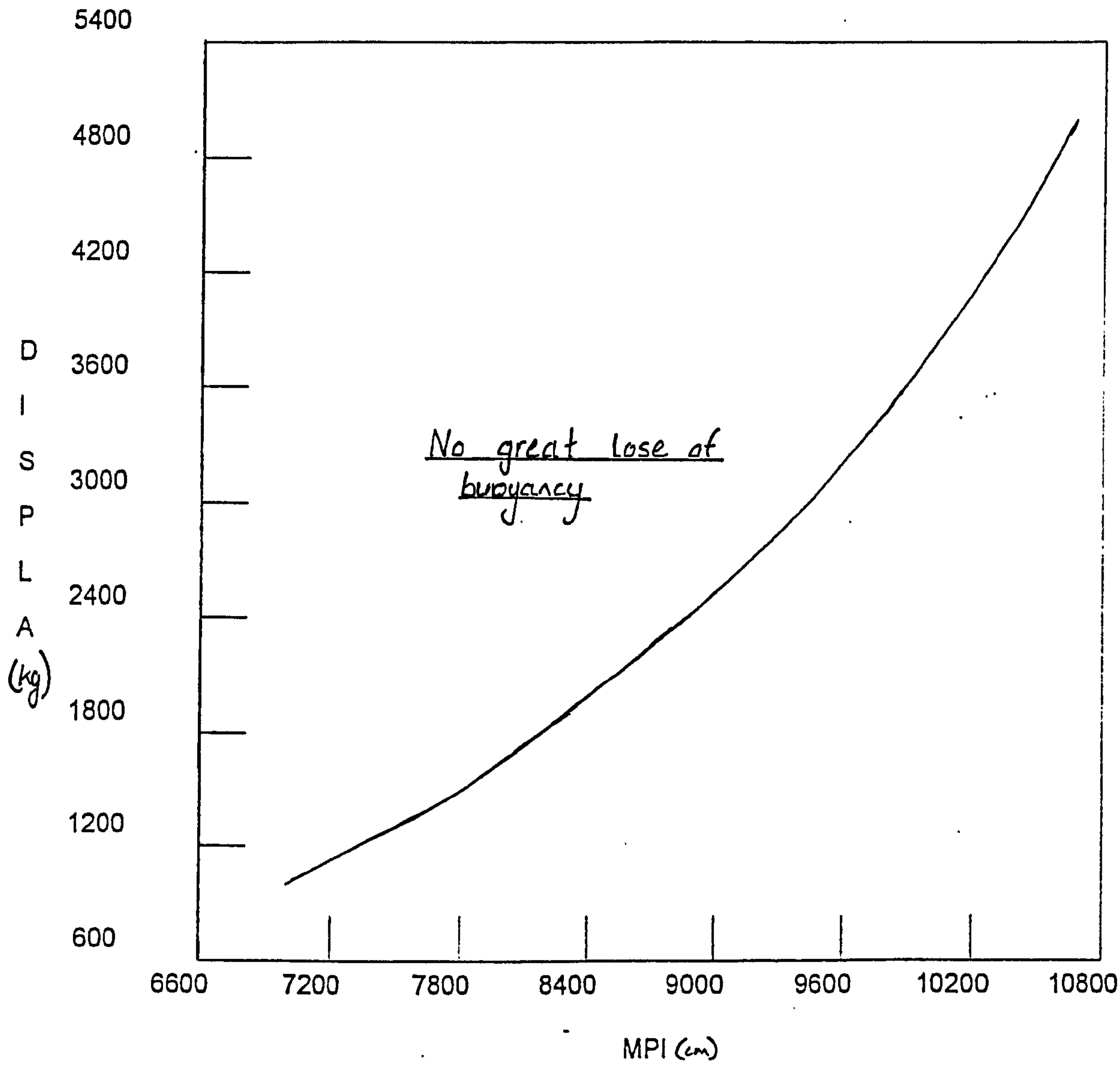
Z-centre of mass (VCG)	0.400 m
Vertical centre of buoyancy	0.393 m
Metacentre above waterline	0.507 m
Metacentre above baseline (KM)	1.162 m
Metacentre height (GM)	0.762 m

Righting lever (GZ)	0.000
KN	0.000

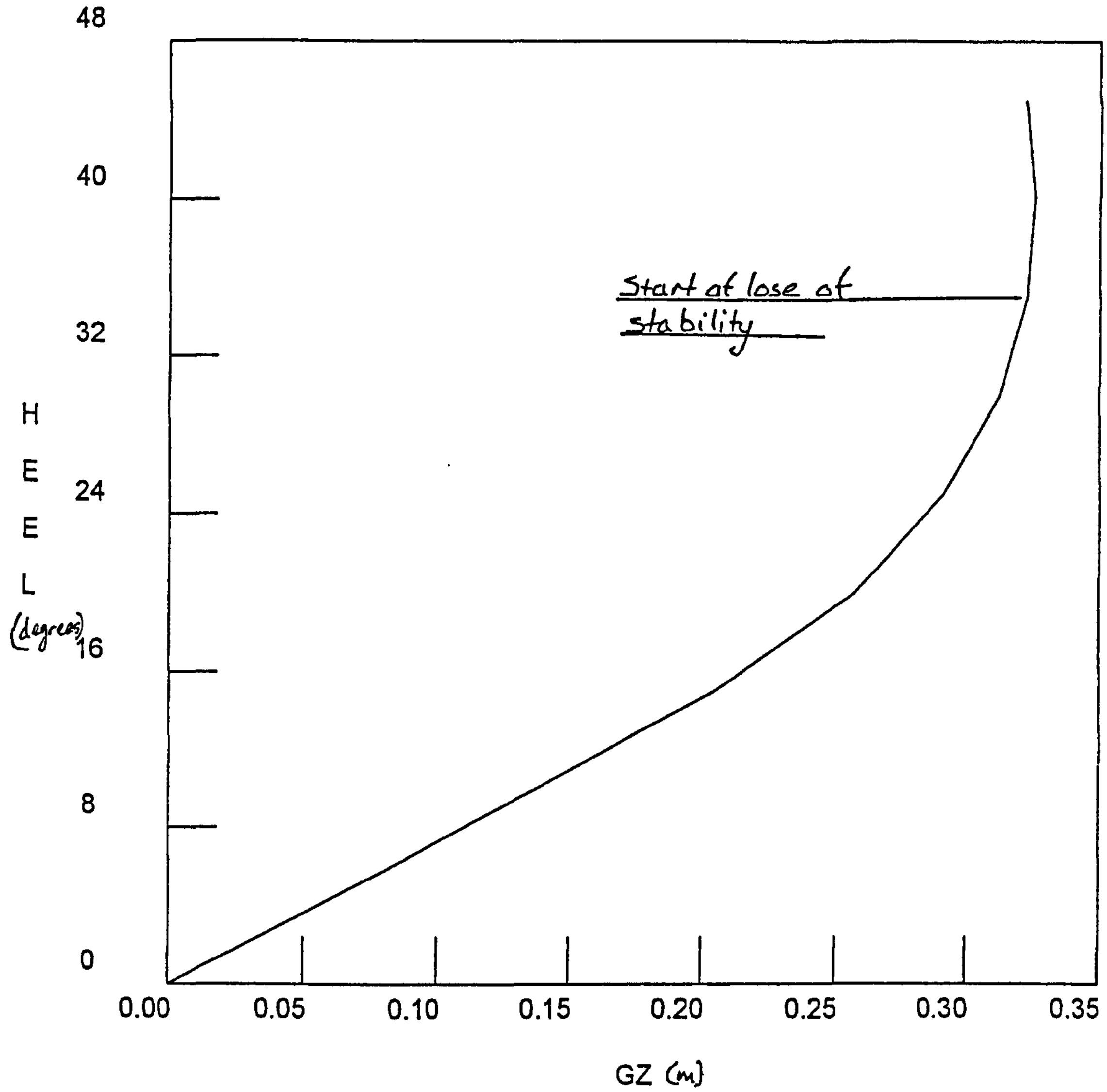
Appendix 2b.3- Hull form data sheet.



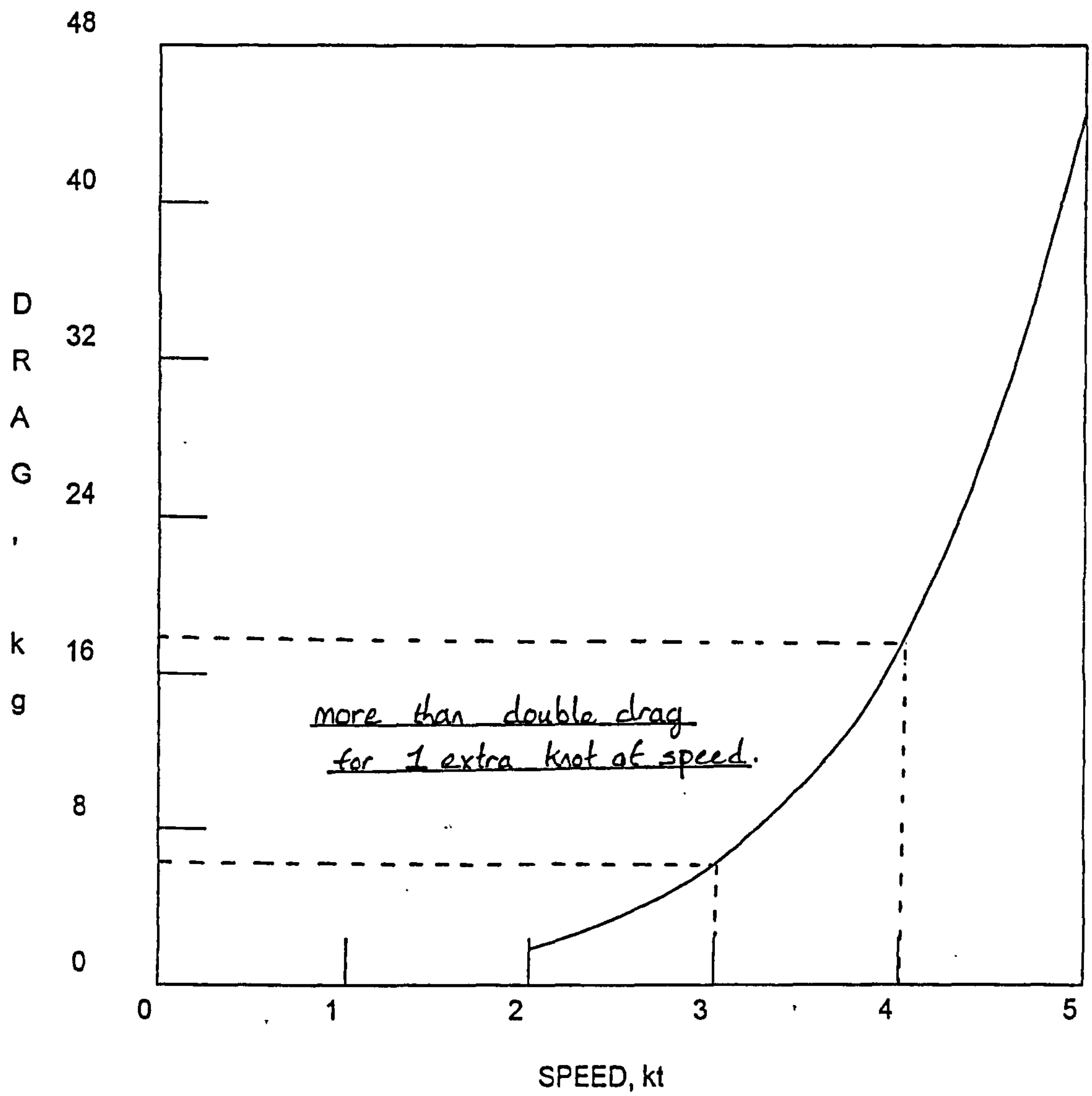
Appendix 2b.4- Draft/Displacement curve.



Appendix 2b.5-Displacement/MPI curve.

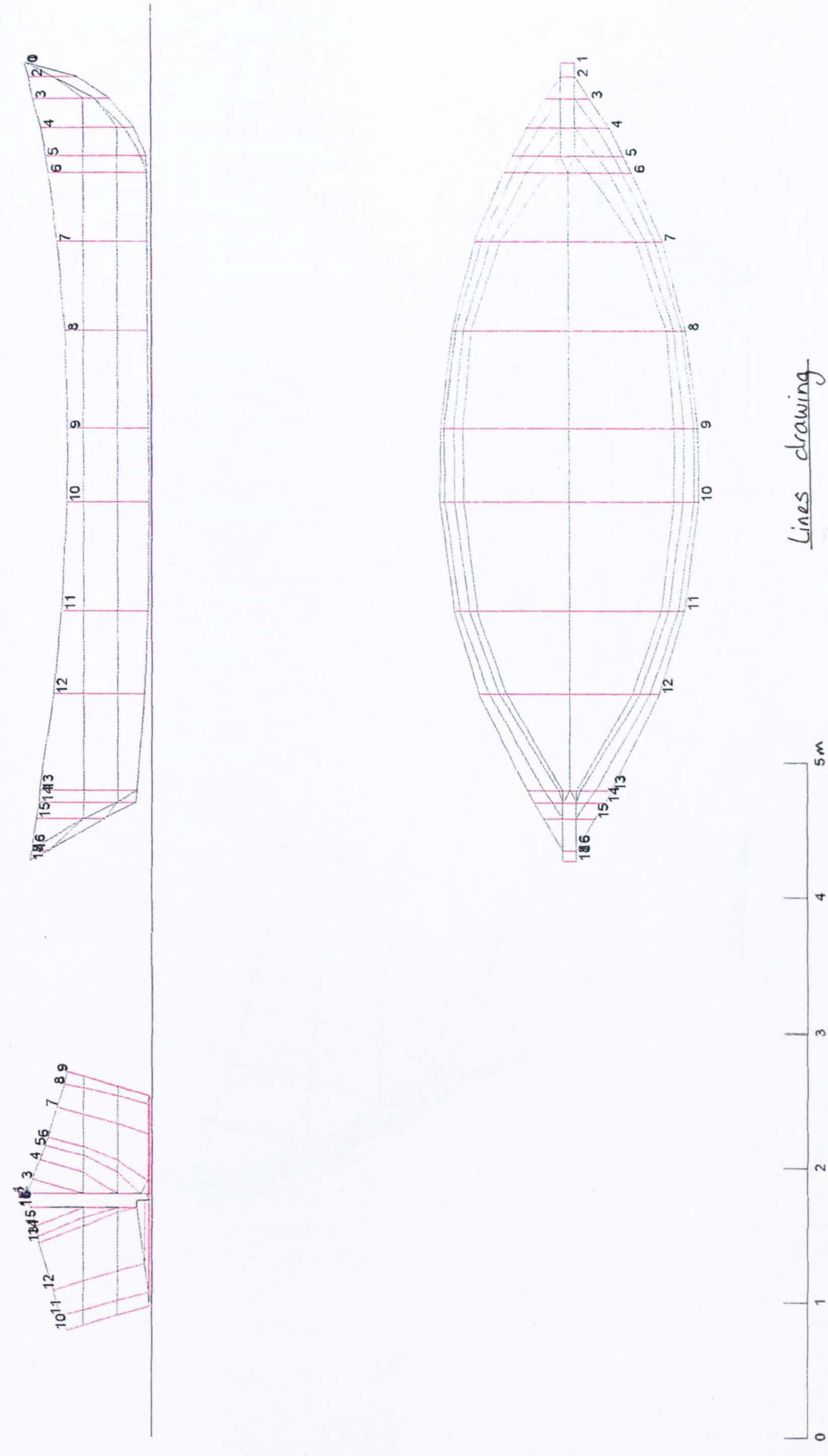


Appendix 2b.6- GZ/Heel curve.

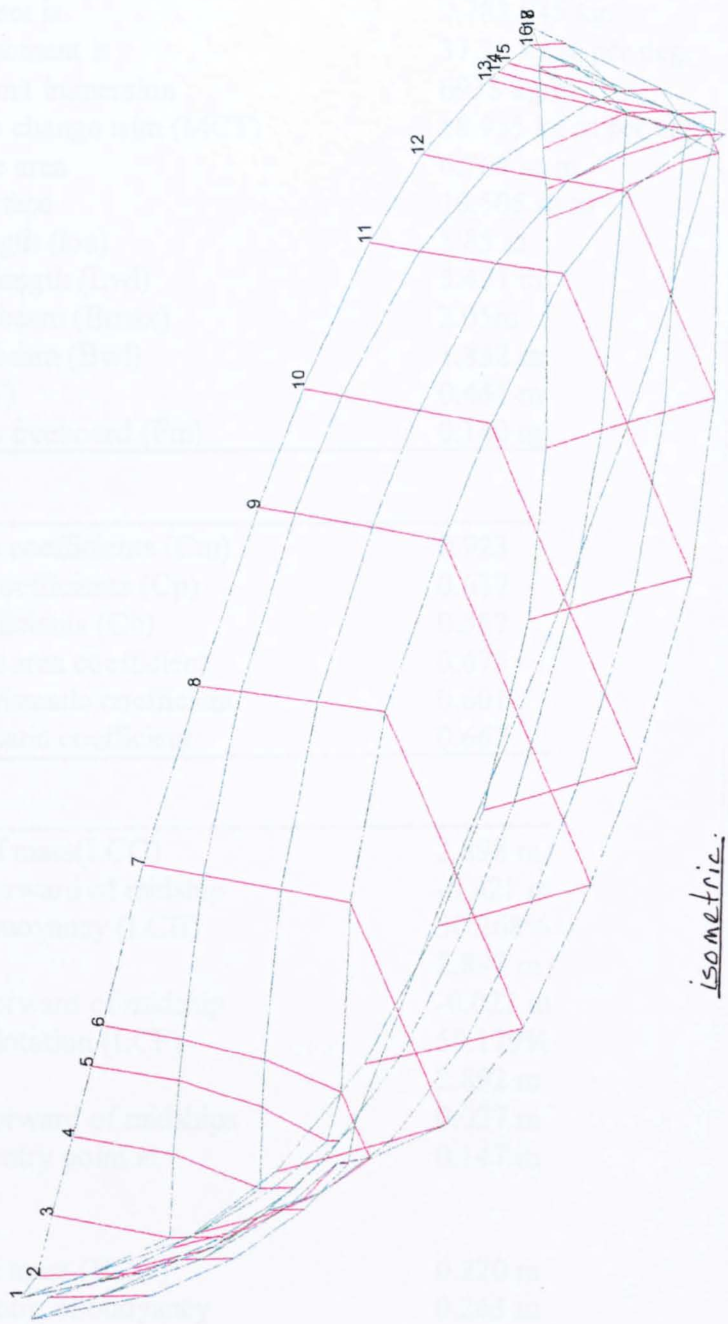


Appendix 2b.7- Drag/Speed curve.

2.c- Llyn Padarn Boat.



Appendix 2c.1



Appendix 2c.2

C:\HULSEVEN\HULLDATA\DOUGPADARN.HUD

At a heel angle of	0.000 deg
Pitch angel is	0.067 deg
Volume displacement is	2.715 cu m
Displacement is	2.782.545 kg.
Righting moment is	37.28 kg m per deg.
Mass per unit immersion	6938 kg/m
Moment to change trim (MCT)	18.955 kg m per cm
Waterplane area	6.769 sq m
Wetted surface	10.505 sq m
Overall length (loa)	5.85 m
Waterline length (Lwl)	5.471 m
Maximum beam (Bmax)	2.05m
Waterline beam (Bwl)	1.832 m
Draught (T)	0.461 m
Midsection freeboard (Fm)	0.140 m

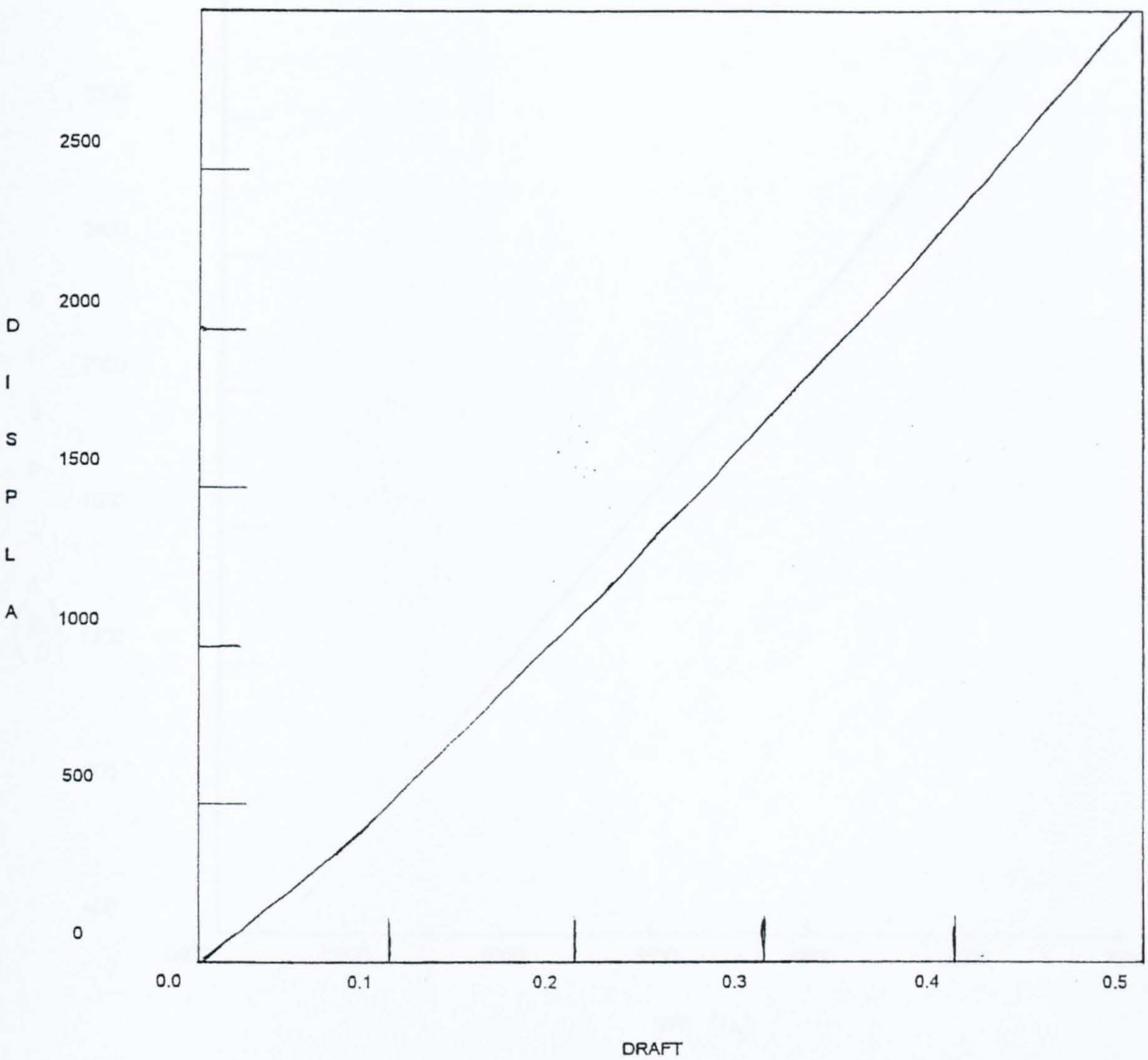
Midsection coefficients (Cm)	0.923
Prismatic coefficients (Cp)	0.637
Block coefficients (Cb)	0.587
Waterplane area coefficient	0.675
Forward prismatic coefficient	0.601
Stern prismatic coefficient	0.667

X-centre of mass(LCG)	2.898 m
-distance forward of midship	-0.021 m
Centre of buoyancy (LCB)	50.268%
-at	2.897 m
-distance forward of midship	-0.022 m
Centre of flotation (LCF)	50.179%
-at	2.892 m
-distance forward of midships	0.027 m
Waterline entry point at	0.147 m

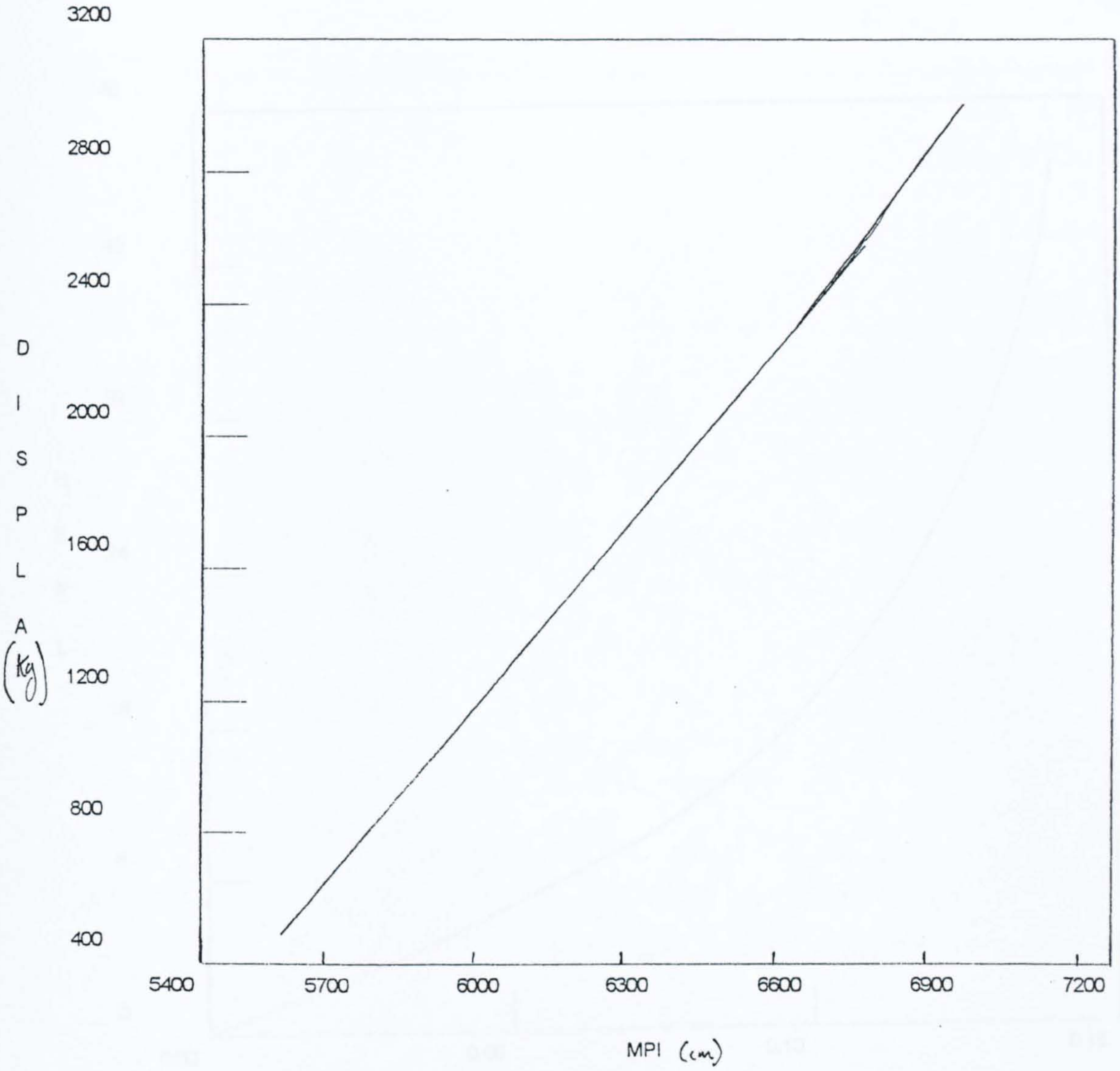
Z-centre of mass (VCG)	0.220 m
Vertical centre of buoyancy	0.263 m
Metacentre above waterline	0.288 m
Metacentre above baseline (KM)	0.768 m
Metacentre height (GM)	0.768 m

Righting lever (GZ)	0.000
KN	0.000

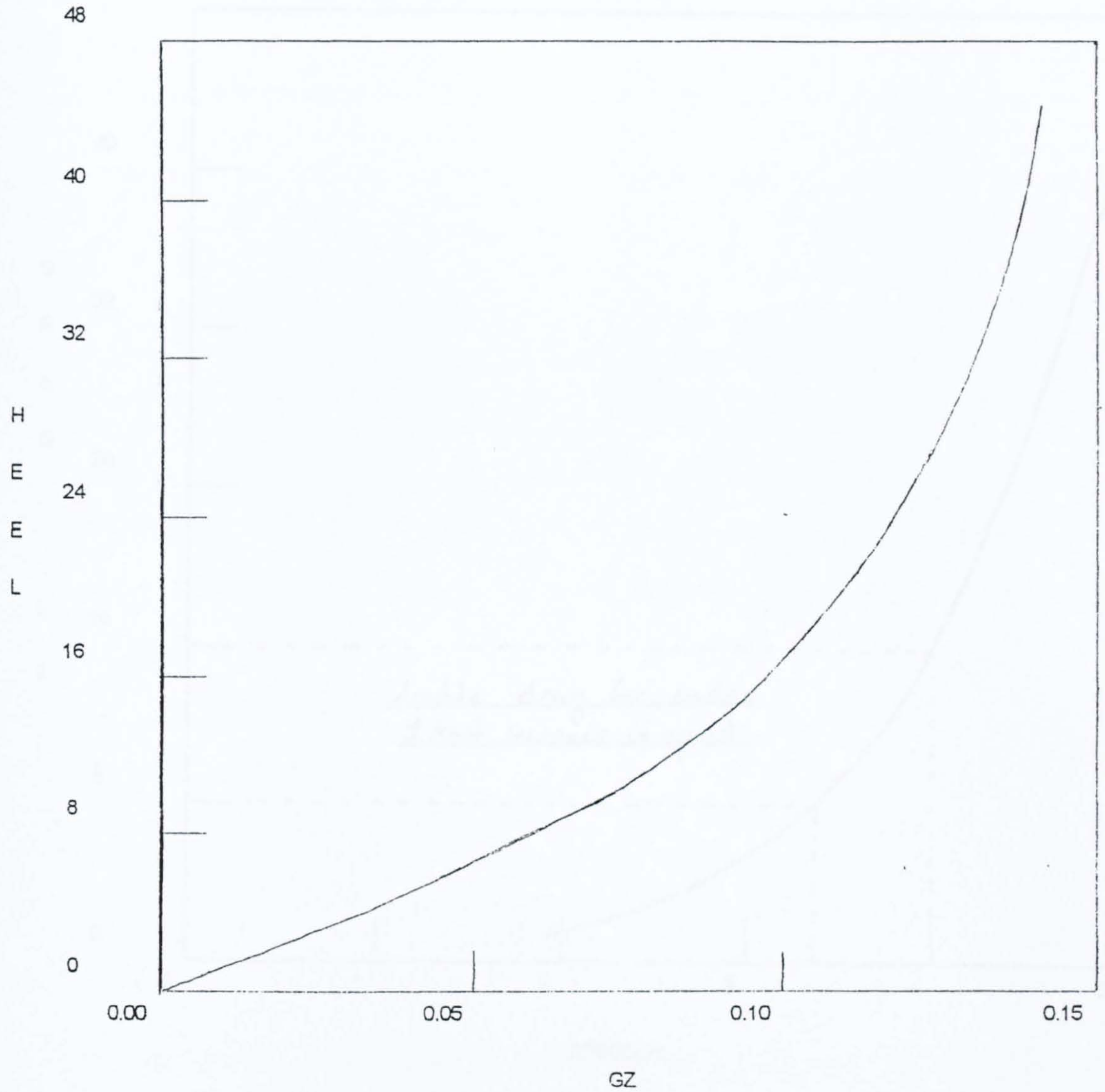
Appendix 2c.3- Hull form data sheet.



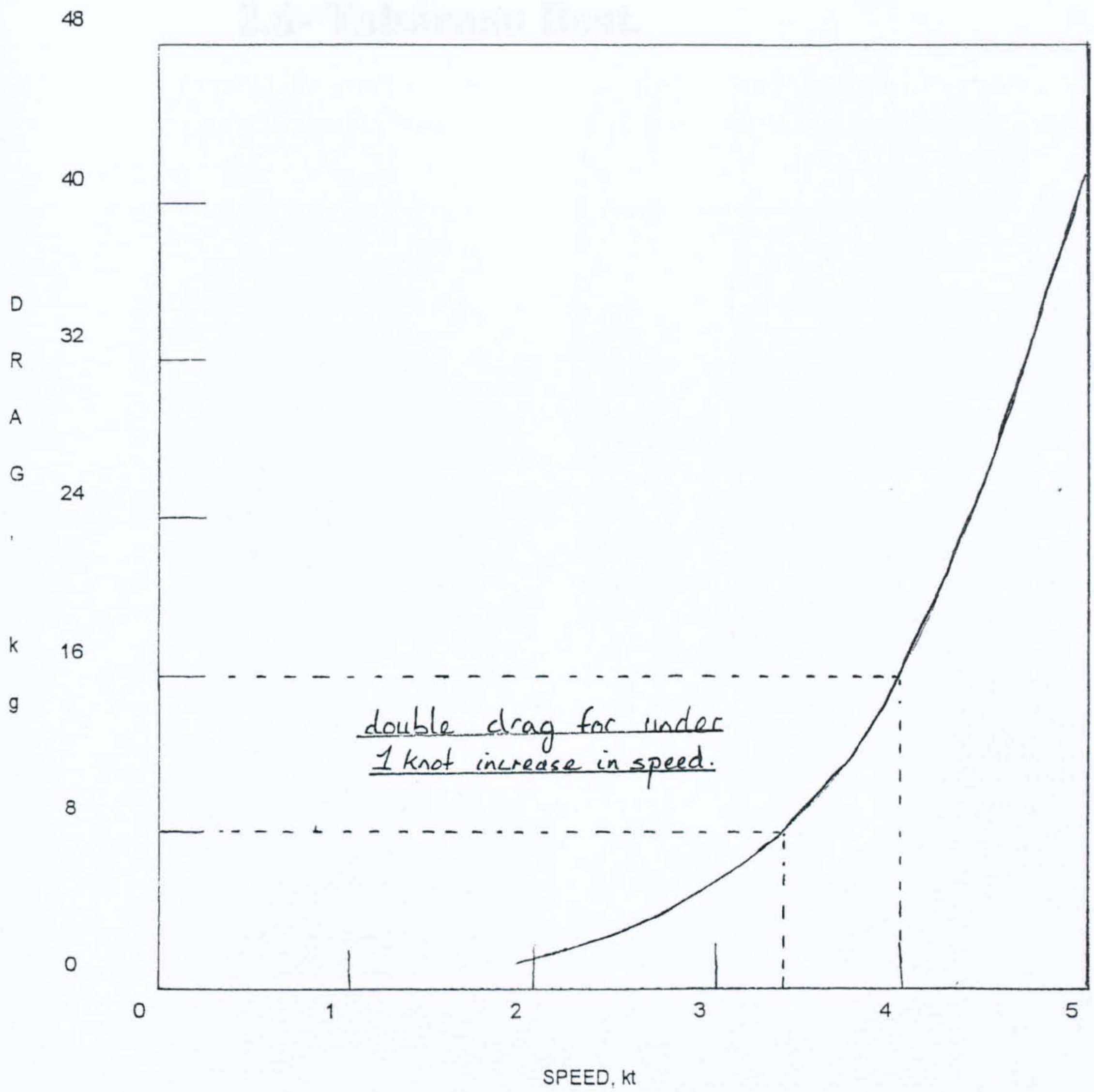
Appendix 2c.4- Draft/Displacement curve.



Appendix 2c.5-Displacement/MPI curve.

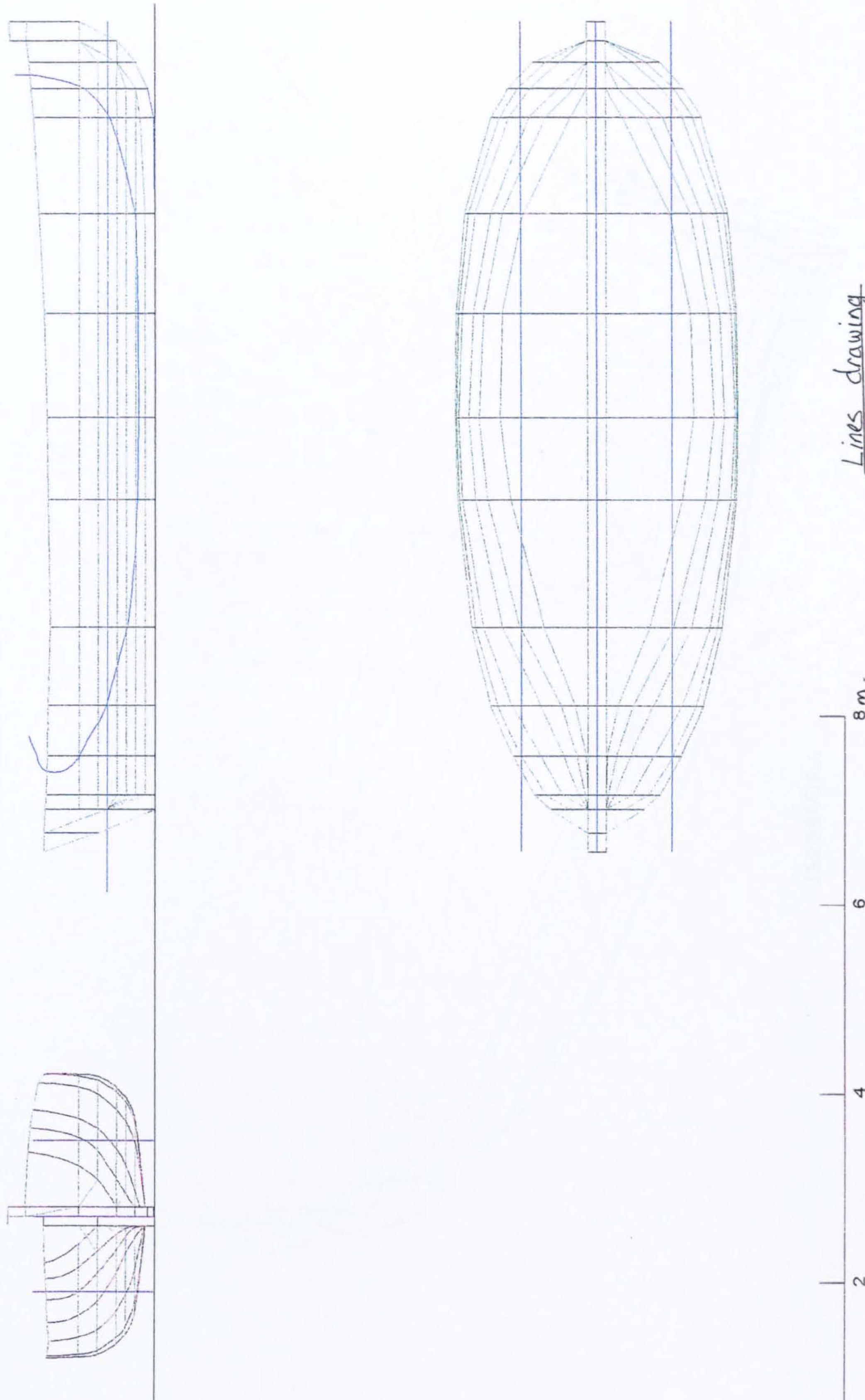


Appendix 2c.6- GZ/Heel curve.

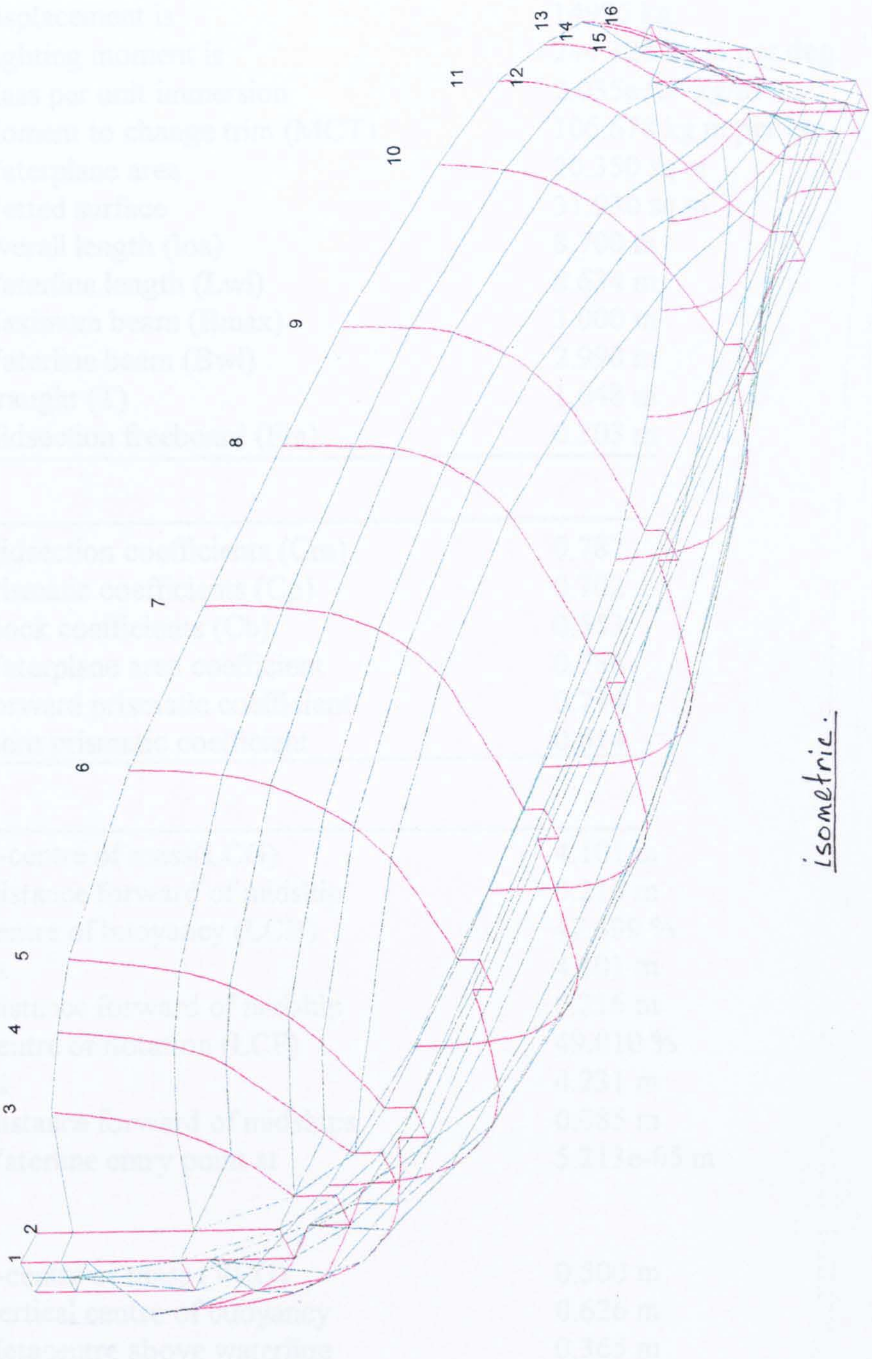


Appendix 2c.7- Drag/Speed curve.

2.d- Talsarnau Boat.



