A Cromwellian Warship wrecked off Duart Castle, Mull, Scotland, in 1653

Colin Martin

ISBN: 978-1-908332-11-0 (hardback) • 978-1-908332-37-0 (PDF)

Martin, C J M 2017 *A Cromwellian Warship wrecked off Duart Castle, Mull, Scotland, in 1653*. Edinburgh: Society of Antiquaries of Scotland. https://doi.org/10.9750/9781908332189

A Cromwellian Warship wrecked off Duart Castle, Mull, Scotland, in 1653

IN MEMORY OF THOSE WHO PERISHED, 13 SEPTEMBER 1653

for Paula
with love and gratitude

A Cromwellian Warship wrecked off Duart Castle, Mull, Scotland, in 1653

Colin J M Martin

James H Barrett, David Bate, Sue Black, Darren Cox, George Dalgleish, Peter Spencer Davies, Peter Ditchfield, Glenn Foard, Headland Archaeology Ltd, David Lamb, Ian MacLeod, John McManus, Wolfram Meier-Augenstein, Rachel L Parks, Andrew Ramsey, Janet Shelley, Theo Skinner, Catherine Smith and Lore Troalen

Jacket images by Colin Martin

First published in Great Britain in 2017 by the Society of Antiquaries of Scotland

Society of Antiquaries of Scotland
National Museums Scotland
Chambers Street
Edinburgh EH1 1JF
Tel: 0131 247 4115
Fax: 0131 247 4163
Email: administration@socantscot.org
Website: www.socantscot.org

The Society of Antiquaries of Scotland is a registered Scottish charity No SC010440

ISBN 978 1 908332 11 0

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

The author and the Society of Antiquaries of Scotland gratefully acknowledge funding towards the publication of this volume from HES Scotland. The project was supported by the University of St Andrews, National Museums Scotland and Sir Lachlan Maclean of Duart and Morven, 28th Chief.

Design and production by Lawrie Law and Alison Rae
Typesetting by Waverley Typesetters, Warham, Norfolk
Manufactured in Slovenia by SvetPrint

CONTENTS

Excavation Plan: please see foldout at end of book

LIST OF ILLUSTRATIONS

Note: all photographs and drawings are by Colin Martin unless otherwise credited. Those already deposited with Historic Environment Scotland (formerly RCAHMS) in the Dr Colin and Dr Paula Martin Collection and the Archaeological Diving Unit Collection are © Historic Environment Scotland 2016. These can be identified by an SC or a DP prefix.

Chapter 9

LIST OF TABLES

LIST OF CONTRIBUTORS

JAMES H BARRETT
McDonald Institute for Archaeological Research, University of Cambridge

DAVID BATE
Nikon Metrology, X-Tek Systems Ltd, Tring Business Centre, Icknield Way, Tring, Hertfordshire

SUE BLACK
Professor and Director of the Centre for Anatomy and Human Identification, University of Dundee

DARREN COX
National Museums Scotland, Collections Services Department, National Collection Centre, Granton, Edinburgh

GEORGE DALGLEISH
National Museums Scotland, Edinburgh

PETER SPENCER DAVIES
Scottish Pewter Society

PETER DITCHFIELD
Oxford Laboratory for Archaeology and the History of Art

GLENN FOARD
Reader in Battlefield Archaeology, University of Huddersfield

HEADLAND ARCHAEOLOGY LTD
Edinburgh

DAVID LAMB
Scottish Pewter Society

IAN MACLEOD
Fremantle Museums and Collections, Western Australia

JOHN McMANUS
Emeritus Professor, Department of Geography and Geosciences, University of St Andrews

WOLFRAM MEIER-AUGENSTEIN
Environmental Forensics & Human Health Laboratory, Environmental Engineering Research Centre, Queen's University Belfast

RACHEL L PARKS
Department of Archaeology, University of York

ANDREW RAMSEY
Nikon Metrology, X-Tek Systems Ltd, Tring Business Centre, Icknield Way, Tring, Hertfordshire

JANET SHELLEY
Duncan of Jordanstone College of Art, University of Dundee

THEO SKINNER
National Museums Scotland, Collections Services Department, National Collection Centre, Granton, Edinburgh

CATHERINE SMITH
Alder Archaeology, Perth

LORE TROALEN
National Museums Scotland, Collections Services Department, National Collection Centre, Granton, Edinburgh

FOREWORD

The Hon Sir Lachlan Maclean of Duart and Morvern, Bt, CVO, DL
28th Chief of Clan Maclean

When in 1992 I was informed about the discovery of an unidentified shipwreck off Duart Point, I had no idea how long its exploration would take, or what a vast amount of information would be revealed by its remains. When the project really got off the ground in 1993 I was happy to do what I could to help. Colin Martin's base-camp was set up discreetly behind the tea-room and shop, and he and his team proved to be interesting and sympathetic neighbours. I was honoured to be invited to be the Patron of the project.

While many shipwrecks have no direct link with the shores on which they were wrecked, this one does. It was one of six vessels sent by Cromwell to land troops and attack Duart Castle in 1653, to quell a royalist uprising. But the clan chief and his entourage had fled. The troops and equipment were landed, but then a storm caused the wreck of three of the ships, and serious damage to the others. No harm was done to the Macleans or to Duart Castle. The expedition achieved nothing significant. Little did those men know, however, how much interest would be shown in the evidence surviving under water of them and their expedition three-and-a-half centuries later.

I am so pleased to see the published results of long study by Colin Martin and others, and to be asked to write this Foreword. Colin never boasted about the importance of the wreck. He worked slowly and carefully to extract the maximum amount of information from the material he was investigating, so that the remains could tell their own story. What those involved have uncovered, and the range of conclusions which they have drawn from the finds and their context, have spread wider than I ever could have imagined. The story of the wreck, the story of its excavation, and the stories the finds can tell, have added to the story of Duart Castle, and proved of great interest to many of our visitors from all over the world. I remember meeting Colin one day on the path as he returned from a dive on the wreck. He had with him, in a container of salt water, an oak twig with its leaves. How excited he was with this new find, as he was with everything they discovered on the wreck.

Illustration 1
Sir Lachlan Maclean, 28th Chief and Patron of the project, outside Duart Castle (DP 173655)

This book, the finds in the National Museum of Scotland, the little exhibition within Duart Castle, and the reburial of the human remains in the little graveyard beneath the castle walls, will all be a lasting legacy. Excavation stopped in 2003, though the site is still monitored to ensure its long-term stability, and there is an underwater trail for visiting divers. This project has involved many people, both divers and researchers, but the key figure all along has been Colin Martin. I have been proud to be Patron of such a well-run and interesting project, and very pleased that all their hard work has yielded such interesting and important results.

Duart Castle, *September 2015*

ACKNOWLEDGEMENTS

This project took 25 years to complete, and has involved the collaboration and support of many people and institutions. Grateful acknowledgement must first be made to the wreck's finder, John Dadd, for informing Historic Scotland of his discovery in 1991, generously waiving his claim to it, and following our subsequent investigations with friendly interest. I hope this monograph, and the permanent curation of the recoveries by National Museums Scotland, will be some recompense for his public-spirited actions. Warm thanks are also due to the Dumfries and Galloway Branch of the Scottish Sub-Aqua Club, whose members came upon the wreck in 1992, unaware that its existence was already known and that behind-the-scenes steps were being taken to give the site legal protection. It was they who reported the erosion which triggered the present project. They also recovered several vulnerable items, forgoing their right to a reward in favour of deposition in National Museums Scotland. One of their members, Donald MacKinnon, subsequently conducted the historical research which associated the wreck with the Cromwellian invasion of Mull in 1653. In addition the Club provided invaluable support during the monitoring and stabilising of the site over the critical winter of 1992 to 1993.

The late Martin Dean, then Head of the Archaeological Diving Unit at St Andrews University, brought his team to the wreck in 1991 and assessed it on behalf of Historic Scotland. Following his recommendation the site was designated as a Protected Historic Wreck. The following summer he directed the ADU's recovery and first-aid treatment of erosion-threatened artefacts, in conjunction with National Museums Scotland, the Dumfries and Galloway Club, and students and staff from St Andrews University. Martin then encouraged me to apply for a licence to continue monitoring the wreck, thus initiating the long-term investigation of which this report is the outcome. Over successive years he and his colleagues continued to visit the site in both their official and private capacities, and have supported the project in many ways, corporately and individually. In addition to Martin the ADU team has included Dave Burden, Dr Antony Firth, Annabel Wood (now Lawrence), Mark Lawrence, Steve Liscoe, Jon Moore, Ian Oxley, Duncan Simpson, and Kit Watson. Since 2003 monitoring has been continued by the ADU's successor, the diving team from Wessex Archaeology directed by Steve Webster and Graham Scott. During the preparation of this report Steve Liscoe has made available his extensive personal records and prodigious memory to correlate early activities on the site with the author's investigation. His perceptive observations have greatly aided our interpretation of the site-formation processes.

During the early stages Dr Robert Prescott of the Scottish Institute of Maritime Studies at St Andrews fostered the cross-institutional collaboration which has since characterised the project. Historic Scotland, as the agency responsible for Scotland's designated historic shipwrecks, has been a tower of strength throughout. In 1991 this responsibility had only recently been placed on the agency, and complex legal and administrative issues had yet to be resolved. Far from regarding these difficulties as an excuse for inaction, however, Historic Scotland saw the Duart Point wreck as a test-bed for establishing sound management policies for regulating and nurturing this important, but previously largely unrecognised, part of the nation's heritage. As a result of this experience, and other pioneering initiatives which it has fostered and supported, Historic Scotland has for two decades been a leading player in the development of effective strategies for managing the maritime cultural resource at both devolved-national and UK levels. Members of the agency with whom we have dealt include Dr Gordon Barclay, Professor David Breeze, Dr Andrew Burke, Deirdre Cameron, Ron Dalziel, Dr Noel Fojut, Olwyn Owen, Philip Robertson and Richard Welander. I thank them all for their support, encouragement, and good advice, much of which went far beyond the strict call of duty.

National Museums Scotland (NMS) have been similarly supportive and helpful from the outset. Dr David Caldwell, George Dalgleish, and the late Alan Saville have been generous with their time and expertise in the study of artefacts, while Tom Bryce, Dr Jim Tate, and Dr Theo Skinner, assisted by Stephanie Erpenbeck, have performed wonders in the conservation laboratory. It is no reflection on his colleagues to single out Theo for special mention, for over the years he has carried out the bulk of this gargantuan task with consummate skill and patience, and in a spirit of collaboration which has maximised the information we have been able to extract from the objects before, during, and after conservation. Working with him in the lab and in the field has been an instructive delight. A particular triumph has been the three-dimensional computed tomography X-radiographic investigation of the pocket-watch conducted by Dr Andrew Ramsey and Dr David Bate of X-Tek Systems Ltd (today Nikon Metrology), supported by Theo and his colleagues Dr Lore Troalen and Darren Cox from the scientific and engineering conservation sections at the Museum. The finds are currently housed in the NMS store at Granton under the management of Jackie Moran, who has facilitated our study of the artefacts there with unfailing skill and good humour.

When I took on the project I had retired from active diving, and my earlier archaeological work under water had been conducted in the blissfully unregulated days between the late 1960s and early 1980s. By 1992 rigorous regulations for underwater work had been introduced by the Health and Safety Executive, so at 53 I was obliged to gain the necessary professional qualifications from scratch. This was arranged by my old friend and former diving colleague Lt Cdr Alan Bax, then Director of the Fort Bovisand Underwater Centre at Plymouth. If I thought he would give me an easy ride I was mistaken, for his instructors (mostly former Royal Marines) made no allowances for a recruit more than twice the average age of his fellow squaddies and put me through the mill with the rest. I hated them (and Alan) for it at the time, but it paid rich dividends later. I thank (and forgive) them all.

I have been especially fortunate in the colleagues with whom I have worked on the site. They are: Adrian Barak, Neil Dobson, Professor David Gregory, Jane Griffiths, Brian Hession, Annabel Lawrence, Mark Lawrence, Dr Ian MacLeod, Edward Martin, Peter Martin, Philip Robertson, Kevin Robinson, and Graham Scott. The project has profited from their skill and perception as archaeologists, and whether as diving buddies or surface supporters (the roles were interchangeable) each always inspired the confidence of the others. That 13 seasons of intensive diving were completed without serious incident or upset speaks for itself.

The only non-diving team member (though she has been a distinguished diving archaeologist in the past) is my wife and long-standing research colleague Dr Paula Martin. From the outset she has been an unfailing source of encouragement and support, and during the project's excavation phase she took on the tasks of deputy director and finds manager. Her abilities as a historian and archaeologist, her computing and administrative skills, her editorial acumen, and above all her wisdom and sound common sense, are attributes on which I have constantly relied and all too often taken for granted. I acknowledge them here now. Our son Edward, a professional photographer and digital specialist, has constantly and uncomplainingly been on hand to advise on and assist with photography, scanning and data management.