Appendix 2d.1



Appendix 2d.2

C:\HULSEVEN\HULLDATA\DOUGDWYRYD.HUD

At a heel angle of	0.000 deg
Pitch angel is	0.0571 deg
Volume displacement is	14.997 cu m
Displacement is	14996 kg.
Righting moment is	244.328 kg m per deg.
Mass per unit immersion	2.035e+04 kg/m
Moment to change trim (MCT)	106.678 kg m per cm
Waterplane area	20.350 sq m
Wetted surface	31.930 sq m
Overall length (loa)	8.700 m
Waterline length (Lwl)	8.634 m
Maximum beam (Bmax)	3.000 m
Waterline beam (Bwl)	2.998 m
Draught (T)	1.048 m
Midsection freeboard (Fm)	0.303 m

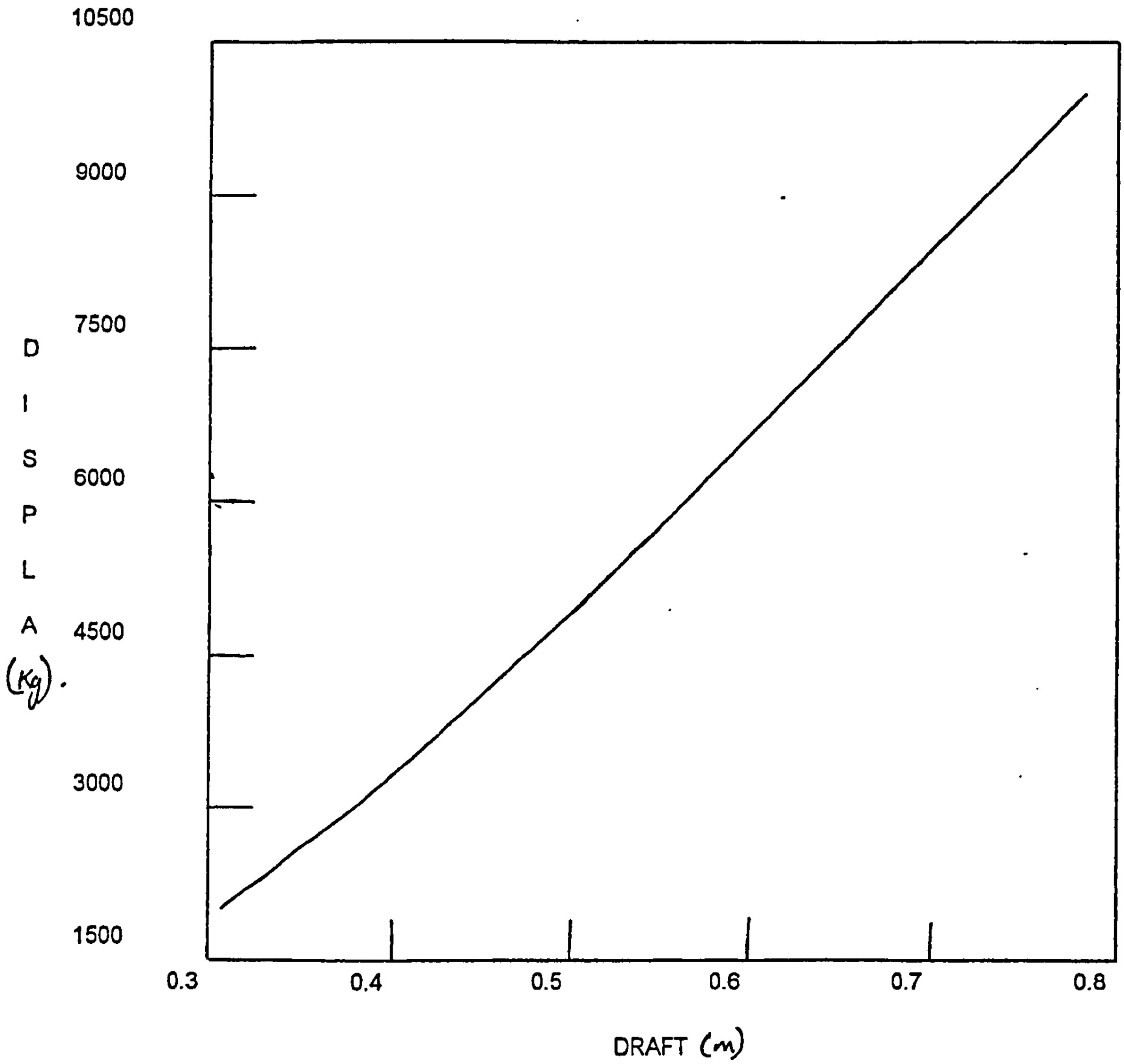
Midsection coefficients (Cm)	0.787
Prismatic coefficients (Cp)	0.702
Block coefficients (Cb)	0.553
Waterplane area coefficient	0.786
Forward prismatic coefficient	0.754
Stern prismatic coefficient	0.654

X-centre of mass(LCG)	4.101 m
-distance forward of midship	0.216 m
Centre of buoyancy (LCB)	47.499 %
-at	4.101 m
-distance forward of midship	0.216 m
Centre of flotation (LCF)	49.010 %
-at	4.231 m
-distance forward of midships	0.085 m
Waterline entry point at	5.213e-05 m

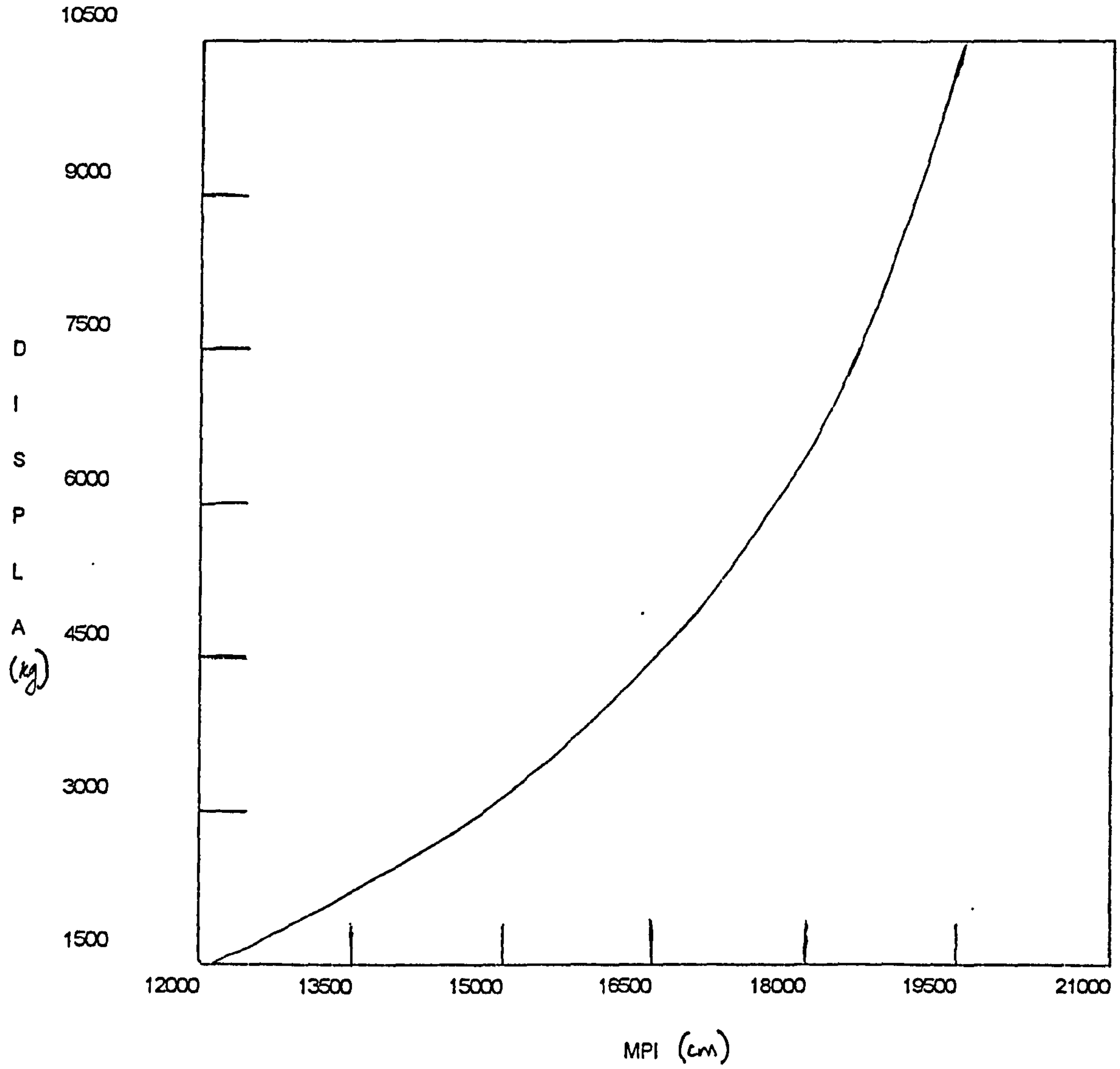
Z-centre of mass (VCG)	0.500 m
Vertical centre of buoyancy	0.626 m
Metacentre above waterline	0.365 m
Metacentre above baseline (KM)	1.433 m
Metacentre height (GM)	0.933 m

Righting lever (GZ)	0.000
KN	0.000

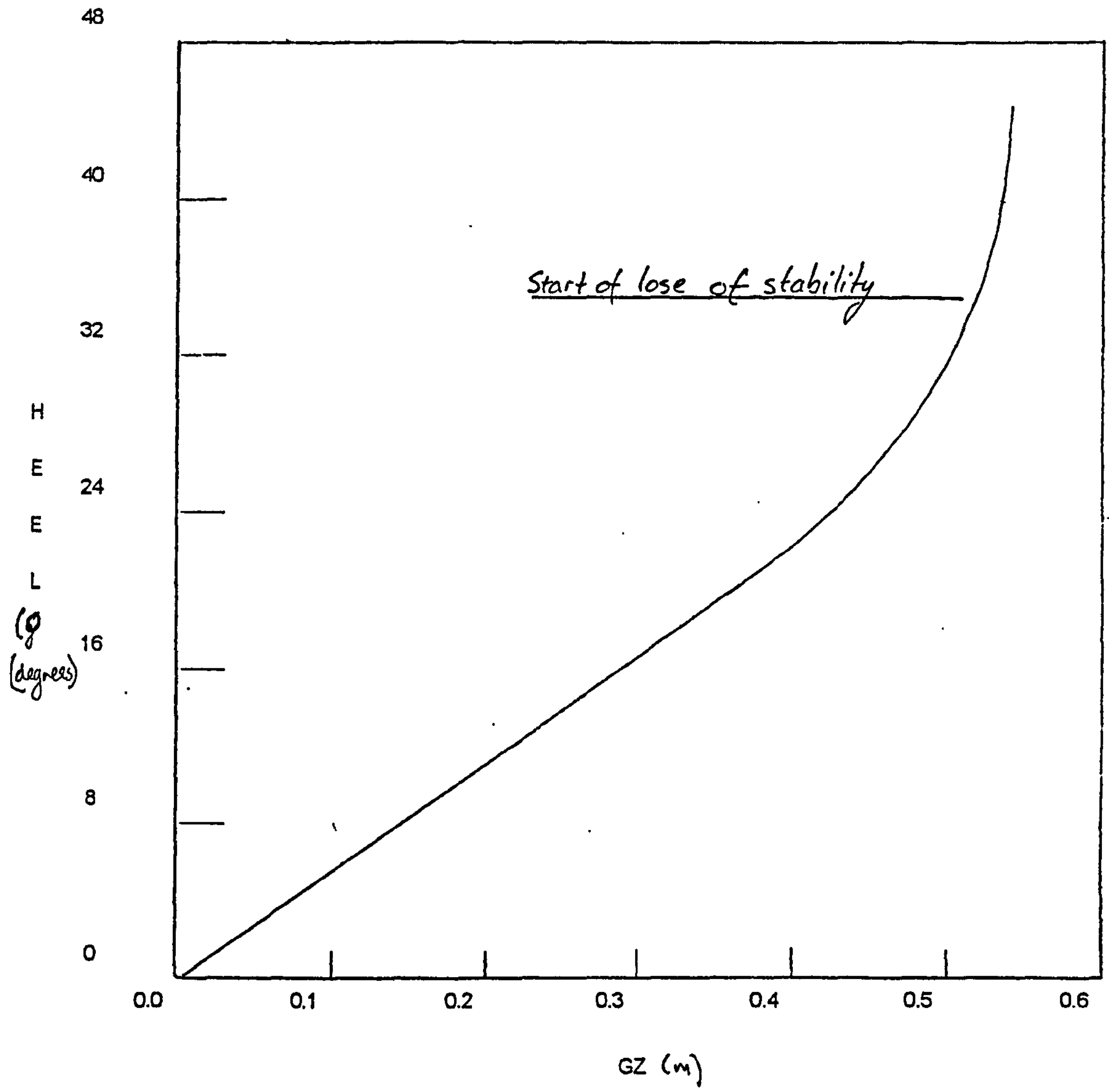
Appendix 2d.3- hull form data sheet.



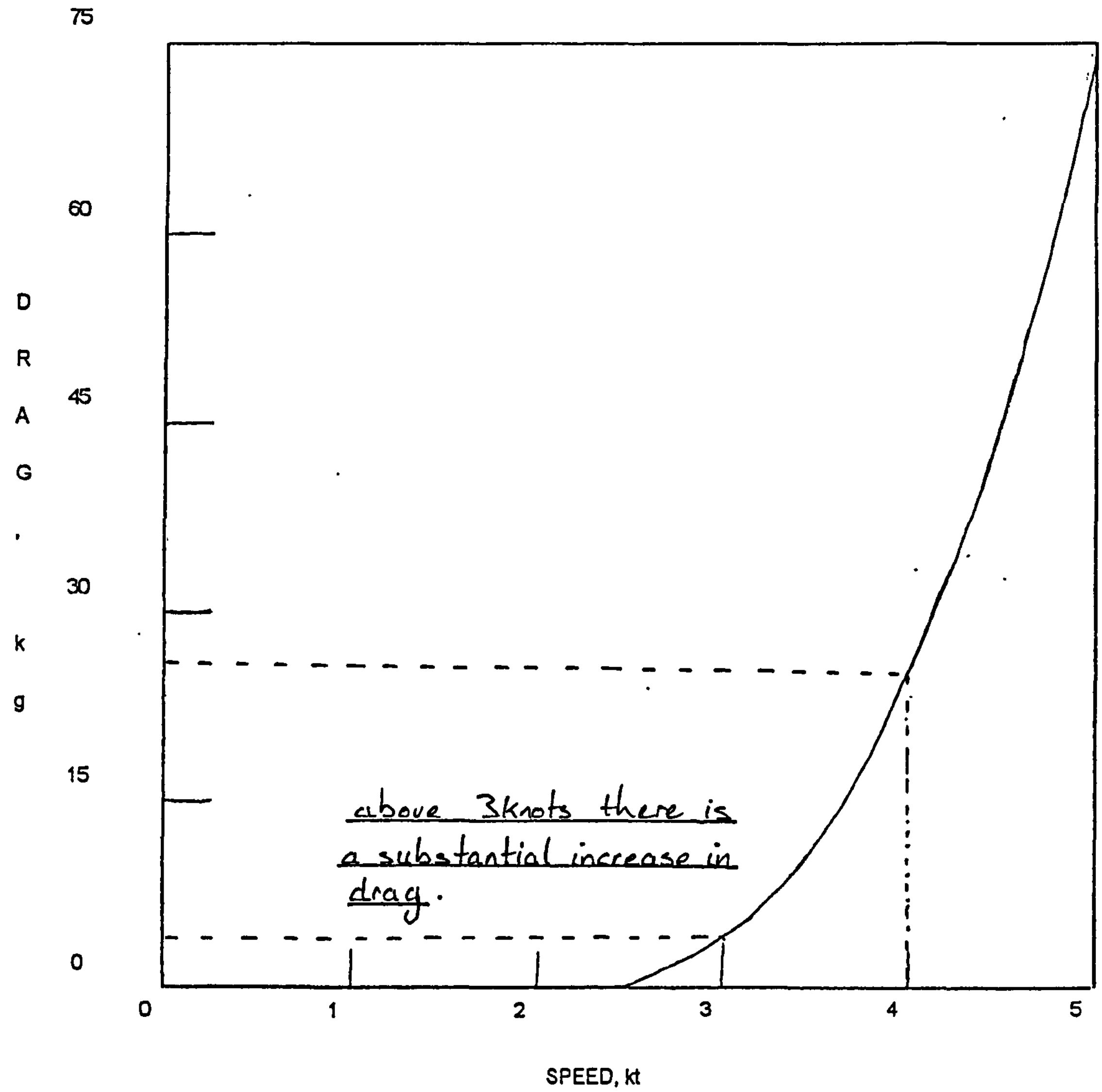
Appendix 2d.4- Draft/Displacement curve.



Appendix 2d.5-Displacement/MPI curve.



Appendix 2d.6- GZ/Heel curve.



Appendix 2d.7- Drag/Speed curve.

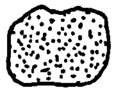
Vol II

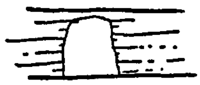
Figure List

and Figures

PAGE NUMBERING AS IN THE ORIGINAL THESIS

Key to timber drawings.

Concretion (general) = 

Framing position = 

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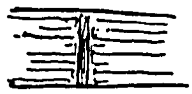
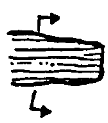
Side branch evident = 

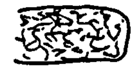
Side branch showing = 

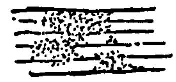
Knots = 

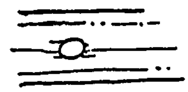
Damage/degradation = 

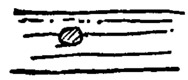
Slopes = 

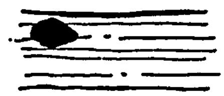
Dendrochronological sample = 

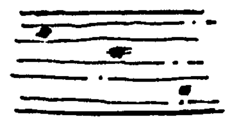
Moss luting = 

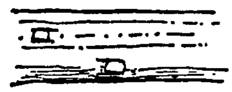
Luting/paying = 

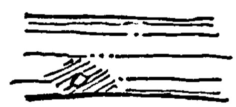
Treenail hole = 

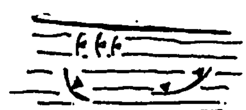
Treenail *in situ* = 

Iron fastening concretion = 

Nail hole, full = 

Nail hole, empty = 

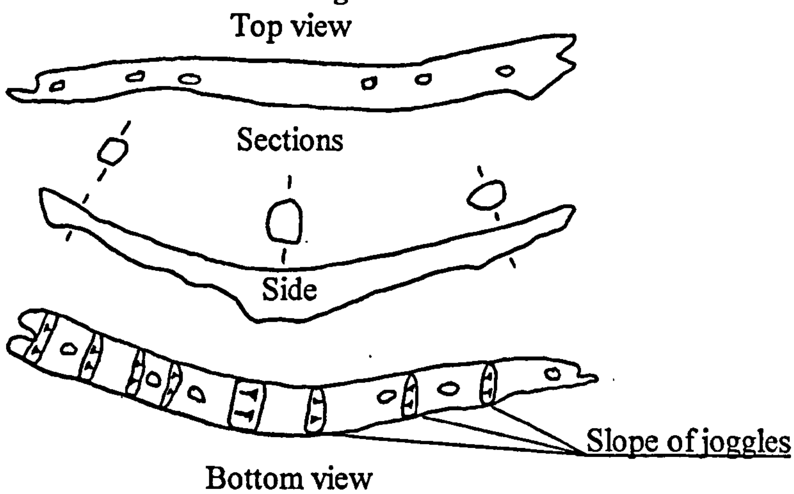
Rove stain/impression = 

Axe/adze mark = 

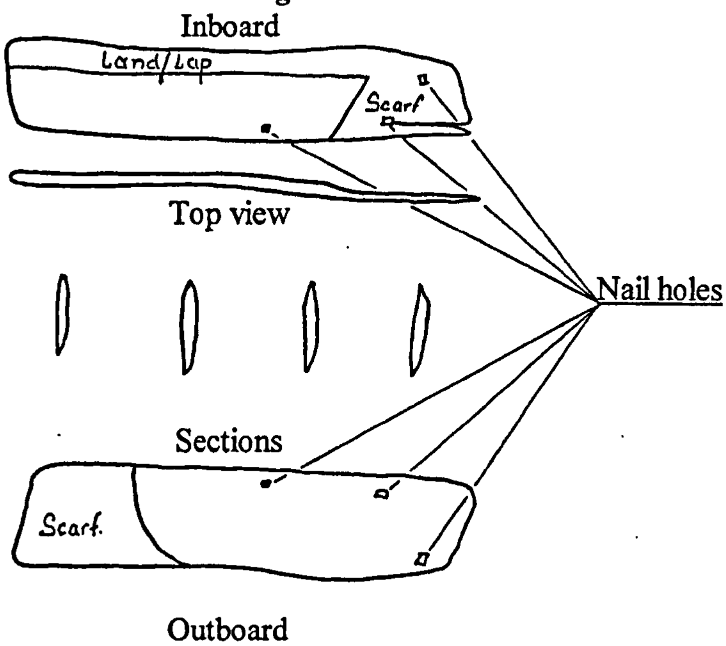
The wood grain is shown on the elevations and plans of the planking and frames. Where identifiable the radial lines and rings are shown on the cross sections of the planks. They are not necessarily shown on other parts, such as frames due to the complex nature of the grain. As a general rule where the rings/rays/conversion is identifiable then it is shown. If there is any uncertainty then it is not.

Timber drawing orientation

Framing



Planking



All drawings follow the above orientation as far as is feasible. All drawings have a relevant scale, either at the foot of the page or directly associated with the drawing, the scale being either to the side or immediately below the drawing. Any deviation from the above is either due to an usual part being drawn or the failure of the author to stick to the above orientation. If this is the case then it is clearly stated onthedrawing.

Figures

The figure list has been arranged by chapter. Each figure is given the prefix of the chapter, and a consecutive number in turn of appearance within that chapter. A description of what the figure is and its page number in the thesis is listed. Unless stated otherwise all photographs and drawings are by the author, John Illsley (JI), Cecil Jones (CJ) or Owain Roberts (OR). The kind permission of the Fellows of Winchester Art College, the National Library of Wales and Gwynedd Archives Services are acknowledge for permission to reproduce paintings within their charge.

Chapter 2. **Pwll Fanog Wreck.**

Chapter 3 **Llyn Peris Boat.**

Introduction

Figure List

Llyn Peris Logboat

1.1-1.9

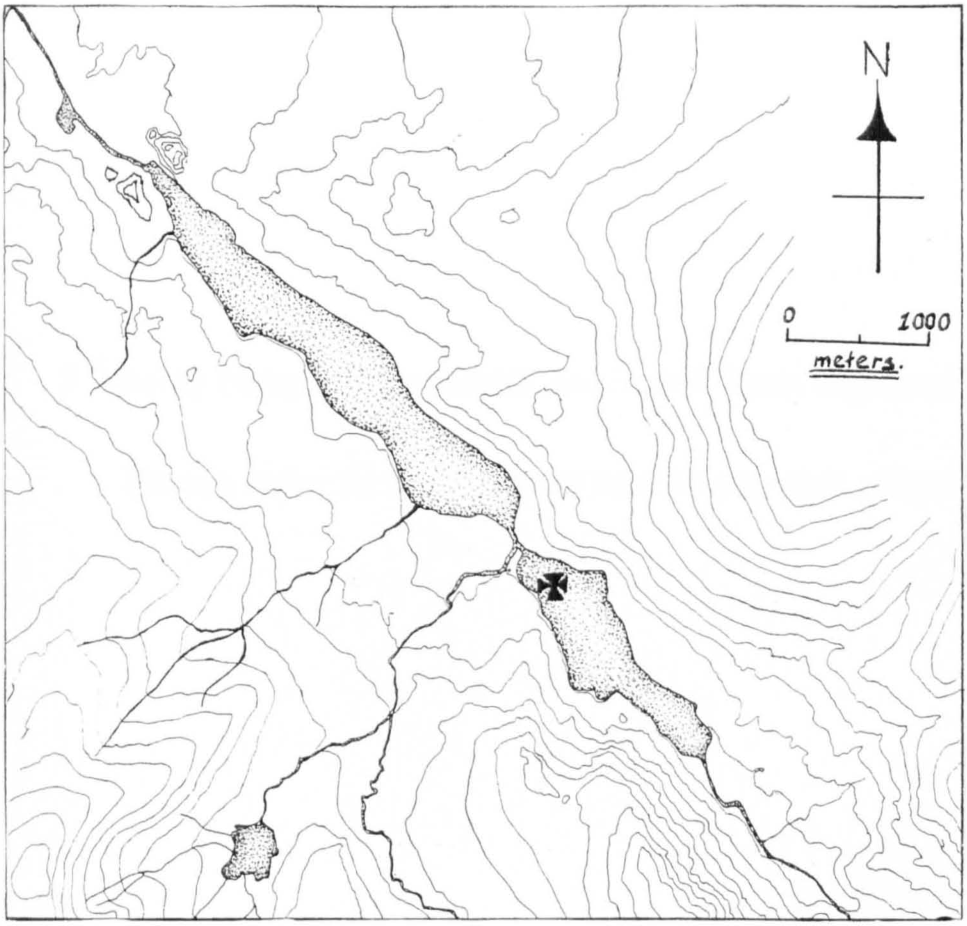


Fig.1.1a- Llyn Peris Logboat location map.

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Please refer to the original text to see this material.

Fig. 1.1b- Llyn Peris drained showing drag lines (C.J.).

Fig 1.2a & b- Llyn Peris Logboat pieces as found (OR).

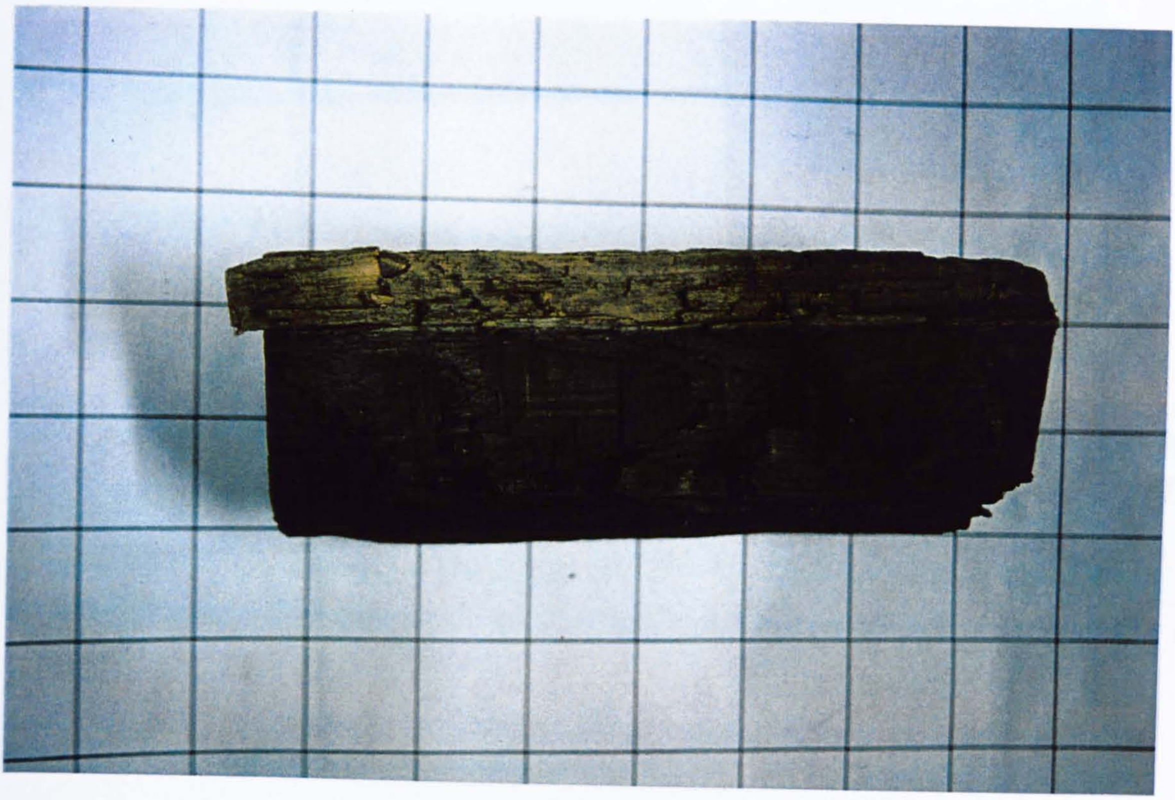

Fig1.3- Sapwood on extremities of logboat.

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Fig 1.4b- close up of tool marks on the bottom of the logboat (OR).

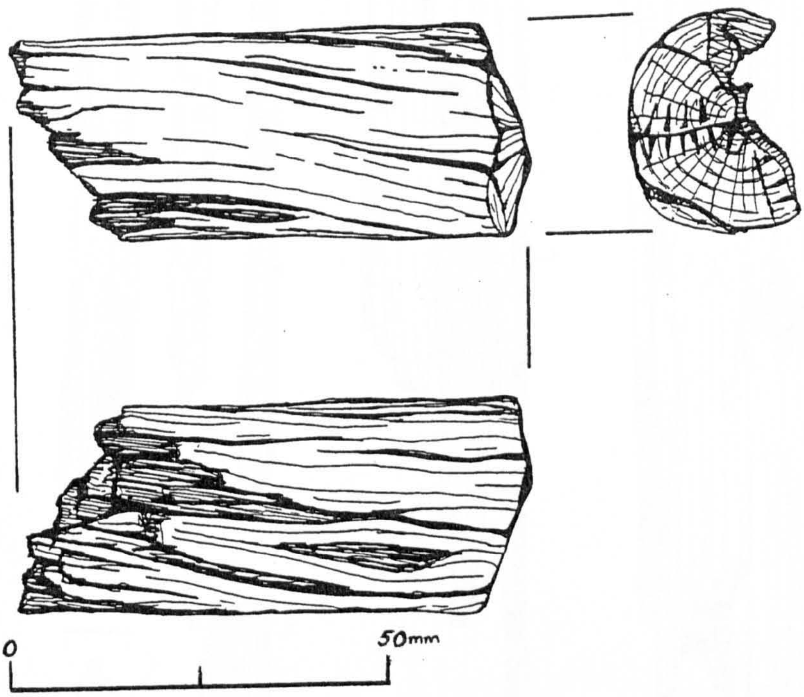

Fig. 1.5- Holly branch from the hole in the end of the Logboat.

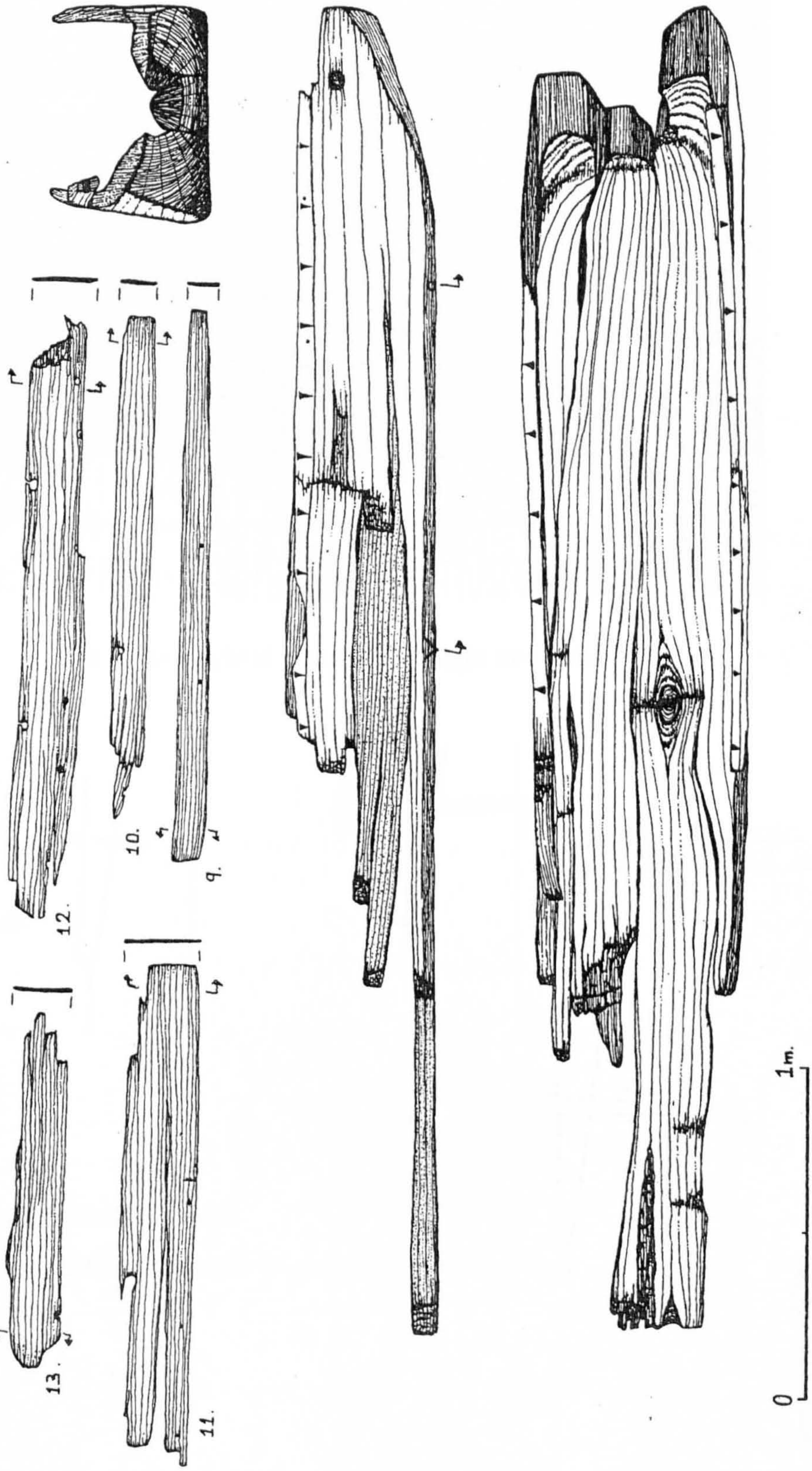

Fig.1.6- Logboat and associated wash strakes.

Fig.1.7a- Logboat clenched wrought iron nails.

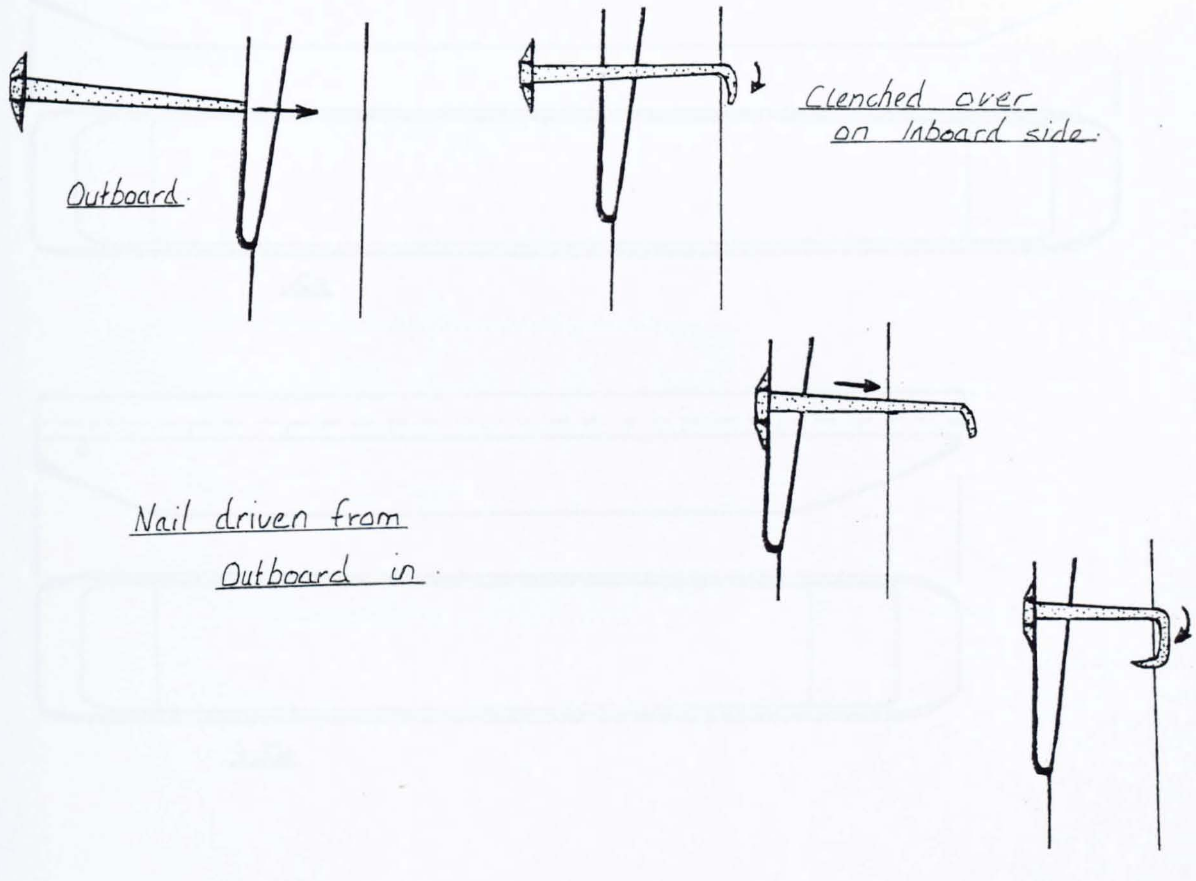

Fig. 1.7b- clenching sequence.

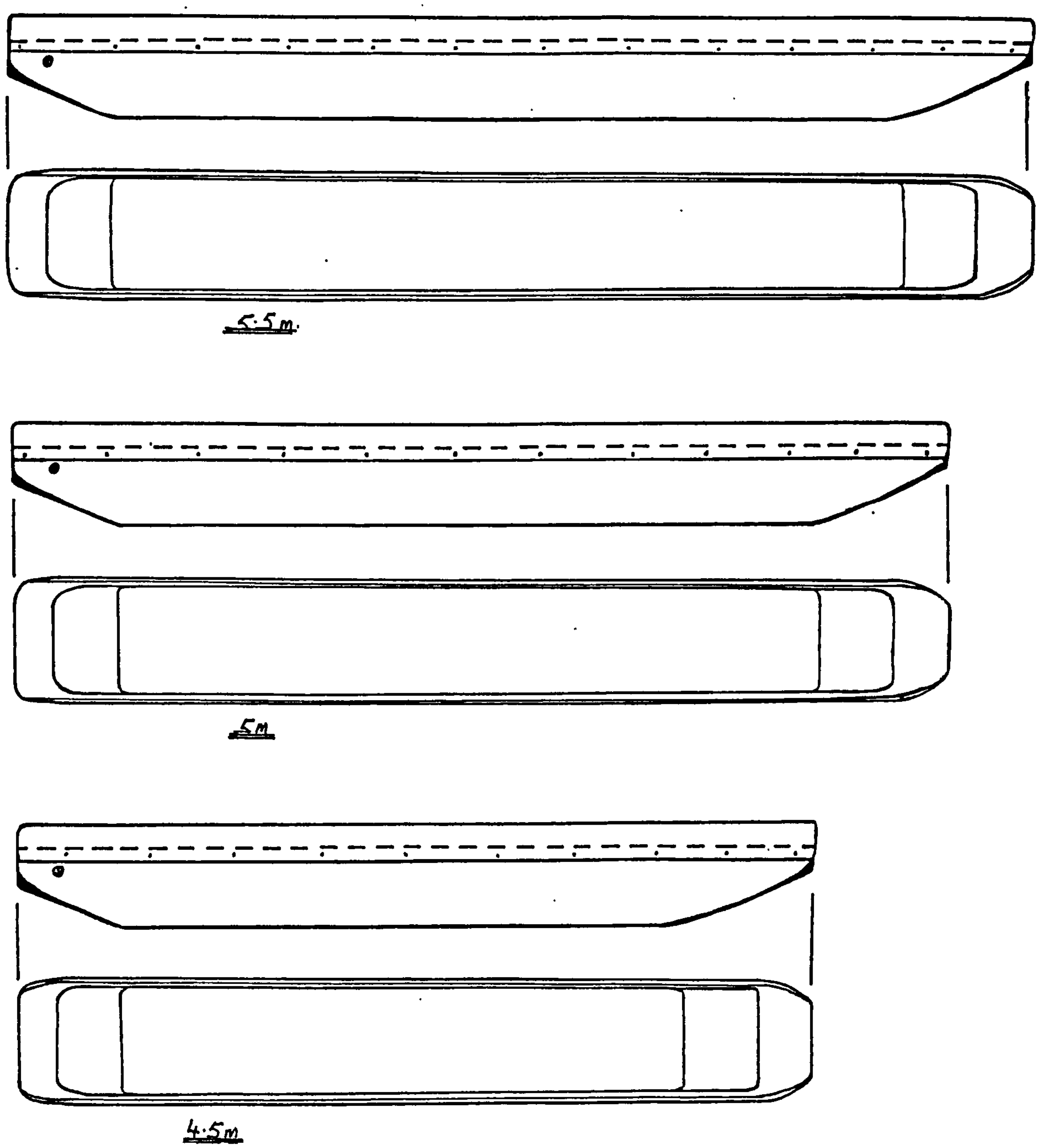

Fig. 1.8- Hypothetical reconstruction of logboat 5.5, 5 and 4.5m.

sectional information can be derived from appendix 2a.1. if required.

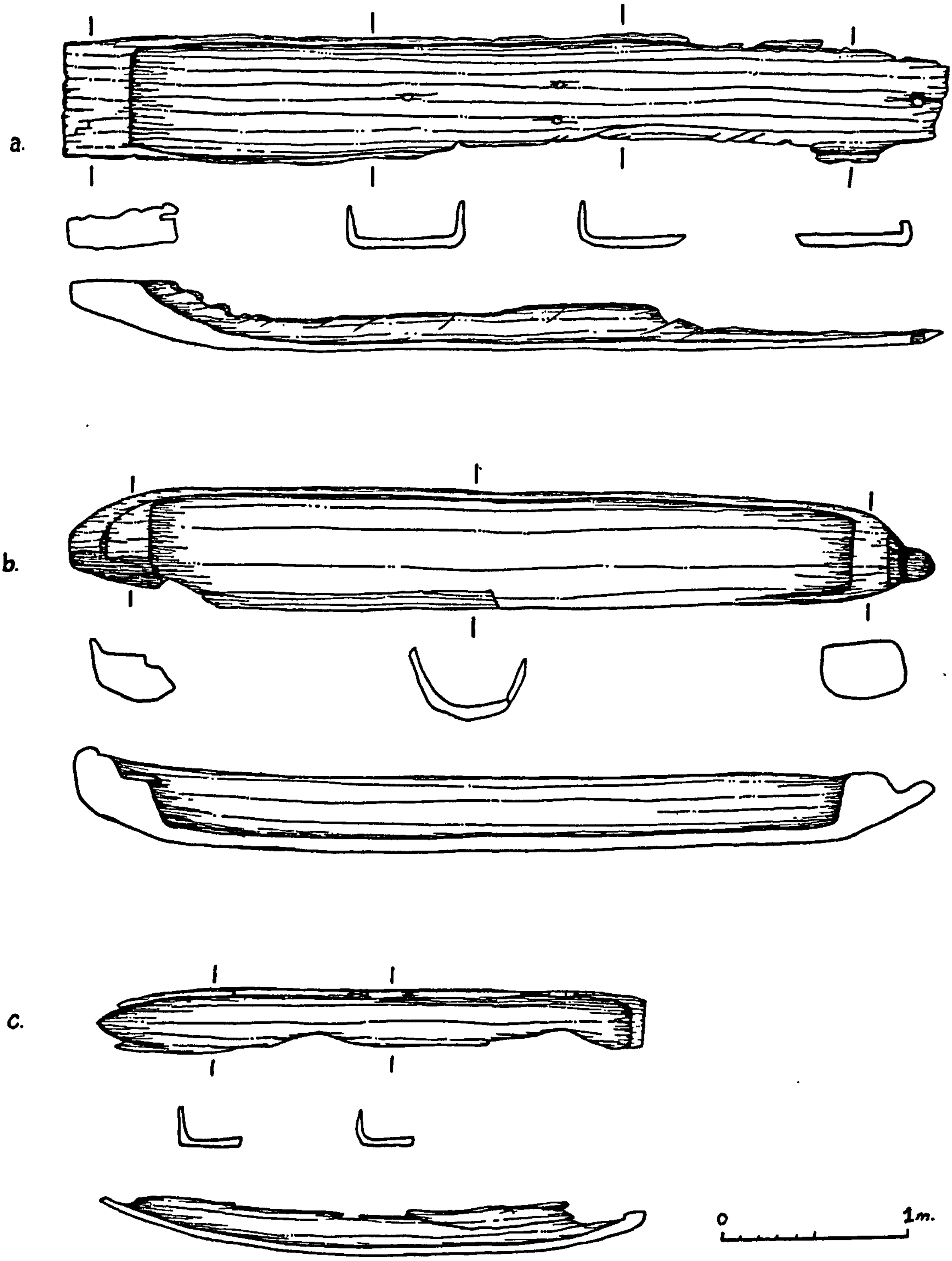

Fig. 1.9- Logboats from North Wales. A- Llandrindod Wells, B- Llangorse, C- Llyn Llydaw (Drawn from McGrail, 1978).

Figure List

Pwll Fanog Wreck

2.1-2.11

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Above- Location map Pwll Fanog.

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Fig. 2.2a- section of excavation trench (OR . 1979)

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Fig 2.2b- plan of timbers (OR . 1979)

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Fig. 2.3- Random sample of Pwll Fanog slates (CJ).

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Fig. 2.4- Pwll Fanog slates, note knapping marks and missing calcium inclusions (CJ)

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Fig. 2.5- Dunnage from between the slate layers (CJ).

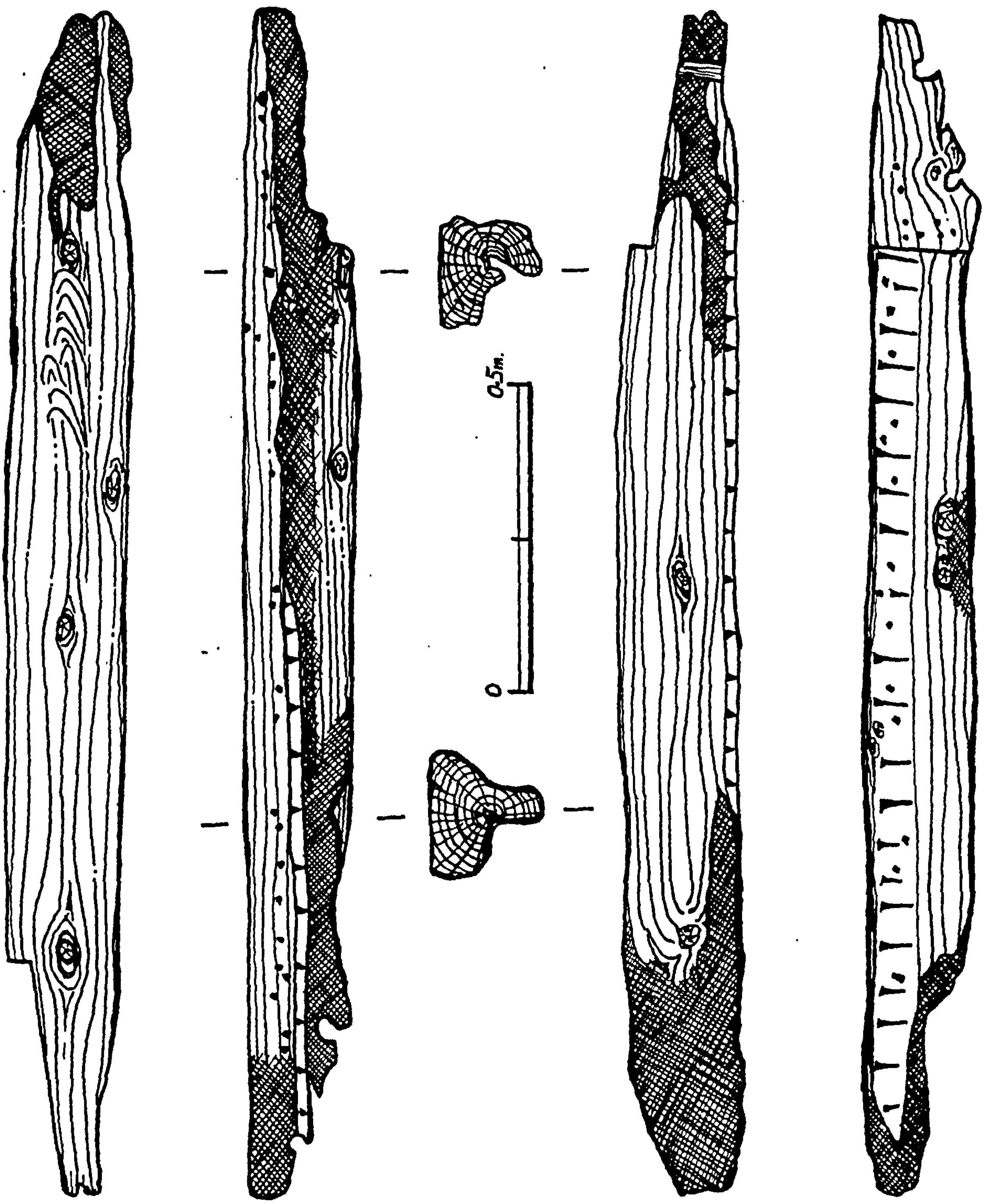

Fig. 2.6- Pwll Fanog keel.

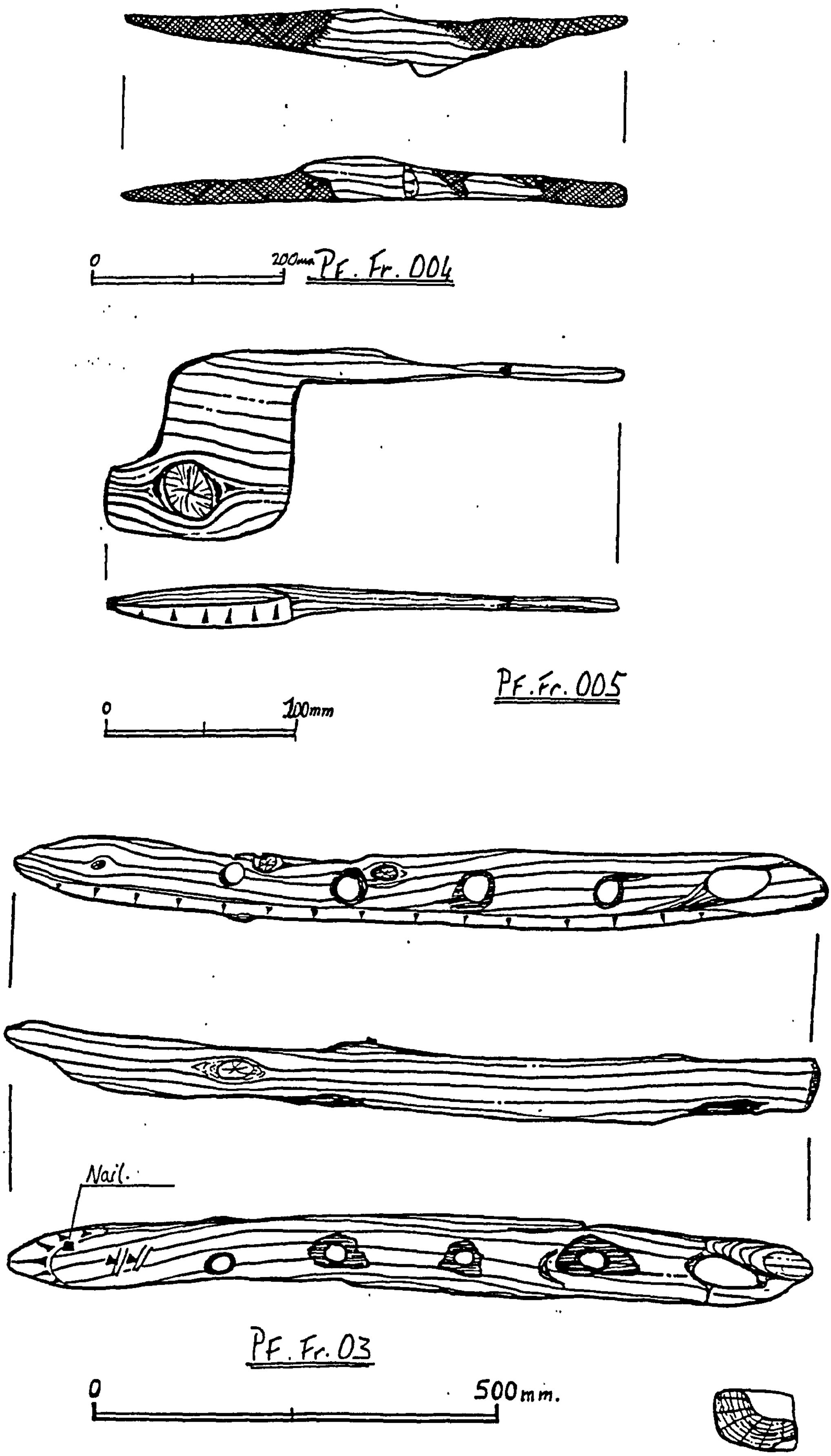

Fig 2.7- Pwll Fanog framing.

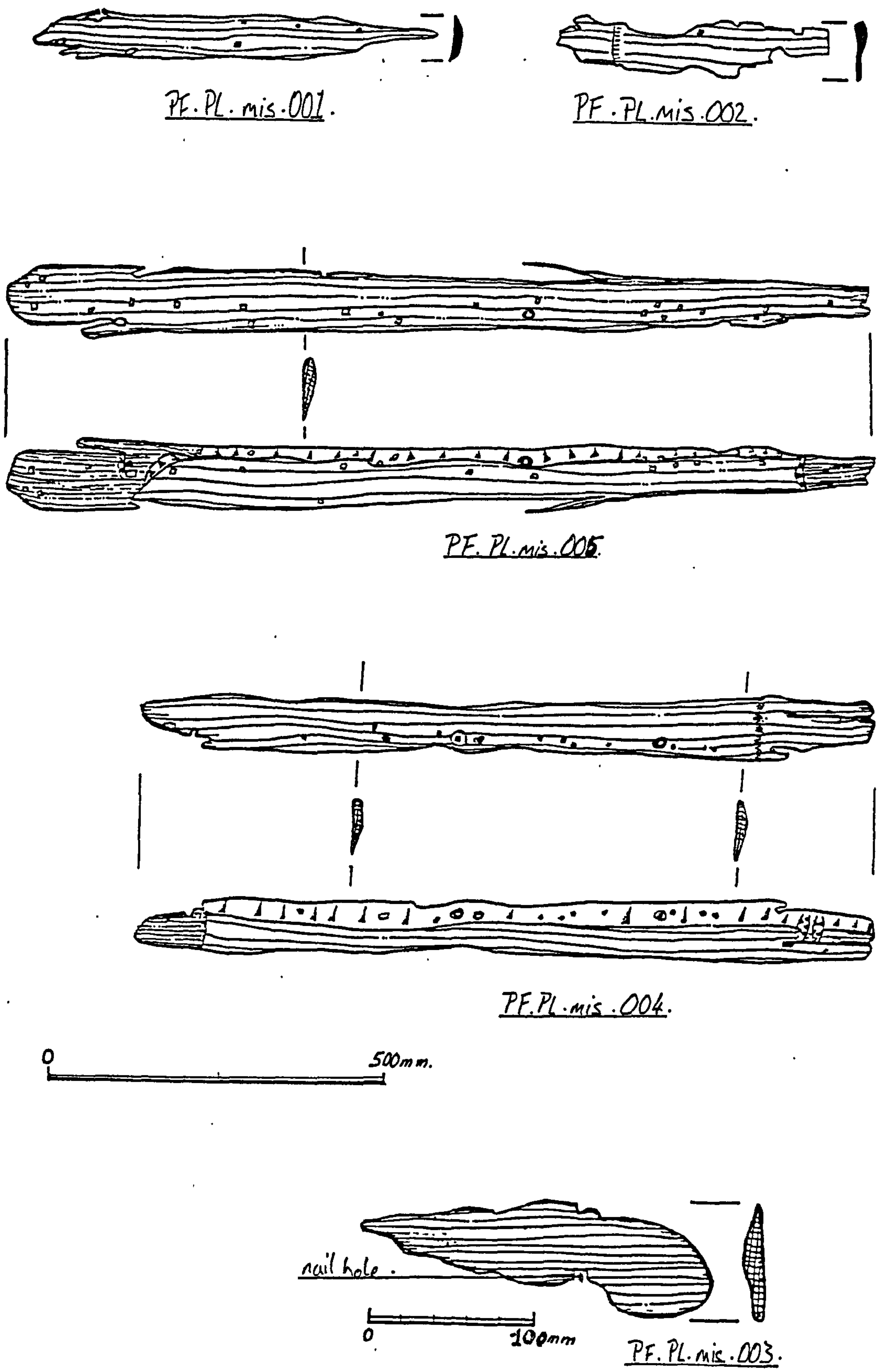

Fig. 2.8- Pwll Fanog planking.

Fig. 2.9- Mr Owens Letter.

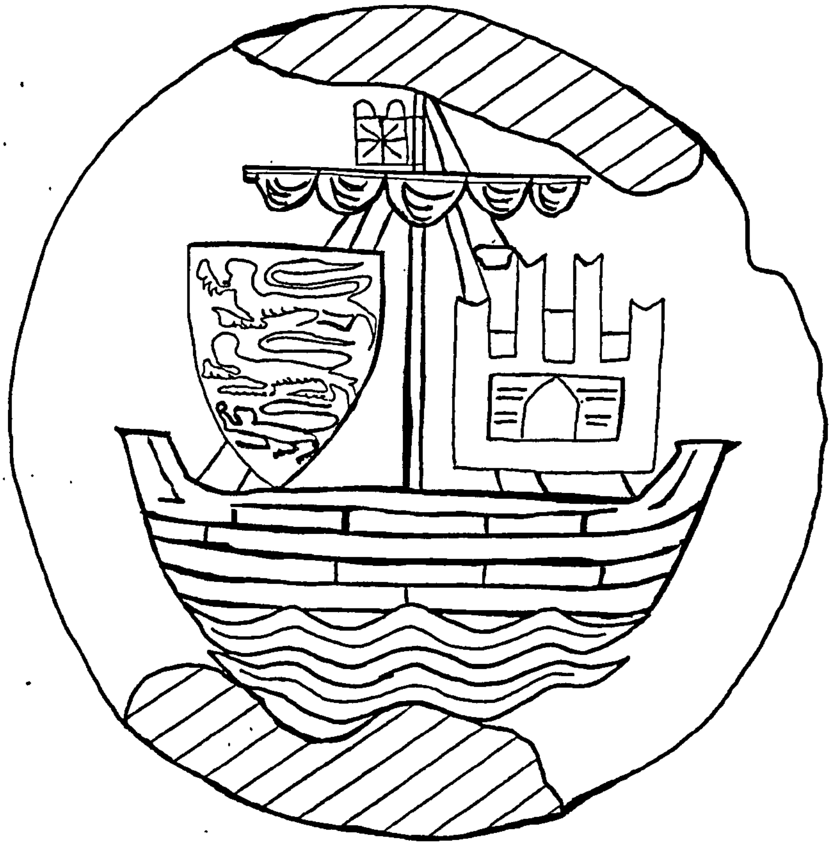

Fig. 2.10a- Beaumaris seal pre-1580's

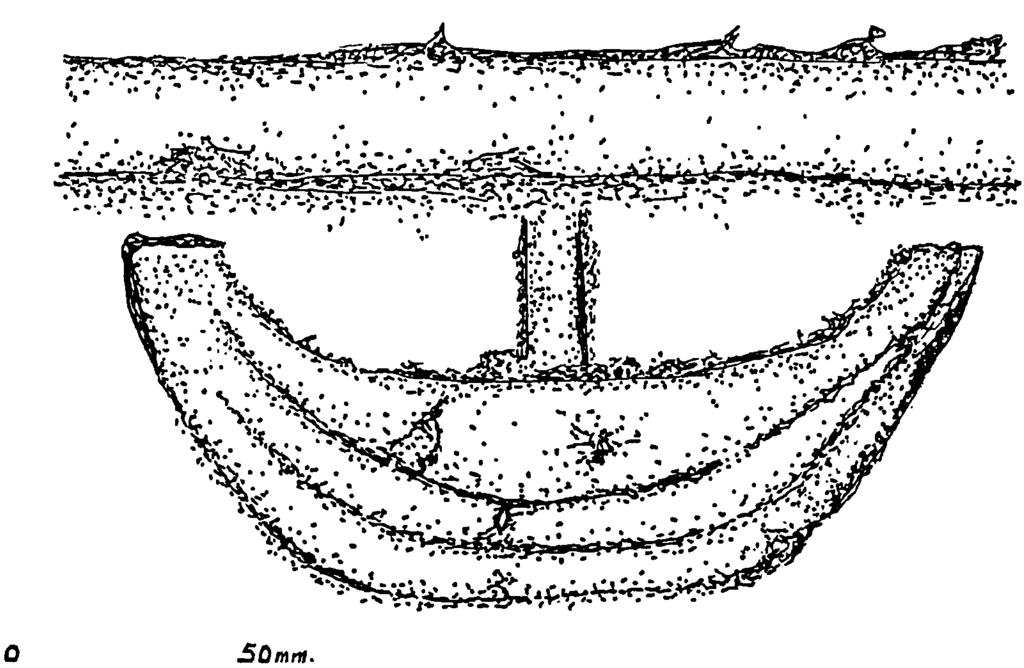

Fig. 2.10b- St. Baglan Church boat.

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Fig 2.11- reconstruction painting of Pwll Fanog vessel in the Menai Straits (CJ).

Figure List

Llyn Peris Boat

3.1-3.48

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Fig. 3.1a- Construction camp at Llyn Peris with pumping barge in fore ground (CJ).

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Fig. 3.1b- Llyn Peris drained looking North (CJ).

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Fig. 3.2a- Detritus mound forced out from under slate dumping (JI).

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Fig. 3.2b- site on edge of slate dumping (JI).

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Fig 3.3a & b-Llyn Peris boat as found (JI).

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Fig 3.4- Location map and general view of site (JI).

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Fig 3.5a- Site excavation showing wet working conditions (JI).

Fig 3.5b- Stern area after being pumped dry (JI).

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Fig 3.6a- Llyn Peris boat with outer planking removed (JI).

Fig 3.6b- Llyn Peris boat with detritus removed showing internal framing (JI).

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Fig 3.7- Llyn Peris boat in temporary holding tank, Amlwch (JI).

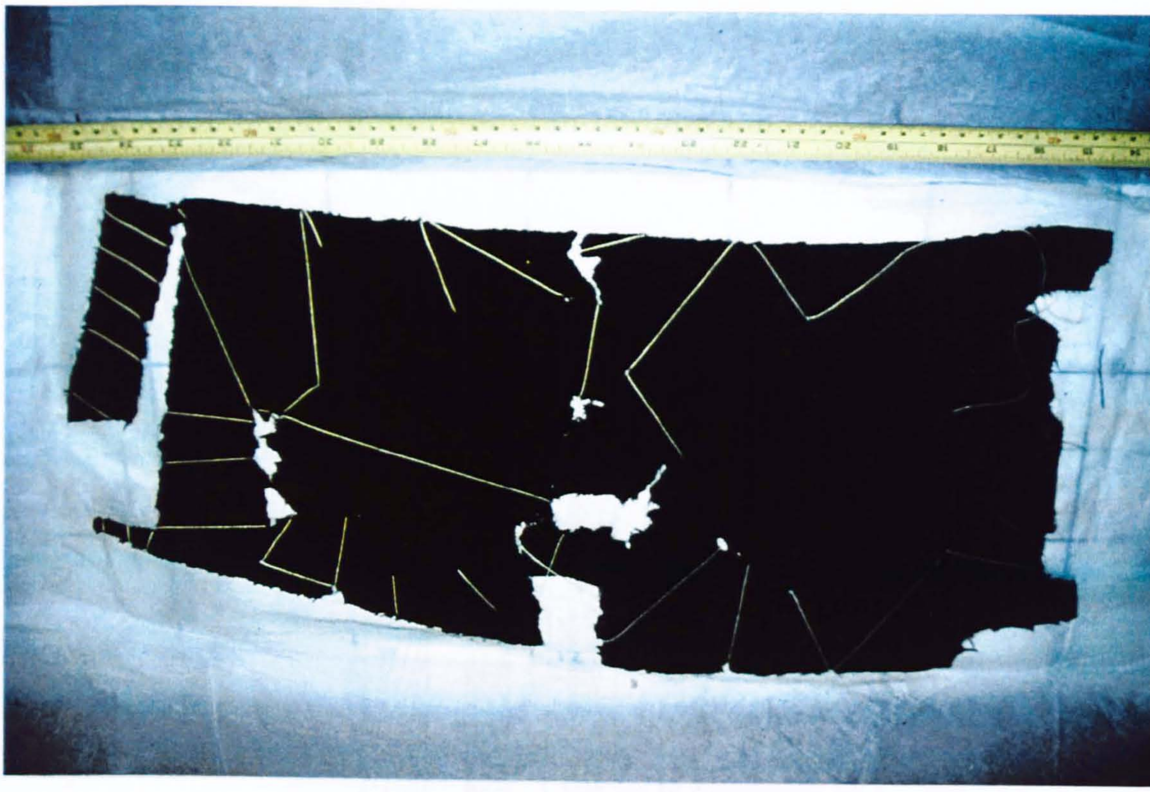


Fig 3.8a- Wool twill fragment from Llyn Peris boat.

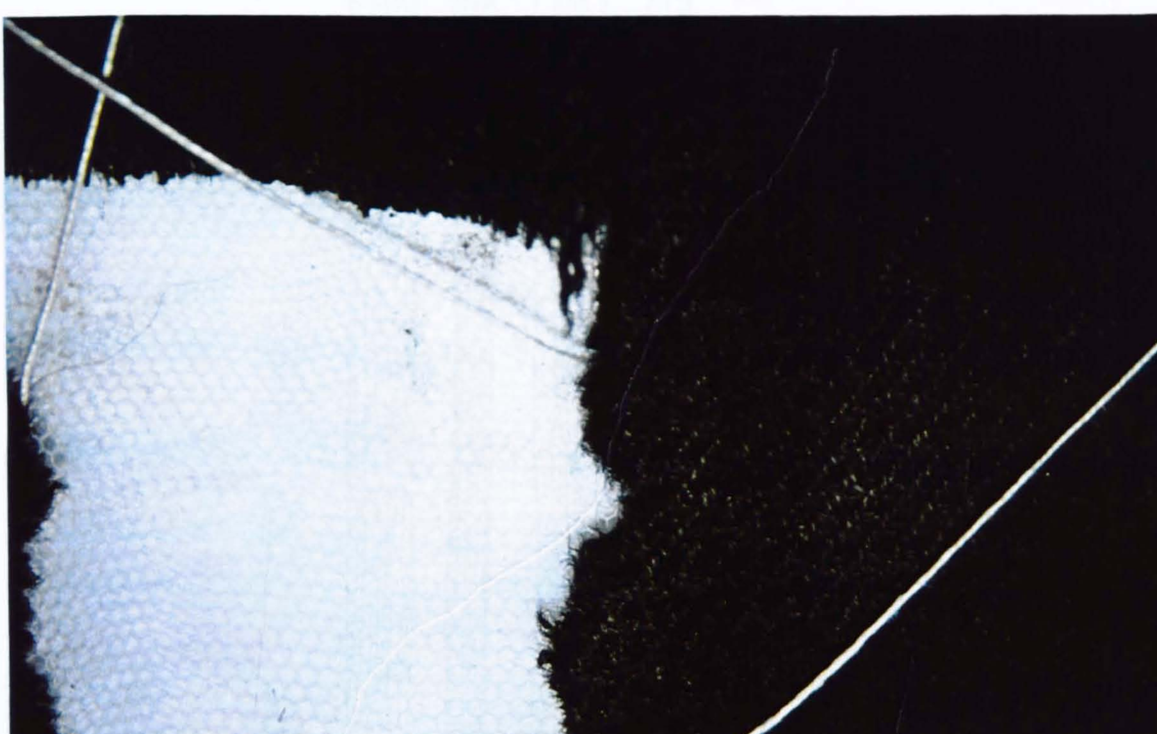


Fig 3.8b- detail of the same.

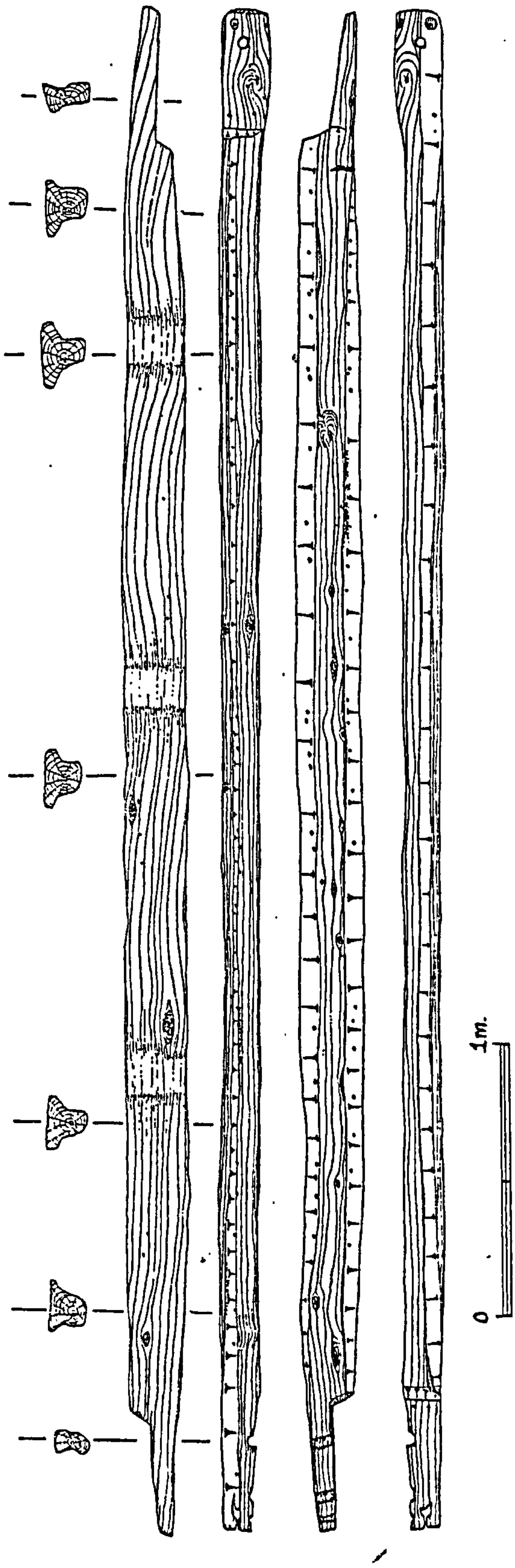


Fig 3.9- Keel.

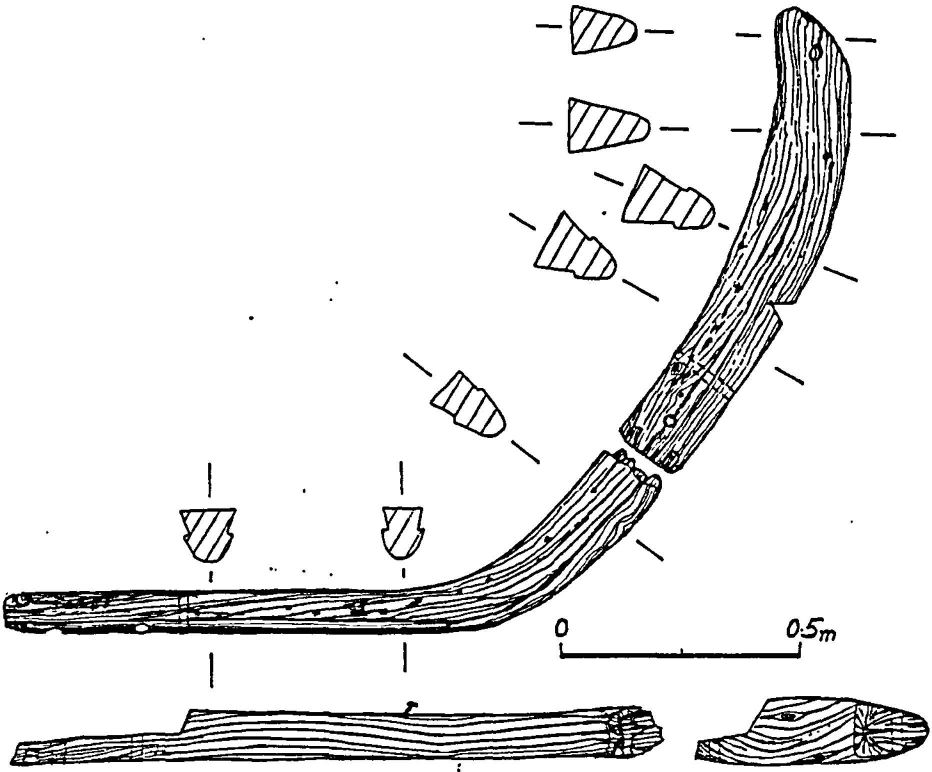


Fig. 3.10a- stem post.

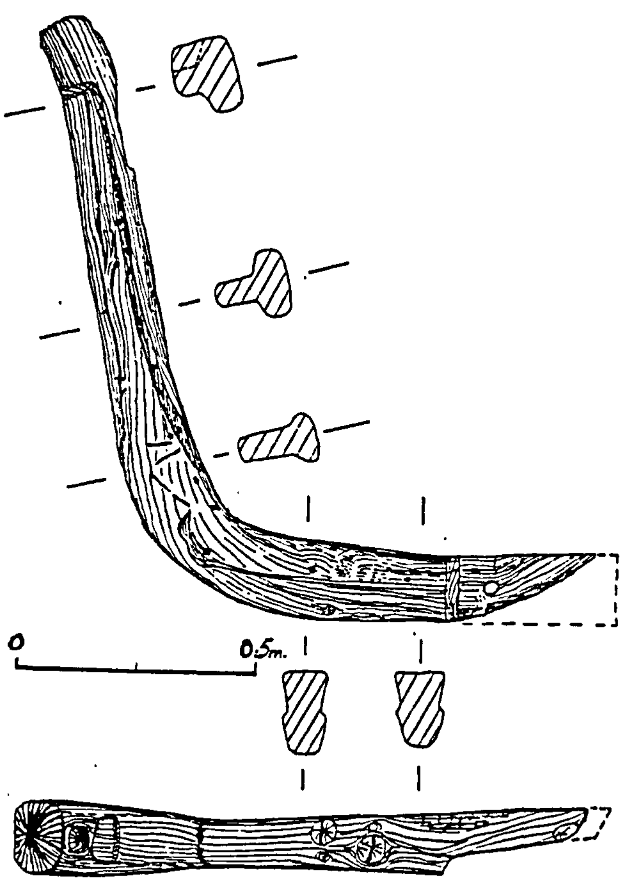


Fig. 3.10b- stern post.

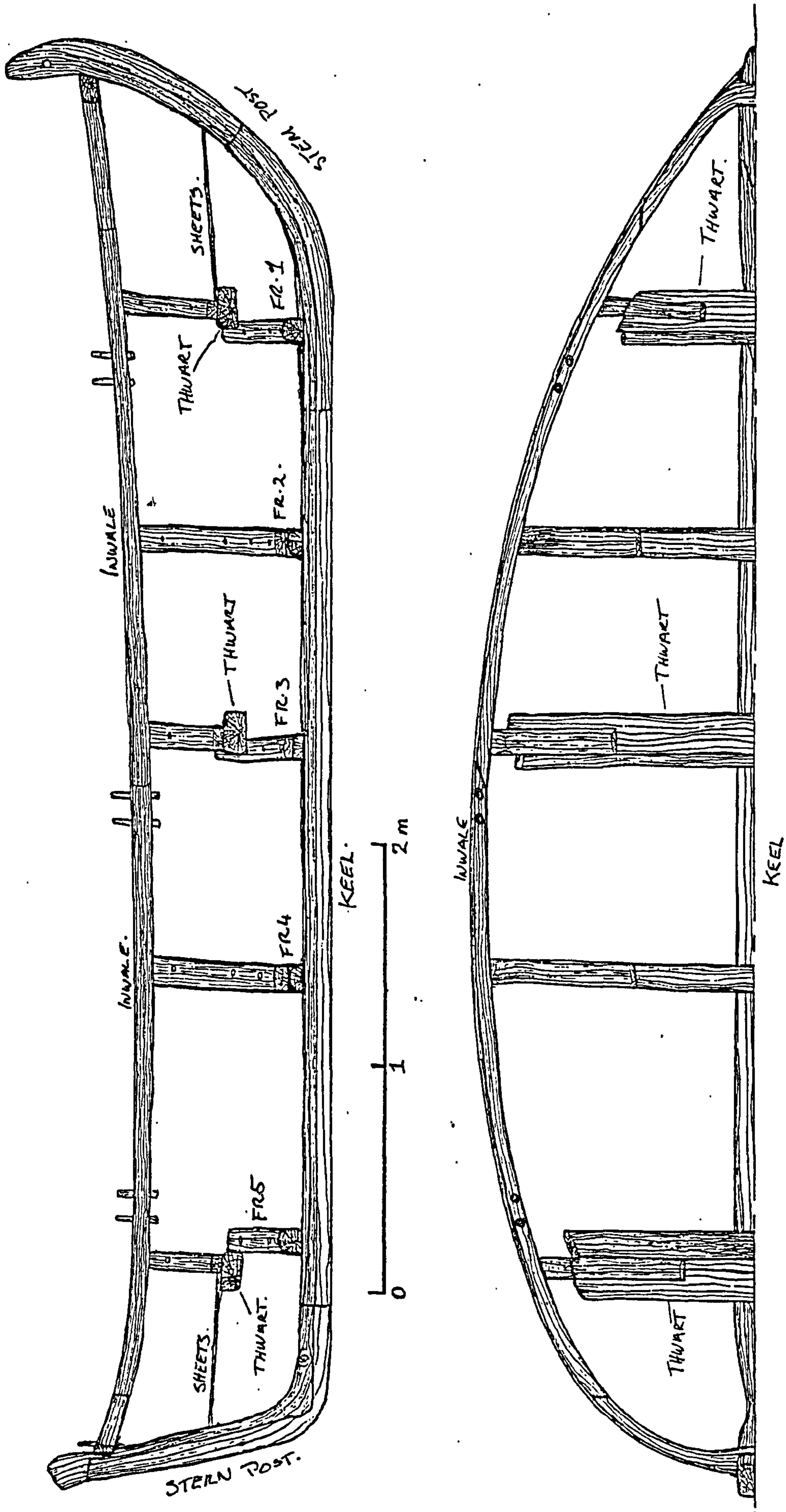


Fig. 3.11- Llyn Peris boat framing, inwale, centerline structure and stringer reconstructed.

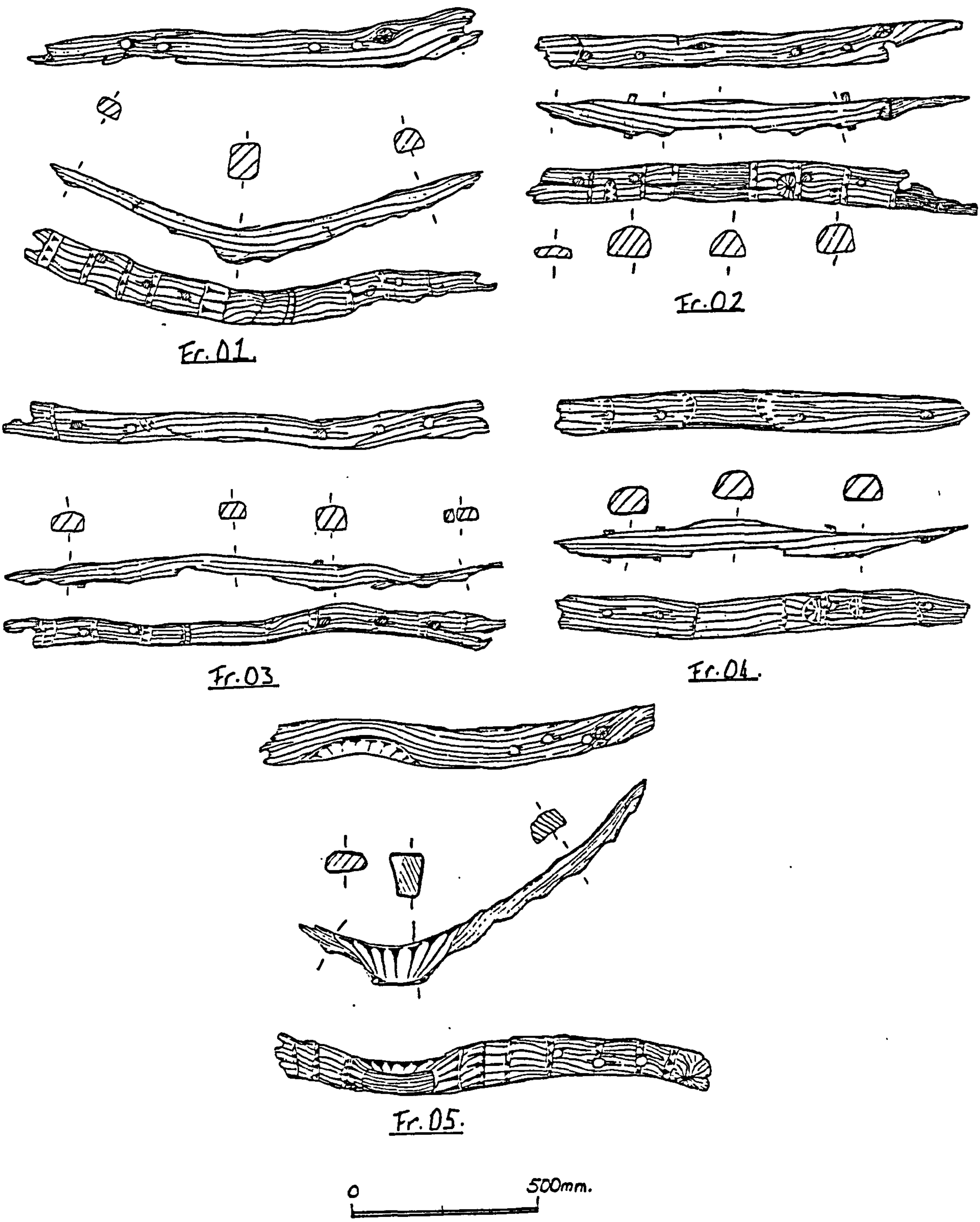


Fig. 3.12- Llyn Peris boat framing.

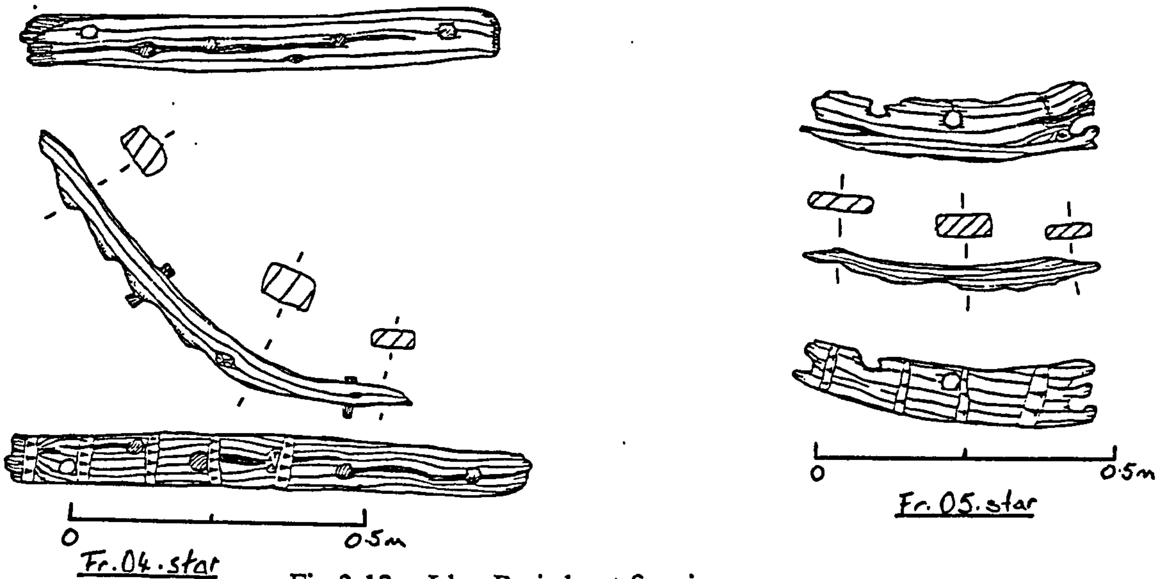


Fig.3.13a- Llyn Peris boat framing.

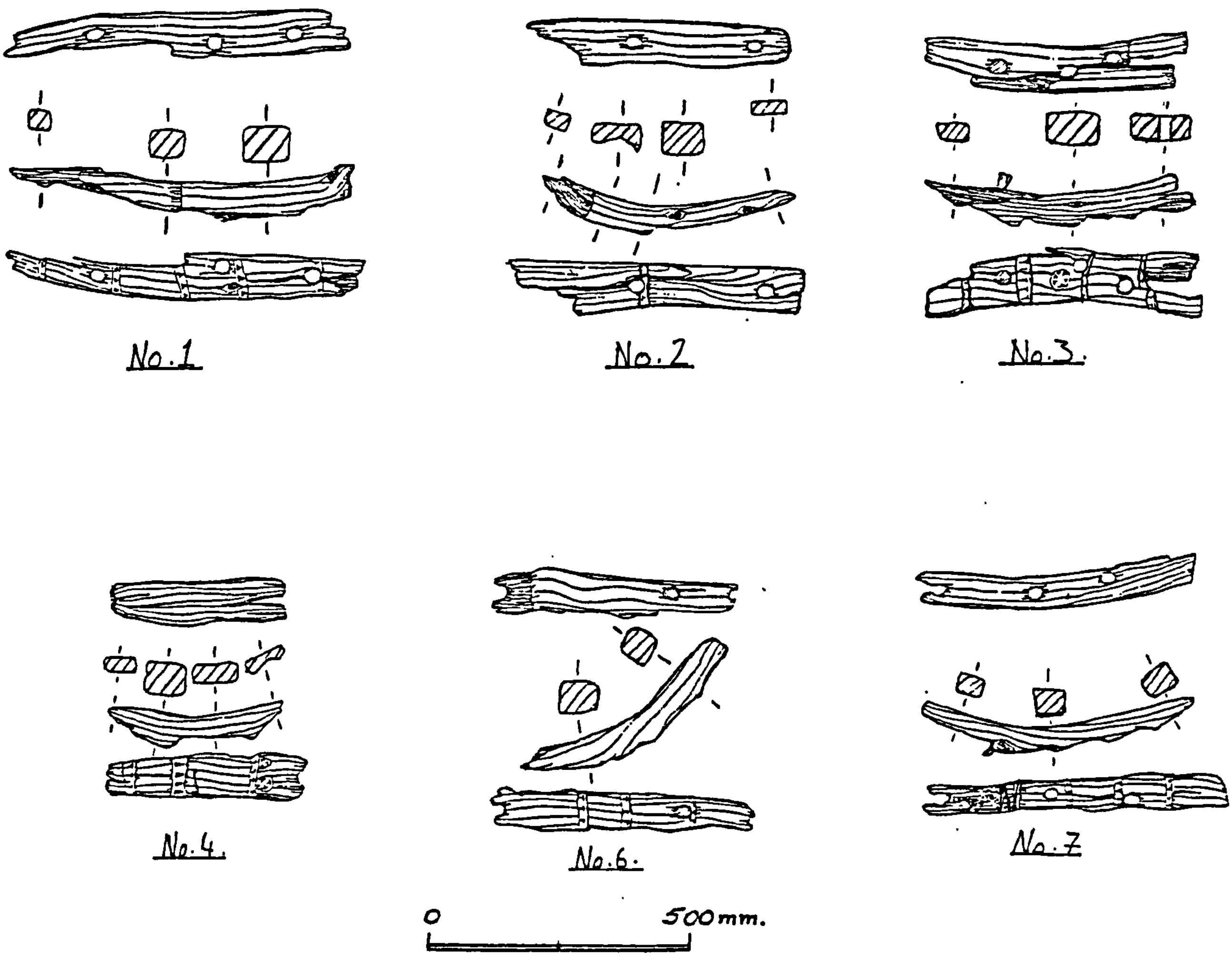


Fig. 3.13b- Llyn Peris boat miscellaneous framing pieces.