Behind-the-scenes support has been provided by the Research Grants Office at St Andrews, whose staff, through the good offices of Vice-Principal Professor Frank Quinault, guided us through the intricacies of financial management and fund-raising with patience and good humour. We owe special debts to Jimmy Bone, Ann Thom and Mary Clark. In the final phases of the project we enjoyed much practical support from the University's Development Office, especially from Jonathan Livingstone and Louise Taylor. Over the years the Bute Photographic Unit has cheerfully serviced my old-fashioned ideas about pen-and-paper approaches to archaeological illustration. In an age which increasingly relies on computer graphics its staff applied their traditional lithographic skills to deal with my often prodigiously sized line-drawings, and when they could no longer stem the advancing tide of technology they arranged to relocate their redundant process camera (a quarter-ton monster) in my home so that I could operate it myself. For advice and many kindnesses in these matters I am especially indebted to Jim Allen. The Royal Commission on the Ancient and Historical Monuments of Scotland (now Historic Environment Scotland) helped with the digitisation of large site-plans, a task undertaken by Edward Martin. The Royal Commission also facilitated the flights which enabled me to take the aerial photographs of the site and its environs, working in collaboration with Dave Cowley. The results owe much to the piloting skills of Ronnie Cowan.

For many seasons Ray Sutcliffe, formerly a producer with the much-missed BBC *Chronicle* programme, joined us in the field to co-ordinate the video coverage which now constitutes a valuable part of the project's archive. He shot most of the surface material, and taught us how to take usable footage under water. In 1999 our activities were filmed for the BBC 2 series *Journeys to the Bottom of the Sea*, directed by Sian Griffiths, and in 2002 Channel 4's *Wreck Detectives* sponsored two weeks of work on the site which resulted in another programme, directed by Peter Wyles. As a consequence of the latter production I was able to visit the *Vasa* Museum in Stockholm to examine comparative material, particularly the carvings, through the kindness of Klas Helmers.

The owner of Duart Castle, Sir Lachlan Maclean of Duart and Morvern, 28th Chief of the Clan, is directly descended from Sir Allan, the 19th Chief, whose castle our vessel came to attack in 1653. Sir Lachlan kindly agreed to be the project's Patron, and has generously supported us throughout. To him, his late wife Lady Mary Maclean, his mother the Lady Elizabeth Maclean, and their delightful family, we are indebted for many kindnesses and much practical help. We hope our long-term occupancy of a base-camp behind the castle, and the constant noise of our compressor on the rocks, did not unduly discommode them or deter visitors. Warm thanks also go our many friends and supporters in Mull and Morvern, especially the late Allister Campbell and Susan Campbell, the late Bill Ackroyd and Janet Ackroyd, Ken and Jenny Masters, Chris James of Torosay, and Billy and Janice McGregor of the Craignure Inn. Nor do we forget the magnificent baking of the Duart tea-room girls.

Scott McAllister, master of the *Duchess* launch, which throughout our time at Duart brought parties of tourists from Oban to the castle twice daily, uncomplainingly made a wide detour around the site whenever our 'A' flag was flying, and on one occasion rescued our boat when it became detached from its moorings. We wish him well in his (semi-)retirement. The Marine and Coastguard Agency has been a constant ally. Our diving operations were conducted in constant radio contact with Oban (latterly Clyde) Coastguard, ensuring that help was always within immediate call. Confidence was boosted by the knowledge that we were only half-an-hour away from the recompression facilities at the Scottish Association for Marine Science at Dunstaffnage, and its availability in an emergency – happily never drawn upon – is gratefully acknowledged.

More than once (alerted by friends ashore) the prompt arrival of a high-speed Coastguard RIB deterred potential interlopers from diving on the site before any damage could be done. Such responses are now seldom necessary thanks to the scheme pioneered by Historic Scotland and Philip Robertson in conjunction with the Nautical Archaeology Society, which allowed responsible divers to visit the wreck by arrangement. This controlled access removed all sense of public exclusion, and engendered a protective attitude towards the wreck among local and visiting divers. Their support and goodwill has been, and remains, greatly appreciated. On 1 November 2013, the site was designated as a Historic Marine Protected Area, superseding protected status under the Protection of Wrecks Act (1973) (for more information see http://portal.historic-scotland.gov.uk/designation/HMPA7). As the site is considered stable and relatively robust, divers are now permitted to visit the wreck without a visitor licence on a 'look but don't touch' basis. The Lochaline Dive Centre* continues to keep a watchful eye over the site and offers educational tours on request. A visitor trail map and information sheet is downloadable from http://nauticalarchaeologysociety.org/duart-wreck-diver-trail ~~or http://www.lochalinedivecentre.co.uk/?page_id=1455.~~ *Centre now closed

The Receivers of Wreck with whom we have had dealings, notably Veronica Robbins and Sophia Exelby, have been outstandingly helpful in ensuring a smooth transfer of the recovered material to National Museums Scotland.

The valuable contributions made by various specialist scholars will be evident in their individually authored reports, but it is appropriate to acknowledge and thank them here. Professor Sue Black and her colleagues of the Anatomy and Forensic Anthropology Department at the University of Dundee have produced an extraordinarily detailed profile of the individual whose remains we recovered from the wreck, while Dr Wolfram Meier-Augenstein of Queen's University Belfast has been able to suggest, on the basis of isotope analysis, that he was probably a native of Yorkshire. Dr Peter Ditchfield of the Stable Isotope Laboratory at the University of Oxford (part of the Research Laboratory for Archaeology and the History of Art) has conducted further analysis which has cast light on the individual's dietary history. Dr Rachel Parks and Dr James Barrett, formerly of Fishlab at the University of York, have examined fish bones associated with the wreck and concluded that some may have been of local origin. Catherine Smith, of the Scottish Urban Archaeology Trust, carried out work on the animal bones and reached a similar conclusion. Samples of organic material from the ship's bilges were assessed by Headland Archaeology, and Janet Shelley of Duncan of Jordanstone College of Art, University of Dundee, examined the textile remains attached to a compass base.

Professor John McManus of the School of Geography and Geosciences at St Andrews investigated the ballast with unexpected and valuable results. Dr Ian MacLeod, recently retired as Executive Director, Fremantle Museums and Collections, in Western Australia, spent many hours under water and in the field laboratory pursuing his pioneering research on the in situ conservation of iron guns. He subsequently collaborated with Dr Theo Skinner in the analysis of the important John Browne cast-iron minion drake and later, when the composition of the metal yielded results of great significance to the history of early metallurgy, with Professor Hubert Preβlinger. Our collection of lead shot has been studied by Dr Glenn Foard of the University of Huddersfield, while the pewter has been investigated by George Dalgleish (National Museums Scotland), Dr Peter Davies and Dr David Lamb (Scottish Pewter Society). Dr Pieter van de Merwe of the National Maritime Museum has guided me through the mysteries of Stewart nautical iconography, and Professor Hugh Cheape of Sabhal Mor Ostaig, University of the Highlands and Islands, has kindly provided help with Gaelic words.

I am not by training a historian, and have relied heavily on others to research the history of the Duart Point ship and the circumstances of her wrecking. Unfortunately much of this has been misdirected by my early identification of the wreck as the pinnace *Swan* built for Charles I in 1641 (Martin 1995a: 25–8). Though this seemed so convincing at the time it has proved to be incorrect. For pointing out the error I am deeply indebted to Dr Patrick Little of University College London, who has shown unequivocally that the 1641 *Swan* survived beyond 1653. With great generosity Dr Little has made available his researches and extensive knowledge of the period in seeking to track down the true identity of the Duart wreck, and the evidence for this is set out below (Chapter 2.2). I also acknowledge the unpublished information kindly provided by

his colleague at UCL, Dr Andrew Thrush, whose unrivalled expertise on the evolution of small English warships during the 17th century I had already drawn upon, in published form, during my pursuit of the 'wrong' *Swan*.

Others upon whose goodwill I trespassed during the initial wild-*Swan* chase include Professor Jane Ohlmeyer of Trinity College Dublin, Dr John Crampsey of St Andrews University, and Gillian Hutchinson of the National Maritime Museum. Although in the event some of their researches have not proved directly relevant to the Duart Point wreck they have informed and widened my knowledge of small warships and their activities off western Britain during this crucial period, and for that I thank them warmly. Though it is too early to be certain, the possibility that the 'right' *Swan* may be a vessel of that name once owned by the Marquess of Argyll is opened up by a reference to this ship discovered by Alastair Campbell of Airds in the Inverary archives, and it is hoped that further research may throw more light on the matter.

Whatever the identity and origins of the ship, the circumstances of her loss are well documented and uncontroversial. The connection of the Duart Point wreck with the Cromwellian invasion of Mull in 1653 was first established by Donald MacKinnon, as acknowledged above. Much of the written source material has been calendared and published, but Dr Frances Henderson of Worcester College, Oxford, has generously allowed me to cite a previously unknown description of the incident which she has identified among the coded shorthand notes of the army secretary William Clarke, who was based in Edinburgh during the 1650s. Paul Dryburgh of The National Archives, Kew, and his colleagues very kindly checked a key word which had been transcribed differently by two scholars, and their adjudication has been invaluable.

Valuable information about *Swan's* captain, Edward Tarleton, was provided by Professor Bernard Capp of Warwick University. I am also grateful to Adam Tarleton who, though not a blood relative of Edward, has researched aspects of his career and generously communicated this information to me. Captain Christopher Tarleton Fagan, a direct descendant, kindly allowed me to photograph the portrait of Edward in his possession, and showed me important documents relevant to his ancestor's career. Joni L Davidson of San Francisco, who has conducted extensive research into the family, has generously made the fruits of her investigations available to me. We thank the National Trust for Scotland for granting permission to photograph the 17th-century plasterwork at the House of the Binns in West Lothian, and Tam and Kathleen Dalyell for their hospitality and kindness when we went there to do so.

Although underwater archaeology can be highly productive in terms of the information it yields it does not come cheap, and without the support of our sponsors little could have been achieved. The project would have died unborn in 1992 without a timely and extremely generous grant from the Russell Trust which allowed a full suite of diving and archaeological equipment to be assembled, a 4×4 vehicle obtained, and a field base established at Duart. This capital resource, together with an inflatable boat provided by Glenfiddich (William Grant & Sons Ltd), has sustained us through 13 field seasons and continues to support other research activities on the west of Scotland. Running-costs over the years have been provided by grants from Historic Scotland, National Museum Scotland, the Pilgrim Trust, the Esmée Fairbairn Charitable Trust, and Mr and Mrs Ellice B McDonald Jr. A major award by the Arts and Humanities Research Board, supplemented by further monies from Historic Scotland, sustained the excavation phase of the work from 1999 to its close in 2003. The Pilgrim Trust, the Russell Trust, the Thriplow Charitable Trust and the Arts and Humanities Research Board provided generous grants to assist with post-excavation work. During a visit to the site Drs Toni Carrell and Donald Keith of the Ships of Discovery program in the United States made a generous and unexpected contribution to the project. Honda UK lent us a quad bike which was invaluable during the setting-up phase of the excavation, while O'Three of Portland, Dorset, gave the project two of their unrivalled drysuits. That used by the writer is now in its 17th year of trouble-free service.

Final acknowledgement goes to the friendly and helpful editorial team at the Society of Antiquaries of Scotland, Erin Osborne-Martin, Catherine Aitken, Lawrie Law and Alison Rae.

EDITORIAL NOTES

There are some difficulties in structuring a report of this kind. Normally the identity of the wreck and its historical context would be set out first, but in this case the ship's name and origins are not certain, while its date – and consequently its likely historical associations – can only be derived from a critical assessment of the archaeological evidence, which is normally contained in the main body of a report. A summary of this evidence, and its likely interpretation, is therefore set out at an early stage. Then again, a consideration of the site-formation processes involved – an essential prerequisite to interpreting a wreck's archaeology – would most logically be explained as a prelude to a description of the excavation, yet these processes only become clear when the information derived from excavation has been assimilated. The excavation itself cannot be described without reference to the structural remains encountered, and this pre-empts the subsequent analysis of these remains in an attempt to reconstruct the basic attributes of the ship's dimensions, hull-form, and internal arrangements. The sequence of the report has therefore been ordered to accommodate these inconsistencies without compromising clarity or logic.

As will become clear, this ship's operational life and eventual demise is linked to the region's underlying historical dynamics and maritime geography, so an overview of these processes through time is presented by way of setting the scene (Chapter 1). The Cromwellian invasion of 1653, during which overwhelming evidence indicates that the ship was lost, is then analysed in detail, followed by the wrecking event and its aftermath. The circumstances of discovery, and how the project developed, are then presented (Chapter 2). This is followed by a summary of the archaeological and historical evidence for the wreck's date, probable identity, and historical context. Though much of the evidence is considered more fully in later sections, readers will want to know at an early stage the substance of this information. Questions of site management and research design are next addressed. Survey and excavation techniques are explained more fully than is usual in an excavation report, since not all readers will be familiar with the practicalities of applying archaeological procedures and standards under water.

The main body of the report begins with a description of the site's characteristics, recorded during the non-intrusive survey and assessment phase of the project (Chapter 3). This leads to an account of the subsequent partial excavation of the wreck, described sequentially from its aftermost remains to the forward surviving extent of the bow. A consideration of site-formation processes, based on this evidence, follows in Chapter 4. Chapter 5 describes the process of reconstructing the dimensions, body-lines, displacement, and structural characteristics of the hull. Chapter 6 considers the finds directly related to the ship and its working, from the ballast to the rigging.

Chapter 7 describes the ship's armament on its own terms and in terms of its disposition on the gun-deck. Because artefacts from a wreck represent a closed assemblage derived from a self-contained and largely self-sufficient specialised community, the remaining finds have been categorised by type or perceived usage rather than by material (Chapters 8 and 9). Chapter 10 presents the human remains and their interpretation. A final chapter considers the findings of the project in a wider historical perspective.

An Excavation Plan is included as a fold-out at the back of the book.

A number of other ships and shipwrecks are mentioned during the narrative. For ease of reference, and to avoid unnecessary repetition, those cited more than once to provide comparisons with the Duart Point Ship herself or with objects found on board are listed in Appendix 1.

Much of the archive of drawings and photographs has already been lodged with Historic Environment Scotland, and may be accessed online via the database Canmore, site 80637. Those interested in details of the diving operation, or aspects of the project such as the procedures developed for lifting delicate finds, can find much more detail there.

Units of measurement

All primary measurements involving general survey data, the dimensions of objects, and volumes follow metric conventions. Imperial English equivalents are given in brackets for dimensions which may originally have been calibrated to these standards. Occasionally, usually when using figures from contemporary sources, the original measurement is used, with the metric equivalent in brackets.

Place-names

Place-names within quotations are as in the original. All other place-names have been standardised wherever possible to the spellings on modern Ordnance Survey maps.

Site grid

Maps and diagrams of above-water features are oriented northwards, but an exception has been made for the orientation of the wreck. Since the archaeological remains represent a hull lying partly on its side, it has been felt logical to present the wreck, as it were, 'right way up', and the local site-grid is adjusted to an arbitrary 'north' of 246° (T) and 'east' of 336° (T). This orientation is adopted in all the wreck-plans.

A metric grid has been superimposed on the site from an arbitrary point just beyond the most easterly identified archaeological deposit. Since the wreck is lying towards its port side the grid has been orientated so that the keel/keelson-axis lies towards the bottom of the coherent structure. The grid has a eastings component of 295° (T), running from **000.000** to **000.310**, and an northings one of 205° (T), running from **000.000** to **000.130**. Grid locations are given as 4- or 6-figure references, always eastings followed by northings. The crown of the anchor thus lies at **24.01** (within 1m square) or **240.015** (within 0.1m square).

Hull-axis and frame numbering

The observed axis of the keel runs from just aft of the mainmast step (**186.071**) to a point at or close to its forward end (**278.060**). The estimated position of the aft end of the keel, which may be presumed to lie below the limit to which the stern assembly was excavated, is at **096.075**. This position is 0.6m to starboard of an aftwards projection of the midships to forward keel-axis which, as argued elsewhere, indicates a probable break of the keel and keelson somewhere beneath the aft ballast-mound and a consequent displacement to starboard of the axial symmetry of the aft lower hull. This displacement however is relatively slight, and does not compromise an estimated keel length of 18.25m. The axis of the keel is the primary reference in Illus 60, and transverse structural features (mainly frame-timbers) are identified by their distances forward or aft of the master-frame (U), projected at right-angles from the axis line.

Technical terms

For precision and clarity, technical terms and their meanings employed in the text are those which would have been used and understood by a 17th-century seaman. The definitions in the Glossary are based primarily on John Smith's 1627 *A Sea Grammar* and Henry Mainwaring's *The Seaman's Dictionary*, which, though not published until 1644, is believed to have been prepared in manuscript by 1617 (Manwaring and Perrin 1923: 3). Where appropriate William Falconer's magisterial *Universal Dictionary of the Marine* (first published in 1769) has also been consulted.

Finds numbers

The core system used was a simple numerical sequence of three digits prefixed by DP (for Duart Point) and the final two digits of the calendar year and a / (for example DP01/037). However, in 1997 a more complex system was used, involving separate numerical sequences depending on the context (A, C or E). This used 4 final digits, but as the highest number reached was 0051 these have been reduced to 3 digits for consistency with other years. The finds from 1992 were originally given simple numerical sequences, one by the ADU and one by members of the Dumfries and Galloway Club. These have been retrospectively standardised to the format DP92/001 and DP92/DG01. Three items found by John Dadd which have been recorded have been retrospectively numbered DP79/001–003.

Catalogue numbers

For ease of cross-reference within the text and illustrations, finds have been assigned catalogue numbers. For simplicity and clarity, catalogue numbers (boxed to distinguish them from other numbers, eg [1]) consist of one sequence running through Chapters 5–9. They are also used to identify individual finds elsewhere in the text where appropriate, and in illustrations and captions.

Chapter 1

HISTORICAL BACKGROUND

1.1 Sea-power in western Scotland from prehistory to 1746

The Sound of Mull is a route of prime importance in the maritime geography of Scotland's west coast and islands (Illus 2–4). Its south-eastern end gives ready access to Loch Linnhe, a long arm of the sea which penetrates the Highland massif as far as Fort William, the gateway to Lochaber. Loch Linnhe's geological continuation, the Great Glen, strikes through the mountainous interior along a series of navigable lochs to reach the Moray Plain at Inverness. This easy route into the fertile and populous north-east coastlands facilitated the spread of Christianity from Iona to the Picts in the 6th century AD (Fisher 2004; Nieke 2004), and the expansion of the Dalriadan Scots into Pictland three centuries later (Nieke 2004). The latter migration triggered the state-formation processes from which the kingdom of Scotland evolved (Foster 1996). In later periods this remote and dangerous back-door into Britain, vulnerable to seaborne penetration by continental enemies, internal malcontents, or both, was feared as much in Edinburgh as it was in London (Lenman 1995a; 1995b).

These same seaways were regarded, by those who lived among them, as arteries of movement and power. No doubt the prehistoric magnates whose strongholds fringe Argyll's convoluted shorelines projected influence and fought battles by sea (Harding 1997: 119 fig 7.1). Dalriadan expansion from Ireland in the 6th century, and the forging of a kingdom in Argyll (*Airer Gáidel*, or 'coastland of the Gaels'), was achieved and sustained by organised naval force (Rodger 1997: 5–6; Rixson 1998: 54–5). From the outset the sea was crucial to Dalriada's development and cultural contacts. Early manuscripts tell of Gaulish merchants visiting the area in the 6th century, and distinctive pottery of this period from east Gaul has been recognised at high-status sites in Argyll and beyond (Cunliffe 2001: 447–81).

Ease of maritime access also drew Christian missionaries and hermits in their skin-covered craft, to proselytise, establish monastic communities, or find solitude on the world's edge (Fisher 2004: 71–9). St Columba came to Iona from Ireland in AD 563 in a currach large enough to carry 13 men. Others included the celebrated navigator St Brendan of Clonfert, who is believed to have founded the early monastic settlement on the Garvellach Islands, with its distinctive beehive cells and adjacent natural harbour (Fisher 2004: 77). Adomnan's *Life of Columba*, written a century after its subject's death, contains much detail about seafaring and sea-craft. Both a skin-boat (*pelliceum tectum navis*) (bk 2 ch 42) and timber-built vessels (*longae naves*) (bk 2 ch 45) are mentioned, the latter being constructed of oak and pine. Oars and sails were used for propulsion (eg bk 1 ch 19, Anderson & Anderson 1961: 45, 169, 175; Martin 2009: 137–42).

In the Norse period more direct evidence of naval activity in the area begins to emerge (Crawford 1987: 11–27). During the 10th and 11th centuries the Atlantic seaboard of Scotland became a distinct political entity, which by the 12th century lay under Norwegian overlordship. By about 1156 the Norse-Gaelic warlord Somerled had won control of Argyll and the southern Hebrides (Woolf 2004: 102–5), and over the following two centuries the Macdonald hegemony became increasingly powerful. The Norwegians relinquished their claim to the remaining islands by the Treaty of Perth in 1266, and the area became a quasi-independent entity loosely bound to the Scottish crown (Barrow 1981: 120; McNeill & MacQueen 1996: 442–5). In 1336 John Macdonald, head of the clan in Islay who exercised *de facto* power over most of the region, boldly adopted the title 'Lord of the Isles' without acknowledgement to any overlord (Oram 2004: 124–8).

Following Norse precedent (Skoglund 2002), power on Scotland's western seaboard was exercised mainly through a combination of secure coastal bases and mobile fleets. The castles allowed chiefs and their retinues to concentrate resources, resist attack, and control the surrounding areas by patronage and military strength. Strongholds were usually located on headlands or close to bays from which they could dominate the labyrinthine passages among the islands and sea-lochs (McNeill & MacQueen 1996: 444) (Illus 5). Their positions were often chosen so as to be visible from one or more of their neighbours, creating networks of surveillance supplemented by lookouts and beacons (Illus 6). By this means movement by sea could be monitored, and hostile or unwelcome activity

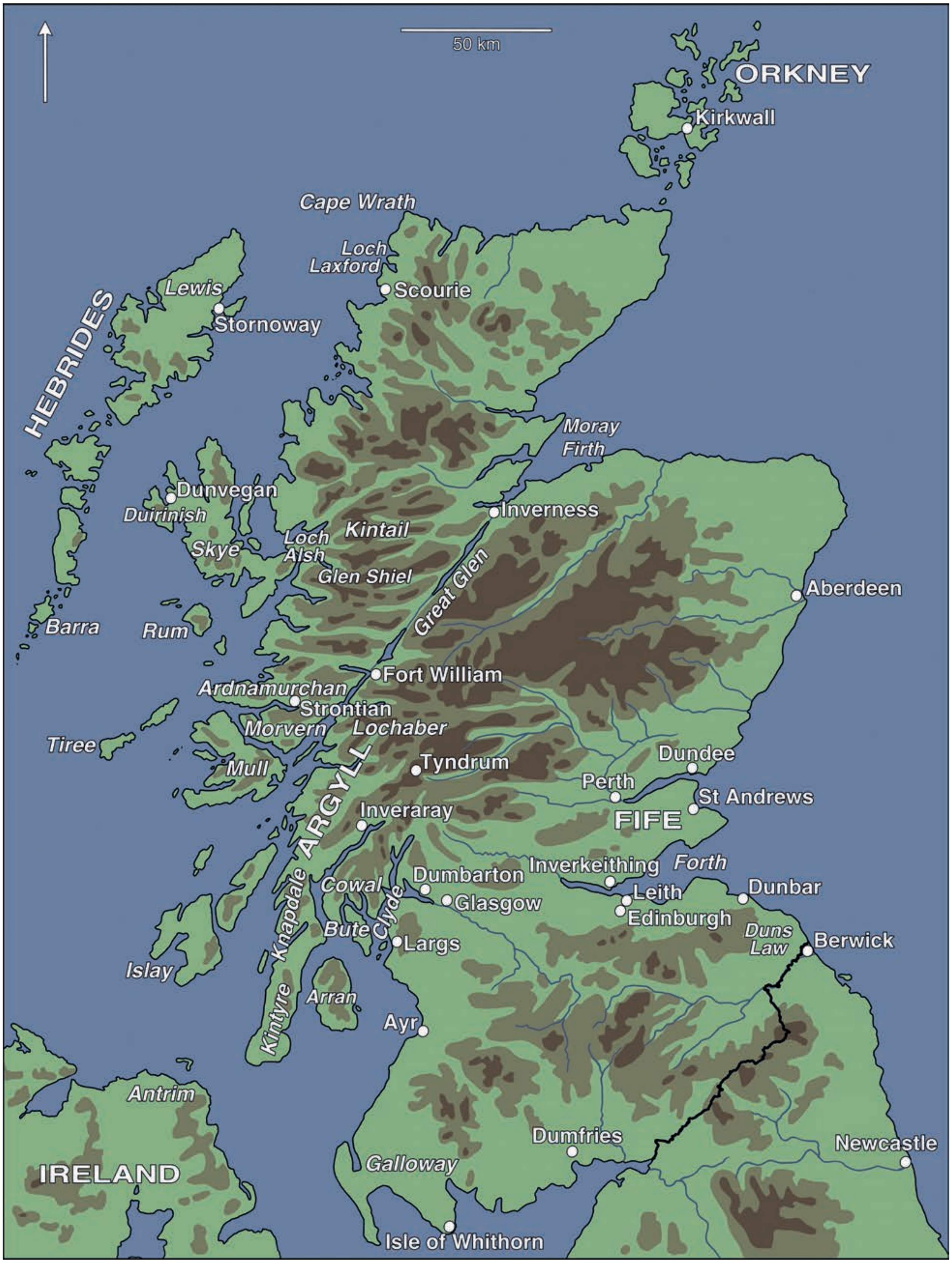


Illustration 2
Scotland showing places mentioned in the text (Edward Martin)