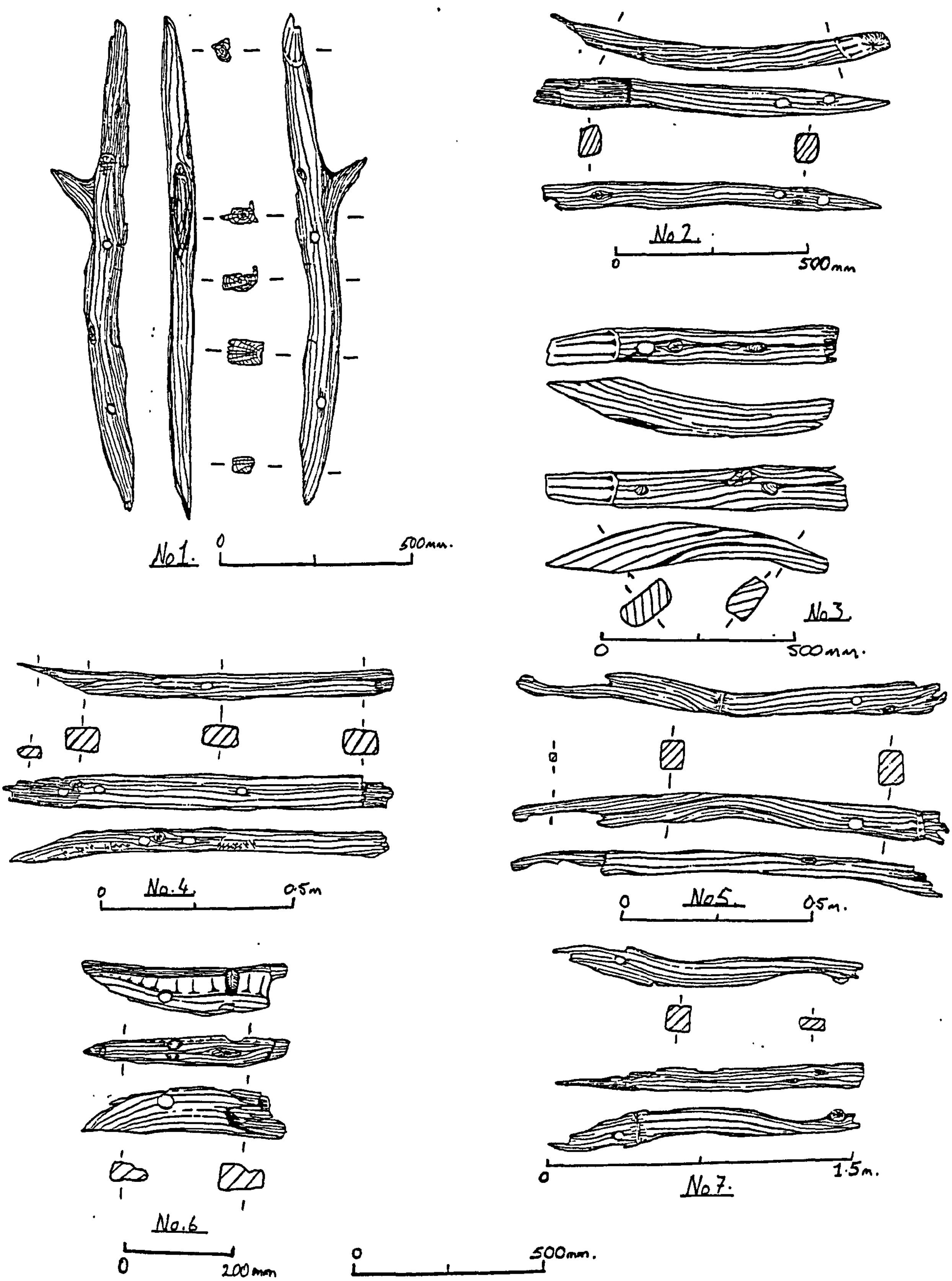


Fig. 3.14- Llyn Peris boat inwale.

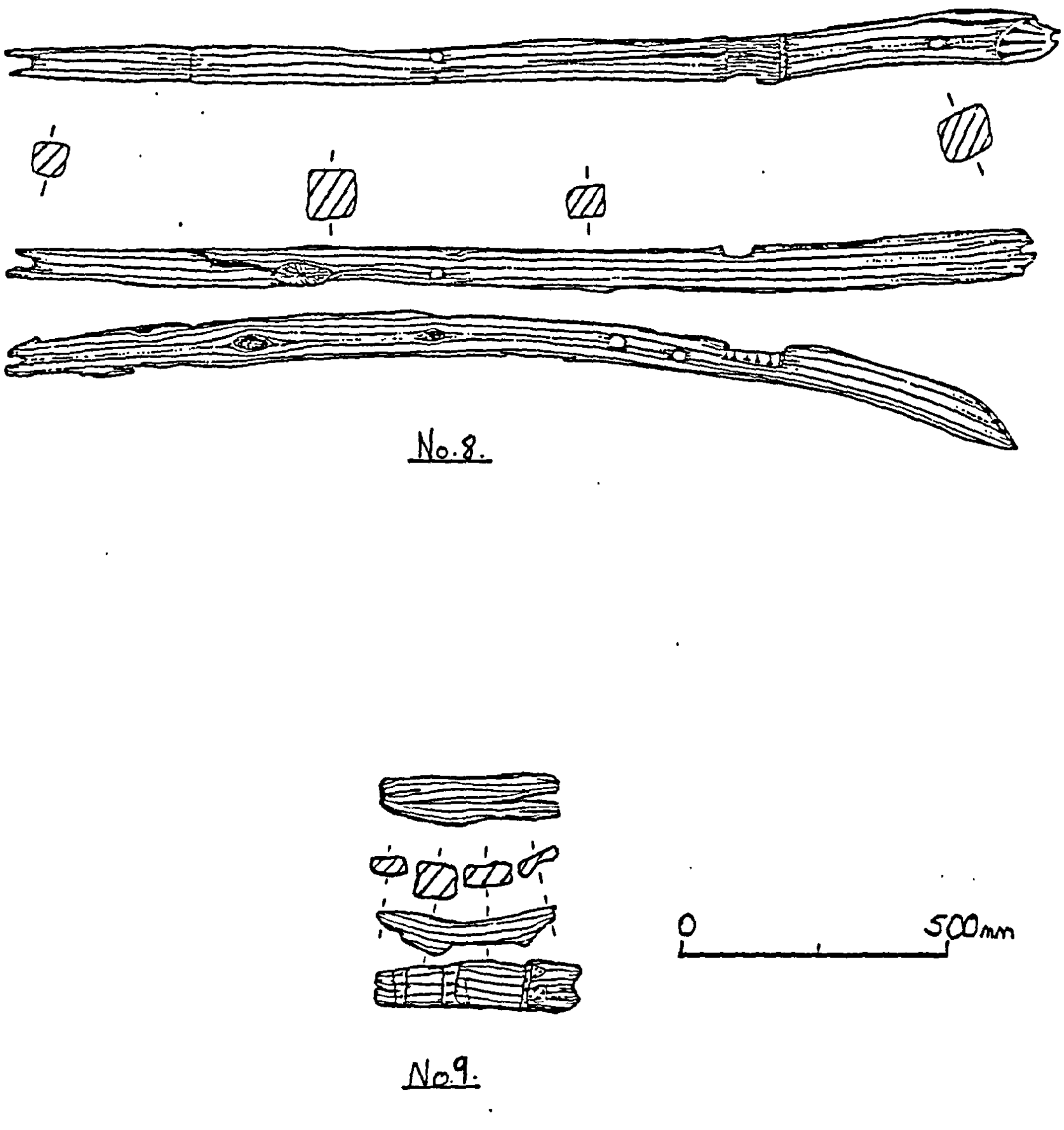


Fig. 3.15- Llyn Peris boat inwale.

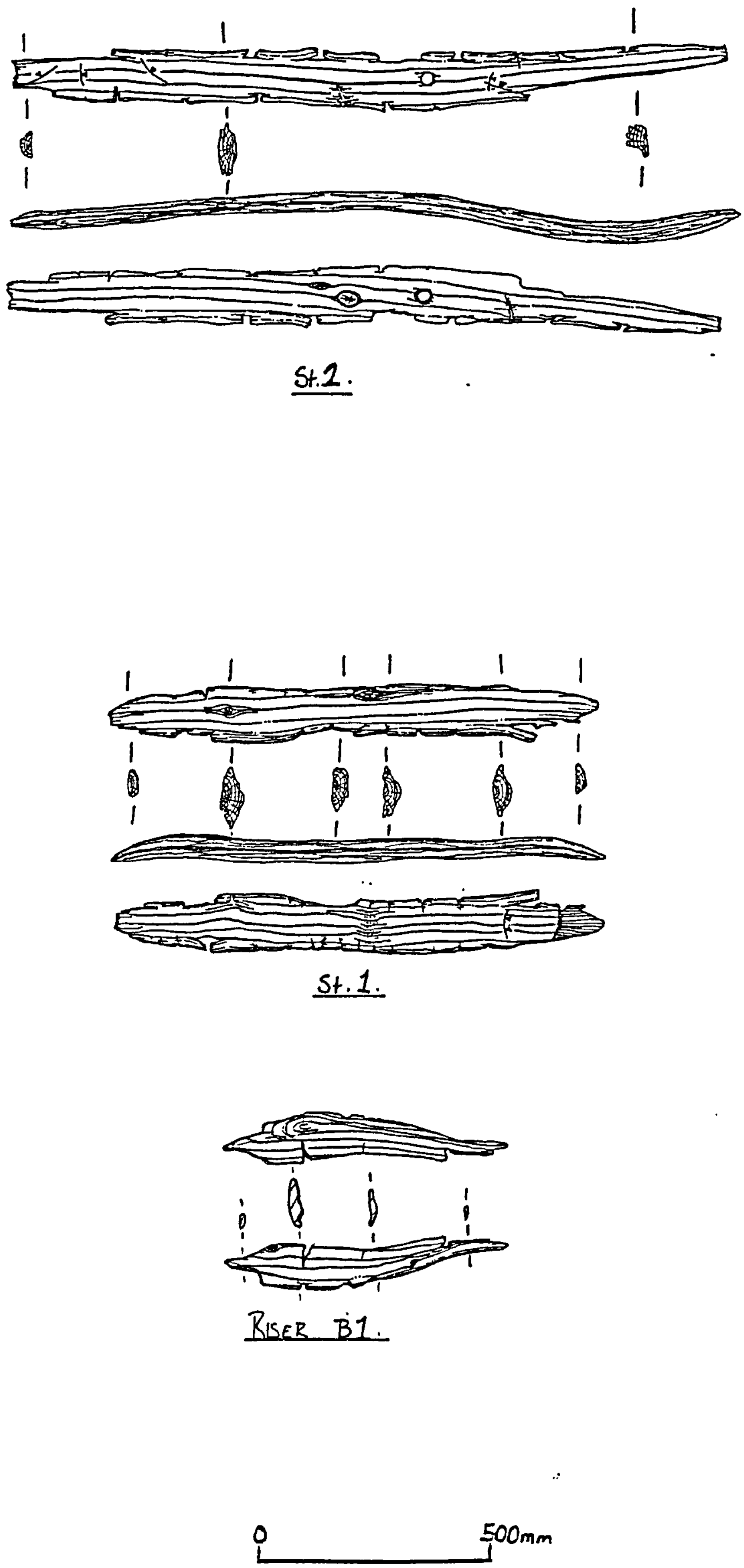


Fig. 3.16- Llyn Peris boat stringer.

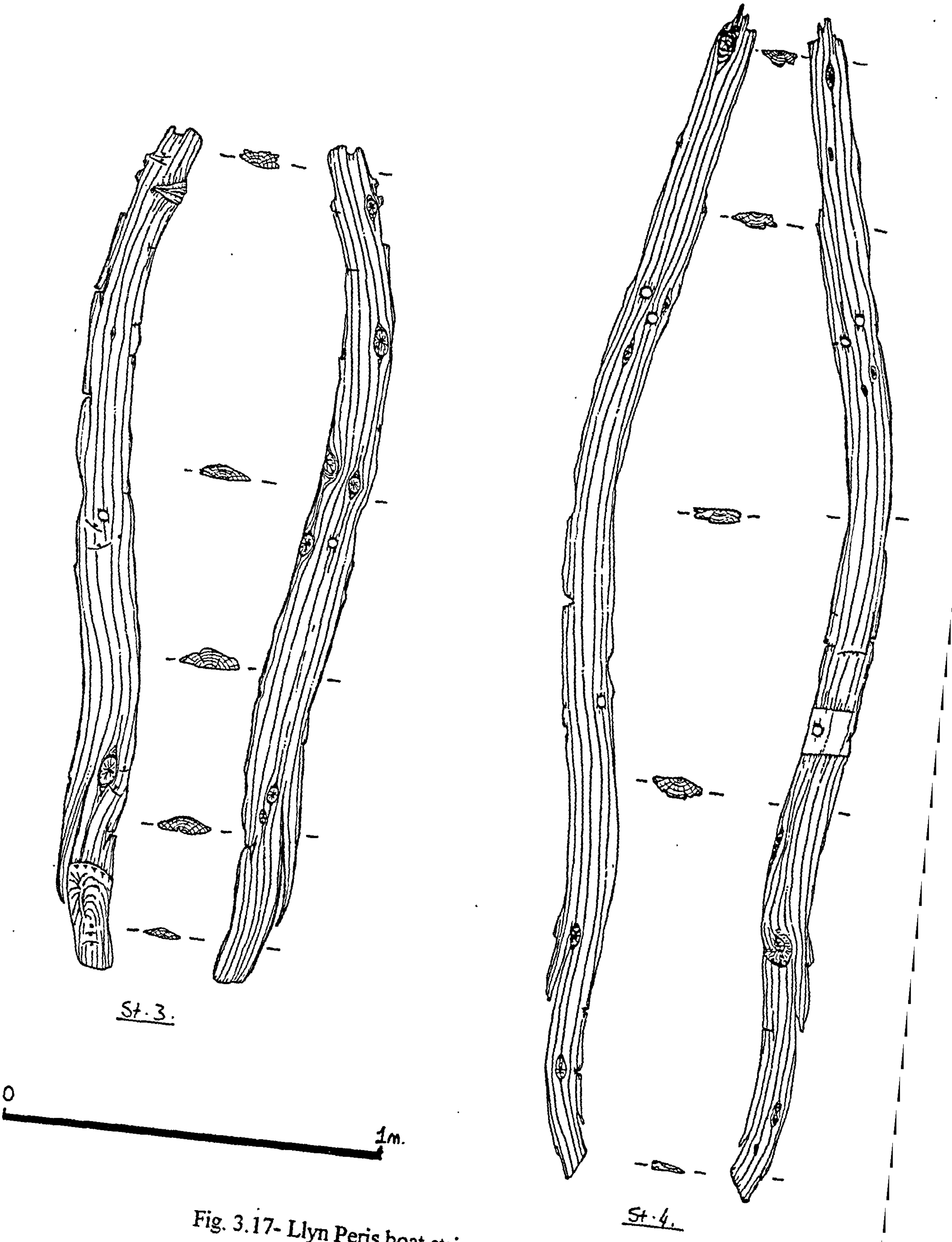


Fig. 3.17- Llyn Peris boat stringer.

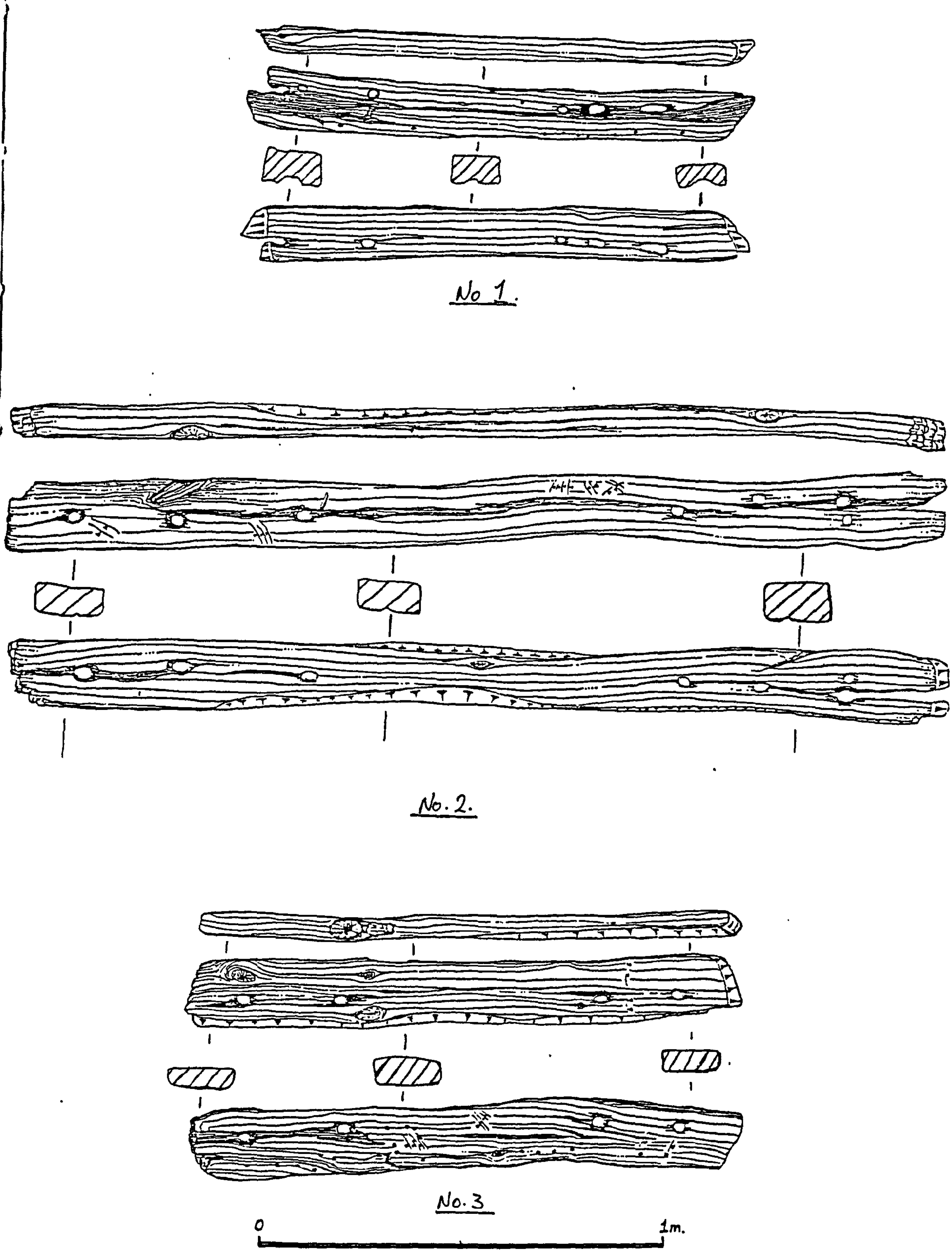
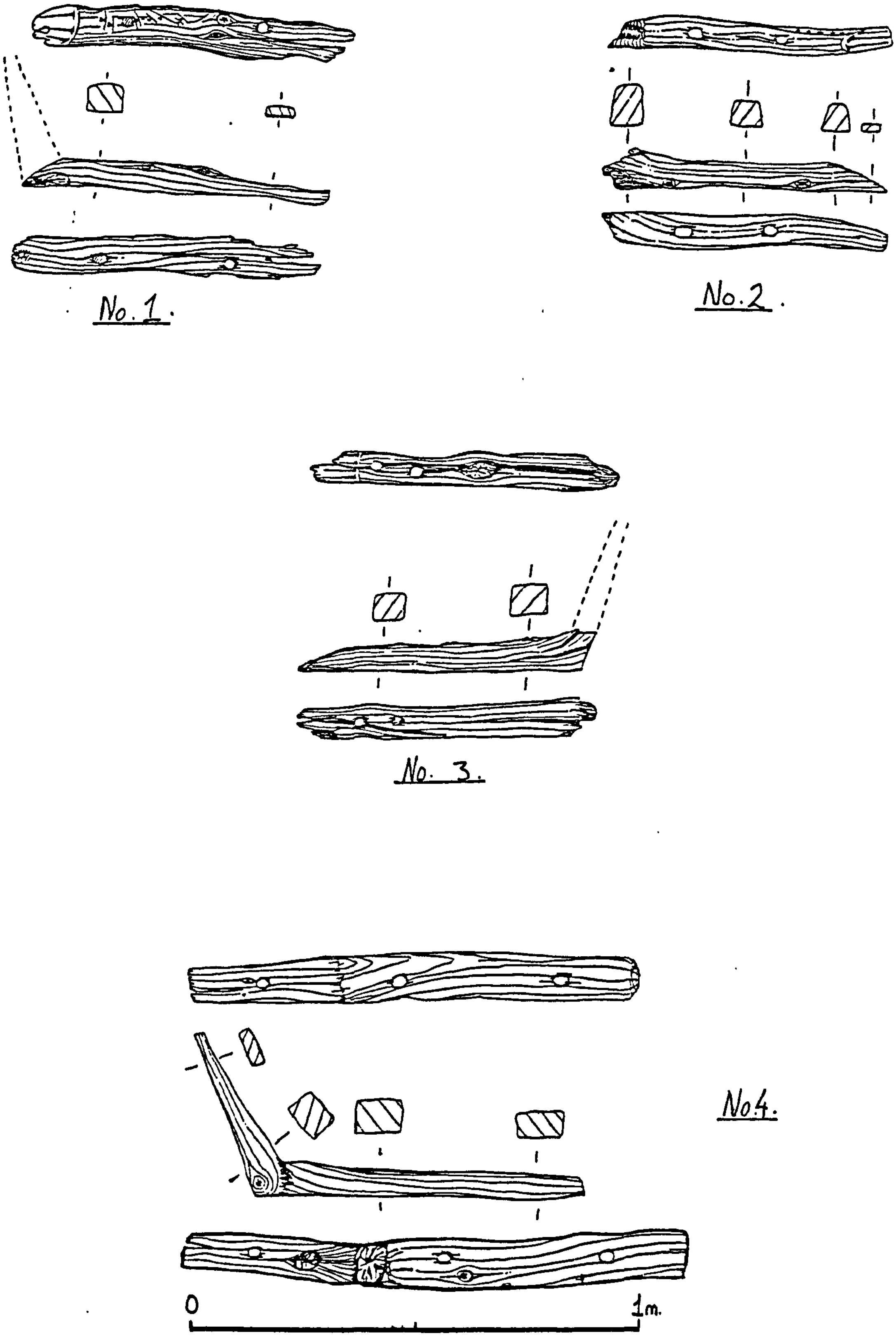


Fig. 3.18- Llyn Peris boat thwarts.



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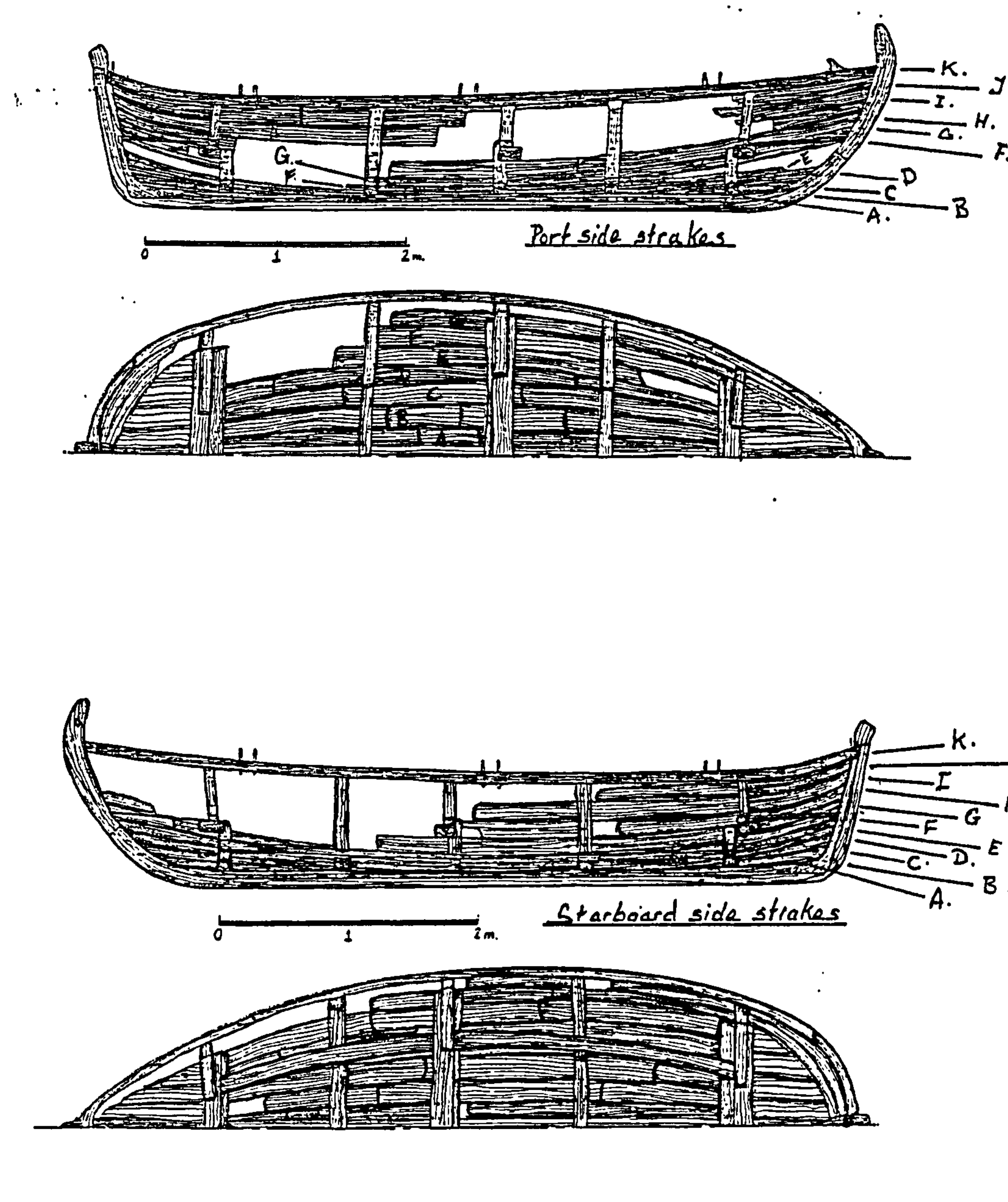


Fig. 3.20- Llyn Peris boat planking port and starboard sides reconstructed.

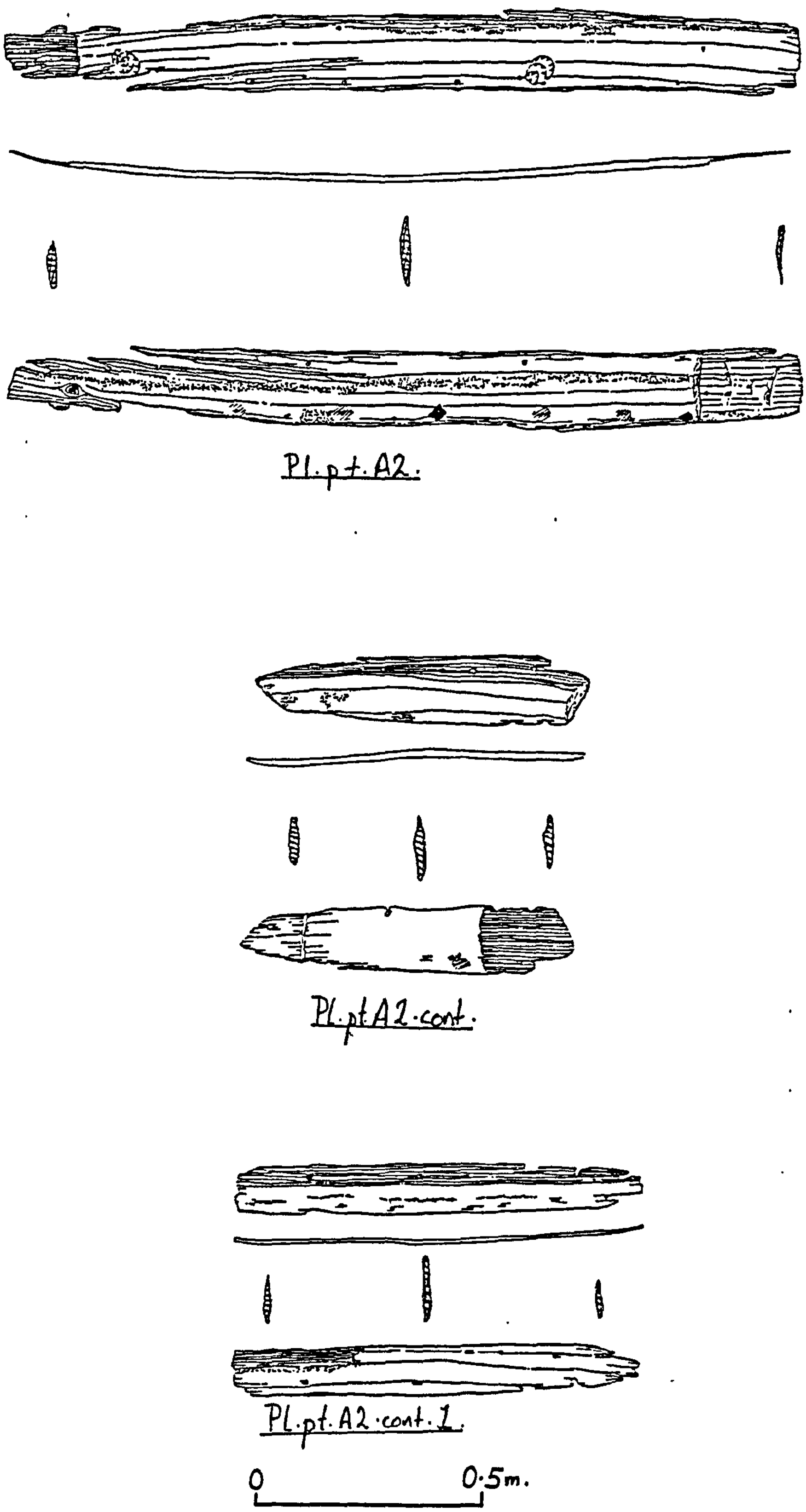


Fig. 3.21- Llyn Peris boat port side planking.

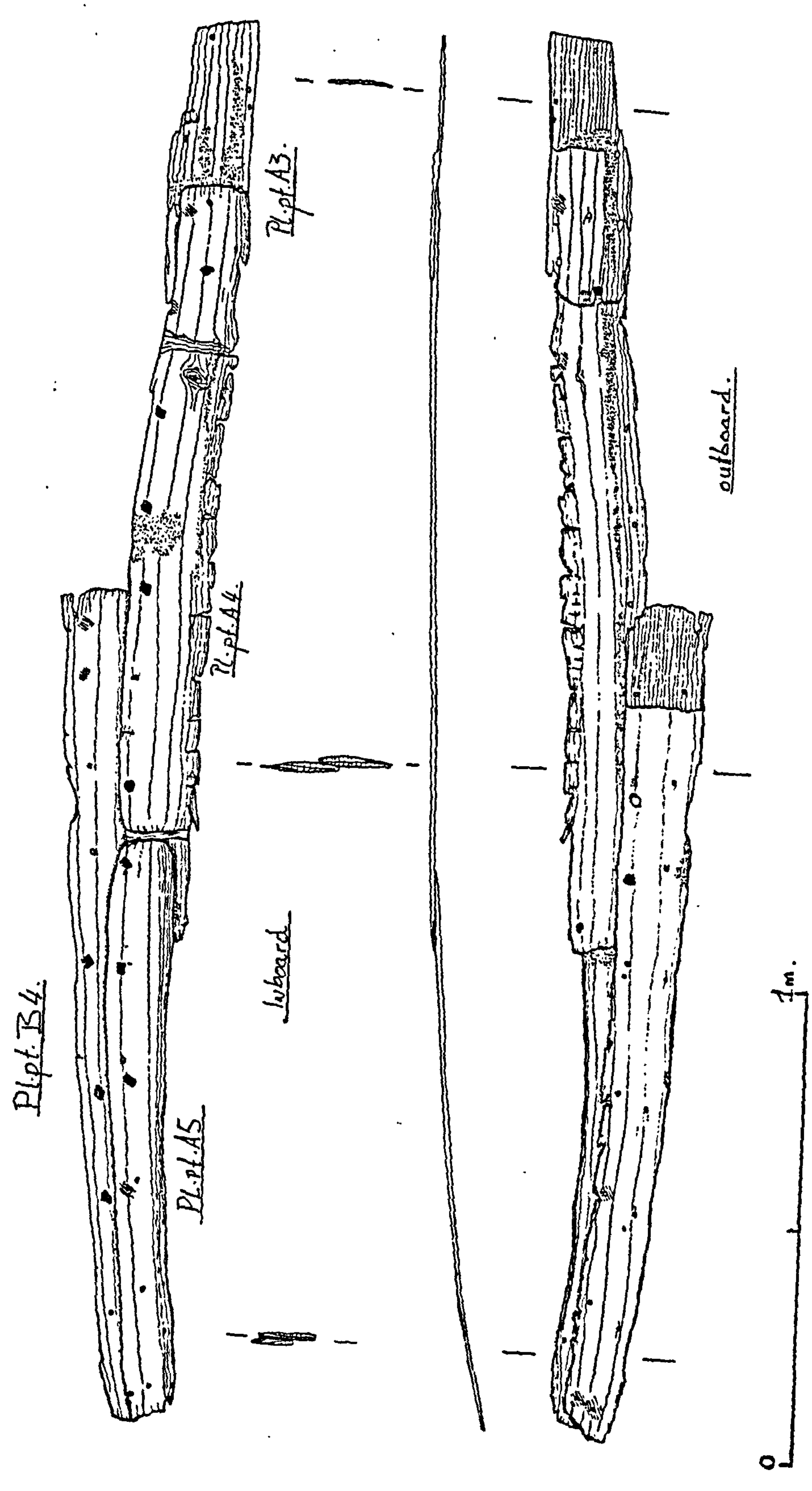


Fig. 3.22- Llyn Peris boat port side planking.

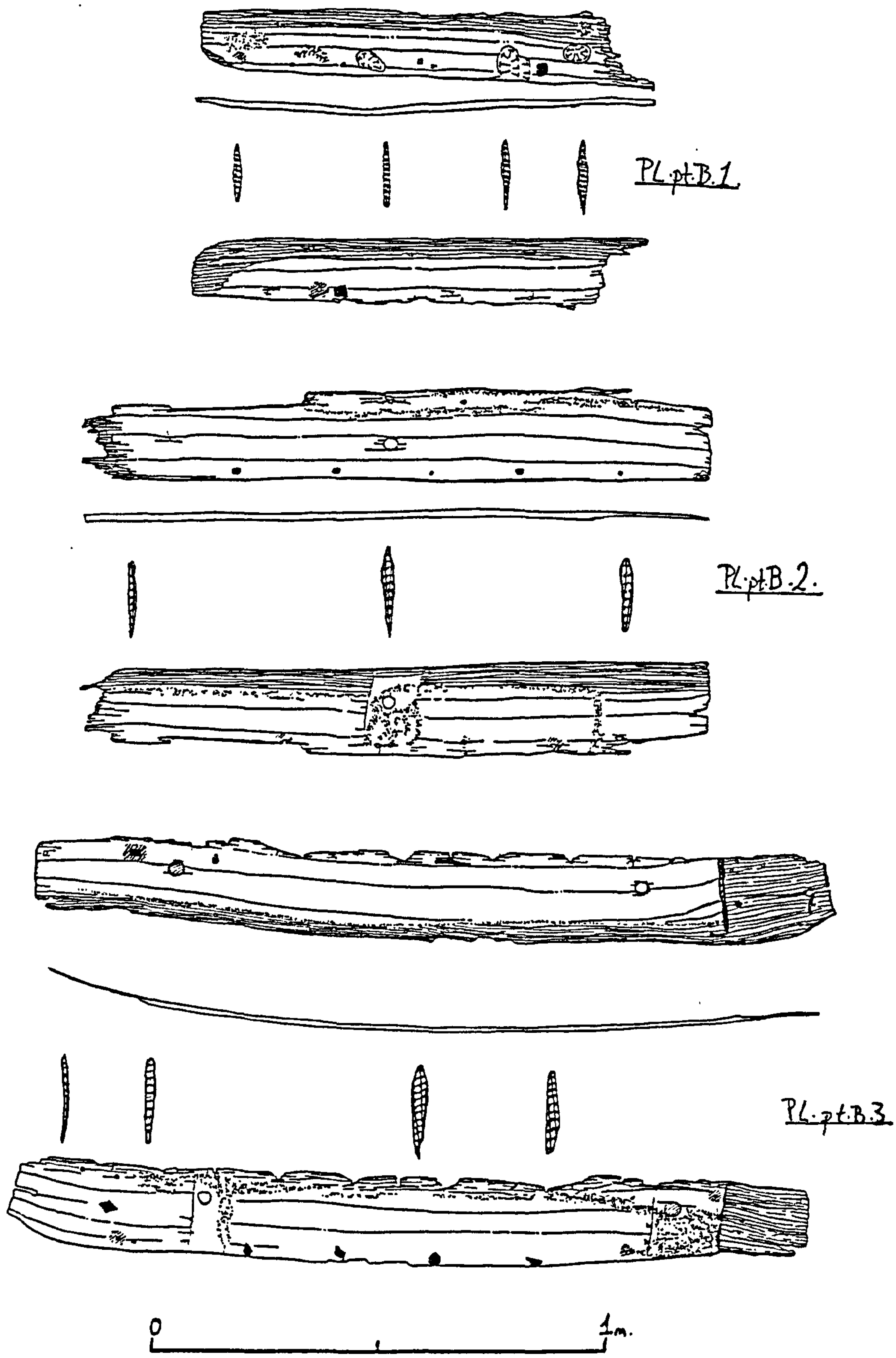
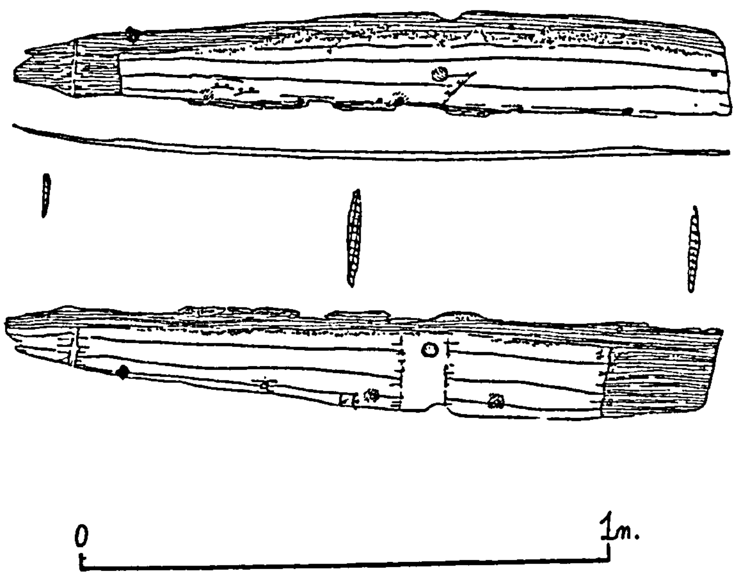


Fig. 3.23- Llyn Peris boat port side planking.



PL.pt.C2.

Fig. 3.24- Llyn Peris boat port side planking.

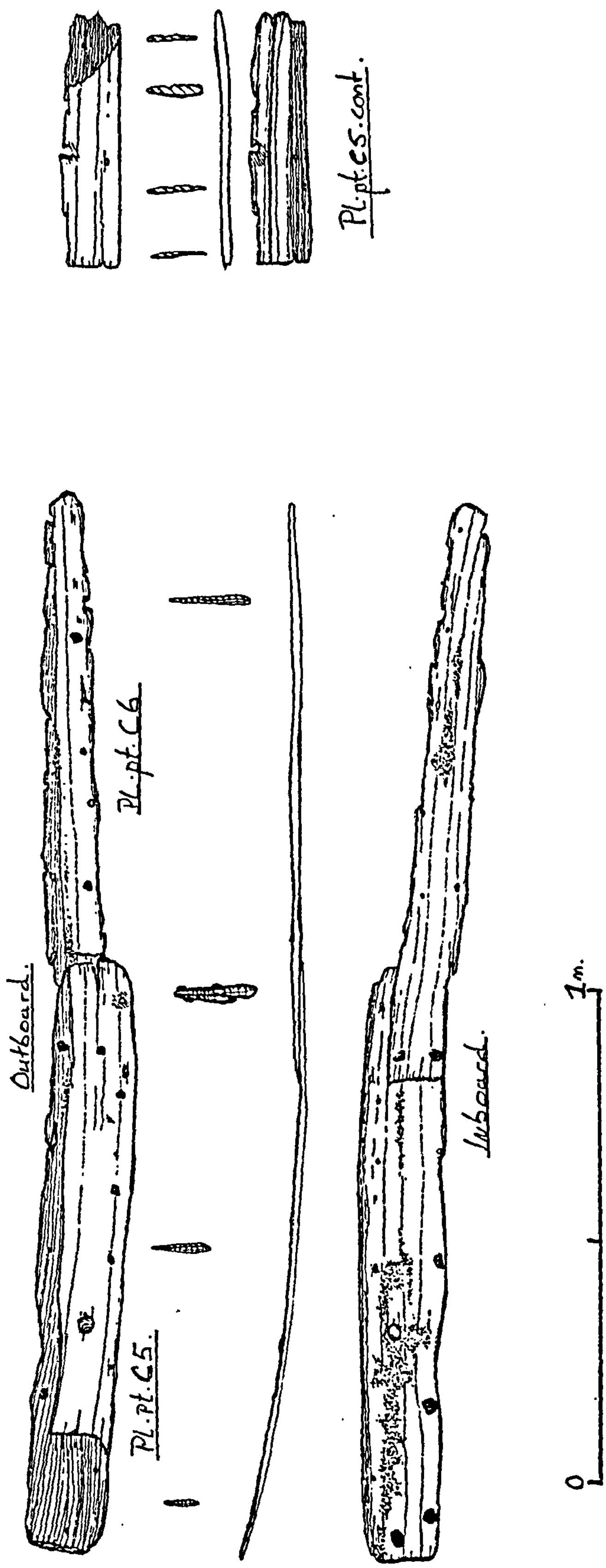


Fig. 3.25- Llyn Peris boat port side planking.

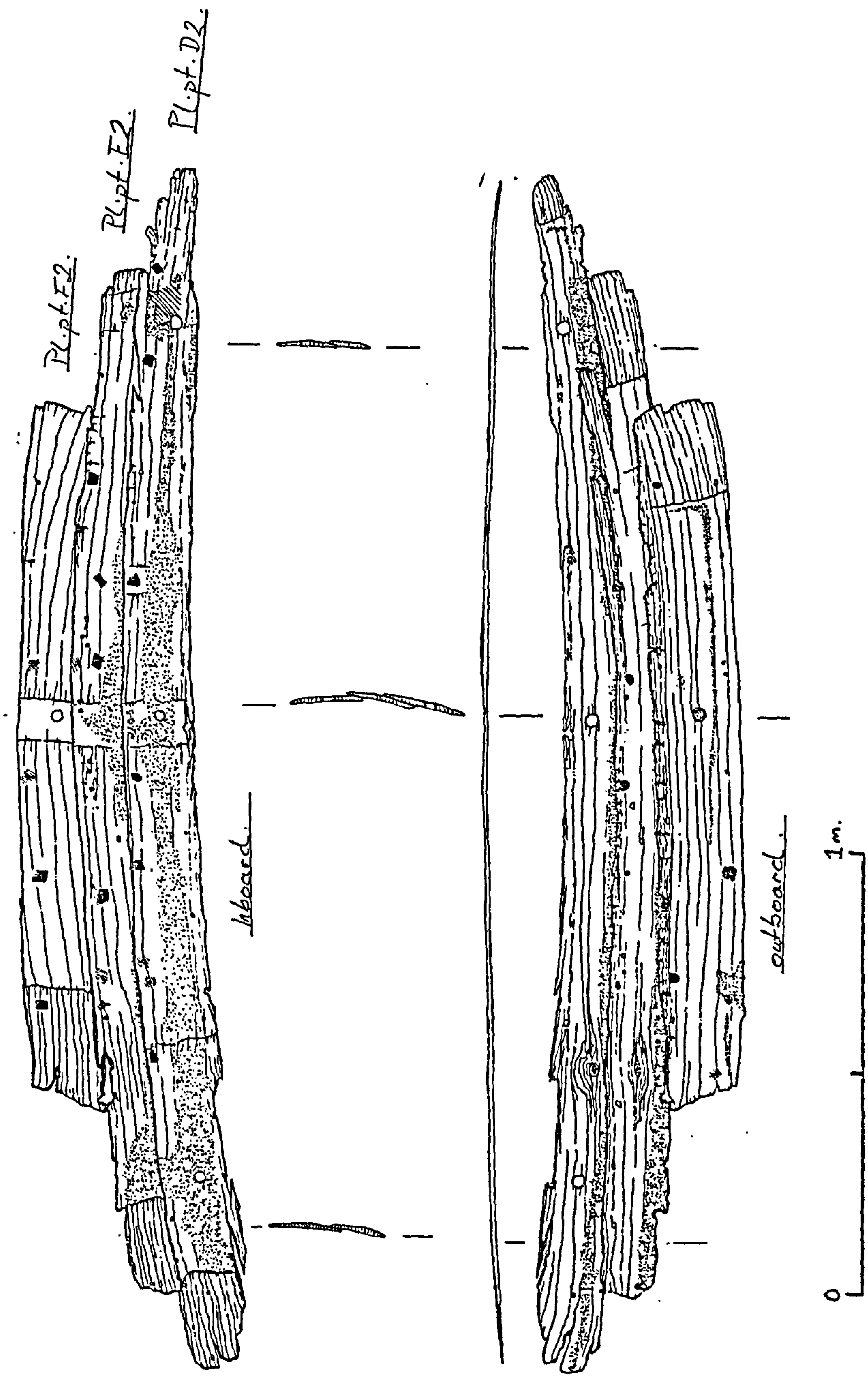


Fig. 3.26- Llyn Peris boat port side planking.