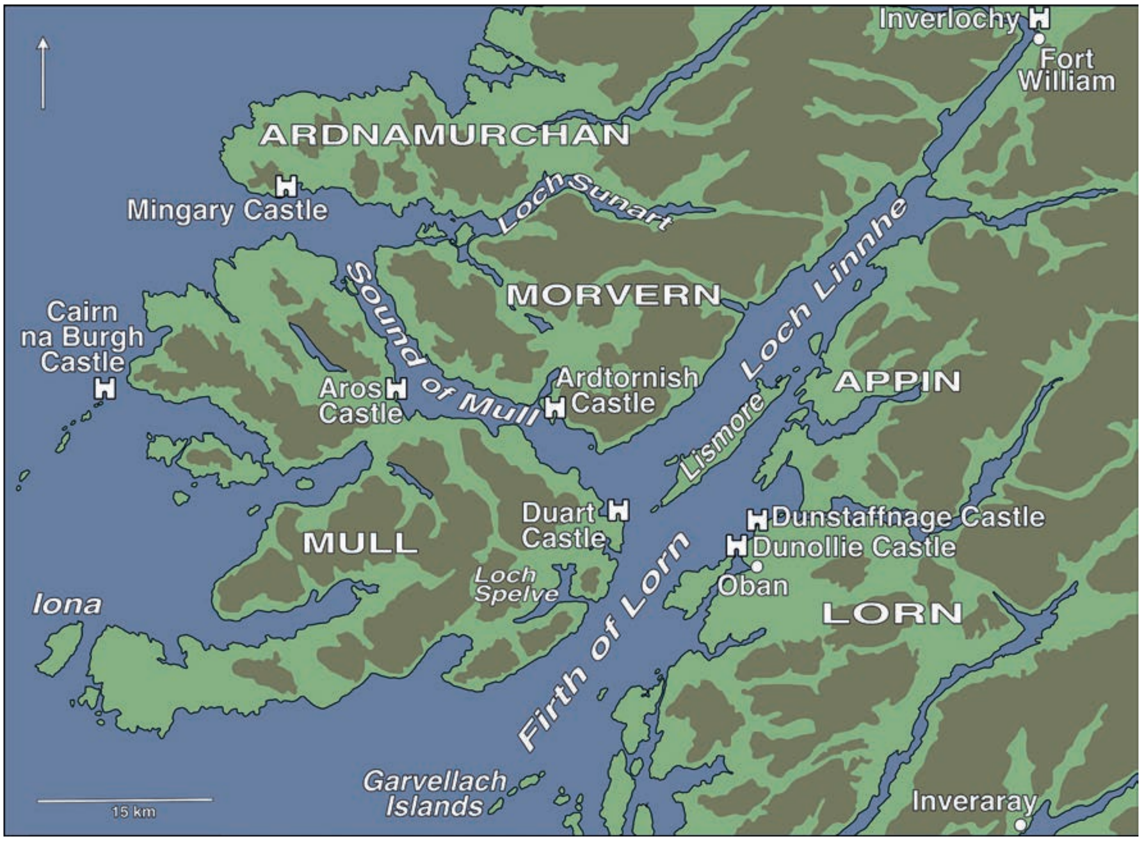


Illustration 3
The Sound of Mull and its environs showing places mentioned in the text (Edward Martin)

Illustration 4
The Sound of Mull, looking north-west towards Ardnamurchan, the Small Isles and Skye. Duart Castle stands on the headland right of centre

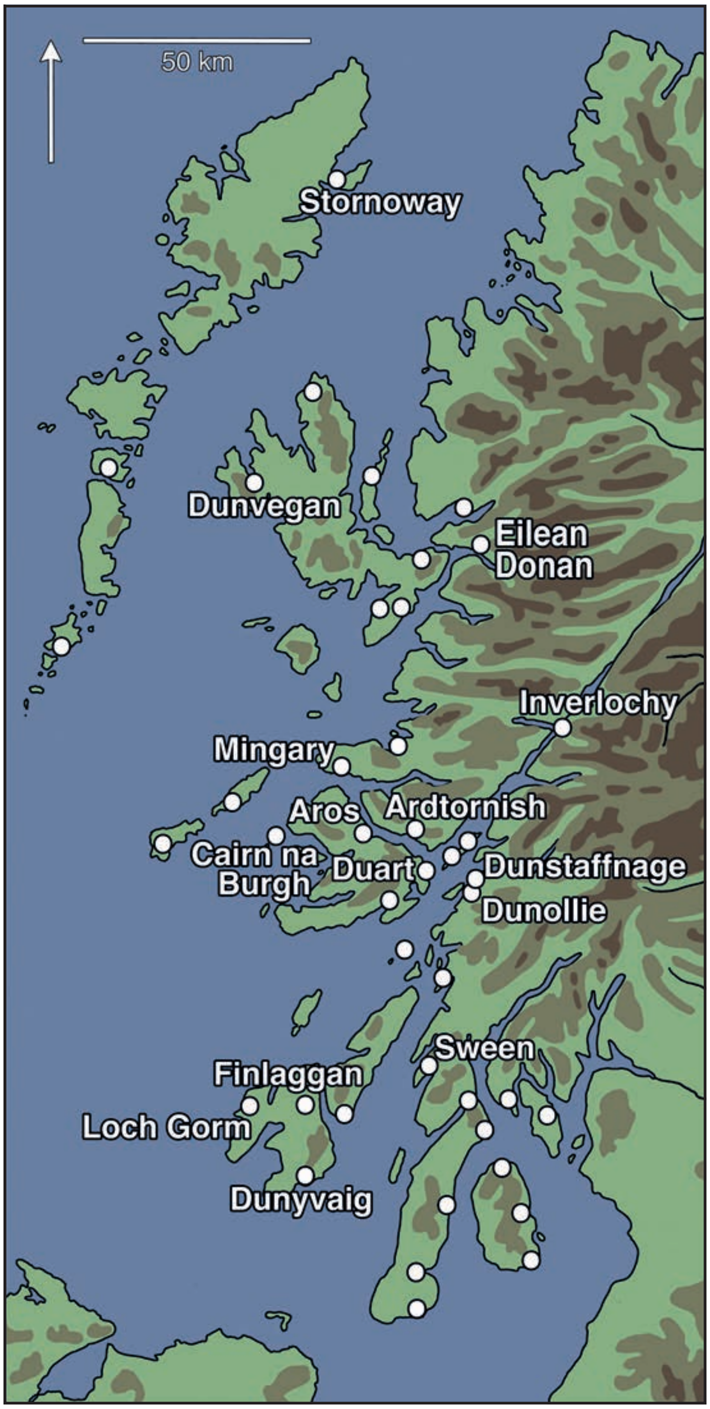


Illustration 5
Castles associated with the Lordship of the Isles. Only those mentioned in the text are named (Edward Martin, after McNeill & MacQueen 1996: 444)

dealt with by galleys operating in concert with the castle networks (Macinnes 1976; Martin 2014: 192–9). This symbiotic relationship between fleets and coastal strongholds is similar, on a microcosmic scale, to the interdependence of galleys and their bases in the power structures of the contemporary Mediterranean (Guilmartin 1974).

The chiefly elites with their retinues of fighting-men, servants, musicians, storytellers and craftsmen moved by sea throughout their often far-flung dominions, enhancing prestige and exercising power by the dispensation of justice, lavish hospitality, gift-exchange, feats of prowess, and marriage settlements. The process depended on 'sorning', the conspicuous consumption of tribute exacted in kind from vassals as the visits progressed (Dodgshon 1998: 9). Extra-territorial seaborne activities included raiding, piracy, the expansion of influence and control, arrangements for marriage, and the prosecution of feuds. There might even have been occasional opportunities for trade (Caldwell 2014: 228–33).

The West Highland galley or *bírlinn* shows a strong Norse ancestry, clinker-built with a high prow and stern, and carrying a single mast with a square sail (Illus 7). Oars provided auxiliary power, and by the 16th century the side-mounted steering-oar had been replaced by a hung rudder (Rixson 1998: 120–1). A magnificent word-picture of handling such a craft is provided by the Gaelic poem *Bírlinn Chlann Raghnaill* (Clanranald's galley) which, although written in the 18th century, is an evocation of the traditional *bírlinn* as a metaphor for Gaeldom's lost maritime-rooted culture (MacAulay 1996: 73–109).

The primary function of such vessels was to carry armed men, who while at sea could work the oars and sails. Galleys operating in concert with shore-based surveillance networks of castles and watch-posts could swiftly concentrate force to counter external threats or, in an offensive capacity, use mobility and surprise to focus violence on a distant enemy's bases or resources. Should things go wrong they might with equal facility flee. Only on rare occasions, as in the internecine clash between the Lord of the Isles and his son at Bloody Bay off Mull (*c* 1481), did fleet encounter fleet in the waterborne equivalent of a medieval land-battle (Macinnes 1976: 542–3). For the most part power was exercised by exploiting small-scale and sharply focused maritime mobility.

The importance of the Sound of Mull in the later Medieval period is emphasised by the role of Ardtornish Castle (a name with Gaelic and Norse components, Nicolaisen 1976: 55–6), which in the 15th century joined Finlaggan on Islay and Aros on Mull as a principal seat of the Macdonald Lords of the Isles (RCAHMS 1980: 173, 177; Caldwell 2014: 227). Here John, the 4th Lord, met Edward IV's commissioners in 1462 to negotiate a secret treaty by which he aligned himself to the English crown in the event of an invasion of Scotland (Gregory 1836: 40). Though never put into effect this was a deeply hostile and treacherous act against the Scottish king, James III, who on learning of it in 1476 stripped John of his titles and properties as the earl of Ross, though for the time being he was allowed to continue holding the Lordship of the Isles (Oram 2004: 136–7). However John's weakness as a military leader and incompetence as a politician brought chronic instability to

Illustration 6
Ardtornish Castle (left foreground) and Duart Castle (centre) showing their intervisibility across the Sound of Mull

the region, and in 1493 James IV passed sentence of forfeiture against him, abolishing the Lordship as a quasi-independent maritime entity (Macdougall 1989: 100–2).

A revolutionary new weapon had given James a practical means of projecting power to the maritime west. Towards the end of the 15th century European monarchs were beginning to acquire ships based on the recently developed three-masted sailing carrack, which had originated as a cargo-vessel in the Mediterranean, and to arm them with increasingly effective guns (Friel 1994: 86–90). This combination allowed latent violence to be carried, irrespective of distance, to any place accessible by sea, and to apply it (or threaten to do so) with precision and effect. Over the coming centuries this formula would allow European maritime nations to create, secure, and exploit empires on a global scale (Cipolla 1965; Glete 2000). James IV was to make an early if abortive contribution to this revolution with the launch of his great warship *Michael* in 1511 (Macdougall 1991).

But in 1493 this lay in the future. The 20-year-old monarch was then still in his minority, having inherited what was in European terms a small, unstable and impoverished kingdom. Even so, he understood the potential of sea-power to exert influence backed by the threat of swift and effective violence in remote and otherwise-inaccessible parts of his realm. In August 1493 James, accompanied by senior magnates, mounted a seaborne expedition to Dunstaffnage on the Firth of Lorn. Though little is known of its outcome, it was a demonstration of how far the king's arm could now reach (Macdougall 1989: 102–3), and naval developments dominated the rest of his reign. Over the winter of 1494–5 royal accounts show the start of a concerted shipbuilding programme, and the following summer James mounted a second expedition to the west, embarking at Dumbarton and proceeding by way of the Clyde to Bute and thence to Kintyre before anchoring off Mingary Castle on Ardnamurchan (Macdougall 1989: 115). What the visit achieved is not known, but the king no doubt used the combination of a show of force, royal hospitality, and the granting of favours to those who expressed loyalty, to reinforce his authority in the area.

A further expedition to the Isles took place in 1504, unaccompanied by the king. This time the application of shipborne mobility and firepower was put to the test. The objective was two remote fortified islands at Cairn na Burgh off Mull, a stronghold occupied by the rebel Donald Dubh, who laid claim to the defunct Lordship of the Isles. Since both gunpowder and shot had to be replenished during the attack it

Illustration 7
A West Highland *bírlinn* or galley with armed warriors. Detail from a late 15th-century grave-slab in the Session House, Kiel Church, Lochaline, Morvern

is clear that shipboard artillery was involved. Cairn na Burgh fell, though whether by surrender or assault is uncertain (Macdougall 1989: 185–6). Two years later a ship called *Raven* was sent to capture Stornoway Castle in Lewis (Gregory 1836: 86–106; Mackie 1958: 76–7).

Attempts to pacify or 'daunt' Scotland's western seaboard were curtailed by James IV's death at Flodden in 1513. They were renewed by his son and successor, James V, who after a difficult minority assumed full power in 1528 and took vigorous steps to assert his authority in the more remote parts of his troubled realm. A royal progress through the lawless Border area during the summer of 1530 culminated in the hanging of a noted cattle-rustler, Johnnie Armstrong, whose crimes were compounded by his presumption in treating the young king (who was 17 at the time) as an equal when they met (Fraser 1989: 236–9). Shortly afterwards a naval expedition against the turbulent and fractious Western Isles was proposed. By early 1531 preparations were under way for a new daunting, when James wrote to his ally the king of France, Francis I, informing him of his intention to blow the Islesmen out of their ships and castles with his 'culverin' (Cameron 1998: 231). It is possible that the 'culverin' is none other than the remarkable bronze gun of heavy-culverin (147mm) calibre, emblazoned with the emblems of Francis I, which now stands outside the present Duke of Argyll's seat at Inverary Castle (Knecht 2008) (Illus 8). Alternatively it could have been brought to Scotland in 1523 by the duke of Albany (*Letters & Papers, Henry VIII* vol 3: 3365, 3368, 3403, 3446, 3451). Although this weapon has often been associated with the Armada ship which sank in Tobermory harbour (Martin 1998: 22), there is no positive evidence to support this, and the strong links which existed between the French and Scottish crowns in the 1520s and 1530s would provide a plausible alternative explanation for the otherwise mysterious presence in Scotland of this magnificent French royal gun.