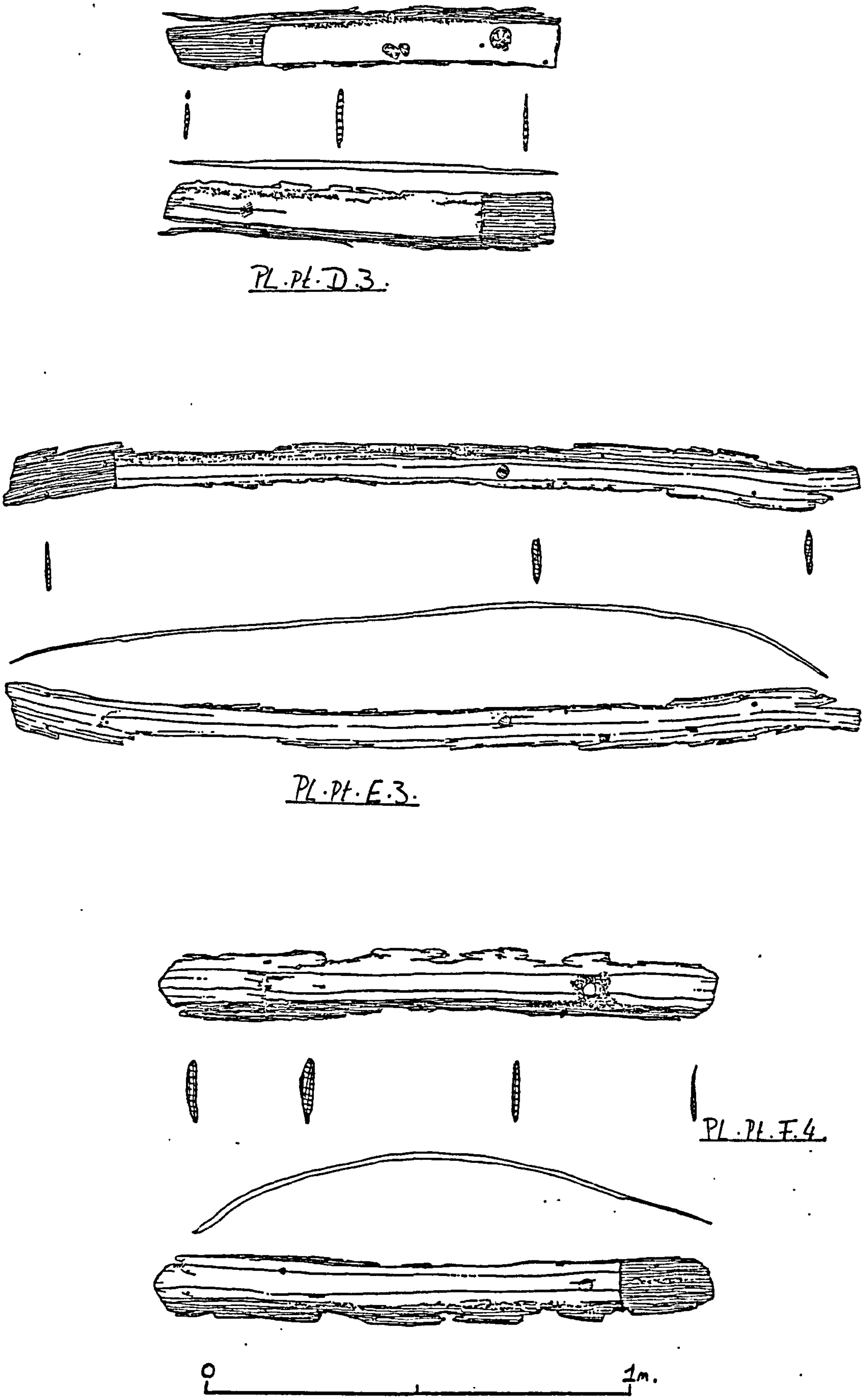


Fig. 3.27- Llyn Peris boat port side planking.

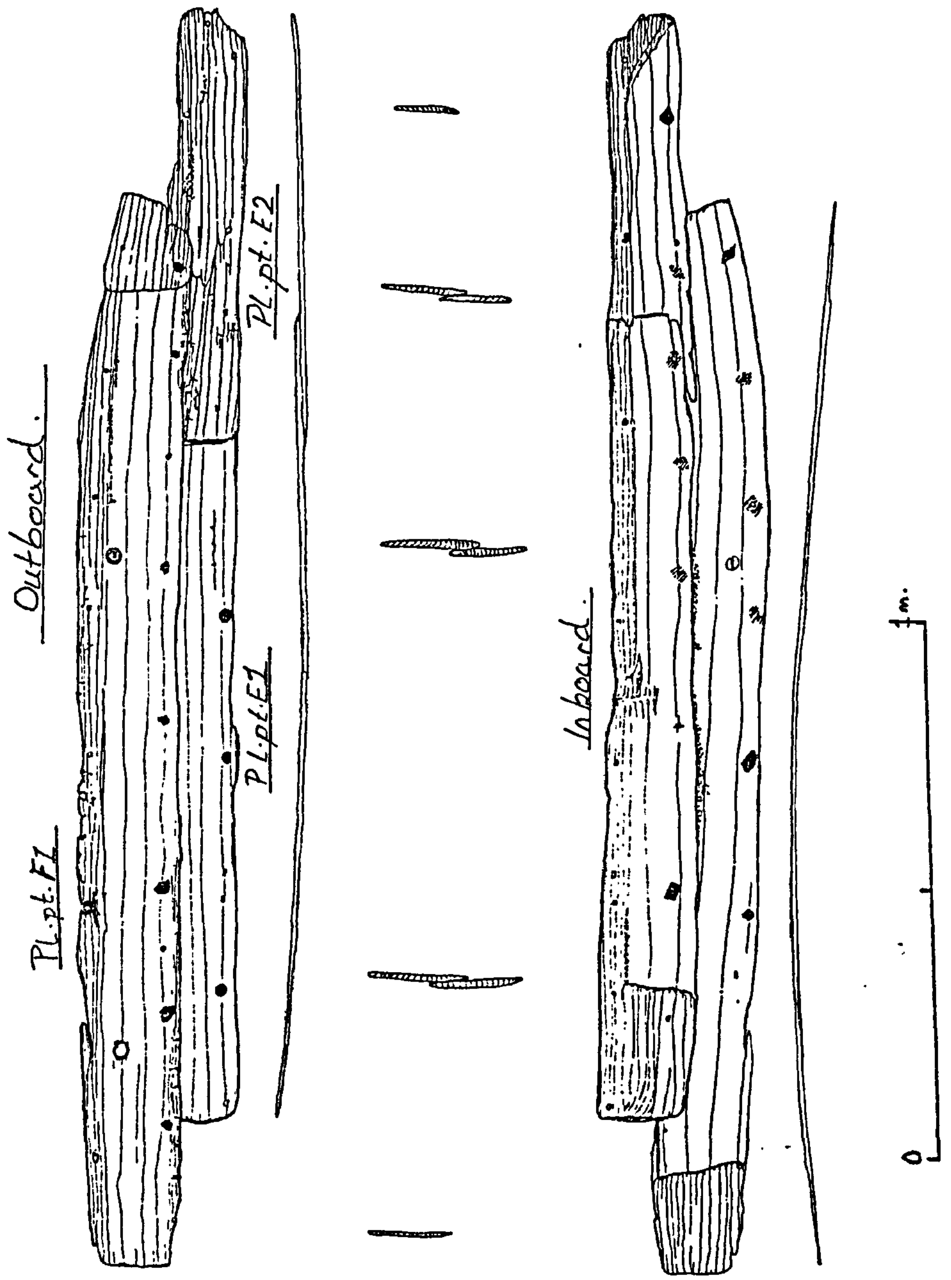
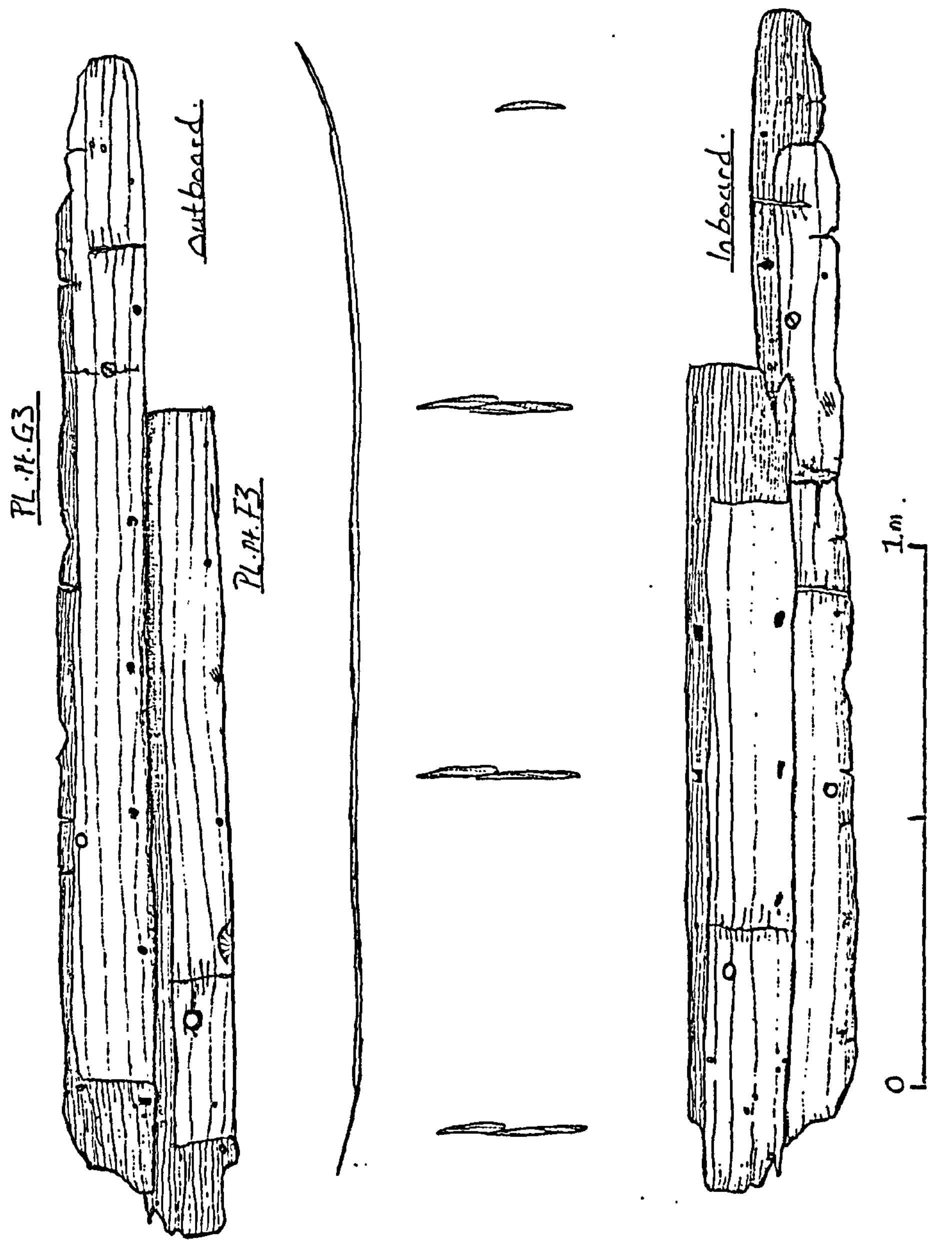


Fig. 3.28- Llyn Peris boat port side planking.



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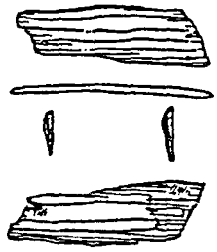

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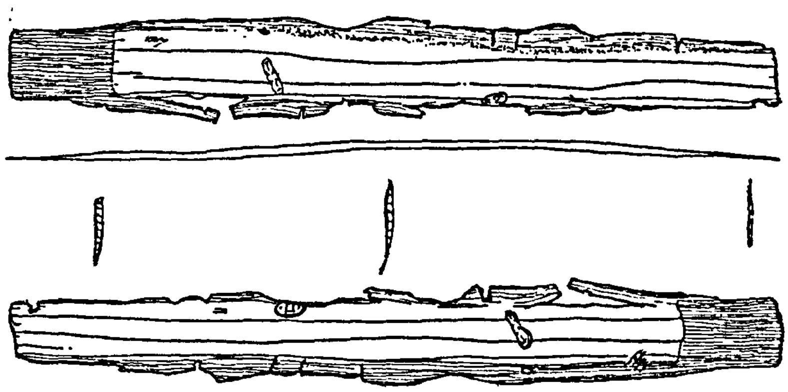

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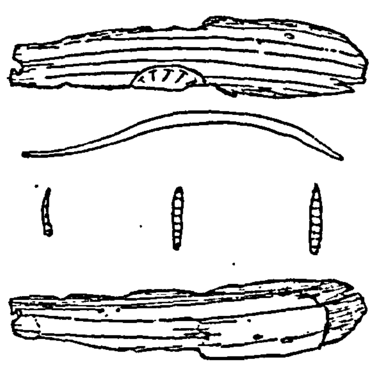


PL·Pt·G4.

0 0·5m.

Fig. 3.30- Llyn Peris boat port side planking.

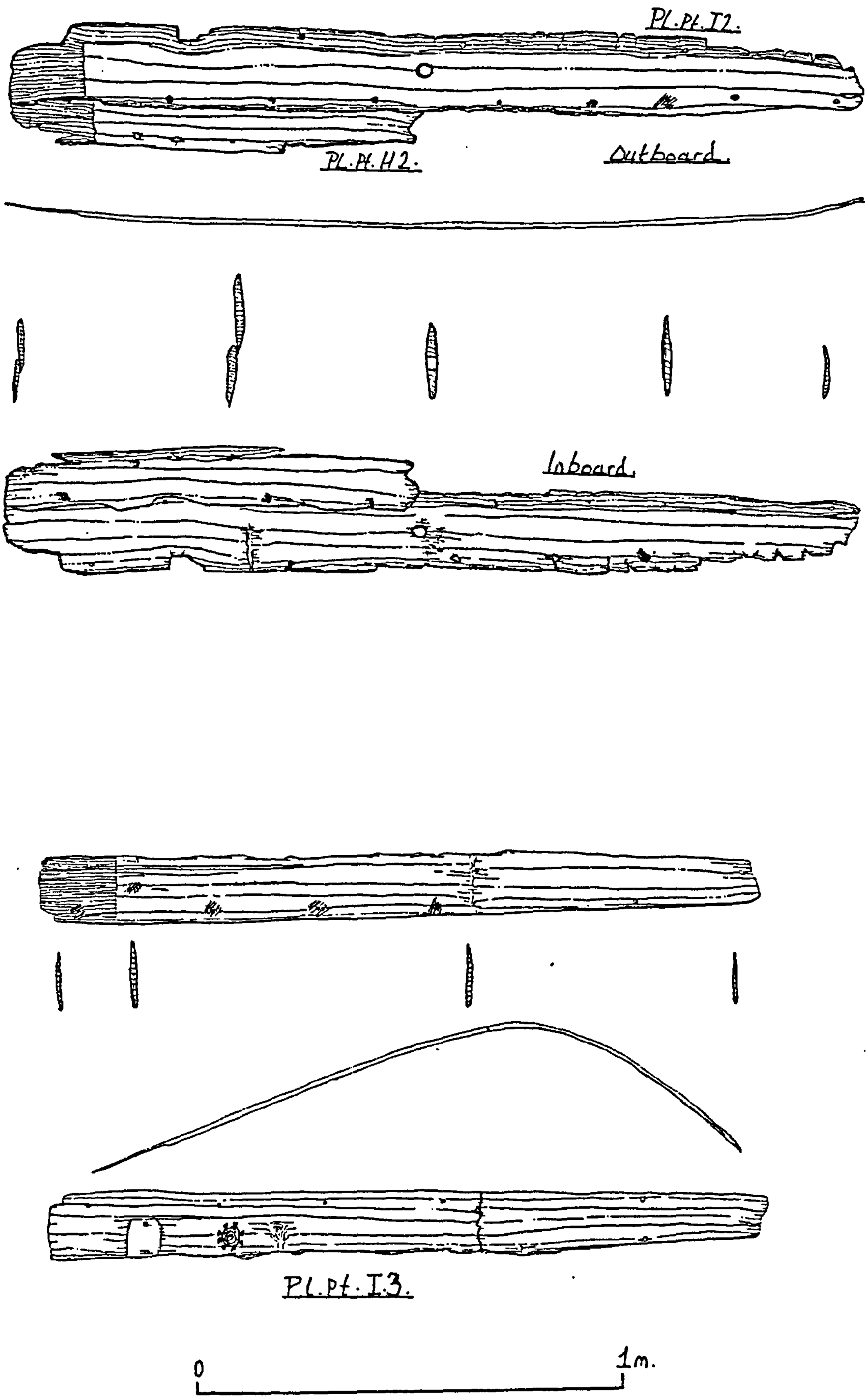
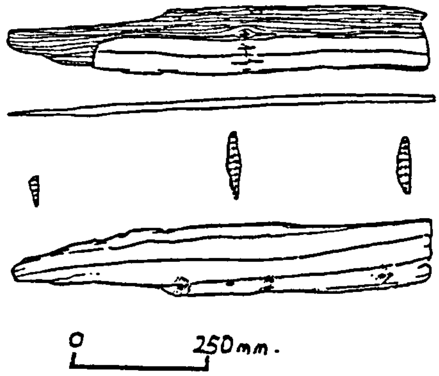
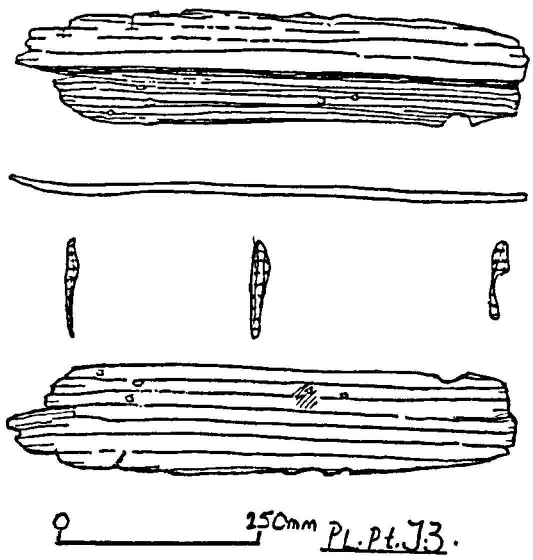


Fig. 3.31- Llyn Peris boat port side planking.



PL.Pt.J2.



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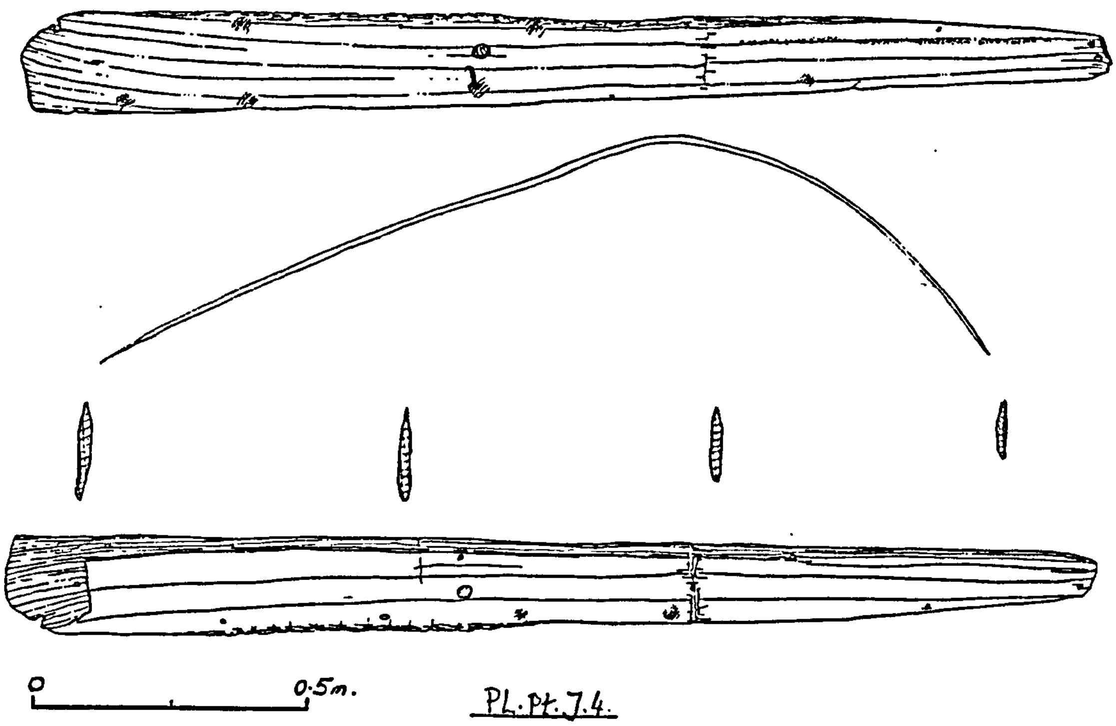


PL.Pt.J.4.

Fig. 3.32- Llyn Peris boat port side planking.

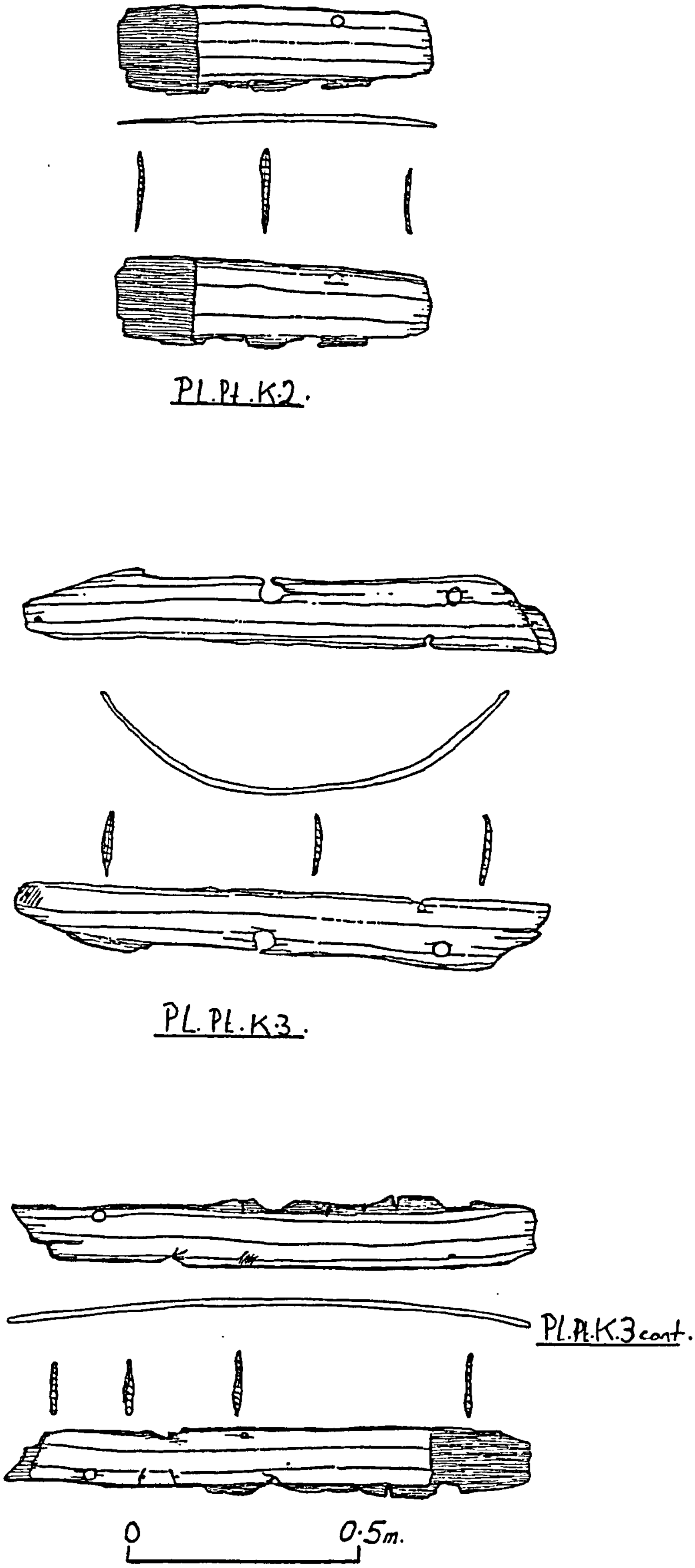
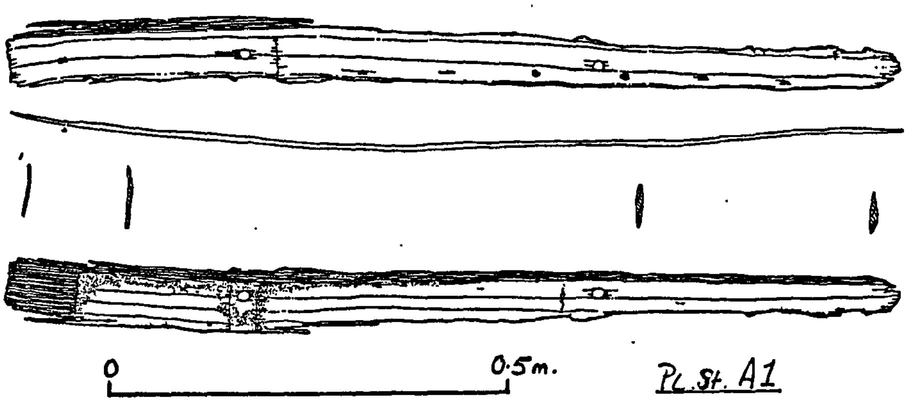
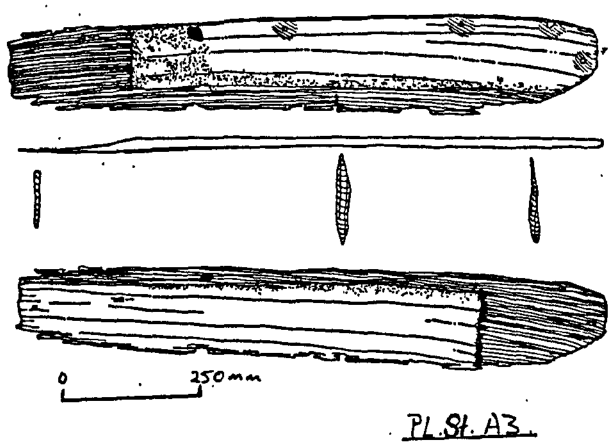
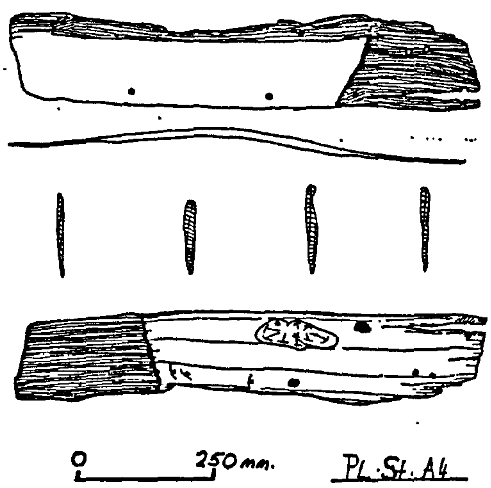
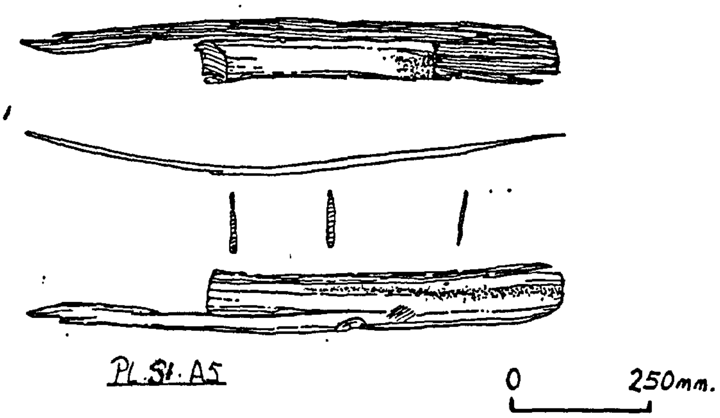


Fig. 3.33- Llyn Peris boat port side planking.









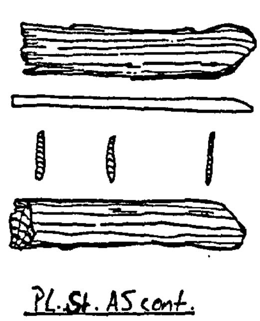


Fig. 3.34- Llyn Peris boat starboard side planking.

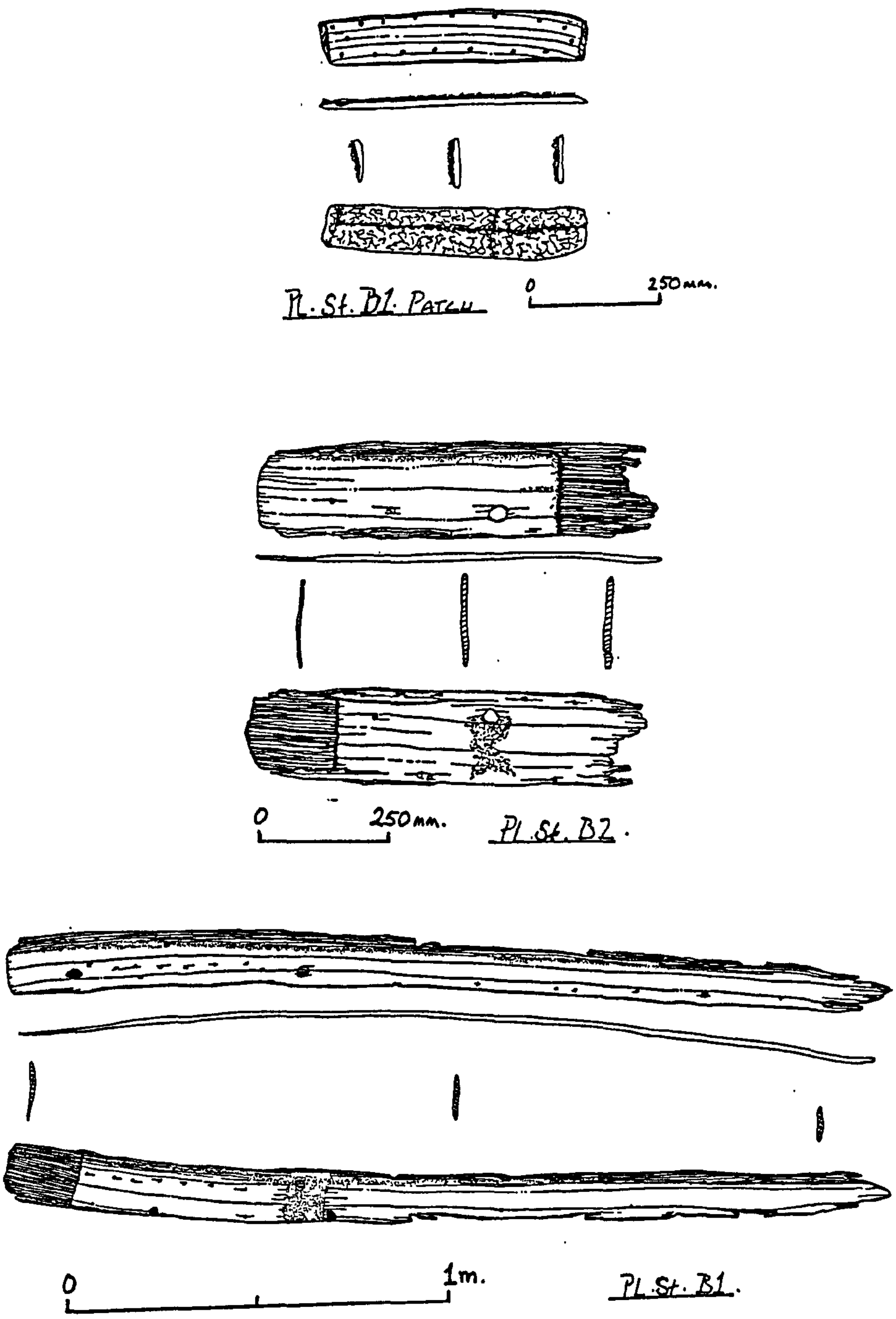


Fig. 3.35- Llyn Peris boat starboard side planking.

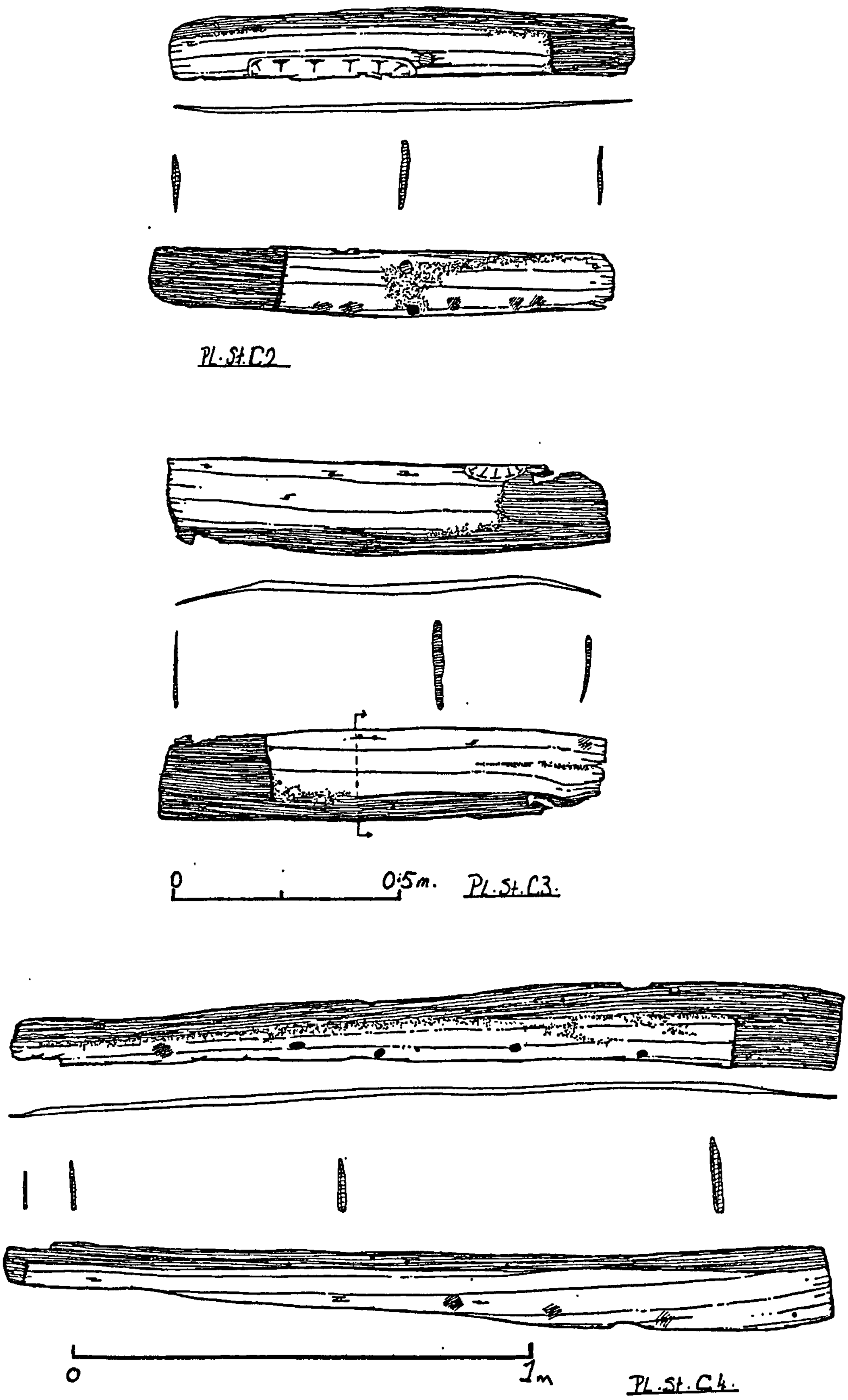


Fig. 3.36- Llyn Peris boat starboard side planking.

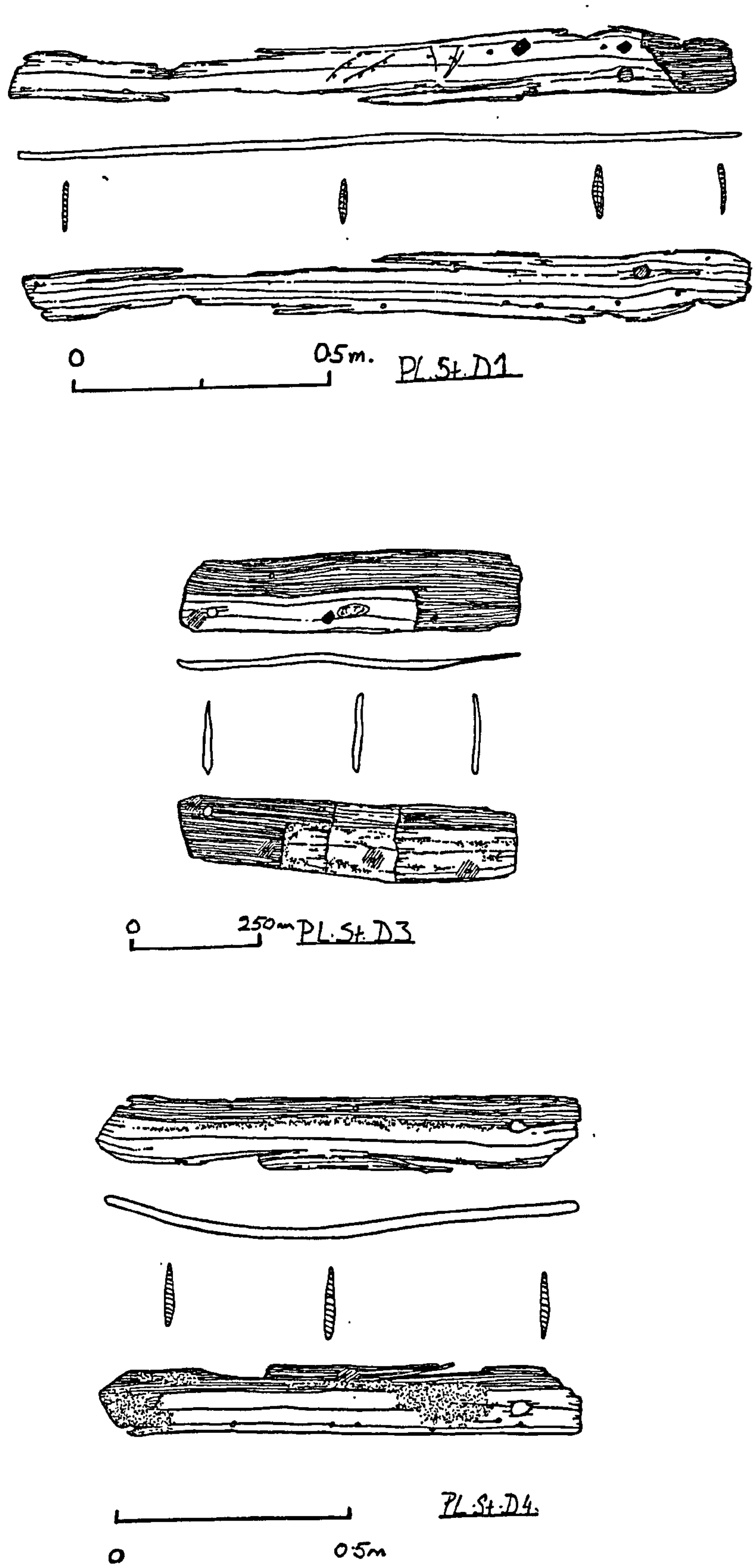


Fig. 3.37- Llyn Peris boat starboard side planking.

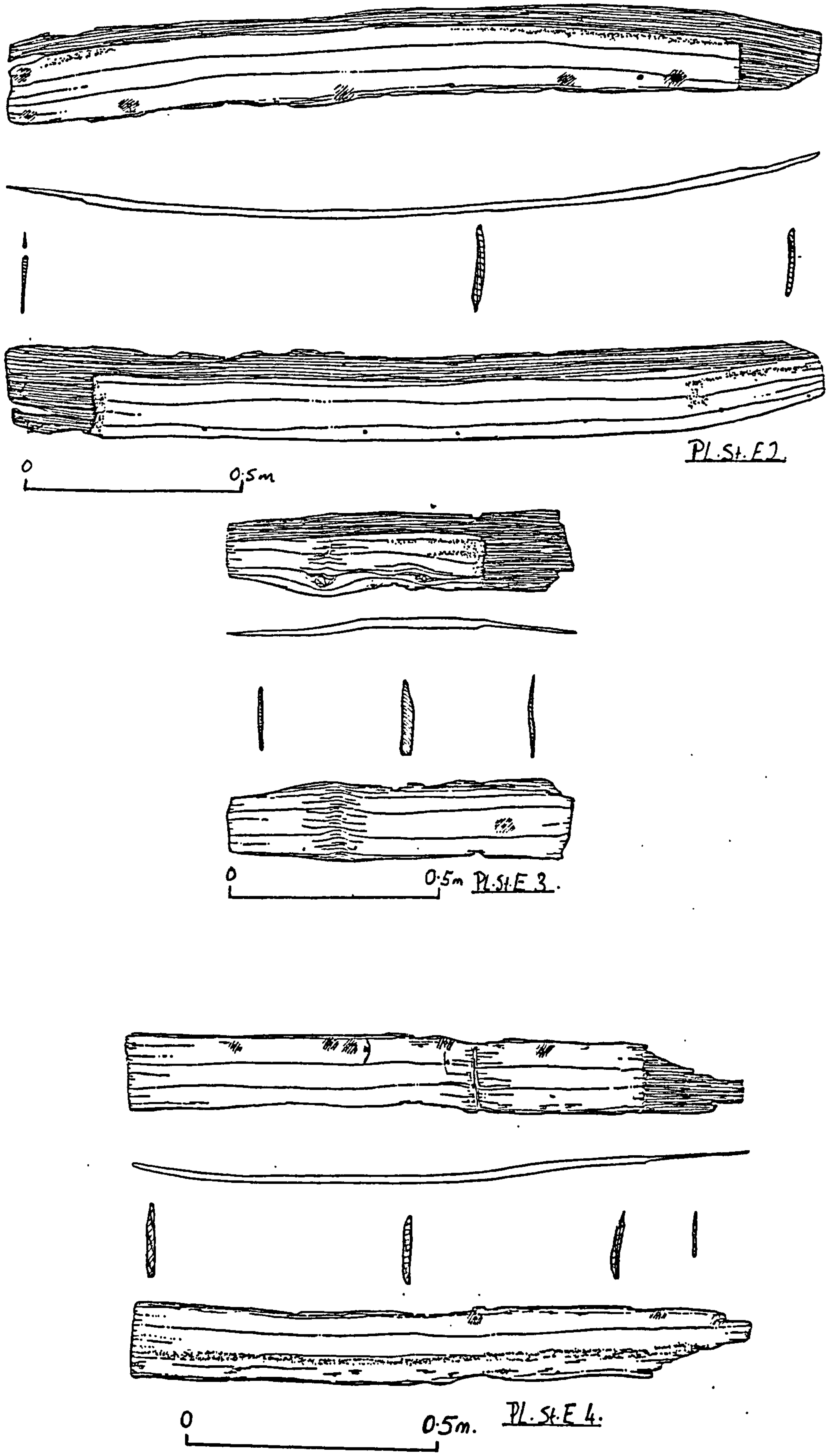


Fig. 3.38- Llyn Peris boat starboard side planking.

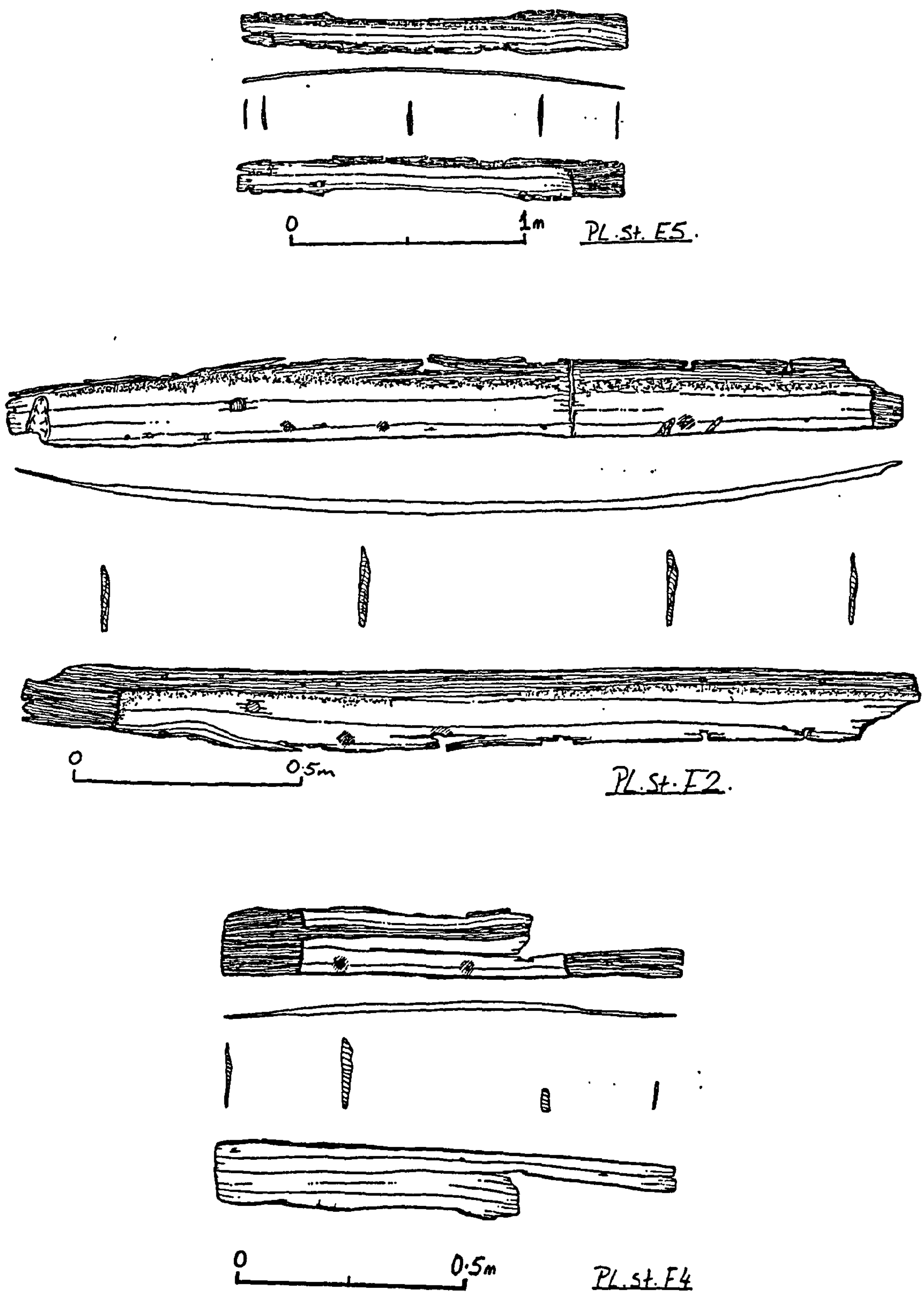


Fig. 3.39- Llyn Peris boat starboard side planking.

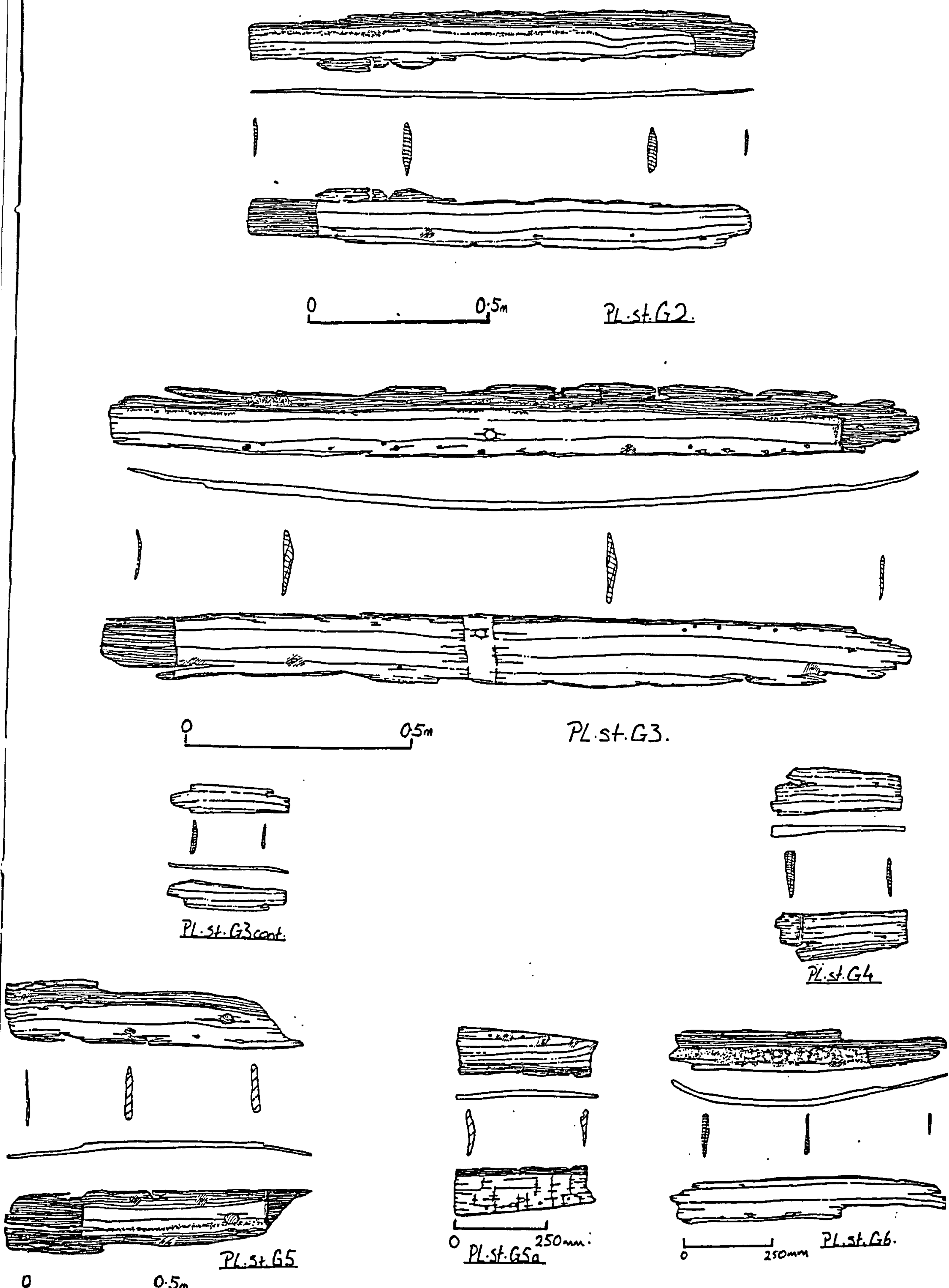


Fig. 3.40- Llyn Peris boat starboard side planking.

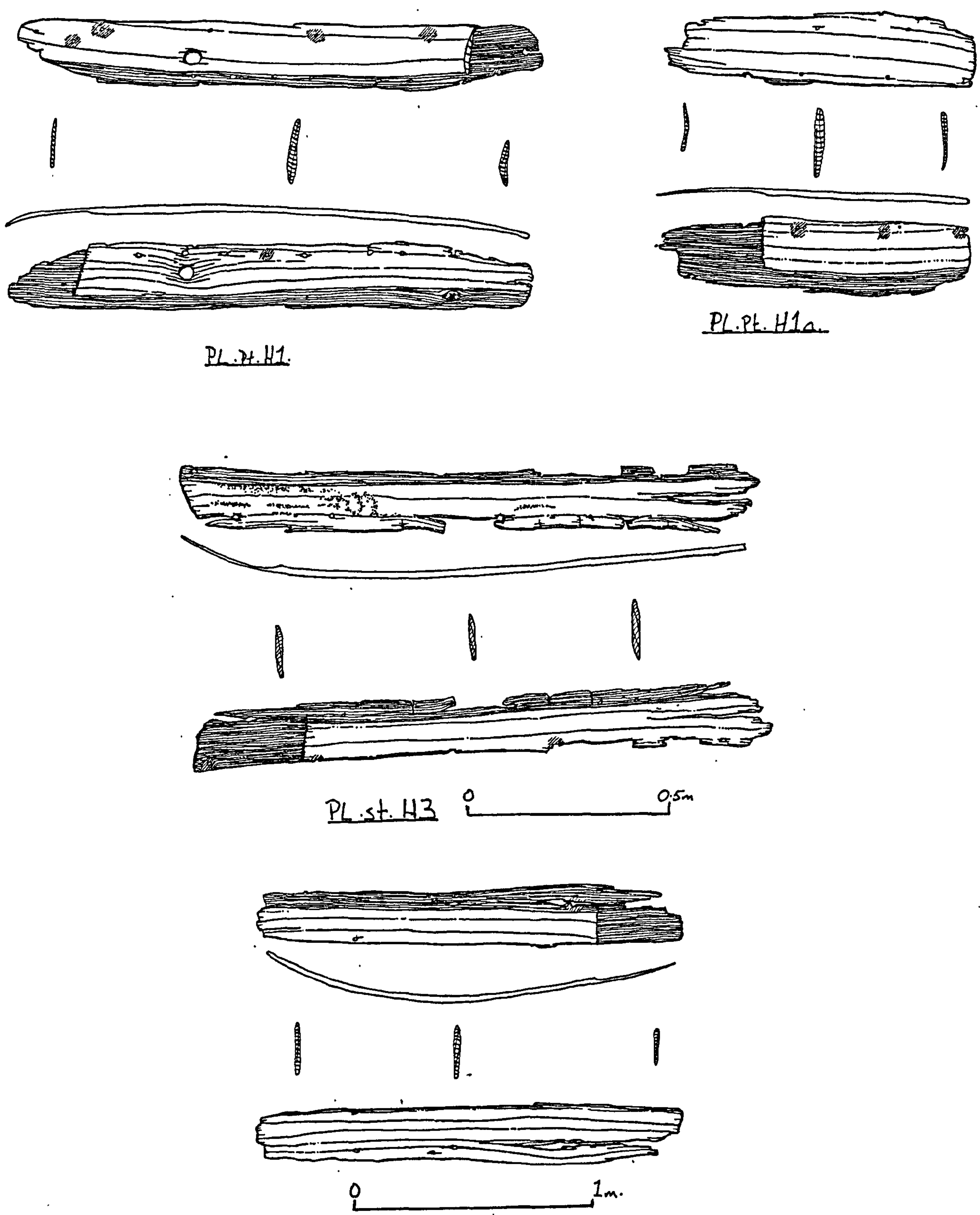


Fig. 3.41- Llyn Peris boat starboard side planking.

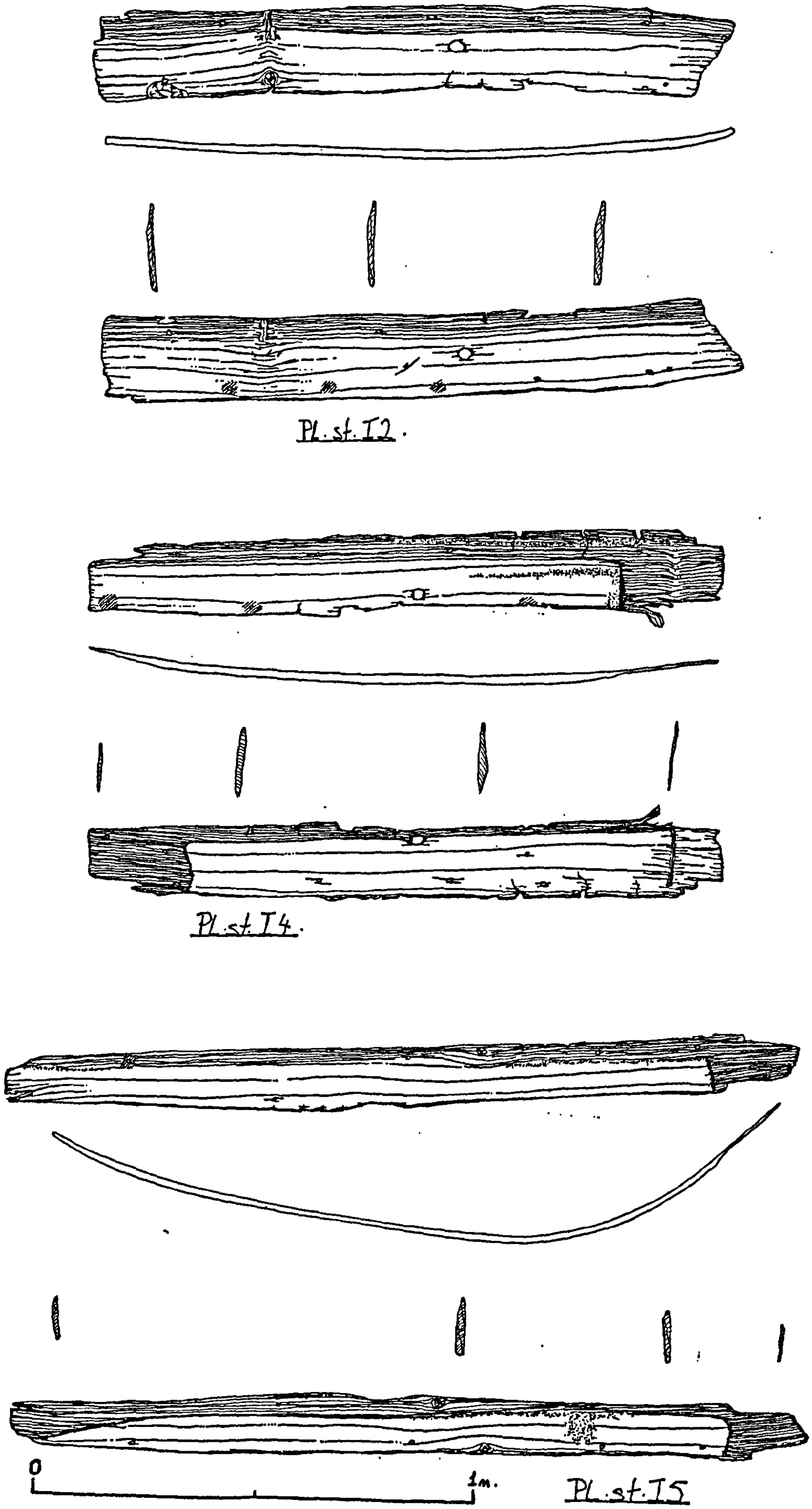
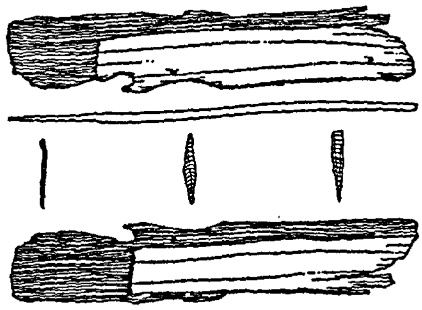


Fig. 3.42- Llyn Peris boat starboard side planking.



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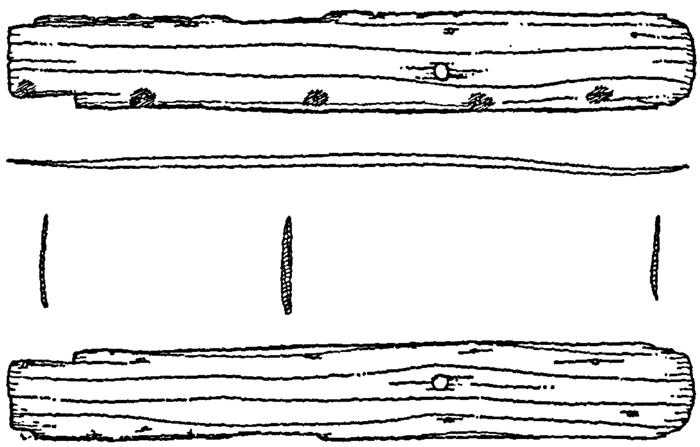

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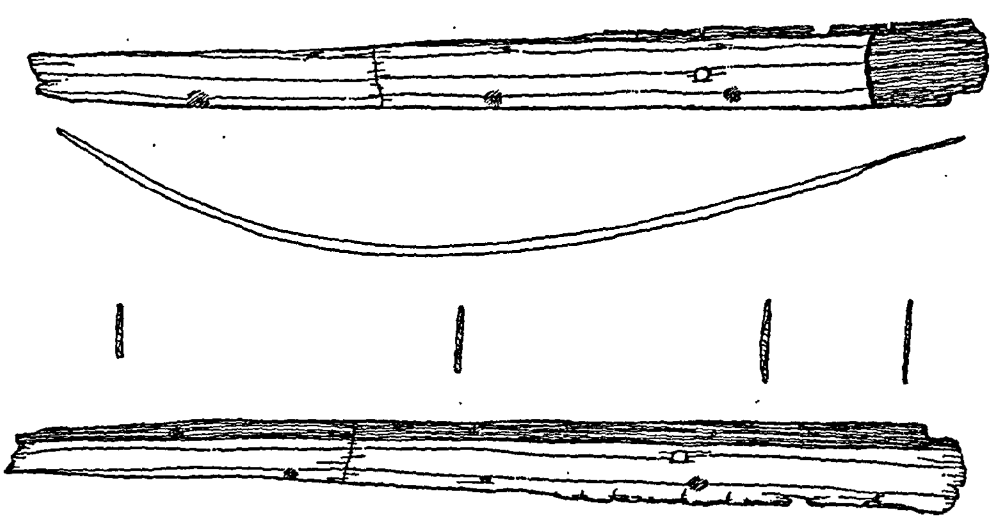

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Fig. 3.43- Llyn Peris boat starboard side planking.

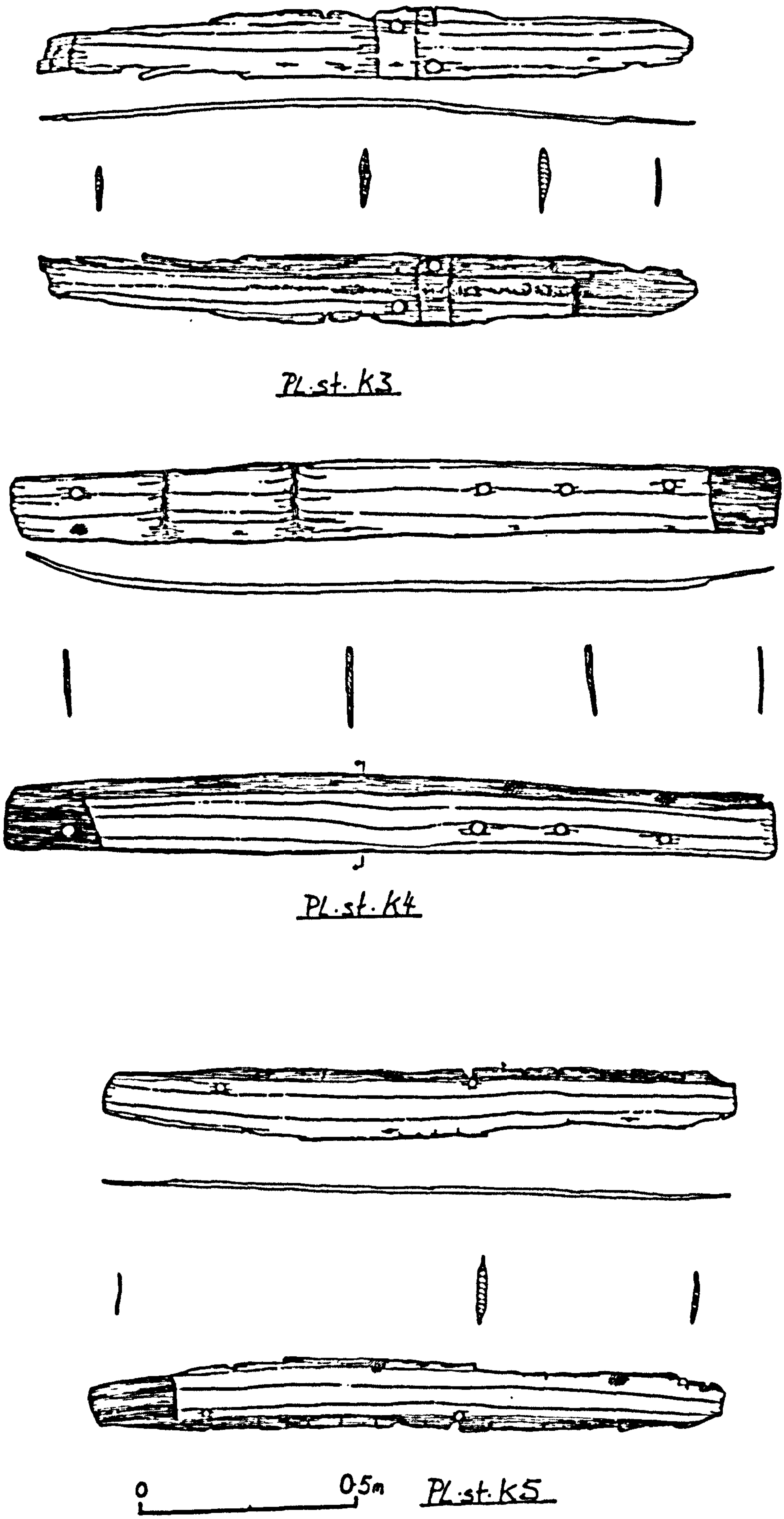


Fig. 3.44- Llyn Peris boat starboard side planking.

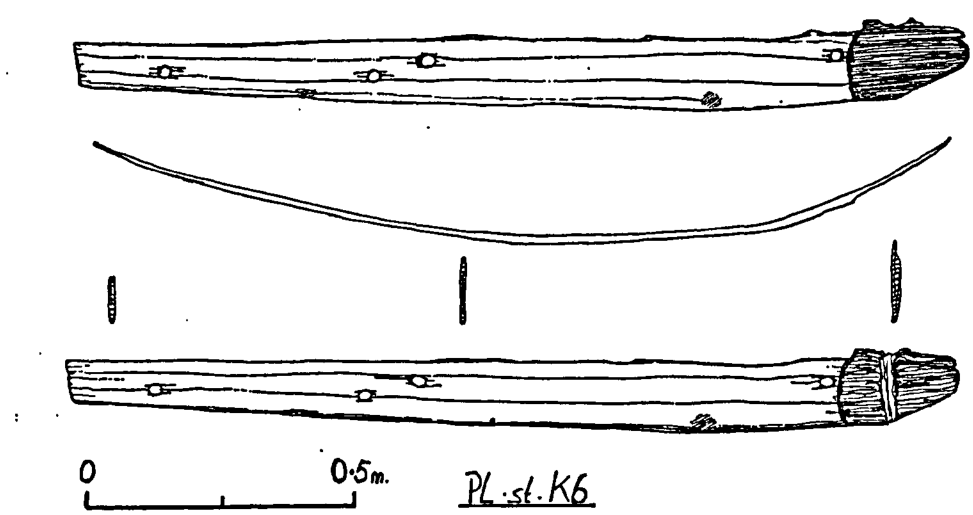


Fig. 3.45- Llyn Peris boat starboard side planking.

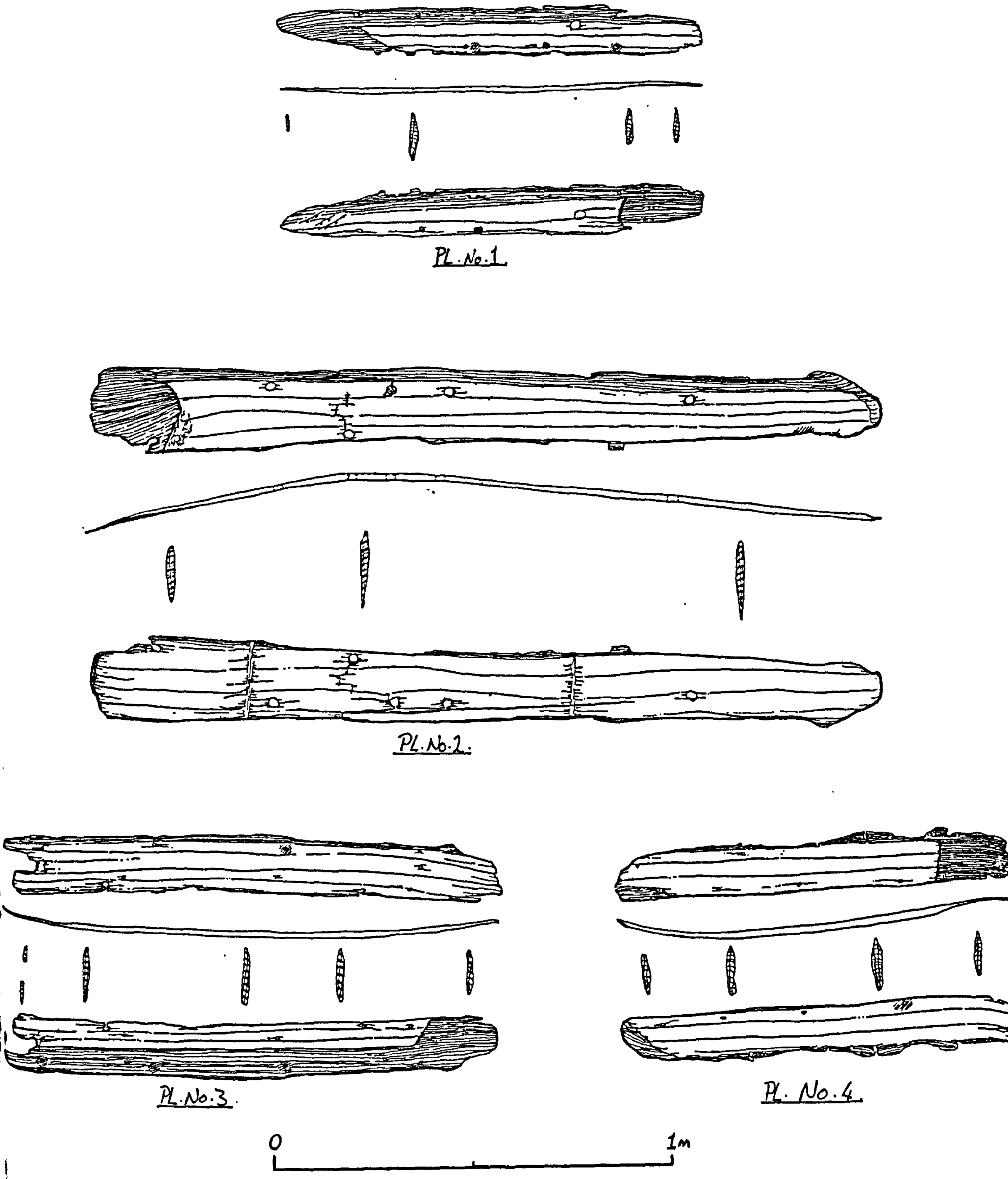


Fig. 3.46- Planking no numbers.

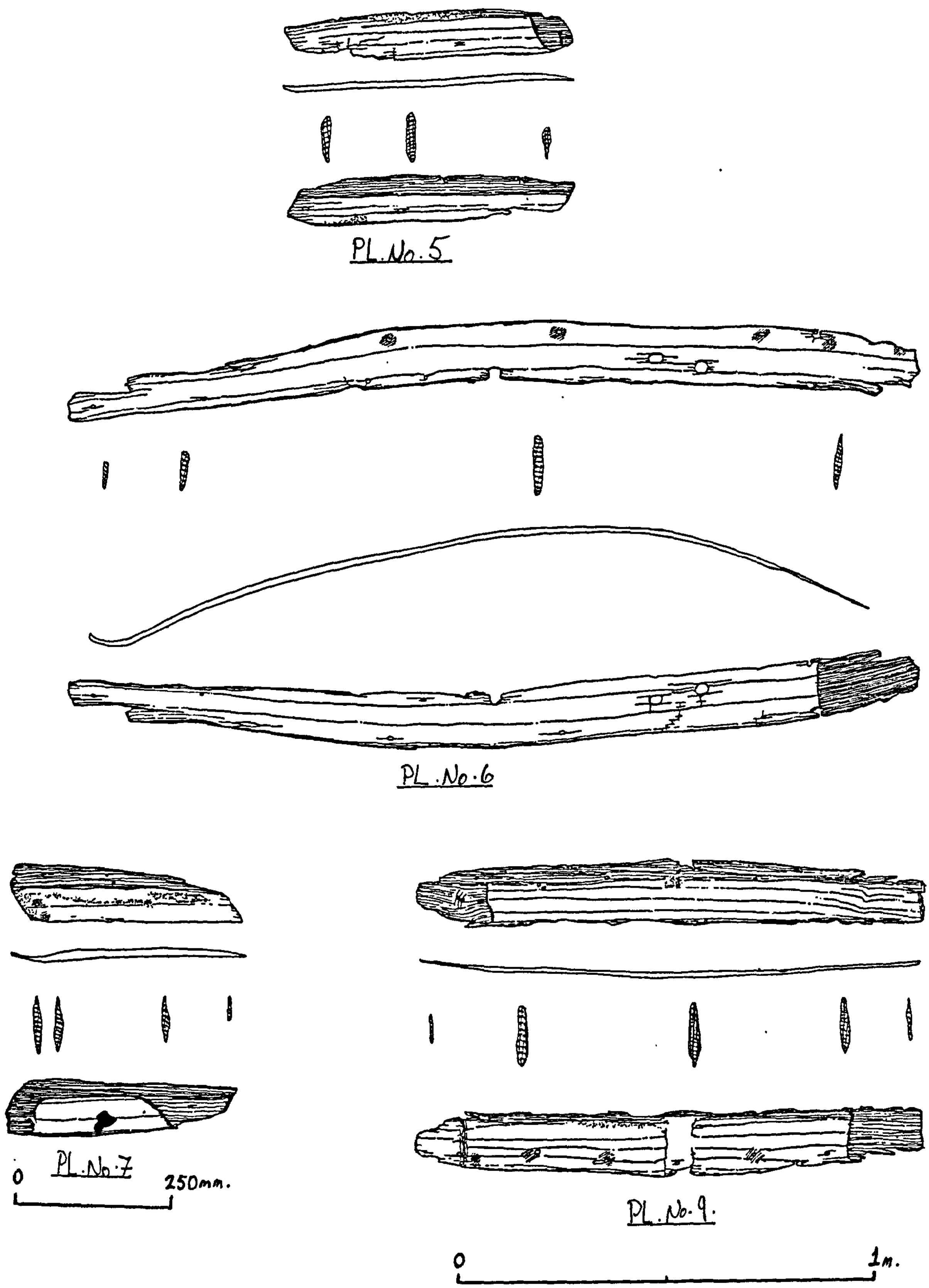
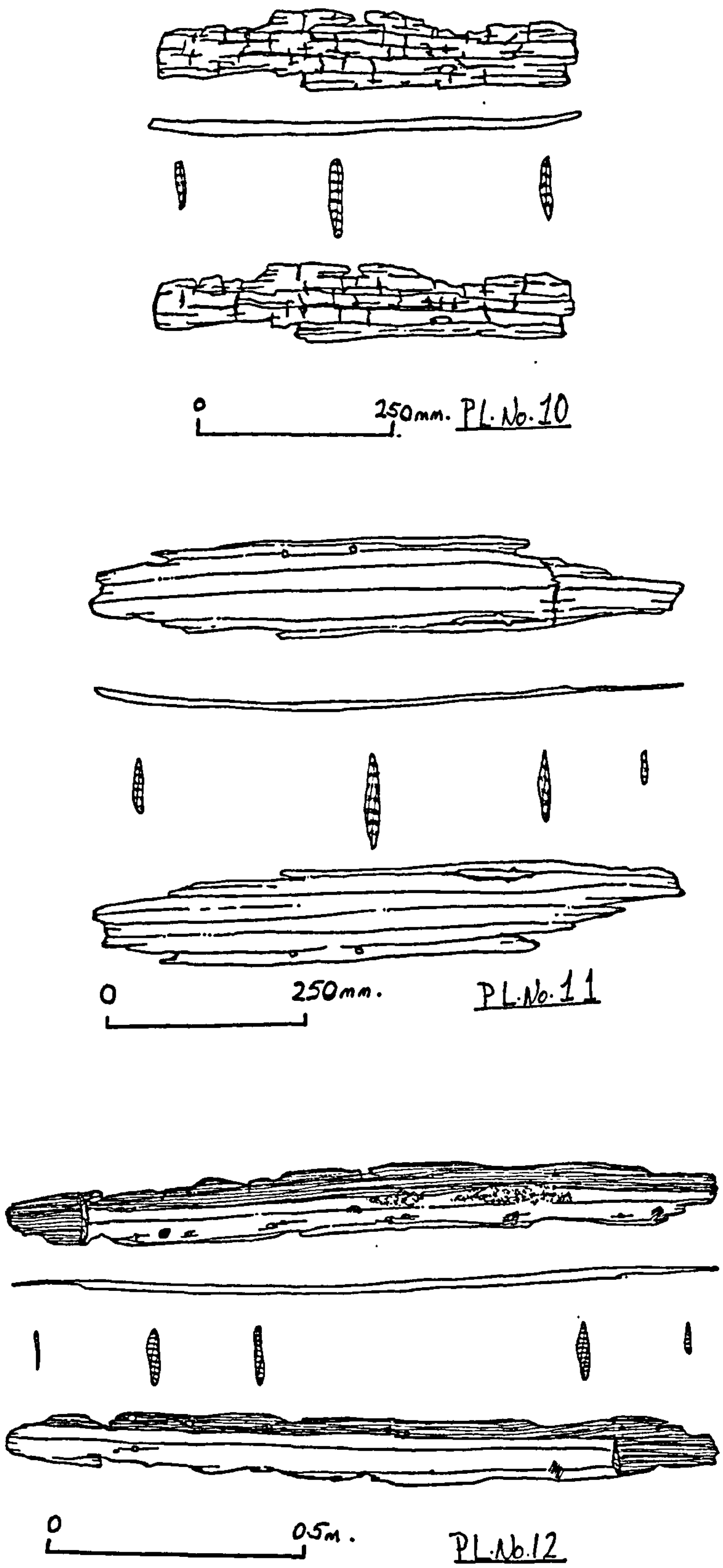


Fig. 3.47- Planking no numbers.



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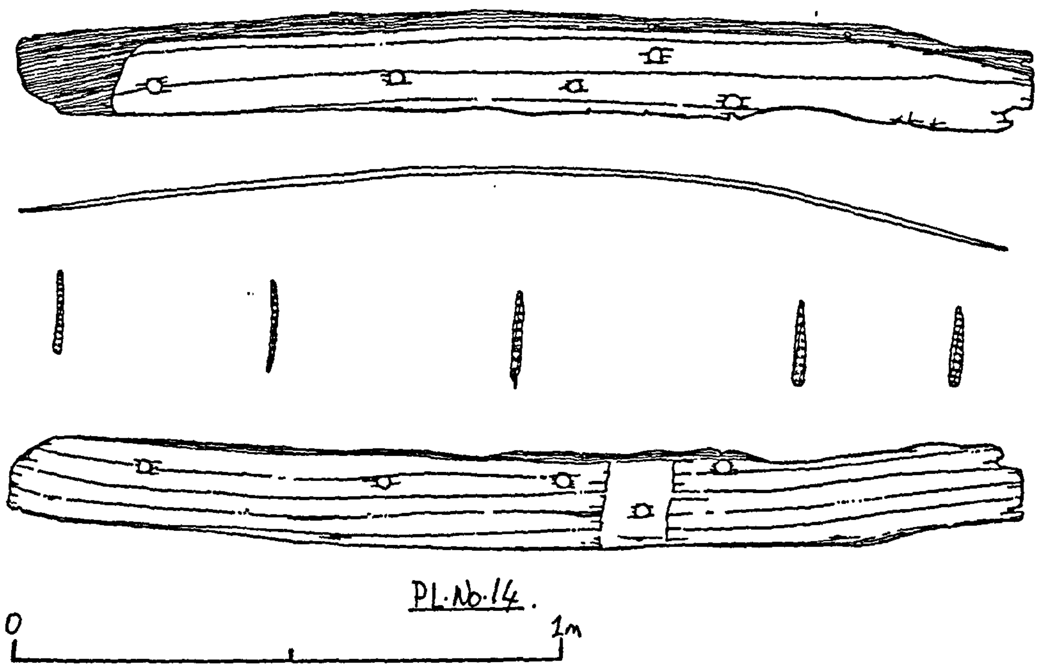

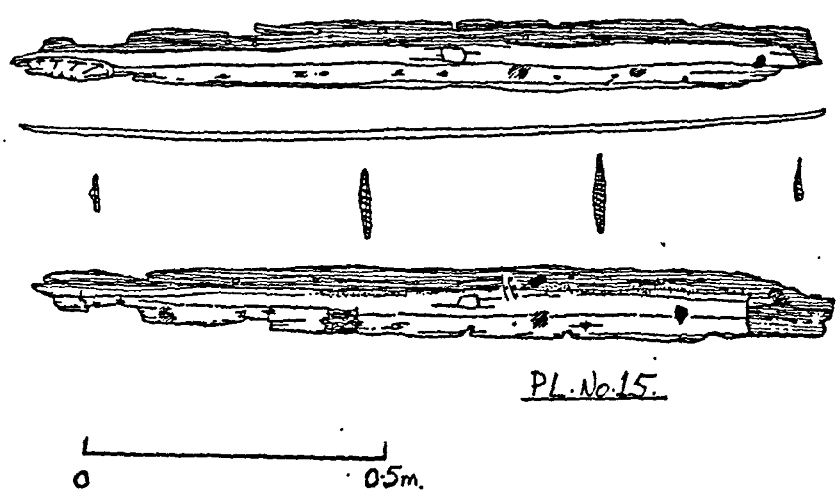

Fig. 3.49- Planking no numbers.

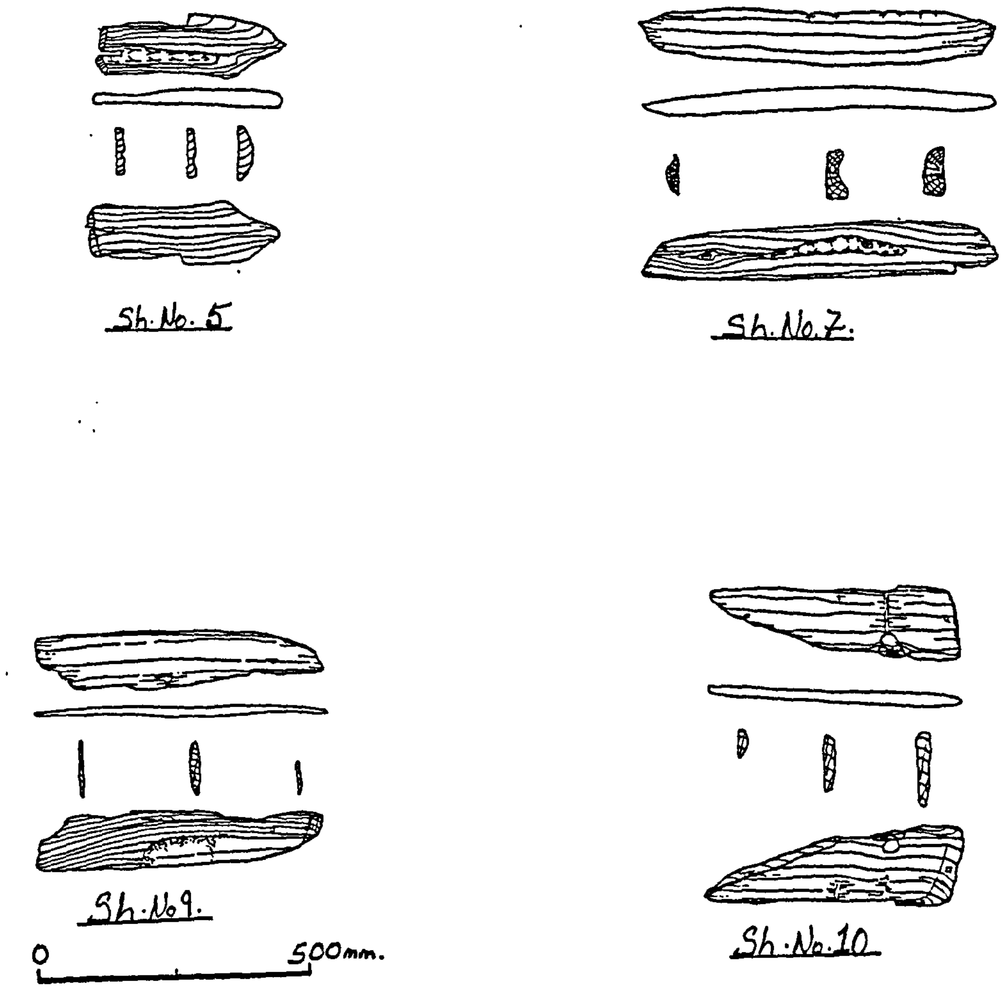

Fig 3.50- sheets.

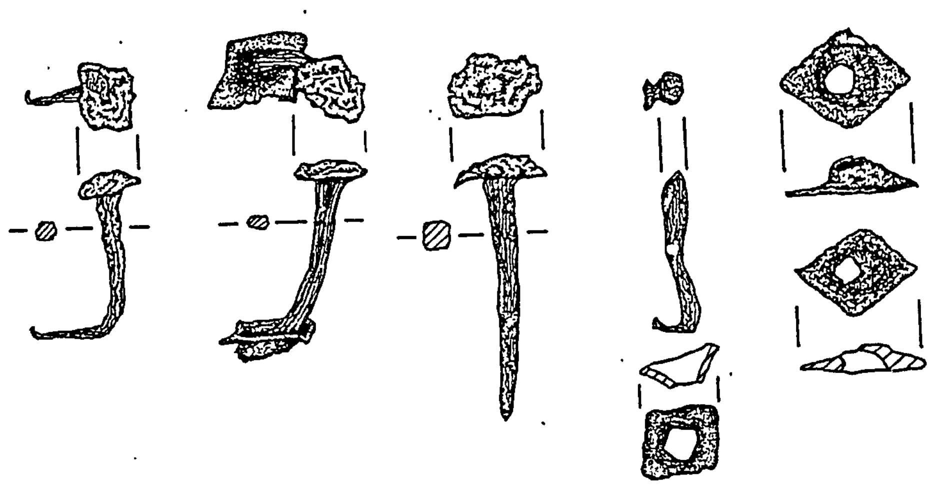

Fig. 3.51a- Llyn Peris nails.

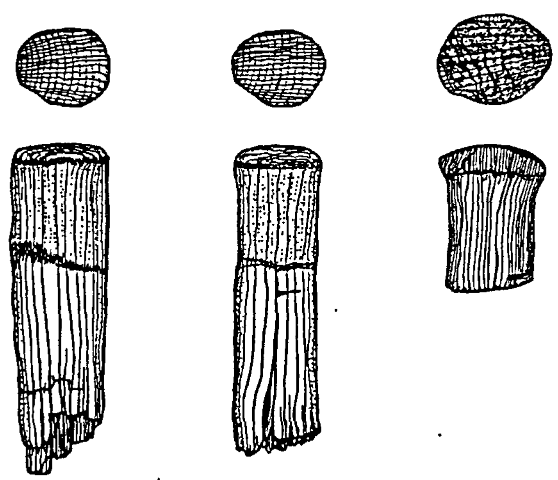

Fig. 3.51b- Llyn Peris boat treenails.