Whether a naval campaign actually took place in 1531 is unclear, since most of the recalcitrant chiefs submitted during that summer, no doubt encouraged by the fate of Johnnie Armstrong. Royal accounts, however, record a payment in April 1531 'for the Kingis passing in the Ilis', suggesting a maritime visitation of some kind (Cameron 1998: 228–32). In 1536 James left Fife on an abortive journey to France, which was abandoned at the Isle of Whithorn in Galloway after circumnavigating Scotland. Alexander Lindsay's *Rutter of the Scottish Seas*, a compendium of navigational and pilotage information, is thought to have been compiled during this voyage (Taylor 1980).

Illustration 8
Bronze culverin with the initial of Francis I of France, the French fleur-de-lys and a salamander, Francis I's personal badge, now at Inveraray Castle

In 1540 the king took a fleet 'to the north and south isles [of the Hebrides] for the ordouring of thame in justice and gude policy' (Taylor 1980: 13). The main achievement of the campaign was to subdue the Macdonalds of Dunyvaig in Islay, with the installation of royal garrisons in their castles of Dunyvaig and Loch Gorm, and the exercise of control over the extensive Islay lands of the MacIans of Ardnamurchan. Relatively little is known of the maritime aspects of this campaign because of secrecy surrounding its objectives, but three letters from English agents provide details of its preparations. The first two, dated 4 May, report the mustering of 12 ships at Leith (the port of Edinburgh), all well-provided with artillery. Various Scots lords had been ordered to attend the king in person. The third letter, of 29 May, notes that James's fleet was by this time 16 strong, and included '*Salamander* which the French king [Francis I] gave him' (Taylor 1980: 13–15). Passenger vessels were provided for the nobility, together with three victuallers, a hulk for baggage, and a reconnaissance craft. Between 3,000 and 4,000 men were embarked. According to a later chronicler (in 1570) the fleet sailed via Orkney to Skye, Lewis, and 'the rest of the Isles', eventually reaching Dumbarton where the king disembarked. Precisely what this 'daunting' achieved is not known, although there was no further rebellion in the region until 1545 (Cameron 1998: 245–8). By then James had been dead for three years, succeeded by his infant daughter Mary.

In the second part of the 16th century English ships were regularly operating in the area as part of the so-called Ulster Patrol. Their activities focused mainly on intercepting Highland mercenaries ('redshanks') travelling to aid their Gaelic kinsmen in Ireland, a practice which since the 13th century had frustrated English efforts to secure control of the island (Hayes-McCoy 1937). Though sailing warships could rarely out-manoeuvre a galley they could attack the supporting network of castles, or land concentrations of troops without warning. The plantation of disaffected parts of Ireland by English settlers had begun in Tudor times, and in 1597 James VI encouraged 'Adventurers' from Fife to colonise Lewis on a similar basis. Though this attempt failed, the principle was established that title to land could be granted only by the crown and was no longer sustainable by the traditional and undocumented genealogical assertions which had hitherto prevailed. This reinforced royal authority, and (in theory at least) replaced the sword as the arbiter of territorial rights with legal process rooted in the centrally administered laws of the state (Lynch 1992: 241–2). These changes were exploited by some clans, notably the Campbells, to dispossess rivals such as the former Macdonald Lords of the Isles, and the Macleans, of their traditional lands. The Union of the English and Scottish crowns in 1603 drove a further wedge between mainland Britain and the Gaelic west, and by the early 17th century the process of naval outreach to control Argyll and the Isles, begun by James IV more than a century earlier, was vigorously being applied by his great-grandson, James VI and I.

In 1608 Lord Ochiltree embarked on a naval campaign in the West accompanied by Andrew Knox, Bishop of the Isles. Four ships and ten 'barkis' were involved, carrying a total of 900 men. Enticed by the prospect of a sermon by the Bishop, a number of leading chieftains came aboard the flagship off Aros in the Sound of Mull. They were arrested and confined to various prisons, from which they were released the following year only after agreeing to conditions prescribed in a document entitled the 'Band and Statutes of Icomkill [Iona]' (Gregory 1836: 318–24). This required them to accept responsibility for the behaviour of their clans and acknowledge the primacy of the reformed Church. It prohibited the practice of sorning – demanding (under implied threat) lavish hospitality and entertainment while journeying. Restrictions were placed on the consumption of strong drink. The activities of bards, whose heroic poetry was regarded as subversive, were explicitly banned. The use of firearms was forbidden, even for game, while the elder sons of the gentry were to be sent to the Lowlands to learn English. Further conditions were ratified by legislation in 1616, restricting each chief to a single *bírlinn* of 16 or 18 oars – a vessel some 40–50 feet long. Other requirements included a limit on the size of chiefly households (Gregory 1836: 391–6; Rixson 1998: 90–8).

Ochiltree had been ordered to destroy all the chiefs' '*lymphads*, galleys and *bírlinns*', apart from those needed to transport the King's rent to the mainland (Gregory 1836: 319). In the event this draconian stricture, which would have dislocated the region's culture, social cohesion and economy, does not seem to have been enforced. But although traditional galleys continued to be used in the West until the 18th century (the last known example was built in 1706) their offensive capability had become neutralised by the growing presence of armed sailing ships in the area, and as instruments of maritime power they were increasingly obsolete (McWhannell 2002).

The constitutional and religious upheavals of the 17th century led to several naval expeditions to the Sound of Mull. In 1644 Alasdair MacColla brought an army of Irish Macdonalds from Antrim to support the Royalist Marquess of Montrose against the Presbyterian Marquess of Argyll. MacColla's troops landed in Ardnamurchan and captured Mingary castle (Campbell 2002: 213–15; Stevenson 2003: 111–14). The subsequent naval battle with five ships belonging to the Marquess of Argyll probably explains the 17th-century shipwreck recently discovered in this locality (http://portal.historic-scotland.gov.uk/designation/HMPA2). One of Argyll's vessels may have been *Swan*, a ship recorded as being in service with the Campbells under Captain James Brown in late 1644 (Campbell 2002: 217). As argued in Chapter 2, it is probable that this ship is the wreck off Duart Point.

In 1653 a Cromwellian task-force of six substantial vessels supported by several smaller craft put 1,000 troops ashore at

Duart to subdue the fiercely Royalist Macleans, only to be hit by a violent storm which wrecked three of the ships, including the small warship *Swan* (Dow 1979: 78–98). The background to this episode is considered more fully below.

A similar punitive operation was mounted in 1690 on behalf of William and Mary against the deposed James II's supporters by a small flotilla headed by the 5th-rate warship *Dartmouth*. Its commander, Edward Pottinger, had been ordered to 'make a diversion, alarm the rebels' coasts, cut their communications with the Islanders now in rebellion against their Majesties authority, and to take away or burn all their boats and *bírlinns*' (Maclean-Bristol 2012: 163; Martin 1998: 67–83). Central authority was now pursuing a deliberate policy of maritime neutralisation in which the confiscation or destruction of boats, or restrictions on their number and size, were the prime instruments. *Dartmouth* and her consorts engaged in this grim work throughout the summer and autumn of 1690, as well as providing labour and guns for establishing a new artillery stronghold to replace the old Cromwellian fort at Inverlochy. In October the ship, while preparing to attack Duart Castle, was caught in a storm and wrecked on an island close to the south-east end of the Sound of Mull. Her remains were discovered in 1973 and subsequently excavated (Adnams 1974; Martin 1978).

Despite these precautions, fear of invasion from the Continent remained strong, and in 1719 a small force of Spanish troops landed at Loch Alsh in support of a planned Jacobite insurrection. Happily for the Hanoverian government the operation quickly descended into farce. A task-force comprising 29 ships and 5,000 soldiers had mustered at Cadiz, with arms for the 30,000 supporters expected to rise in Britain. But bad weather dispersed the fleet before it reached Corunna and in the event only two frigates, intended to tie down troops in Scotland as a diversion from the main invasion effort further south, landed soldiers on the British mainland. There were only 300 of them. Along with a similar number of Jacobite supporters they struck eastwards into Glen Shiel, but had gone barely five miles before they were intercepted by a well-equipped and better-trained government force of similar size. The Jacobite positions were bombarded with mortar-fire before the Hanoverian infantry moved in for the assault. Most of the Jacobite clansmen, familiar with the terrain, vanished into the hills, but the entire Spanish force was captured (Lenman 1995b: 191–4).

The last application of naval force in the west of Scotland was directed against the Morvern peninsula, on the north-east side of the Sound of Mull, in March 1746 by the sloops *Terror* and *Princess Ann*, during the final phase of suppressing the rebellion in support of Charles Edward Stewart. Morvern, though by this time mainly owned by the pro-Hanoverian Duke of Argyll, had come out almost to a man in the Young Pretender's cause, and the navy had been ordered to destroy every boat in Morvern and Loch Sunart (Gaskell 1996: 3–4).

Illustration 9
Bar-shot appropriate to the calibre of an 18th-century 4-pounder gun, found at Fiunary in Morvern. Scale 10 centimetres

This ruthless punitive action effectively wiped out the area's boatbuilding traditions and seafaring skills, and it has not yet fully recovered from the concomitant destruction of its woodlands (Fergusson 1951: 117–26; Macleod 2002: xii). A 3¼in (83mm) bar-shot recently found at Fiunary, appropriate for the calibre of one of the sloops' 4-pounders, may be a relic of this brief campaign (John Hodgson pers comm) (Illus 9). Thereafter history enters a period of economic and social change beyond the scope of this monograph.

1.2 The Cromwellian expedition, 1653

Scotland's situation at the close of the Civil War was complex and confused (Dow 1979: 2–12; Furgol 2002). Following the execution of Charles I in 1649 and the establishment of republican government in England, Oliver Cromwell had embarked on a ruthless subjugation of Ireland (Ohlmeyer 2002). He then turned his attention to Scotland (Grainger 1997). Although most Scots had sided with Parliament during the conflicts of the 1640s, their concern had been more to uphold the Presbyterian religion than to bring down the Stewart monarchy, and they had been outraged by republican England's unilateral execution of their king. In June 1650 the exiled Charles II, after signing a Covenant which repudiated his father's policies against Presbyterianism, landed in Scotland. Cromwell responded by marching north with elements of his New Model Army, which on 4 September 1650 inflicted a crushing defeat on a larger force of Scottish Presbyterians and Royalists under General David Leslie at Dunbar (Illus 10). Notwithstanding this reverse, Charles II was crowned King of Scots at Scone, near Perth, on 1 January 1651. Cromwell's response was delayed by illness, but in July an army commanded by General John Lambert crossed the Forth and on 20 July annihilated a Royalist force, composed mainly of Highlanders, at Inverkeithing (Grainger 1997: 104–11). The English army then marched through Fife and captured Perth.

In a desperate counter-measure Charles led his depleted army into England where, on 3 September, he was decisively defeated at Worcester. After narrowly avoiding capture he fled back into exile on the Continent. Scotland was now firmly under English military control, and major strongholds were