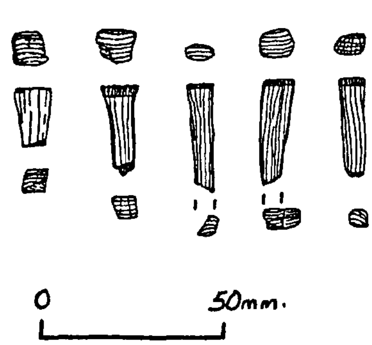

Fig. 3.51c- Llyn Peris Boat wooden pegs.

Fig. 3.52- Sample of luting from lands.

Figure List

Llyn Padarn Boat

4.1-4.12

Fig. 4.1a- Location map

Fig. 4.1b- photograph of Llyn Padarn looking South East towards Dinorwic with Llech y Fulfran on the opposing side (JI).

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Fig.4.2- Boat as found (Drawn from North Wales Divers, 1977).

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Fig. 4.3- Slates recovered from Llyn Padarn boat (JI).

Fig. 4.4- Llyn Padarn boat in recovery frame on the surface (C.J.)

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Fig. 4.5a- Llyn Padarn boat on forecourt of Museum in winter (OR).
Fig. 4.5b- in the Baltic shed (Parham, D).

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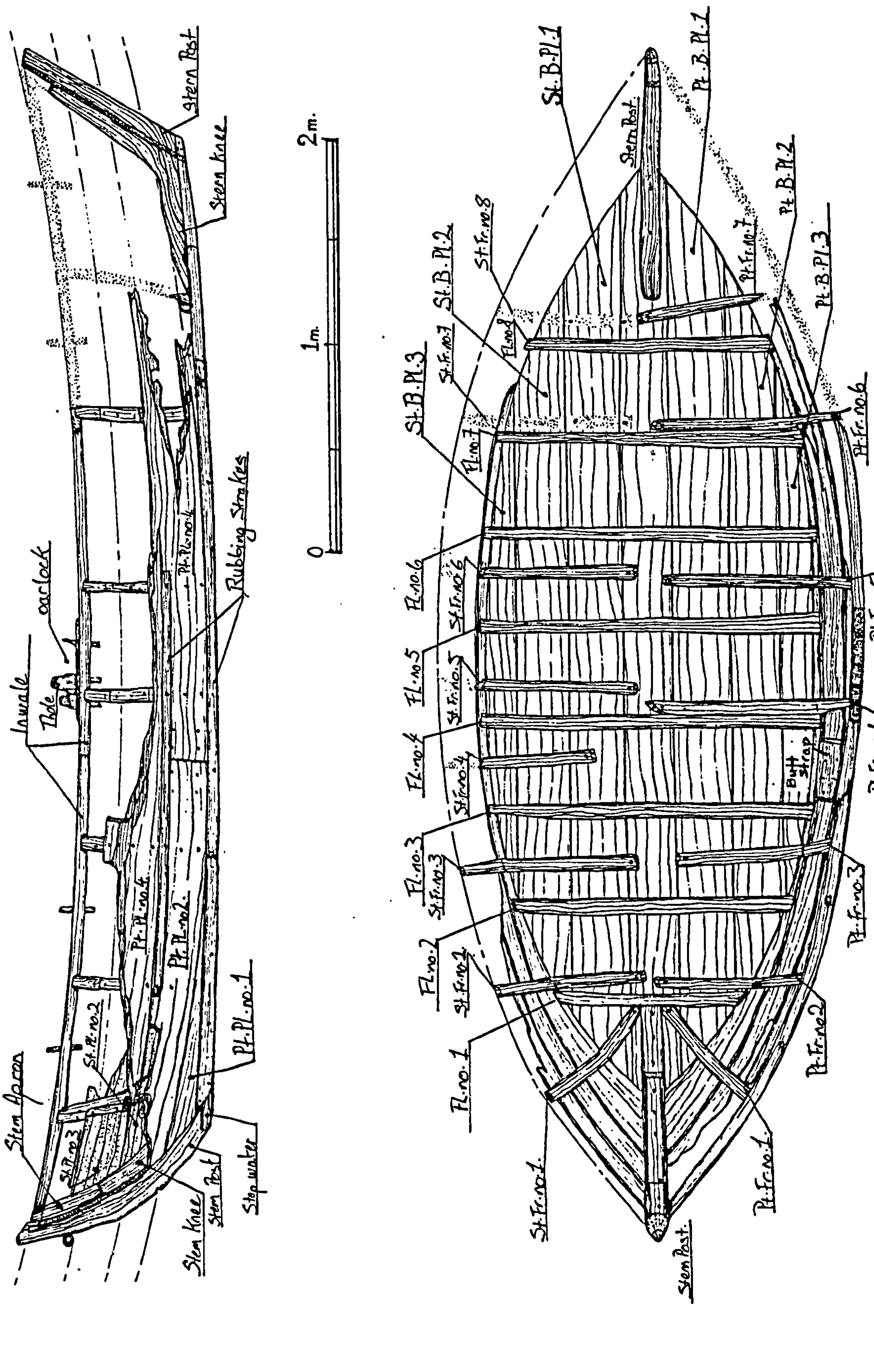

Fig. 4.6- Llyn Padarn boat remains as recorded

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Fig. 4.7- Llyn Padarn boat side frame (JI).

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Fig. 4.8- Llyn Padarn boat stringer (JI).

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Fig. 4.9- Oar locks and metal plate on inwale of Llyn Padarn boat as found.
Note concretion under oarlock (JI).

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Fig. 4.10- Loading slates with Dolbadarn Castle and Snowdon in the background, Nicolas Pocock, c1795 (Courtesy of the Masters and Fellows of Winchester Art College).

Fig. 4.11- Dinorwic Quarry Workshops at Gilfach Ddu, c.1870 (Courtesy of Gwynedd Archive Services, Caernarvon).

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Fig. 4.12- Unloading Slates at Llanberis (Cym-y-glo), Nicholas Pocock, c.1795 (Courtesy of the Masters and Fellows of Winchester Art College).

Figure List

Talsarnau Boat

5.1-5.26

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Fig 5.1- Site location, Talsarnau boat (Drawn from Lewis, 1989).

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Fig. 5.2a- Vessel as found (OR).

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Fig. 5.2b- Setting up baseline (OR).

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Fig 5.3a Site in 1988 (OR).

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Fig 5.3b- visit to site in 1992 (OR).

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Fig 5.4- Sand bagged remains of timbers left behind.(OR)

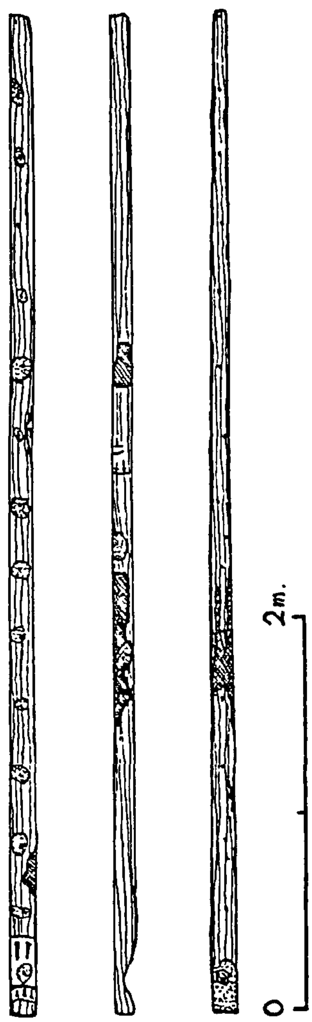


Fig 5.5a- keelson.

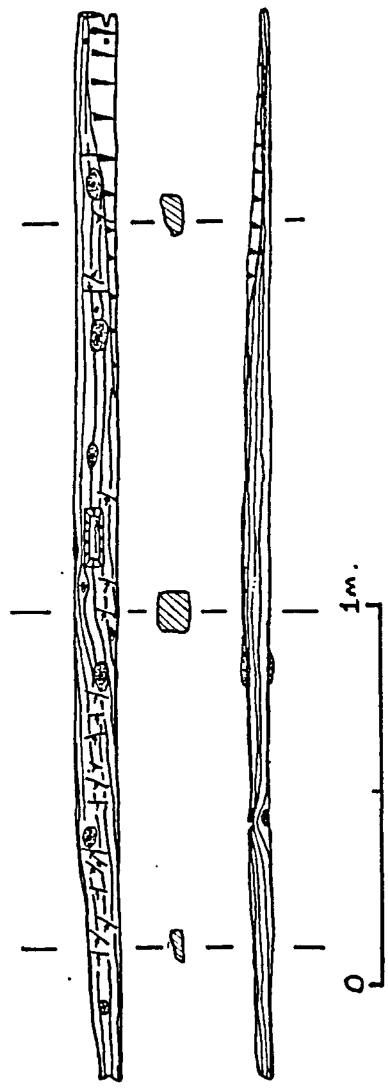


Fig 5.5b- mast step.

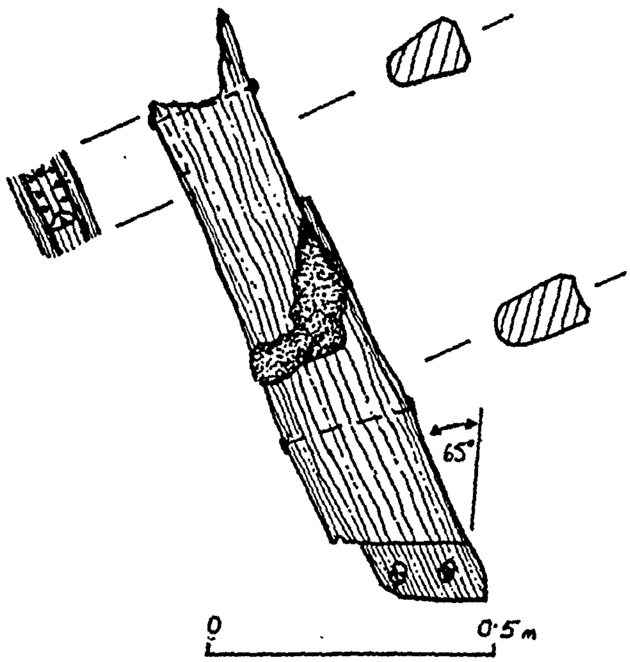


Fig 5.6a- stern post.

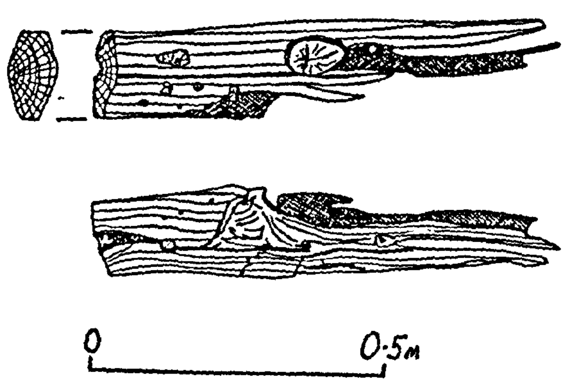


Fig 5.6b- stern post apron.

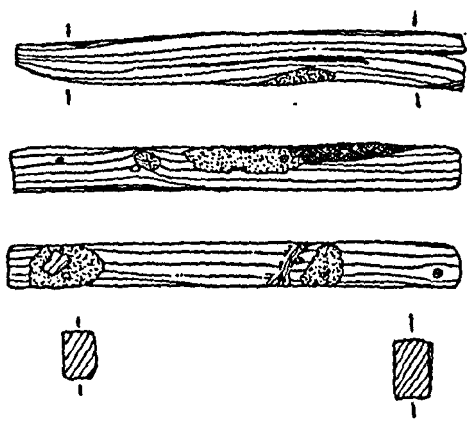


Fig5.7a- King post.

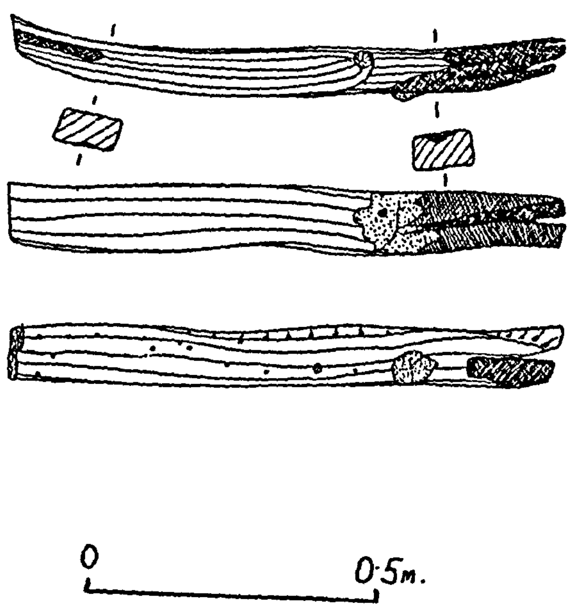


Fig5.7b- Knight Head

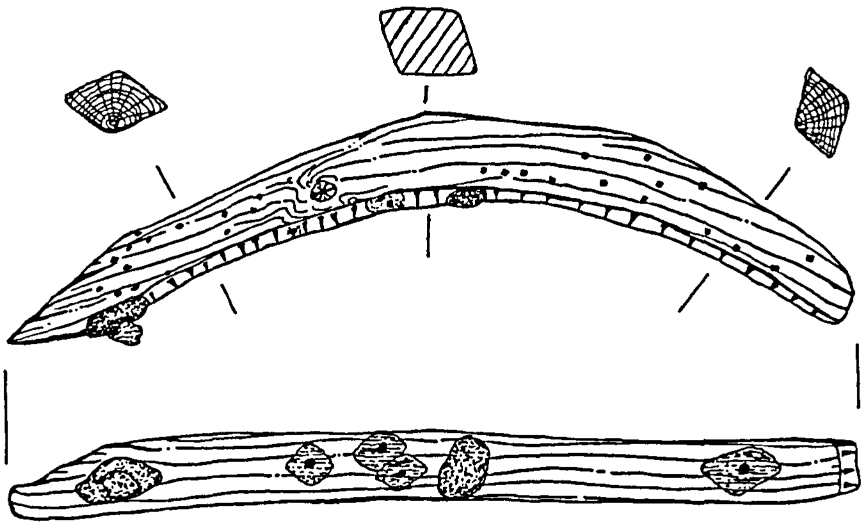


Fig. 5.8a- Deck hook.

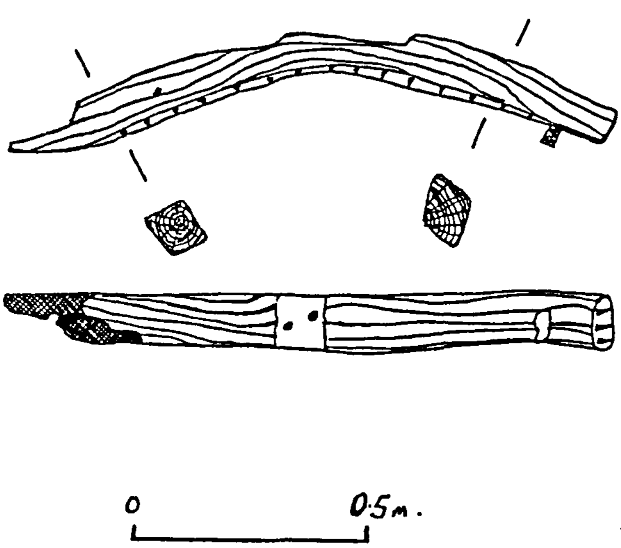


Fig. 5.8b- Breast hook.

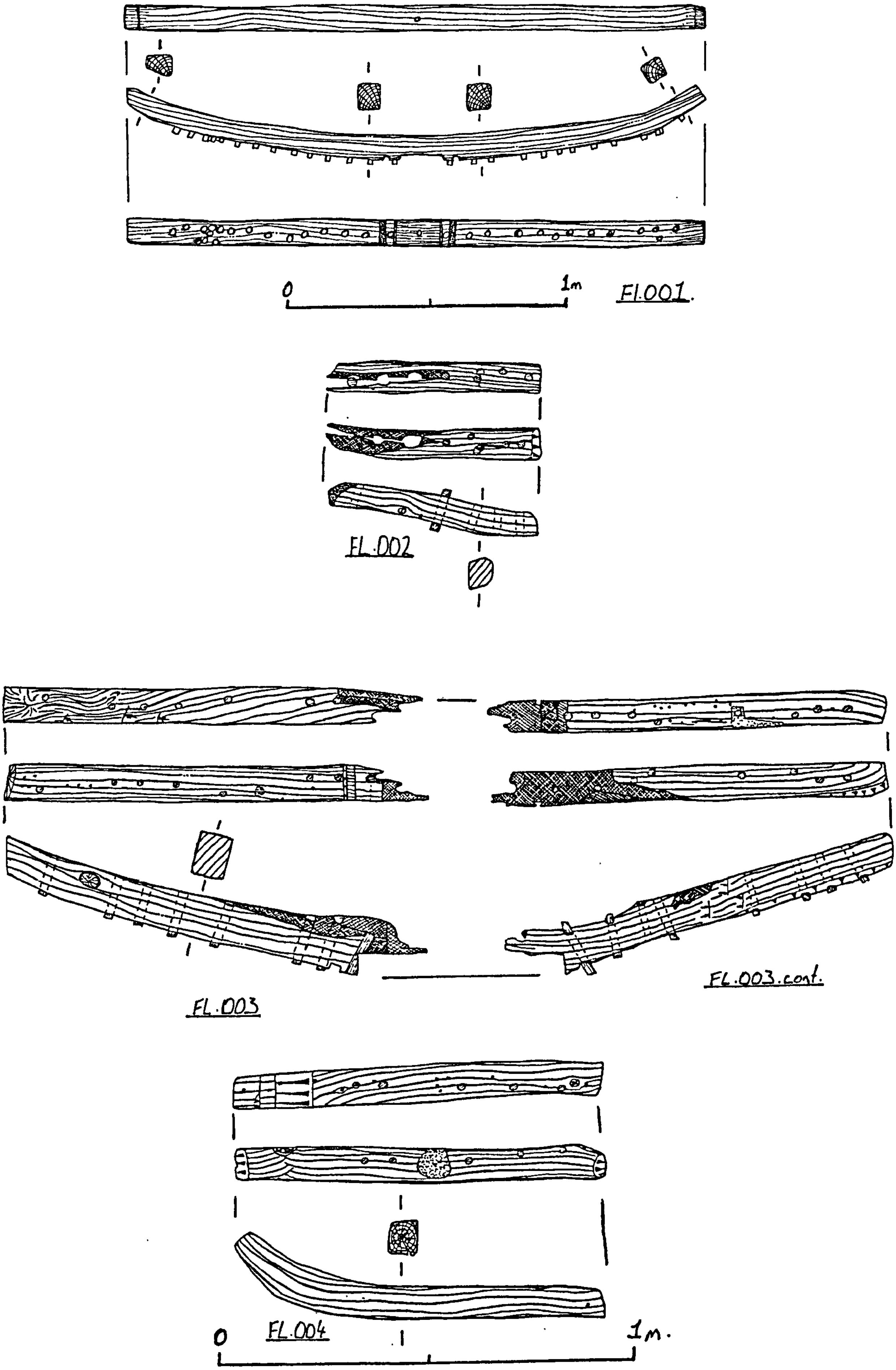


Fig. 5.9- Floors.

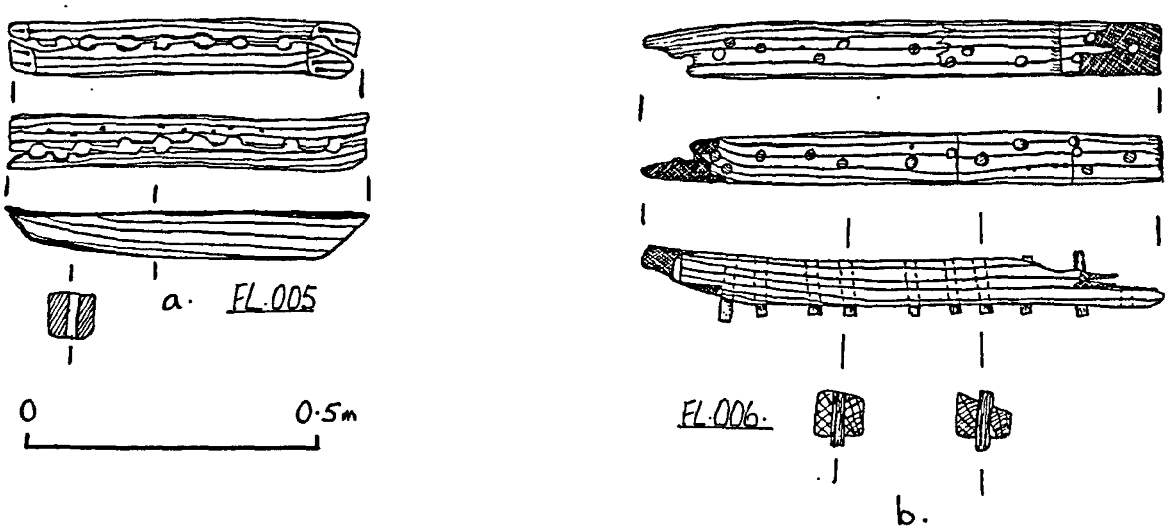


Fig. 5.10a & b- Floors.

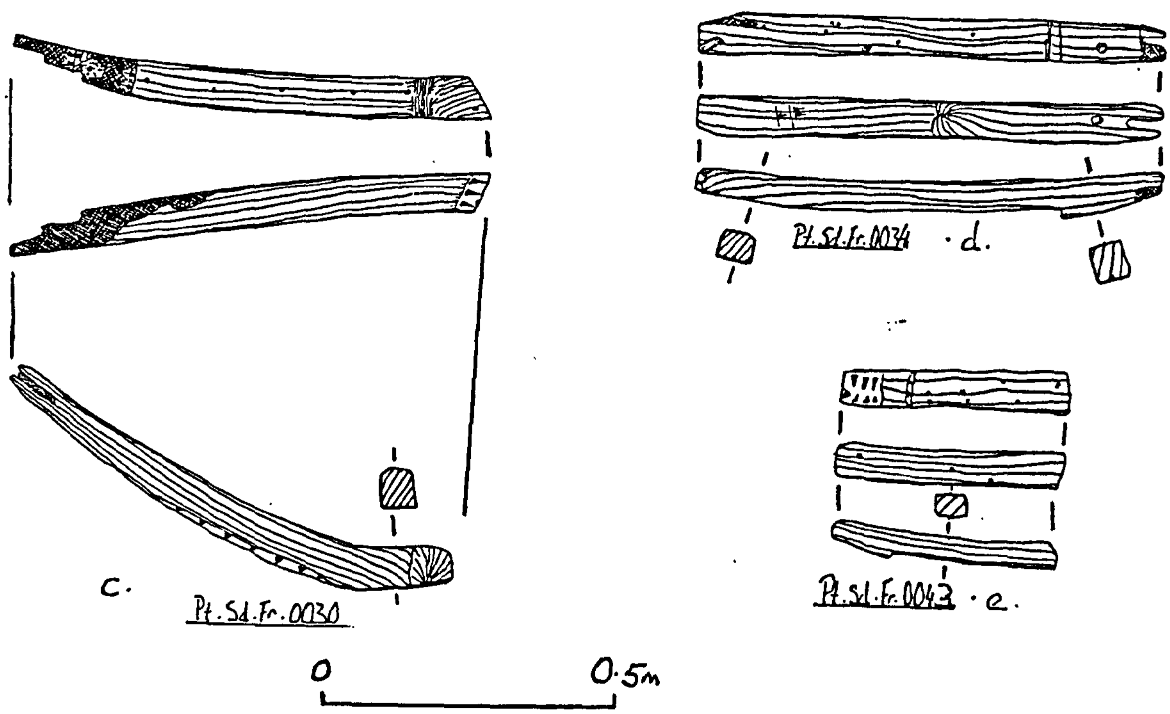


Fig. 5.10c, d & e.- Side frames.

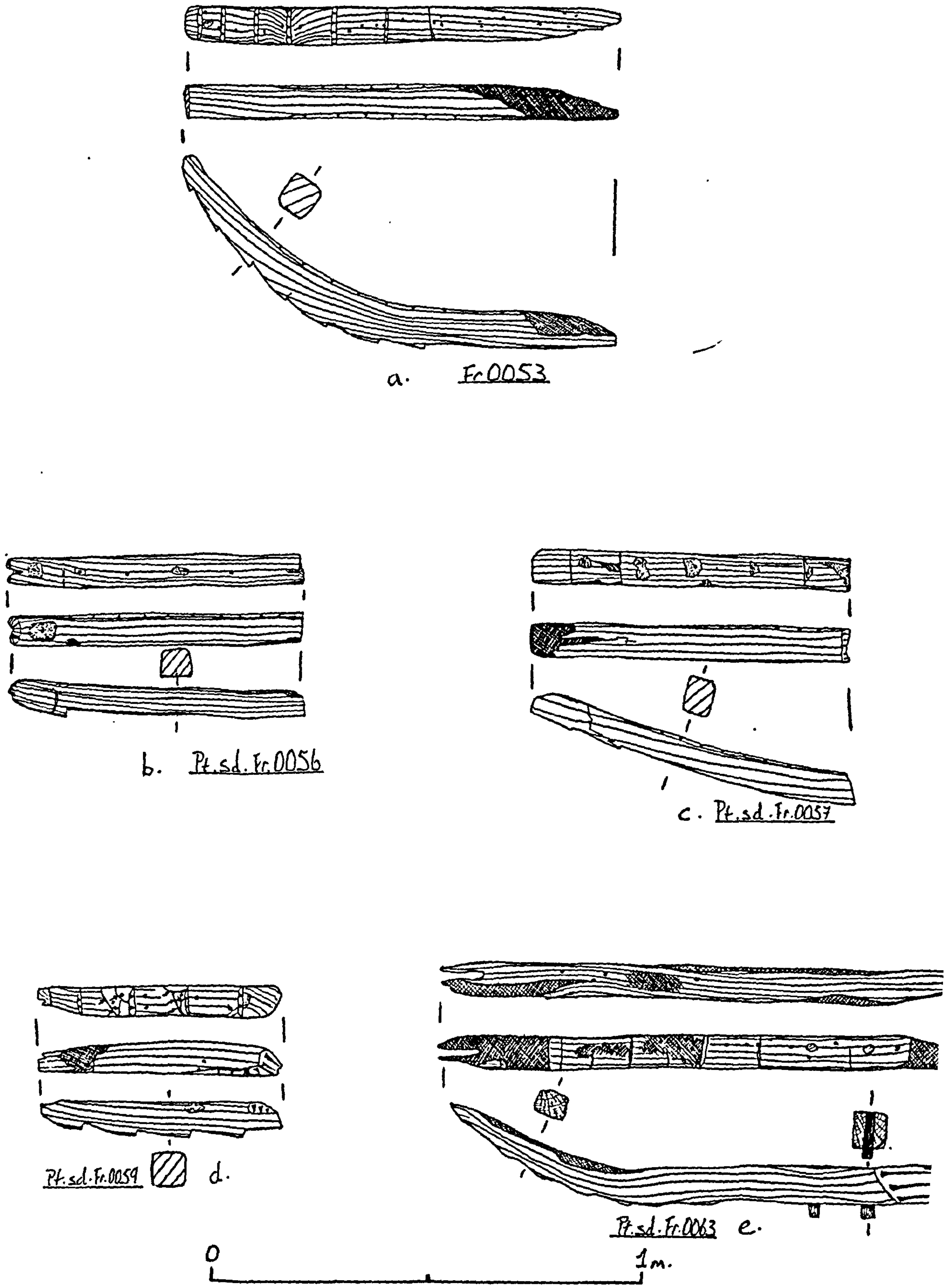


Fig. 5.11- Side frames.

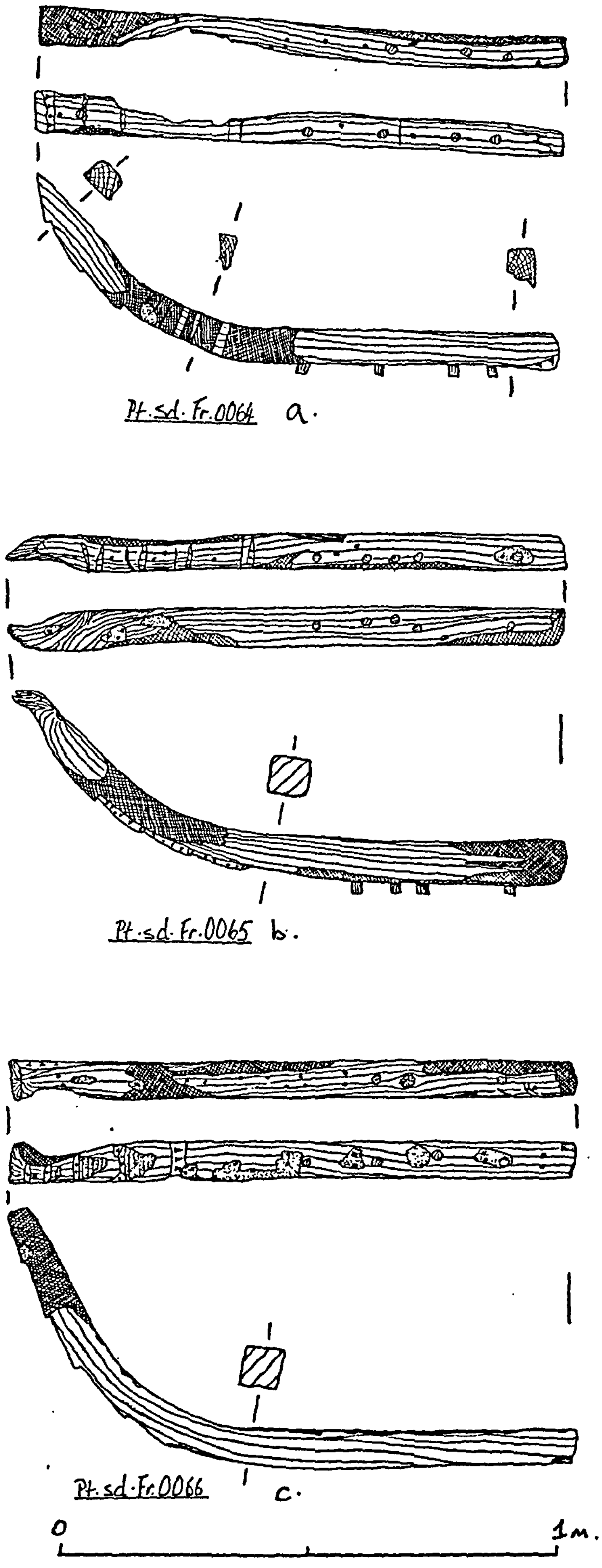


Fig. 5.12- Side frames.

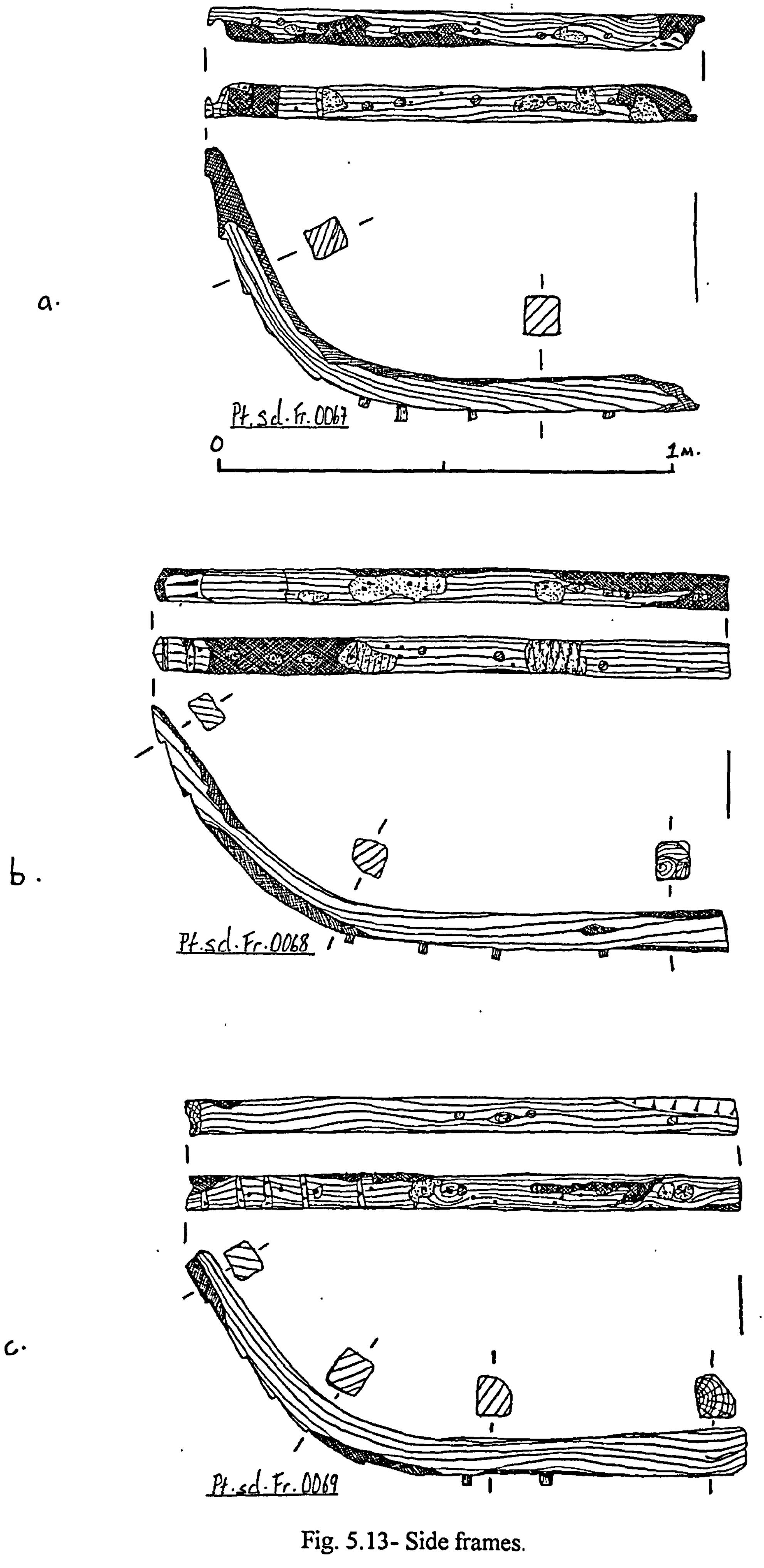


Fig. 5.13- Side frames.

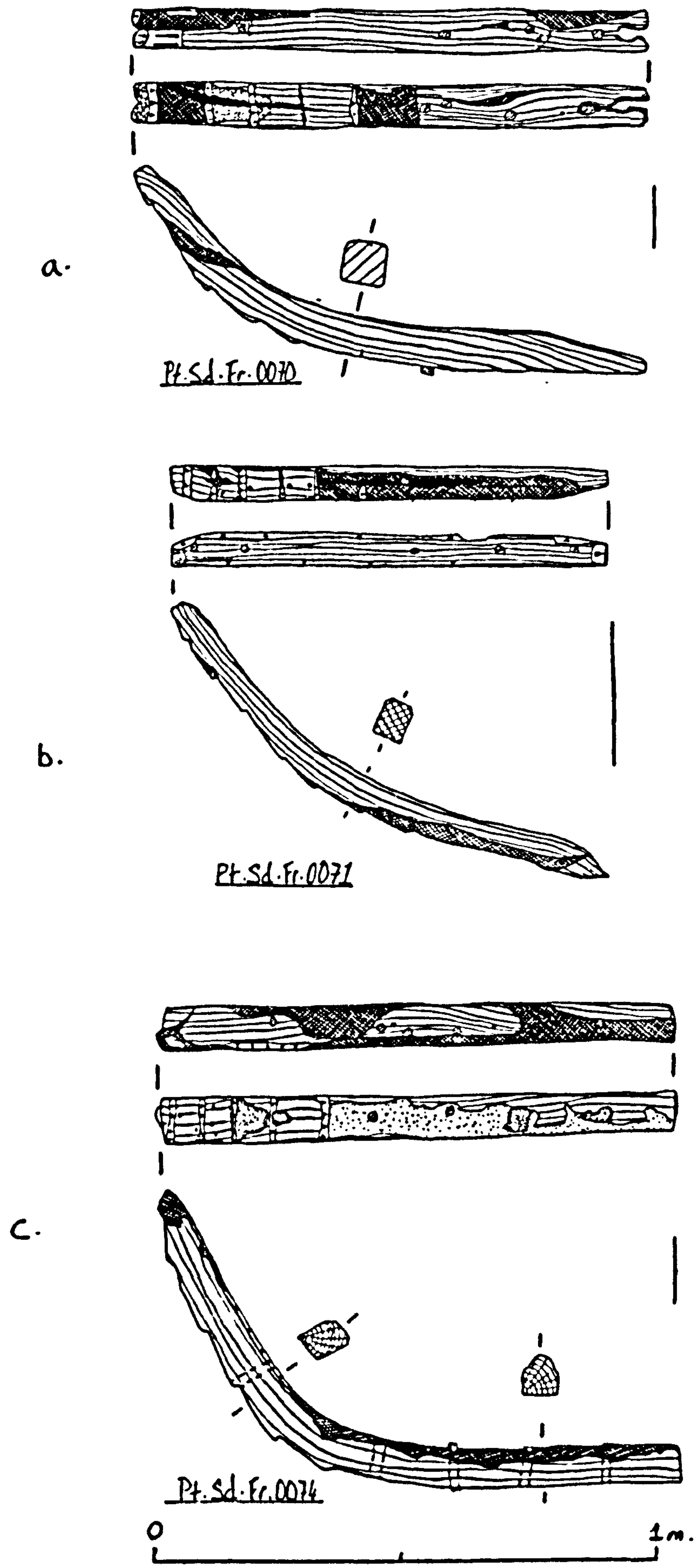


Fig. 5.14- Side frame.

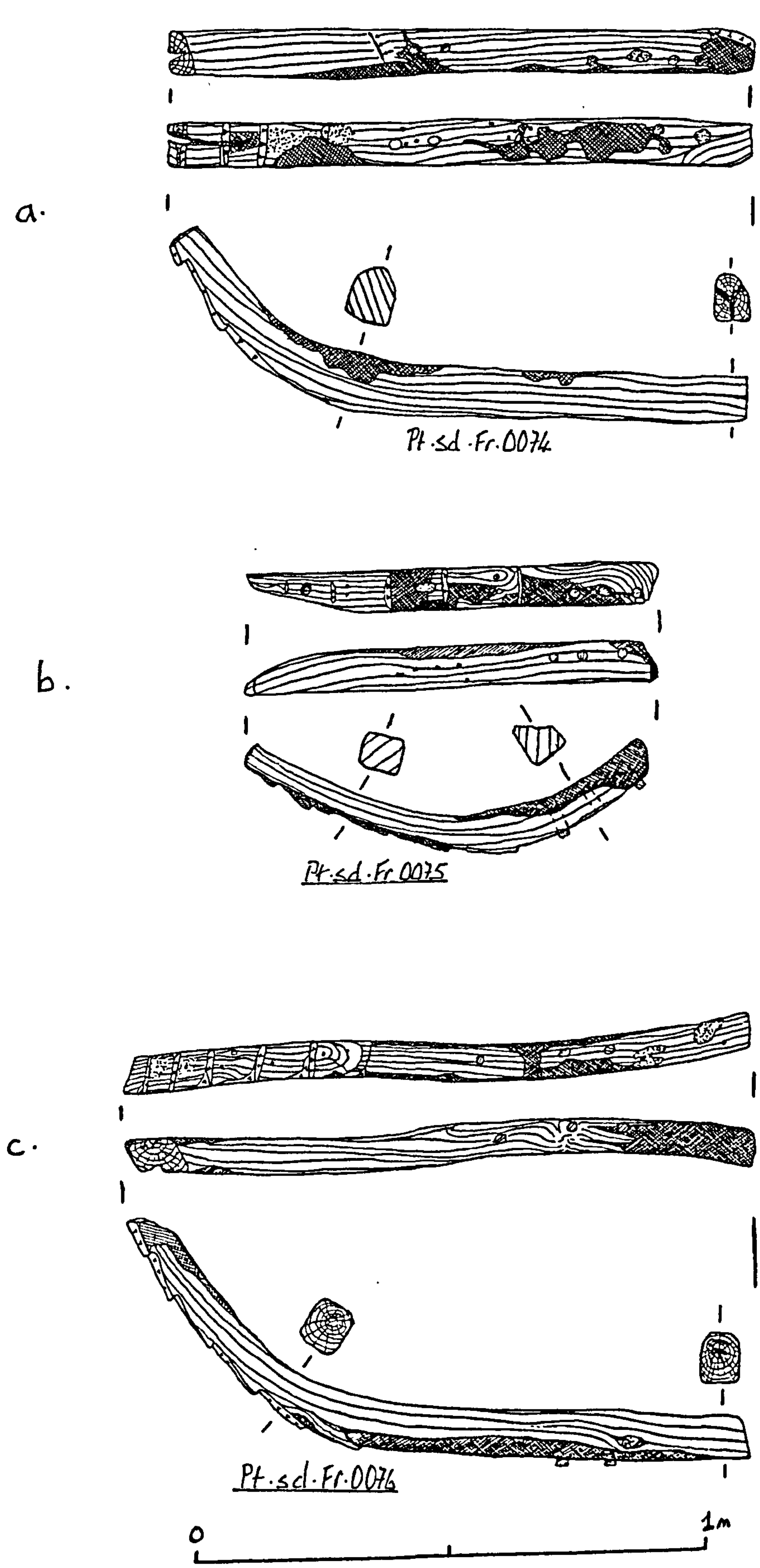


Fig. 5.15-Side frames.

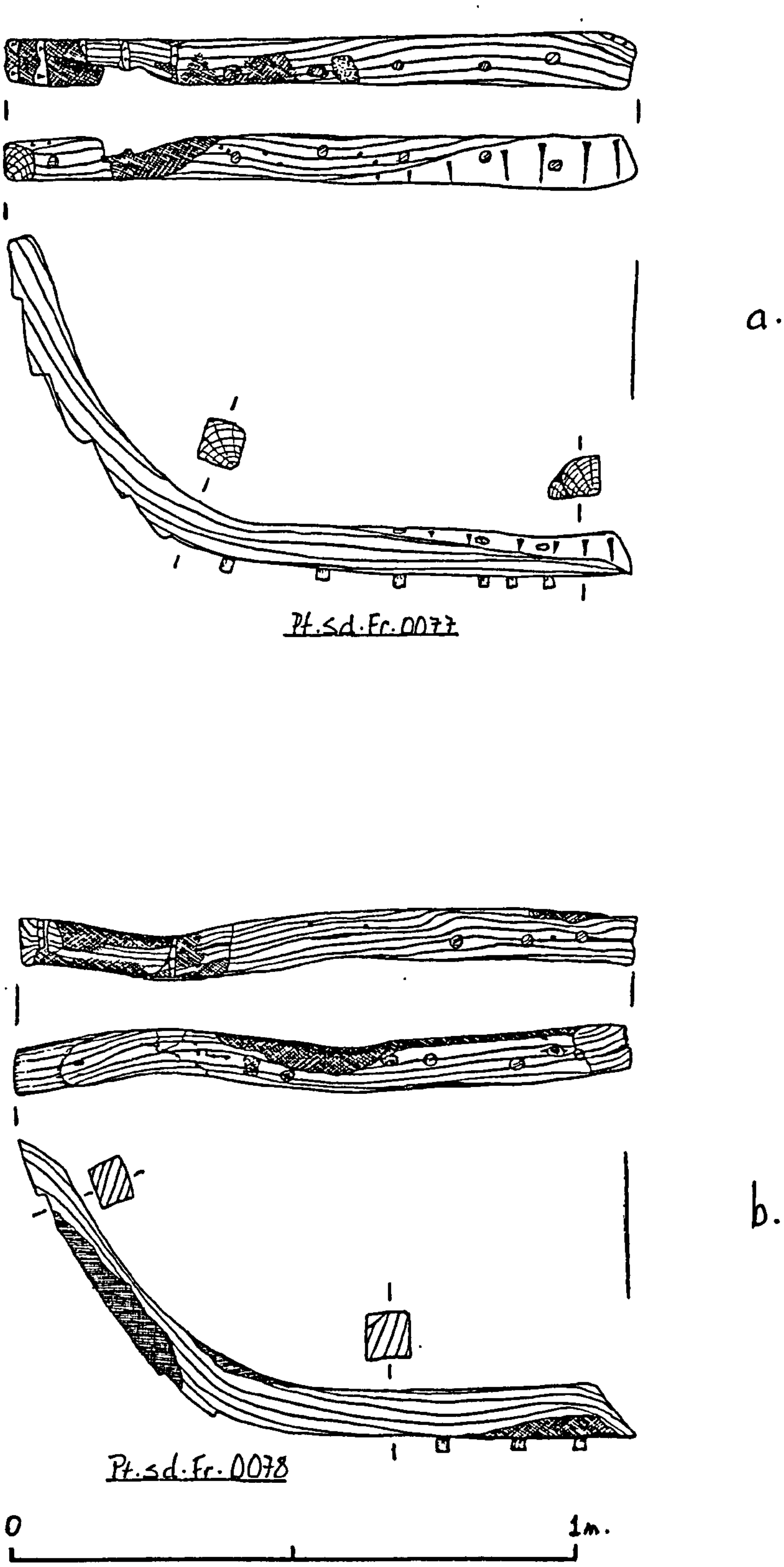


Fig. 5.16- Side frames.