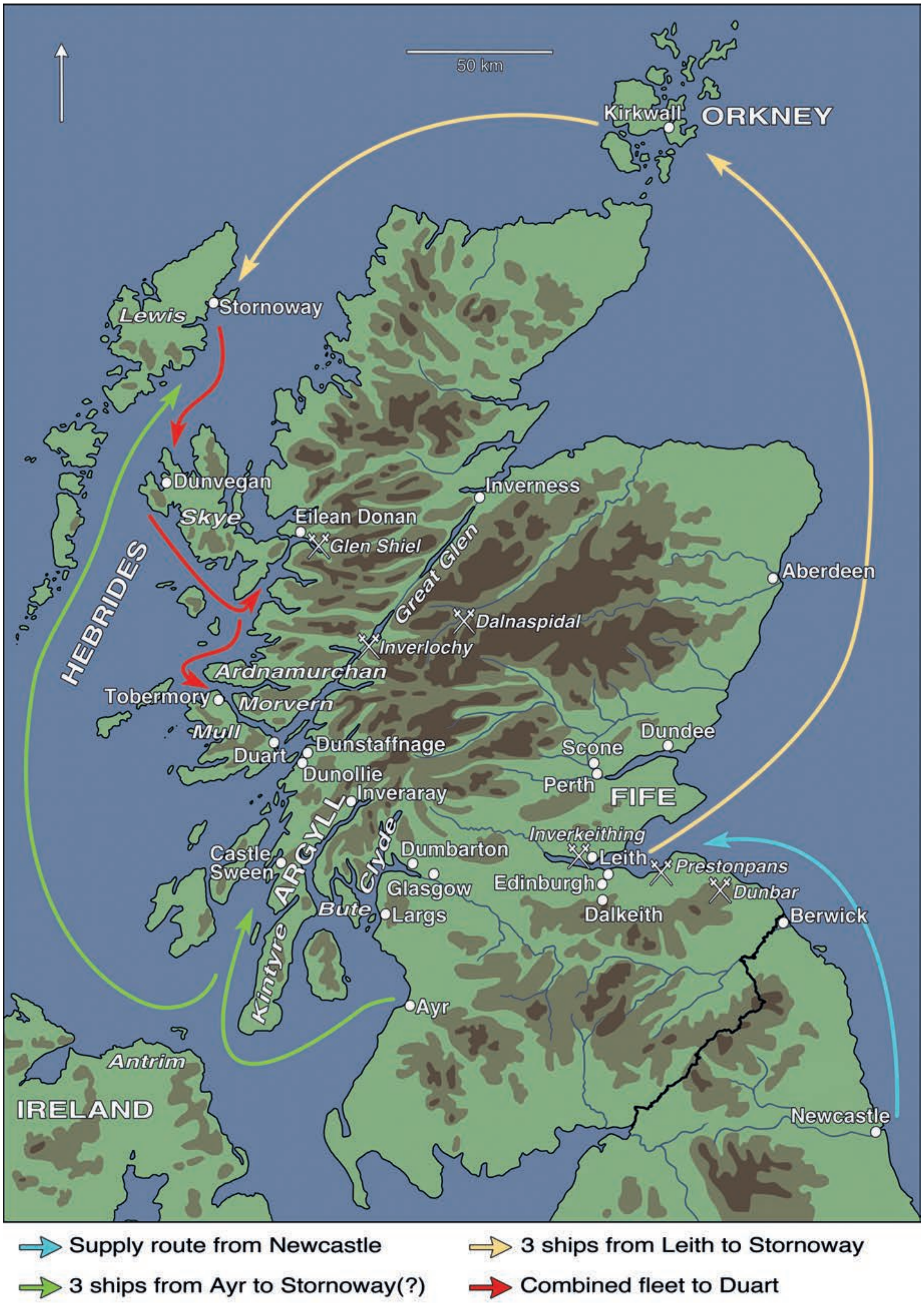


Illustration 10

Cromwellian Scotland, 1650–54. The coloured arrows indicate the progress of Colonel Cobbett's campaign, July to September 1653 (Edward Martin) established at Ayr, Perth, and Leith, with 20 smaller garrisons gripping the rest of the country.

Despite the Cromwellian military occupation Royalist revolt continued to smoulder, especially in the Western Highlands and Islands. But opposition to English-imposed republican rule was fragmented and riven with dissent. On the one hand the Covenanters resisted the new order forced on them by Cromwell and his generals, and supported the compliant young King of Scots, Charles II. On the other stood the hard-line Royalists, whose purpose was to restore an unreconstituted Stewart monarchy. Most were Highland noblemen and clan chiefs, but their leaders were Lowlanders. The situation was complicated by general lawlessness and feuding, particularly in the Highlands. The revolt was not therefore a cohesive movement, but rather a series of dislocated and sometimes conflicting manoeuvres through which the various protagonists vied to secure political and personal advantage, often without regard to a common cause. In such a climate of mistrust and confusion survival demanded cunning and flexibility, and loyalties were adaptable. As is often the case in civil conflict, many of those caught up in it took steps to hedge their bets (Dow 1979: 78–114).

For the most part the rebels avoided direct contact with Cromwell's troops, preferring to box them up in their bases through low-intensity guerrilla activity in the surrounding countryside. This allowed them, in some areas more than in others, to divert by persuasion or coercion the monthly cess (assessment tax) levied by the Cromwellian authorities to defray the massive costs of occupation.

An external factor was the threat of invasion. The western coast and islands of Scotland had long been vulnerable to hostile incursions from the Atlantic seaboard of mainland Europe. As the early 17th-century naval strategist Sir William Monson put it, 'one wind will carry them from their harbours, till they arrive in that part of Scotland' (Monson 1903: 322). This threat was exacerbated by the perceived character of the inhabitants, whose 'brutishness and incivility', according to Monson, 'exceeds the savages of America' (Monson 1903: 58). Worse, the Dutch already had a strong presence in the area through their extensive herring fisheries and the locals, thought Monson, would 'easily rebel by the insinuating practices and instigation of the Hollanders' (1914: 320). Another worry was the increasing practice of European shipping from ports east of the Channel, bound for the Atlantic and beyond, to take the 'north-about' route around Britain. This avoided contrary winds and interference by potentially hostile foreign navies, but it compromised England's ability to control shipping in the area and reinforced the need for a naval presence off western Scotland. Monson considered that three warships would suffice, supported by a fleet of Newcastle colliers whose small crews and capacious holds made them ideal troop transports. Ten or 12 such vessels of between 200 and 300 tons, Monson calculated, could carry a regiment of up to 1,500 men. From a base at the fortified river-mouth harbour at Dumbarton, near the head of the Clyde Estuary, sea-transport would act as a force-multiplier to enable the garrison to deploy swiftly to keep 'all the northern parts of Scotland in awe' (1902: 2, 313–19).

Monson's assessment of naval realities on the western seaboard, made *c* 1640, certainly held true in the early 1650s. War had broken out between England and the Dutch Republic following the anti-Dutch Navigation Act of 1651, and in November 1652 the Dutch Admiral Tromp defeated an English fleet under Blake off Dungeness (Capp 1989: 79–81).

England's fragile Commonwealth was threatened on land as well as at sea. By 1653 the Royalist revolt in Scotland was gaining momentum. From his court-in-exile at St Germain, near Paris, Charles II and the officer appointed to command his forces in Scotland, Lieutenant-General John Middleton, had been planning their return. But the king was not prepared to land until the revolt was well advanced, and its success assured. Middleton, moreover, was ill, so a Lowland lord, the Earl of Glencairn, was appointed acting commander in his place. As a preliminary to more active revolt, several clan chiefs were persuaded to declare for the king, including the Earl of Seaforth, chief of the Mackenzies, whose territories extended from the Isle of Lewis to Kintail on the mainland. Their main stronghold at Eilean Donan, an island castle at the head of Loch Alsh, commanded the route into the Great Glen via Glen Shiel and Glen Morriston. Another Royalist magnate was Macdonell of Glengarry, whose territories also controlled access to the Highland interior.

The Macleans of Duart, most of whose fighting men, including their chief, Sir Hector, had been slaughtered at Inverkeithing, also promised support, though their kinsmen, the Macleans of Lochbuie, refused to come out. The new Duart chief, Hector's young brother Sir Allan, was only six, but his uncle and tutor (guardian), Daniel Maclean of Brolas, declared for the king on his behalf. This may in part have been to thwart plans by their hereditary enemies, the Campbells of south Argyll, to acquire the Maclean lands by guile, force, and legal process. The Campbell chief, Archibald Marquess of Argyll (Illus 11), had not participated in the revolt, though his Royalist son, Lord Lorne, had joined Glencairn, no doubt to hedge the family's bets. In the event Glencairn's insurrection petered out, and its remnants were finally routed at the battle of Dalnaspidal on 19 July 1654 (Dow 1979: 129–30).

Argyll was a leading Covenanter, and had opposed Charles I's attempts at religious reform in Scotland during the 1630s (Willcock 1903; Macinnes 2011). In the Civil War he fought against the Royalists, though on occasion he participated in negotiations with the king, which at one stage came close to securing an accommodation. After Charles's execution Argyll distanced himself from the English Parliamentarians, and officiated at Charles II's Scottish coronation at Scone (Illus 11–12). Though technically now returned to the Royalist fold

This image has been removed
for the online edition.
Click here to view the image online.

Illustration 11
Portrait by David Scougall of Archibald Campbell, 1st Marquess of Argyll (1598–1661) (© National Galleries Scotland, PG 1408)

(albeit with strong personal reservations and unquenched Covenanting resolve), he submitted to Cromwell's forces after being besieged in his castle at Inveraray in 1652. Thereafter he sided with the English invaders, an error of judgement for which, following the Restoration in 1660, he was to lose his head.

In May 1653 the Royalist Earl of Seaforth captured some English soldiers who had landed in Lewis from the private warship *Fortune*, which had come from Ayr to gather information about the situation in the Outer Isles. He demanded that the vessel be pressed into the king's service (Firth 1895: 140). When news of this overtly hostile act reached Colonel Robert Lilburne, commander of the English forces in Scotland, at his headquarters in Dalkeith, he wrote to Cromwell that Seaforth's 'estate might be sequestered, and that Island [Lewis] … might be secured for the State's service' (Firth 1895: 148–50).

This was the trigger for the 1653 campaign. The logistics for mounting such an expedition were complex and time-consuming, especially as Lilburne's finances, munitions, and provisions were almost exhausted. But the operation was pushed forward with urgency and vigour. The officer chosen to command it was Colonel Ralph Cobbett, a hard-line New Model Army veteran who in 1648 had commanded the detachment which removed Charles I from Carisbrooke Castle on the Isle of Wight to Hurst Castle, pending arrangements for his trial. He was subsequently one of the four officers who guarded the king at Windsor (Firth & Davies 1940: 340). In 1651 a regiment bearing his name and under his command was raised for service in Scotland. It comprised five companies each of 200 men. While it was preparing to embark, news came of Charles II's march into England following the Royalist defeat at Inverkeithing, and the regiment was diverted to join the intercepting force which defeated the king at Worcester. Part of Cobbett's regiment eventually arrived at Dundee in mid-October 1651, the remainder following in January 1652. There Cobbett succeeded General George Monck, who had captured and sacked Dundee the previous September, as the city's military governor (Firth & Davies 1940: 476–7).

In June 1653 Colonel Cobbett received orders from Colonel Lilburne to prepare an expedition against the rebels in the west, and by 6 July 'several ships … [were] ready to weigh anchor out of Leith road, with several of our foot forces, commanded by Colonel Cobbet, and provisions of victual and other necessaries' (*Diurnal of Occurrences in Scotland*: 114–50). By this time reports were circulating of Dutch and Irish vessels among the Isles, and the landing of arms. Cobbett's orders were

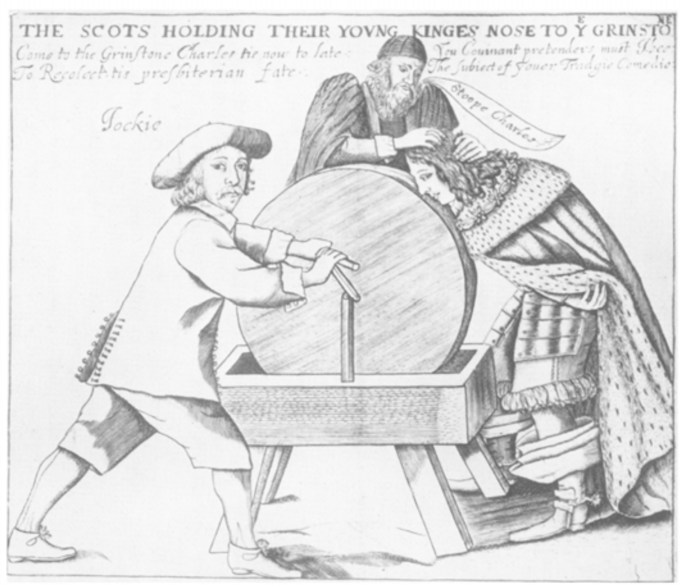


Illustration 12
An illustration from a satirical broadsheet published in London in 1651 showing Charles II having his nose held to the grindstone by a figure representing the Covenanting Presbyterian Scots, one of whose leaders was Archibald Campbell, 1st Marquess of Argyll (Wikimedia Commons)

first to convey reinforcements to Orkney, where a fort was to be established. Then he was to invade Lewis and eject Seaforth from his power-base there. The island had been bought by the Mackenzies of Kintail on the adjacent mainland, who took the title Seaforth from the long sea-loch which penetrates Lewis's interior. In 1651 Connaich Mor (Big Kenneth) became the 3rd earl and clan chief. He was only 16, and a student at Aberdeen University, but he rallied to the Royalist cause and joined the king at Stirling for the ill-fated march to Worcester. He remained fervently loyal to Charles during the king's exile on the Continent, serving as a teenaged Secretary of State for Scotland (in waiting). But Seaforth's estates were sequestrated by the Cromwellian authorities in 1654 and two years later he was imprisoned until the Restoration in 1660.

The task-force was next to subdue Eilean Donan, another Mackenzie stronghold on the mainland at Lochalsh, leaving a company to secure the district. Finally the fleet was to land troops and artillery on Mull, after making contact with the governor of Dunollie Castle, which along with the adjacent Dunstaffnage Castle was in English hands. Cobbett's men were to land at Duart, take the castle by siege if necessary, and place a garrison there. These actions were intended to secure the Western Isles and nip Glencairn's revolt in the bud. Cobbett's final task was to return to Stornoway and investigate the practicality of building a fort (Firth 1895: 148–50).