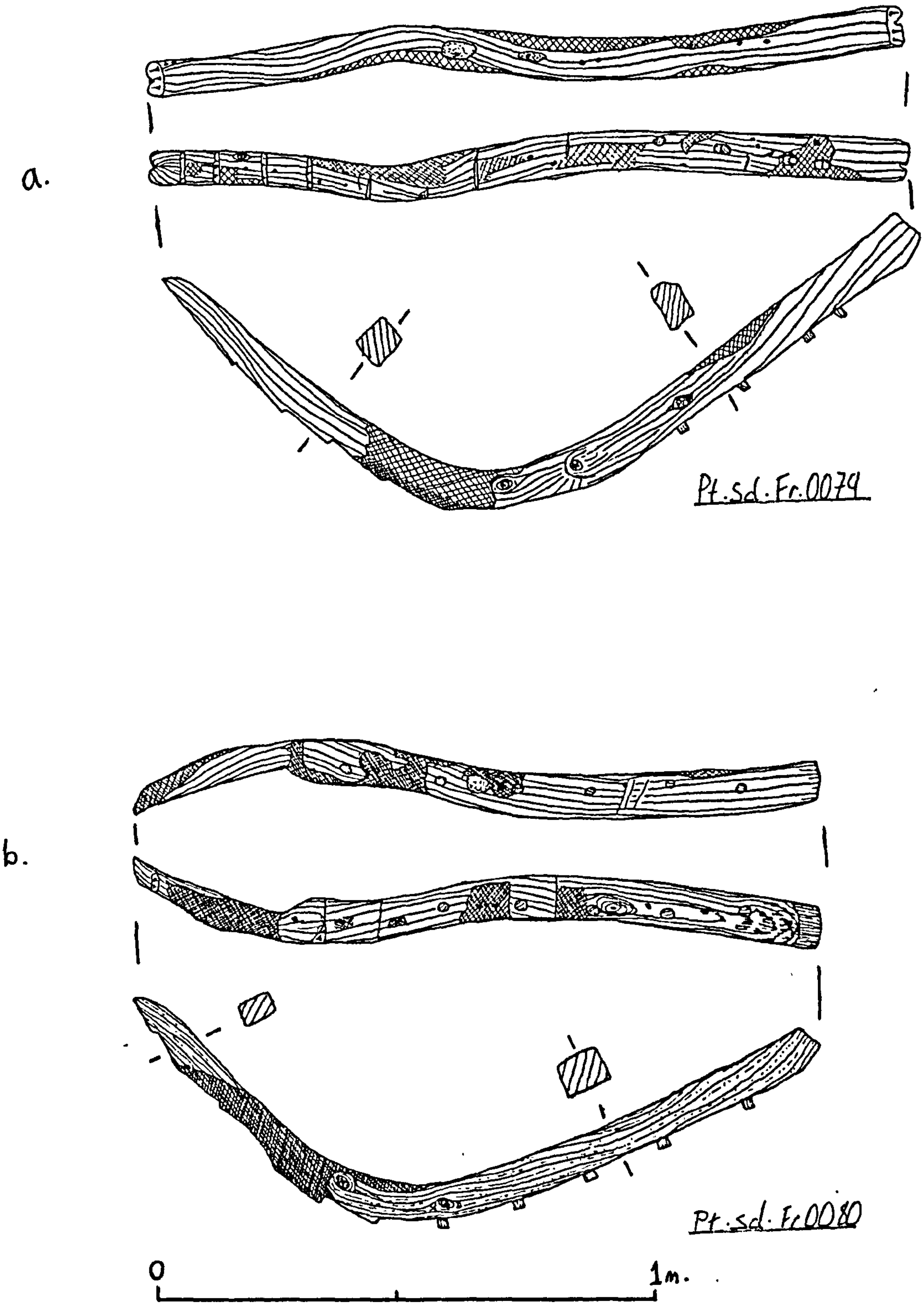
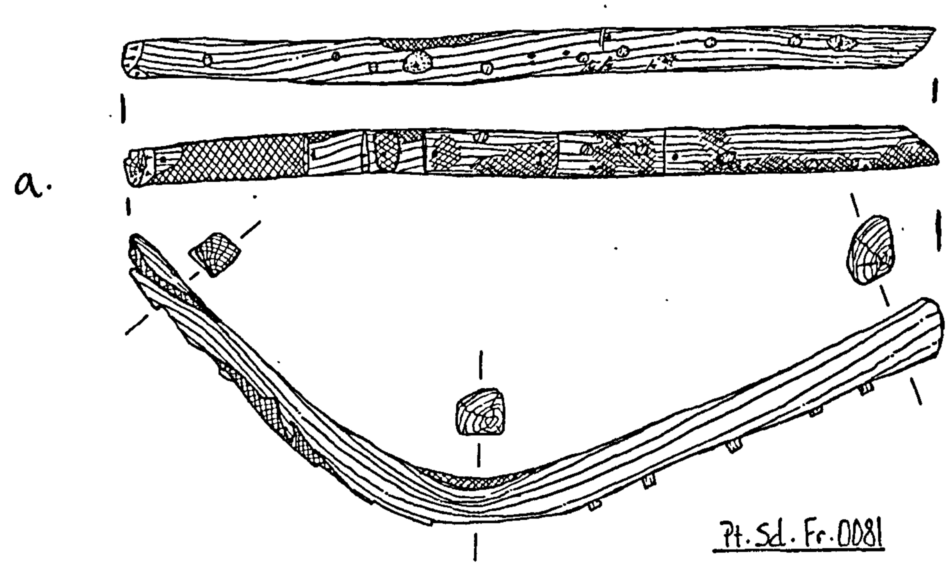


Fig. 5.17- Side frame.



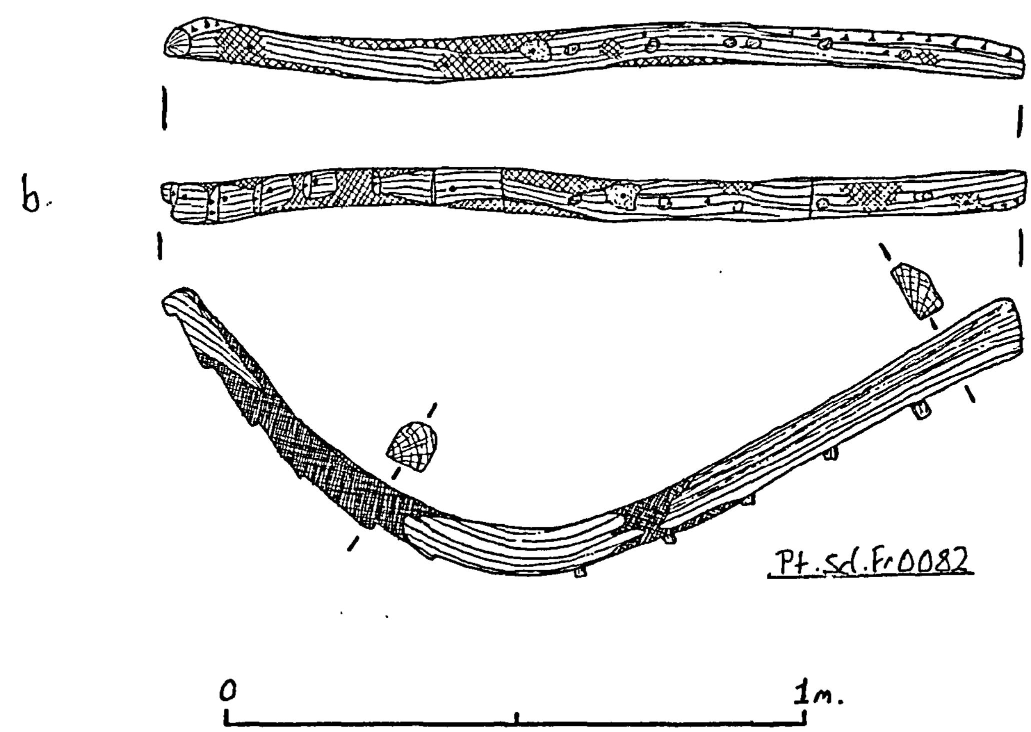


Fig. 5.18-Side frames.

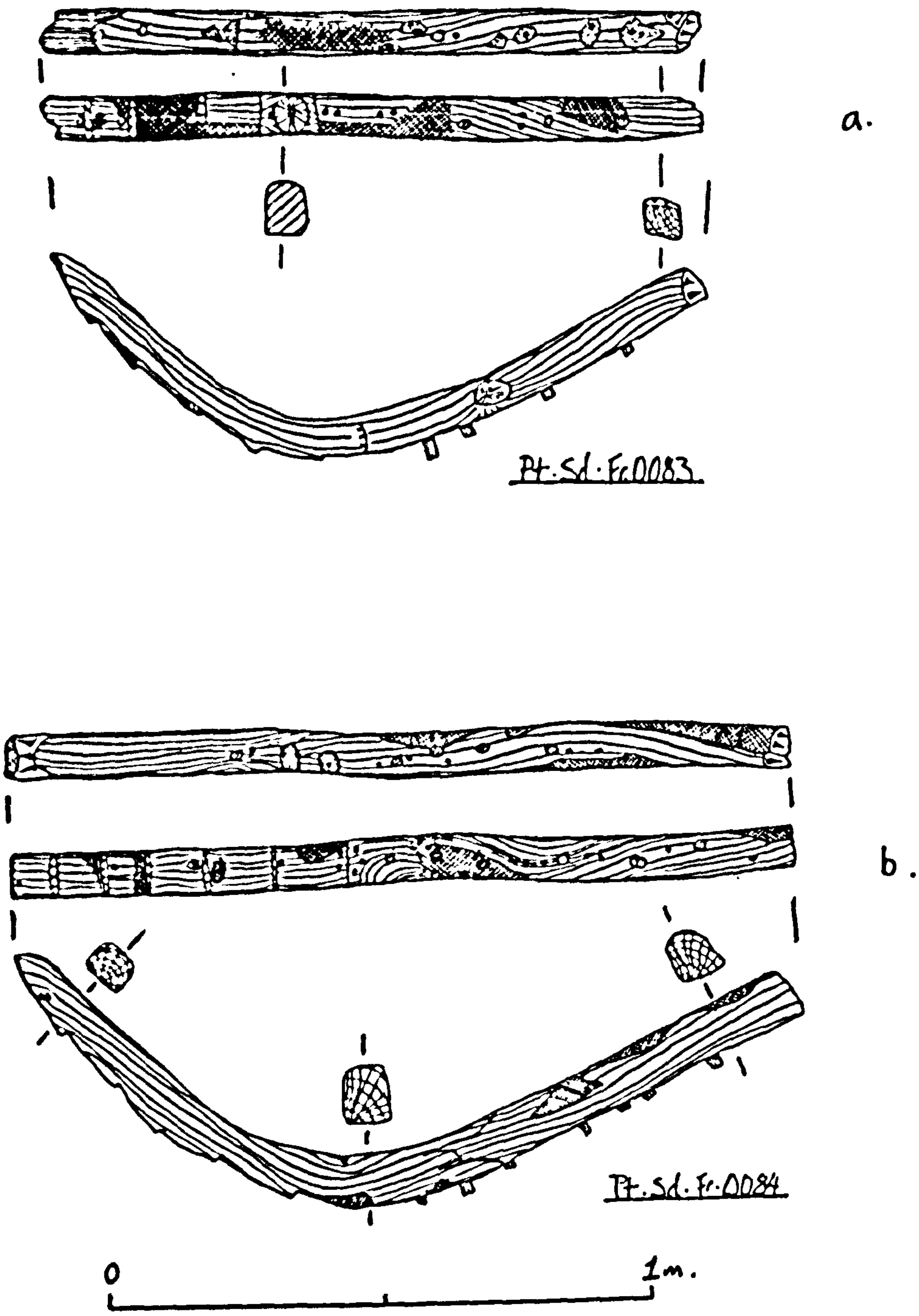


Fig. 5.19-Side Frames.

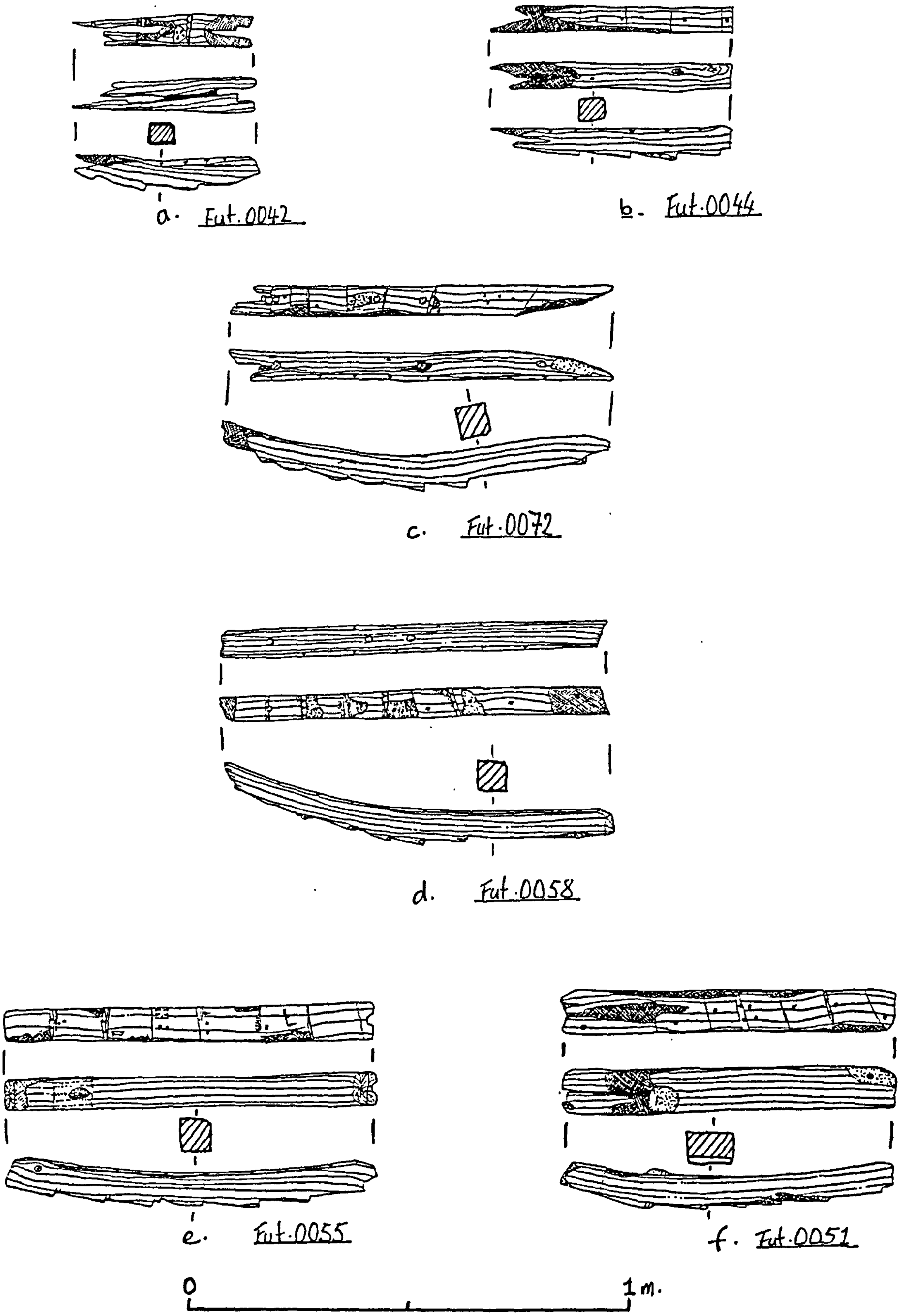


Fig. 5.20- Futtocks.

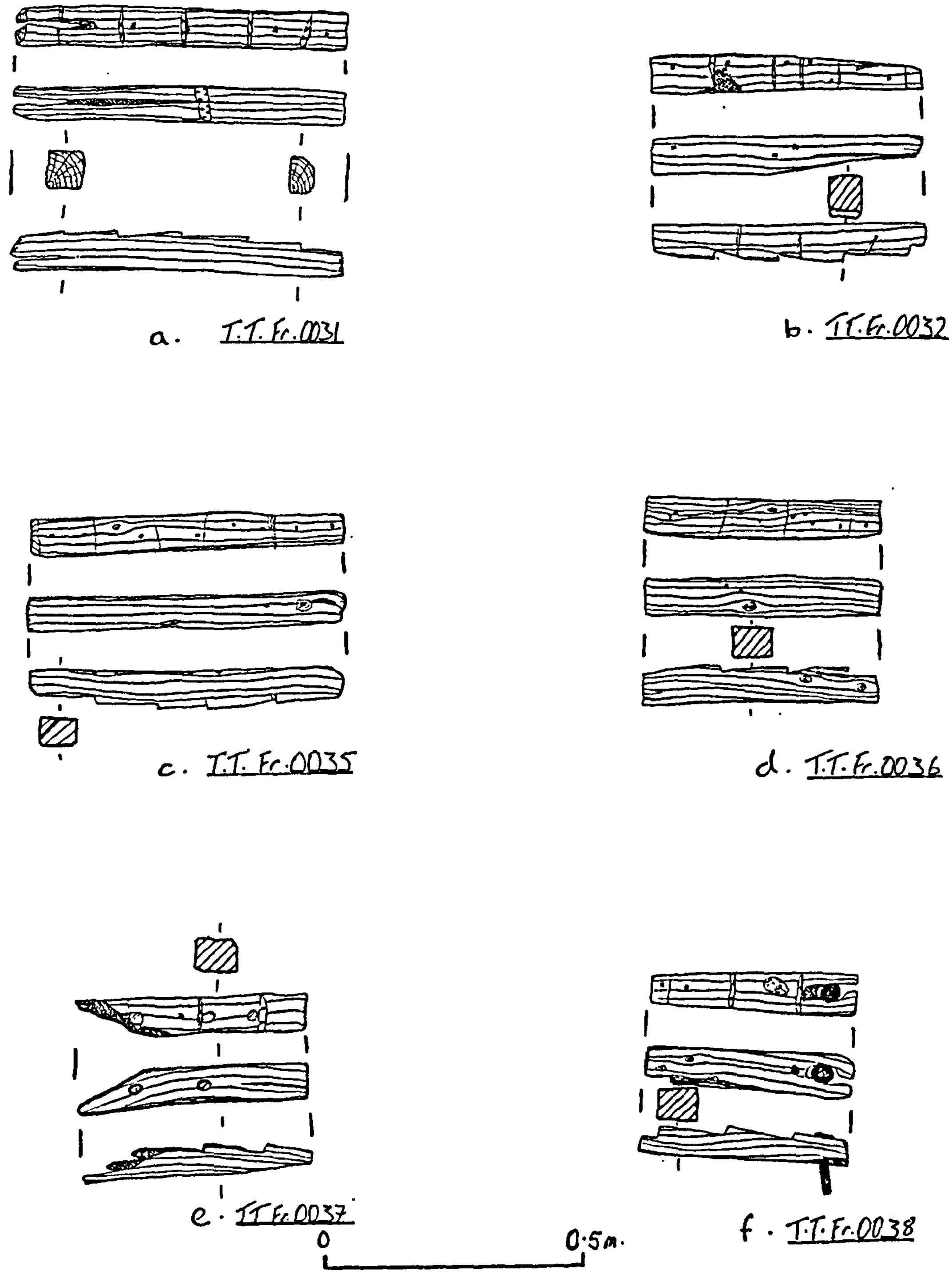


Fig. 5.21- Top timber.

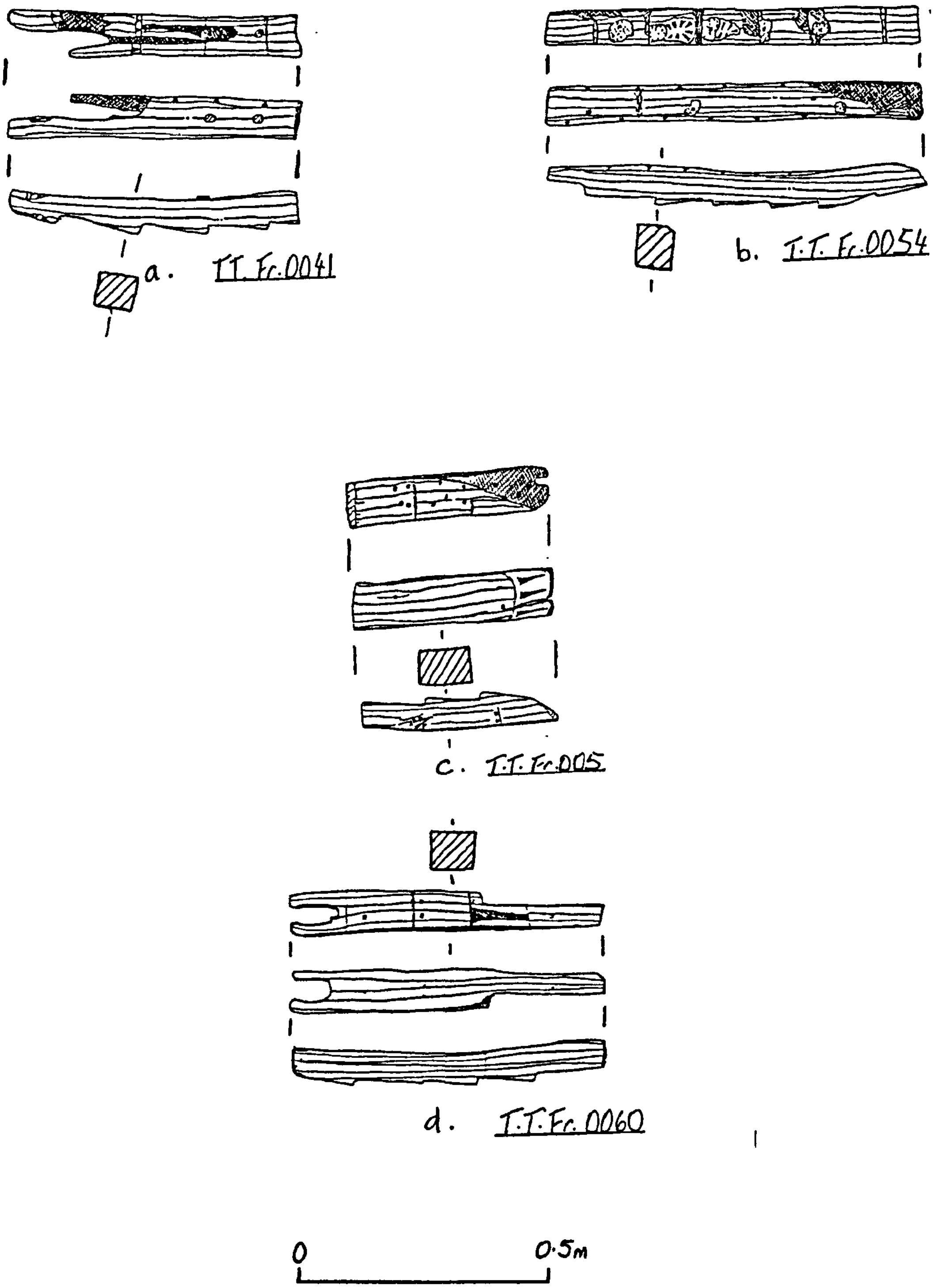


Fig. 5.22- Top timbers.

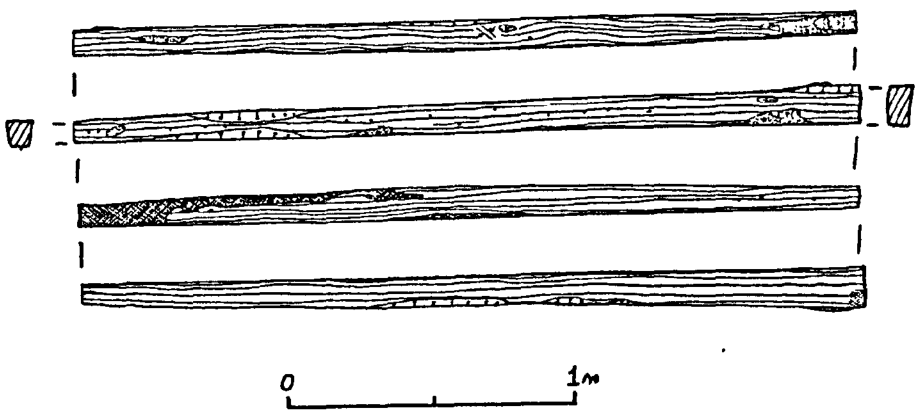


Fig. 5.23a- Deck beam.

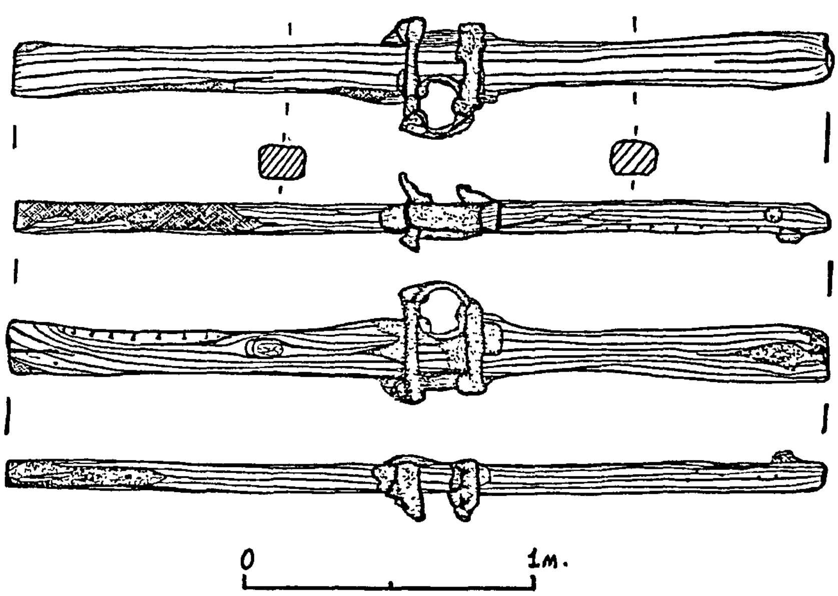


Fig. 5.23b- Mast beam.

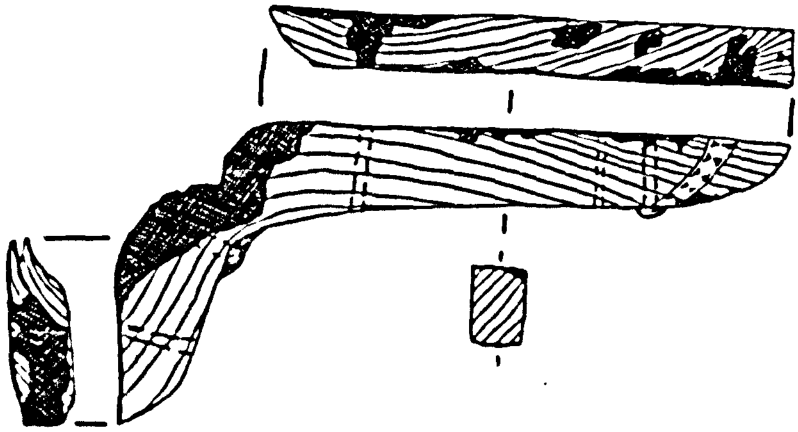


Fig.24a- Aft Mast beam knee.

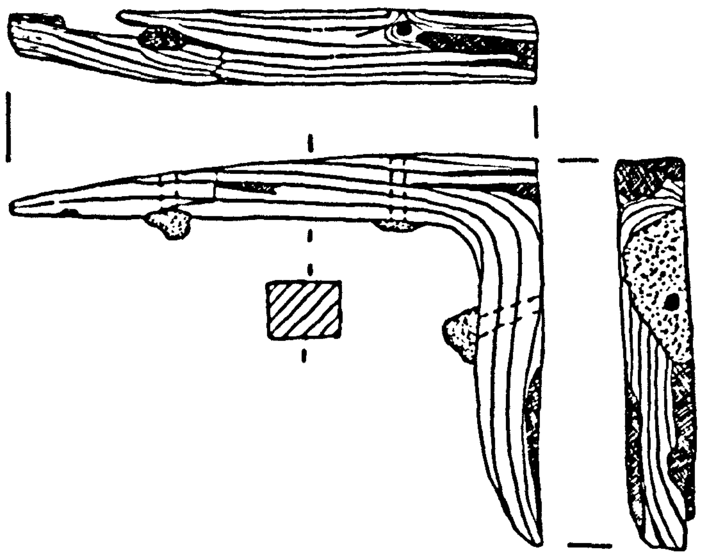
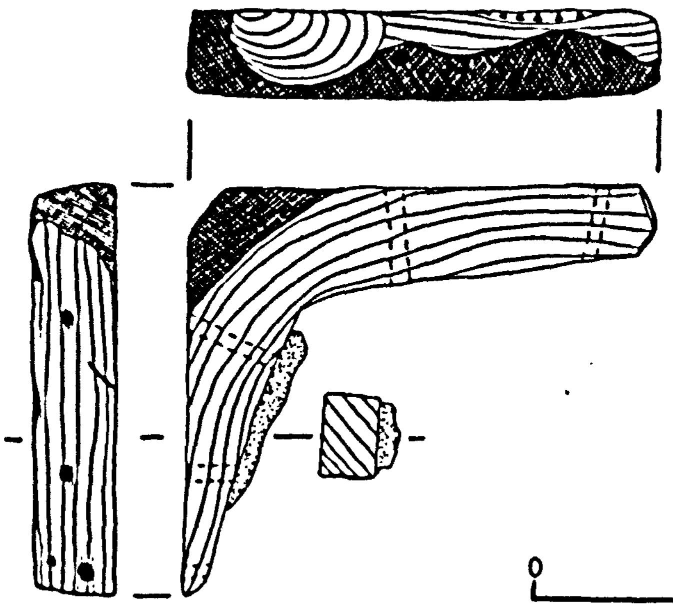


Fig. 5.24b- Mast beam knee.



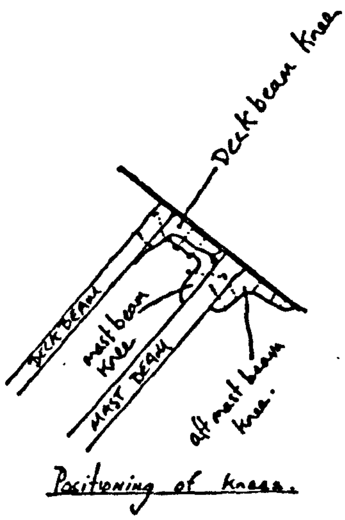


Fig 5.24c- Deck beam knee.

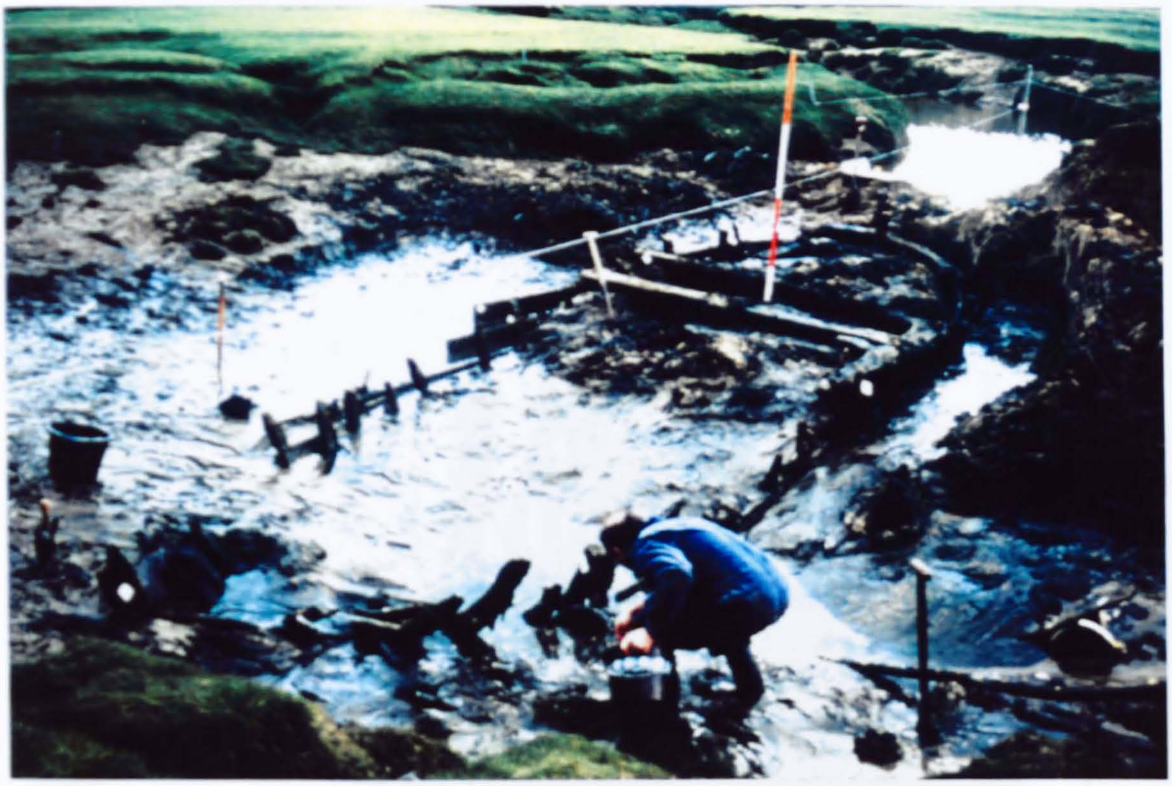


Fig. 5.25a- Excavated boat showing extent of surviving planking.

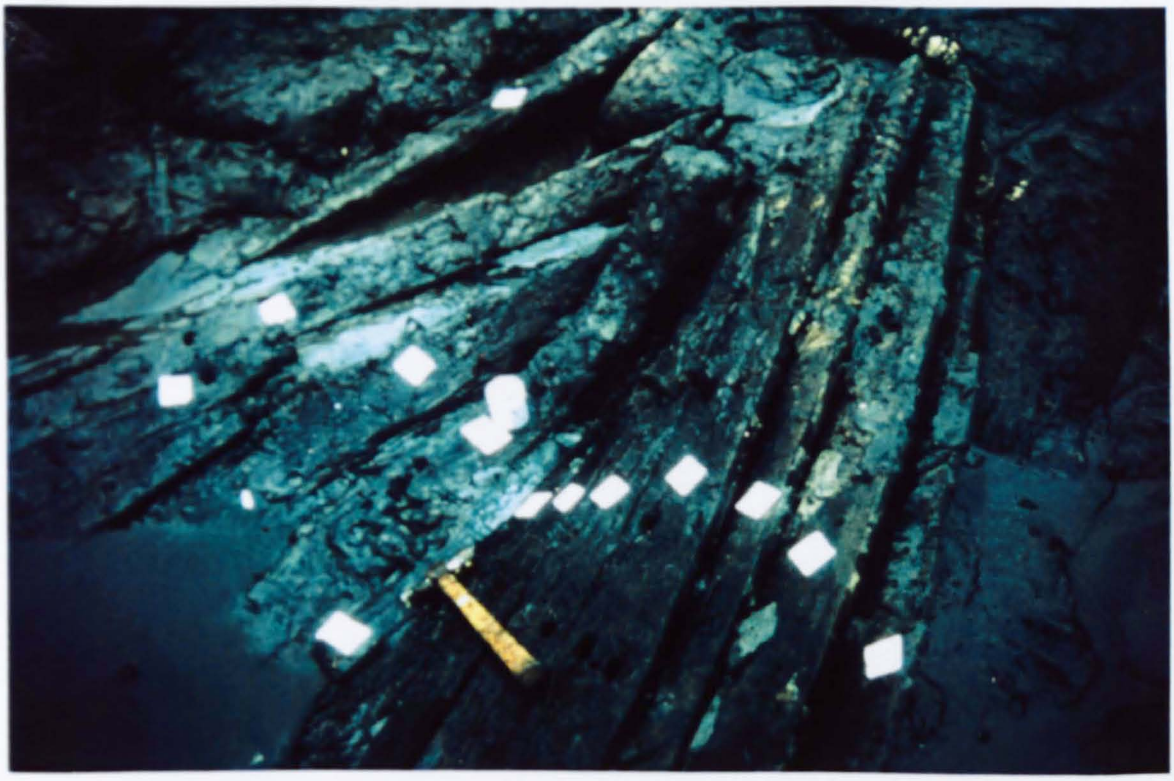


Fig. 5.25b- Run of carvel bottom planks into stern post.

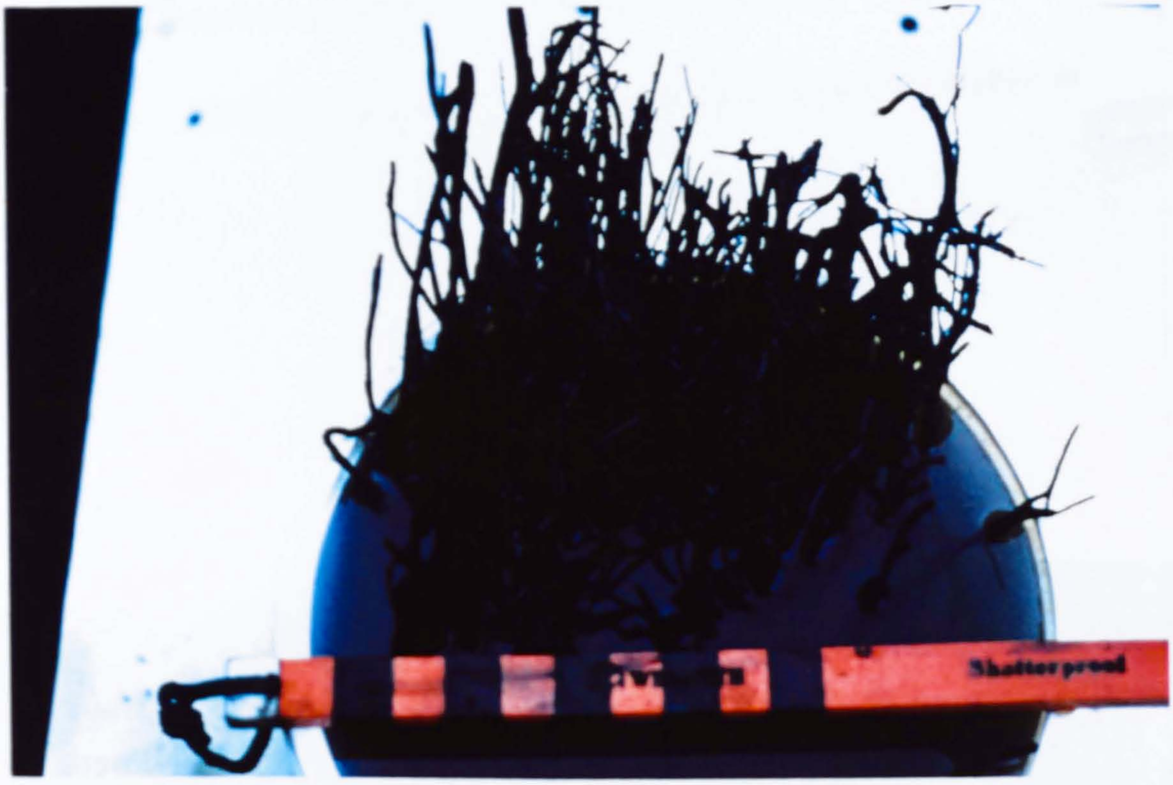


Fig. 5.26- Dunnage.

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Fig. 5.27a- Concreted pewter bottle (OR).

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Fig. 27b- Lamp glass (OR).

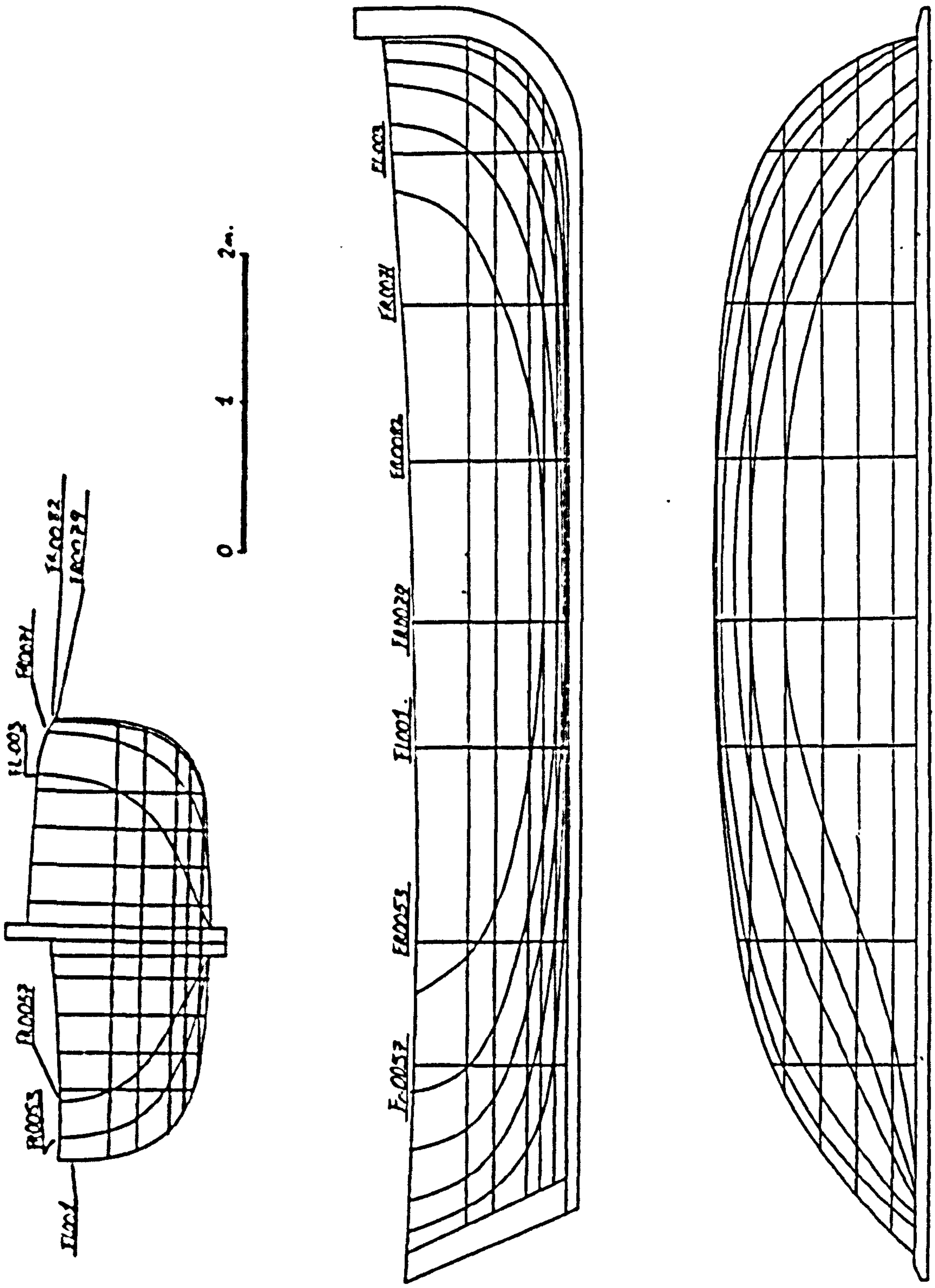

Fig. 5.28- Lines drawing of Talsarnau boat from first reconstruction.