Two merchant vessels were obtained at Leith for the expedition. They were *Martha and Margaret* of Ipswich and *Speedwell* of [Kings] Lynn. *Martha and Margaret* had been hired in May 1653 to carry biscuit and other provisions from England, and on 24 June she was again on her way to Scotland, presumably with supplies for Cobbett's fleet (*CSPD* 1652–3: 585, 614). On 8 July the Leith commissioners paid £40 to William Goodlade, 'master of *Martha and Margaret*', to join the expedition, and on 13 July he was ordered to take on board a contingent of artillerymen before setting out for Orkney and then Lewis (Clarke MS 3/8, unfol., 8 July, 13 July 1653). The hire-charge for the ship was £298, and £200 was later assessed as compensation for her loss. At Lewis *Martha and Margaret* took on board two 24-pounder siege-guns and a mortar which had been brought from Leith by *James* (Clarke MS 3/8, unfol; 20 September 1653). *Speedwell*, or *Anne Speedwell* as she was officially called, was hired from 11 July for the expedition and £203 was subsequently paid to her four owners for her loss (Clarke MS 3/8, unfol; 30 Sept 1653).

It is not clear whether Cobbett called at Orkney as planned, but towards the end of August his fleet arrived at Lewis. The Mackenzie defenders of Stornoway and its castle, commanded by Seaforth's illegitimate brother, fled without resistance and most abandoned their arms. Two large guns and four smaller pieces were captured with the castle (*Thurloe State Papers* vi: 284). A small contingent was left to garrison it. The siege-guns and mortar were transferred from *James* to *Martha and Margaret*, and *James* returned to Leith.

On 27 August the fleet sailed for Skye. Dunvegan Castle was seized and occupied, and the Macleod chief and his kinsmen bound themselves not to act against the Commonwealth. While on Skye Cobbett's men plundered the minister of Duirinish, Martin Macpherson, of 'goods, gear, sheep and nolt [cattle]' (Grant 1959: 300), this action doubtless being the expedition's normal means of replenishing supplies (see discussion in Chapter 6). 'Besides the spoil the English soldiers shall make in the country, that they be careful to destroy their corn as the next way utterly to ruin them. For, besides that they will take away their bread, they will utterly destroy their straw which is the food of their cattle and horses; for hay they have none' (Monson 1903: 317). At some point during the voyage, or perhaps before they left Stornoway, they were joined by three vessels which had left Ayr on Lilburne's orders on or around 20 July. These were led by the frigate *Wren* under Captain Robert Drew with a company of Colonel Alured's regiment aboard, a collier, and a small warship called *Swan*, commanded by Captain Edward Tarleton (Firth 1895: 221).

The possibility that *Swan* had once been a private warship belonging to the Marquess of Argyll is explored in Chapter 2.2. She first appears in official records on 6 June 1653 when 'Captain John [*sic*] Tarleton' was commissioned to command an un-named frigate 'to carry letters between Ayr and Ireland' (Clarke MS 3/8, unfol., 6 June 1653). On 10 June Colonel Alured, the governor of Ayr, sent *Swan* – 'appointed for holding intelligence between Ireland and Ayr' – to Liverpool (*CSPD* 1652–3: 600), and on 21 June the provisioner at Liverpool sent a request to the admiralty commissioners that she should be refitted 'with provision, sails, waist-cloths and colours, tallow and oars'. He noted that the vessel was 'the state's own, being bought by … Colonel Alured', and personally recommended her captain Edward Tarleton, whom he had known 'for some years past', 'and could heartily wish the Commonwealth were supplied with many more of his principles and qualities' (TNA SP18/55/21 ff36r, 38r, Samuel Windis to the navy commissioners 21 June 1653). Tarleton was clearly one of the new breed of officers whose appointments were based on experience and competence rather than privileged birth (Firth 1926; Kennedy 1960). In September 1653 a list of naval ships included the '*Swan* in Scotland, brought for the state by G D [probably the former commander-in-chief, General Deane]'. She was described as a frigate of five guns with a crew of 30 (TNA SP18/58, f63). The refit was authorised on 24 June (*CSPD* 1652–3: 614), and orders to carry it out were issued on 27 June (TNA ADM18/10, unpaginated). Thereafter she returned to Ayr.

The three ships allocated at Ayr to the Cobbett expedition had been ordered to call first at Dunstaffnage to deliver coal and other supplies before returning to Knapdale where 'certain great guns lie … between Sween Castle and Ross'. These were to be brought back to Dunstaffnage in readiness for Cobbett's invasion of Mull. If Cobbett was not in the area the Ayr ships were to sail 'towards the Lewis or Kintail' in the expectation of meeting him there. In the event the rendezvous was successfully accomplished (Firth 1895: 188–9; also *Thurloe State Papers* i: 478).

On 5 September the combined fleet anchored off Duart and landed eight companies of troops in the bay (Illus 13). They found the castle empty, the chief's tutor Daniel Maclean having prudently decamped to Tiree, presumably taking his young charge with him. Glencairn himself went into hiding on Mull. The primary objective of the expedition was thus achieved without a shot being fired.

Also present on the island was the politically flexible Marquess of Argyll, who offered his services to the invaders (*Mercurius Politicus* no 173: 2767), and guaranteed that the cess tax on Mull would henceforward be paid not to the rebels but to Cromwell's authorities. Argyll was a complex character whose shifting loyalties exemplify the fragile politics of the time (Willcock 1903). As a prominent Covenanter he had opposed Charles I's attempts at religious reform in Scotland during the 1630s which led to the so-called 'Bishops' Wars' in 1639 and 1640. The king's attempt to invade Scotland was thwarted by a Covenanting army on Duns Law near Berwick, later joined by Argyll and 1,000 Campbell Highlanders ('supple fellows with their plaids, targes, and dorlachs [blanket-cloaks, round shields and arrow quivers]' (Willcock 1903: 77). An accommodation was reached with the king under which both armies disbanded, and Argyll demonstrated his loyalty to the Crown by kissing Charles's hand. In 1641, despite the king's extreme dislike and mistrust of him, he was created a marquess.

During the Civil Wars which followed, however, Argyll supported the Covenanters, who opposed Charles I's religious policies in Scotland. In 1644 he intercepted an incursion from Ireland of Royalist troops under Alasdair MacColla, which led to the loss of one of the invaders' ships off Mingary Castle in Ardnamurchan (Stevenson 2003: 139–41). MacColla joined the Marquess of Montrose in a brilliant and ruthless campaign which included, in 1645, the battle of Inverlochy at which a Covenanting army was routed. Argyll's Campbell troops were

Illustration 13
Duart Castle on its headland commanding the east end of the Sound of Mull. Cobbett's fleet anchored in the bay beyond. The complex currents around and beyond the Point are evident (DP 173105)

virtually annihilated by the Royalists although the marquess himself was not present at the battle, having been injured in a riding accident. Instead he watched the rout from his ship anchored offshore, in which he was then able to make his escape. It is not inconceivable that the ship, described as his 'barge', was the small warship *Swan*. If so, eight years later, in September 1653, he may have witnessed the demise of the same vessel off Duart Point.

After Cobbett's ships had anchored in Duart Bay, most of the men came ashore and began the task of converting the medieval castle of Duart into a government stronghold. But eight days later disaster struck, as Lilburne reported to in a letter to Cromwell from Dalkeith on 22 September:

> There happened the 23rd [*sic*] instant a very violent storm upon these coasts, which continued 16 or 18 hours, in which we lost the *Martha and Margaret* of Ipswich, a large ship, which carried all our remaining stores of ammunition and provision, only the great guns and mortar piece were saved. We lost a small man of war called the *Swan*, Capt. Tarleton commander, with two small ones and most of our boats. But that which was most sad was the loss of the *Speedwell* of Lynn, which having 23 seamen and soldiers in her, they were all (except one man) cast away (*Mercurius Politicus* no 173: 2768; *Diurnal of Occurrences in Scotland*: 129).
>
> The rest of the Men of War and others of the fleet were forced to cut their masts by the board, and yet hardly escaped: we lost also two of our shallops; and all this in the sight of our men at land, who saw their friends drowning, and heard them crying for help, but could not save them (Firth 1895: 399–400).

Another report of the incident was recorded by the governor of Dunstaffnage, Captain James Mutloe on 17 September,

> Colonel Cobbett has placed a garrison in Duart Castle in the isle of Mull and taking an engagement of all the chief of the clan, only the Tutor who refused to come in. Glencairn is still in the isle. The 13th of this month a great storm arose, in which storm the ships with Colonel Cobbett suffered very much. The small frigate that came with Captain Drew from Ayr was carried away but saved all his men. The commander's name was Tarleton, a very pretty man for his place. We lost a merchant man with 8 guns. [Our] vessel struck upon a rock and sunk [he/who] saved but one man. There were drowned in all 20 or 22 persons. Also the great [coal] ship was cast away, the 2 shallops and most of the boats that belonged to the fleet. 2 of the men of war were fain to cut down their masts to save the ships. I never saw such a storm in all my life. The marquess of Argyle came over to us and has taken a [great deal] of pains with the people of that isle to settle them. The late Tutor is dismissed of his tutorship and Glencairn knows not what to do (transcribed from William Clarke's shorthand notes, Worcester College msxxv f129r, by Dr Frances Henderson, Worcester College, Oxford, August 2005, words in square brackets are unclear in the original).

1.3 After the wreck

Cobbett and his men were transported by boat to Dunstaffnage on the adjacent mainland, from where they made their way overland through difficult and largely Royalist-held terrain to the government stronghold at Dumbarton, assisted by Argyll (*Mercurius Politicus* no 173: 2768; Firth 1895: 174–5). Meanwhile the three surviving ships, which had cut away their masts to save themselves during the storm, were sent to London for repair, with the request that they be returned to their station off northern and western Scotland, or replacements sent, since further rebel activity or a Dutch invasion was still feared (Firth 1895: 238–9). Ralph Cobbett returned with his regiment to Dundee, and subsequently participated in the final suppression of Glencairn's revolt in 1654 (Firth 1895: 472). In 1659 the regiment moved to Glasgow, and during the breach between the army and Parliament later that year most of its officers were dismissed, including Cobbett, who had been one of the nine dissenting colonels whose commissions were declared void on 12 October 1659. When he went to Berwick to negotiate with the pro-Parliament General Monck, Cobbett was arrested and confined for a time in Edinburgh Castle. On his release he was banned from London, and following involvement in an abortive coup he was arrested at Daventry on 22 April 1660 and committed to the Tower. A month later Charles II was restored to the throne, and Cobbett, who had been implicated in the imprisonment and guarding of Charles I before his trial and execution, was a marked man. In 1661 he was transported to a prison overseas, and his subsequent fate is unknown (Firth 1895: 476–7).

Edward Tarleton, *Swan*'s captain (Illus 14), was born into a family of minor gentry on the outskirts of Liverpool. They had owned land at Fazackerly since at least the 14th century, and acquired more at Aigburth in the 16th century. Tarleton was a remarkable man who lived in remarkable times, and his descendants recorded accounts of his exploits which are preserved in the Tarleton family papers, compiled *c* 1770 or earlier (f1, no 9, copy held in the Liverpool Record Office). Unless other documents are cited this is the source of what follows.

Tarleton was the founder of a Liverpool merchant dynasty, and his descendants regarded him as a model of courage, stoicism, and good humour. In the early 16th century the family had been split by religious dissention. During the first quarter of the 17th century William Tarleton of Fazackerley, head of the senior branch, adhered to the Church of England while his younger brother, Edward of Aigburth, was a Roman Catholic. Edward disinherited his second son, John, who had angered him by reverting to the English church. By 1630 John's wife and two of his three children were dead and, with his surviving son, Edward, the ruined but resourceful John went to Ireland where he obtained an estate at Green Hills just

Illustration 14
Portrait of Edward Tarleton (*c* 1628–1690), captain of *Swan* in 1653
(reproduced by kind permission of Captain Christopher Tarleton Fagan)

to the west of Drogheda and close to the town's seaport on the River Boyne.

Drogheda lay within the Pale, the area around Dublin under the direct control of the English Crown. John Tarleton doubtless obtained his estate as part of the process by which English or Scots settlers were 'planted' to suppress Catholic-inspired revolt. Such a revolt erupted in October 1641 and in December Drogheda was besieged by an Irish rebel force under Phelim O'Neill. Although the town held out the rebels ravaged the surrounding countryside and, despite his Catholic wife's entreaties, among those killed was John Tarleton. His son Edward, however, then aged 13 or 14, managed to escape to safety aboard the ship *Tulip*, captained by a friend of his father. We may presume that this is where Edward in the following years served his apprenticeship as a seaman.

Some time later (according to family tradition) *Tulip* fought an action with a Spanish man-of-war. The young Tarleton was by this time second-in-command and when, during the fighting, his captain was killed, and the crew faltered, he pulled out his pistol and rallied the men, threatening to shoot the first who 'showed the least pusilanimity'. Victory over the Spaniard followed. Edward later commissioned a portrait of himself holding the pistol he had used (Illus 14). The engagement must have occurred in the mid 1640s, when England was not at war with Spain, but the apparent contradiction can be resolved by noting that the 80-year war between Spain and the Dutch Republic was close to its end. Final hostilities were mainly conducted at sea, and England was an ally of the Netherlands. *Tulip* might therefore have been an English privateer operating under a Dutch commission.

By 1646 Edward Tarleton had become captain of *Tulip* (presumably in the aftermath of the pistol incident), and about this time he married his first wife. In 1651 the couple and their growing family moved to Liverpool. In a petition of 1655 he stated that he had served at sea during the civil wars, though not as a captain. Before taking command of *Swan* in 1653 he had been involved in various trading voyages, vessels in which he served having been captured by Scottish Royalists and the French (*CSPD* 1652–3: 493). On 20 February 1653 a commission appointing Tarleton commander of *Tulip* was signed by George Monck and John Dissbrowne (private collection). His Liverpool connections and Parliamentary sympathies doubtless secured for him the command of *Swan* when she was refitting there in June 1653 (*CSPD* 1652–3: 610).

On 24 September 1653, less than two weeks after *Swan* had been wrecked, Tarleton petitioned the Admiralty Commissioners for the command of *Merlin* or some other frigate. Because of the shipwreck he had 'lost a considerable value, which … has weakened his estate and causes the distress of his wife and family to be augmented'. He wished to 'be in employment so soon as he can that he may do the state some service and to endeavour to replenish his family' (TNA SP18/58/92 f153r). Though his application was supported by Colonel Lilburne, Cromwell's commander-in-chief in Scotland, he did not get command of *Merlin*, but on 22 November was recommended for another command (*CSPD* 1653–4: 522). This was *Islip*, probably similar to *Dartmouth*, another 32-gun frigate built during the Cromwellian period (in 1655) and coincidentally wrecked only 6km from Duart in 1690.

Islip had been built at Bristol, and Tarleton was there supervising her fitting-out on 8 April 1654, when he asserted that no ship was better built. He recommended that she should carry 32 guns, four more than originally specified. Two days later he complained that the ship had been victualled for only 90 men, though she needed provisions for 100 plus a carpenter (*CSPD* 1653–4: 473–4). Throughout May *Islip* continued fitting out, and on the 14th it was considered that she would be operational by the end of the month (*CSPD* 1653–4: 489). In July she was in north-western waters, delivering money and provisions to the newly established fort at Inverlochy (later renamed Fort William). On orders from the garrison's commander, she then conveyed a commissary officer to north Wales, reaching Beaumaris by 27 July after a five-day voyage. For the next five weeks she patrolled the north Irish Sea and Western Isles (*CSPD* 1653–4: 261, 270).

Islip was not a happy ship. On 28 September 1654 senior members of her crew, including the carpenter, gunner, boatswain, quartermaster, cook and surgeon's mate, signed a petition to the Admiralty Commissioners accusing Tarleton of favouring drunkards and swearers, and of attempting to subvert the authority of the ship's master, so as to put a crony in his place (*CSPD* 1654: 557). Later Tarleton sacked the ship's surgeon for near-mutiny (*CSPD* 1655: 433). In late summer 1654 *Islip* was again at Inverlochy, presumably delivering supplies, and on 20 October she was re-victualling at Liverpool. The commissariat was apparently not up to scratch, and although he received 14 days' provisions from the victualler, Tarleton had to disburse his own money and give his men credit-notes to buy clothes (*CSPD* 1654: 563). The ship's next mission, to convey a senior legal officer to Dublin, was accomplished by 6 November (*CSPD* 1654: 568). In the same letter Tarleton mentions further difficulties with his crew, accusing the boatswain of embezzling and selling ropes.

To his credit Edward Tarleton's personal integrity does not appear to have been in question, for at Liverpool on 24 November he was entrusted with £40,000 to pay the army in Ireland (*CSPD* 1654: 575). Bad weather delayed *Islip's* departure and she did not reach Dublin until 8 December, when the specie was safely delivered. Tarleton was then ordered to cruise for three months between Kinsale and Scilly (*CSPD* 1654: 582). But the ship had lost an anchor at Liverpool, and now had only two left. Moreover *Islip*, despite Tarleton's high opinion of her when she was fitting out at Bristol, had proved crank in bad weather. The shipwright, he now considered, had made her beam two feet too narrow, and only the drastic process of girdling – bulking out the hull around the waterline with solid timber – could cure the defect. His recommendation was accepted, and Tarleton was ordered to escort two merchant ships to Cork with stores for the army before returning to the shipyard at Bristol to have the modification carried out (*CSPD* 1654: 287).

Islip's girdling was completed with dispatch, and on 6 February 1654–5 she landed soldiers at Chester (*CSPD* 1655: 425). Her next assignment, on 1 March, was to transport a group of Irish Members of Parliament from Liverpool to Dublin, where they arrived two days later (*CSPD* 1655: 442). At Dublin *Islip* took on six weeks' stores before sailing for Liverpool on 15 March to receive a further nine weeks' provisioning. At Liverpool the steward absconded after being sent ashore with cash to purchase the supplies. *Islip* then returned to Lochaber where from 23 March to 3 April she lay at Dunstaffnage waiting for a wind to take her through the narrows of Loch Linnhe to Inverlochy (*CSPD* 1655: 451). She reached the fort on 4 April and remained there until 1 June, when General Monck ordered her back to Liverpool to revictual.

In April and early May Tarleton took part in two amphibious operations in the West Highlands, and his subsequent report probably characterises the nature of such actions from the Stewart kings' 'dauntings' of the 15th and 16th centuries to the punitive Hanoverian raids of 1746. As an exemplar of the strategy it is worth quoting in full.

> In compliance with the enclosed orders, on 29 April I marched 10 miles into the country, with the commanded party, and 40 of my own men, to surprise some delinquents, but they must have had notice, for they were gone. We plundered and fired their houses, and brought away 150 cows and sheep without opposition, save that at a pass 3 miles from the garrison [Inverlochy], some Lochaber rogues fired at us and ran.
>
> On the 5th [of May] I received 250 men on board, and sailed at night 8 leagues off to Kynnyogh harbour; but our pilot not knowing the coast well, we lost time, and before we could get our men landed next morning, we were discovered by the inhabitants, who gave the alarm through the town and country; but though we could not surprize the rogues, we burnt 40 of their houses, and destroyed all their cattle. Then we re-embarked in our 2 boats. We saw 50 men together who waited, as we thought, to engage the men who were to be shipped last; but finding us more than they were, they durst not attempt to leave their hills until we had put off, when they came down and fired upon us without effect.
>
> The Highlanders have come in very fast lately; between 3 and 400 have taken the engagement [submitted], and more are expected to do so. They will all come in under protection of this garrison. My provisions will last until 4th June, when I hope to be at Dublin (*CSPD* 1655: 161).

Islip reached Liverpool on 8 June and on 15 June Tarleton reported the ship ill-supplied and his men distressed. She was still there on the 29th, when he complained that he had to borrow £115 to fit her out. The ship was operational by early July, and on the 11th she left Chester for Dublin with the army's pay-chest (*CSPD* 1655: 494, 497, 503). She then returned to Inverlochy.

During that summer *Islip* was wrecked somewhere off western Scotland, and on 8 September an enquiry was ordered into the circumstances of her loss (*CSPD* 1655: 529). Two days later the Navy Commissioners reported that they had examined Tarleton and his officers and could not lay the blame on any individual, though they felt that the ship had come too far into the bay in which she was wrecked. However they were unfamiliar with the place because of its remoteness, and could not therefore reach an informed judgement (*CSPD* 1655: 530). That Tarleton and the ship's master, John Sayers, were held at least partly responsible is indicated a month later by their reduction to half-pay for 'neglect in the performance of their duty as to the loss of the frigate' (*CSPD* 1655: 533).

This wreck may well be the one recorded by Martin Martin, a native of Skye writing *c* 1695, who noted that:

> About four miles on the south-east end of this island [South Uist] is Loch Eynord. It reaches several miles westward, having a narrow entry, which makes a violent current, and within this entry there is a rock upon which there was staved to pieces a frigate of Cromwell's, which he sent there to subdue the natives (Withers & Munro 1999: 61).

A rock submerged at high water in the narrow entry to Loch Aineort is a distinctive feature at NF 799 277 (OS 2015 Explorer 1:25,000 Sheet 453).

Although both Admiral Monck and General Lawson recommended Tarleton for another command, commissions dated 11 November 1658 and 11 June 1659 appointed him Lieutenant on the 40-gun 4th-rate *Maidstone* (Tarleton Papers, f1, nos 3–6). *Maidstone* was part of the fleet under Admiral Robert Blake which defeated a Spanish fleet off Tenerife on 20 April 1657, so it is not certain whether Tarleton was a participant. Family tradition (Joni Davidson pers comm) recounts that he was at one time taken prisoner and held by Barbary pirates, and returned home 'in a very distressed condition'. Blake had attacked Tunis in 1655 to release British captives, while Cromwell's government negotiated the release of English prisoners held by the Bey of Morocco in August 1657 (Matar 2014: 109, 189). It may well be that Edward Tarleton was one of the rescued or ransomed prisoners.

Despite his service with the Commonwealth Tarleton was no puritan. His family remembered him as good-natured and fatalistic, and that he celebrated Christmas with 'dancing and festivity', activities banned while Cromwell was Lord Protector. Among his favourite sayings were 'God's will be done'; 'life is chequered'; and 'good will come by and by'. He made no attempt to claim his father's property in Ireland and did not challenge when the Catholic branch of the family broke an entail on the Aigburth estate to allow the property to be inherited by a daughter rather than come to him through the male line. He is recorded as having said that 'he could maintain himself and family very well, and did not care to disturb either his own repose, or that of others; and wished all the world to live in peace and harmony'.

Tarleton resigned his naval commission about the time of the Restoration and returned to Liverpool to make his fortune in trade, commanding some of his own vessels. Family tradition says that he made the first voyage from Liverpool to Barbados. His first wife died some time between 1660 and 1670, after which he married Ann Corles, the daughter of Liverpool alderman and mayor Henry Corles. In 1673, during the third Anglo-Dutch war, some of Tarleton's ships were pressed into royal service, including *Dublin*, of which Tarleton was made captain. The campaign was abortive, and hostilities were concluded by the Treaty of Westminster in 1674.

Back in Liverpool, Edward Tarleton played an important civic role. He was an alderman and served as mayor 1682–3. One of the last acts of his life was in June 1690 when, as master of *James*, he carried King William III from Hoylake, on the Wirral Peninsula, to Carrickfergus in Ulster on his way to fight the Battle of the Boyne (Mayer 1852). There he may well have encountered the 5th-rate frigate *Dartmouth* which, four months later, was to be lost in the Sound of Mull only 6km away from the wreck of his old ship *Swan*. Tarleton died on 9 July 1690 and was buried in St Nicholas' Church, Liverpool.

Illustration 15
Duart Castle from the north-east (DP 173648)

Chapter 2

THE SHIPWRECK OFF DUART POINT

2.1 Discovery and project development

The wreck-site lies just off a prominent headland which commands the south-east end of the Sound of Mull, off the west coast of Scotland, latitude 56° 27'.440 north; longitude 05° 39'.386 west; NGR NM 7475 3550 (Illus 3–4). The castle of Duart (from the Gaelic *Dubh Ard* – Black Height) stands on a crag at the seaward end of the peninsula (Illus 15). Since the mid 14th century it has been the seat of the Chiefs of Clan Maclean, though they forfeited it with their lands in 1692 to the Earl of Argyll. In 1911 the ruin was bought back and restored by the 26th Chief, Colonel Sir Fitzroy Maclean, and once again it is the centre of the clan and home of the present chief and his family (RCAHMS 1980: 191–200).

In February 1979 John Dadd, a naval diving instructor whose duties had brought him to the area, discovered the wreck of an armed wooden ship at a depth of *c* 10m just to the east of Duart Point (Illus 16–17). The visible remains comprised a number of concreted iron guns, a small anchor, and two distinctive piles of stones which he correctly identified

Illustration 16
Duart Castle and Point with the wreck-site indicated by an arrow (DP 173099)

as ballast. A few recoveries, including a Frechen stoneware flagon of mid 17th-century date, were made during this and subsequent short visits, but Mr Dadd was unable to undertake serious work on the site and the wreck lay undisturbed for several years (John Dadd pers comm). In 1991, anxious that the wreck should be investigated further, but concerned lest it be discovered accidentally by others and perhaps treated inappropriately, he reported his find to the Archaeological Diving Unit (ADU), then based at St Andrews University. This specialist team of archaeologists with commercial diving qualifications and technical support had been established in 1986 to assist UK governmental agencies responsible for the regulation and management of historic shipwrecks, which in Scottish territorial waters fell under the remit of Historic Scotland (now Historic Environment Scotland).

At Historic Scotland's request the ADU visited the site in June 1991, accompanied by John Dadd (Illus 18). The presence of a historic shipwreck was confirmed, and further observations suggested a 17th-century date. Exposed wooden panelling was noted at the eastern end of the wreck, at a location which can be identified as approximately **05.08** on the subsequently imposed grid-system (Steve Liscoe pers comm). Although active erosion was clearly a problem, the site's discovery was not public knowledge and no immediate steps were taken to designate it under the Protection of Wrecks Act (1973). At the time Historic Scotland had only recently assumed responsibility for administering the Act in Scottish territorial waters, and it was felt that the Duart Point site would provide an opportunity to develop appropriate procedures for dealing with historic shipwrecks in an objective and unhurried way.

However the Sound of Mull is one of the most popular diving locations in the UK and the presence of the ADU off Duart Point had not gone unnoticed. Shortly after the team

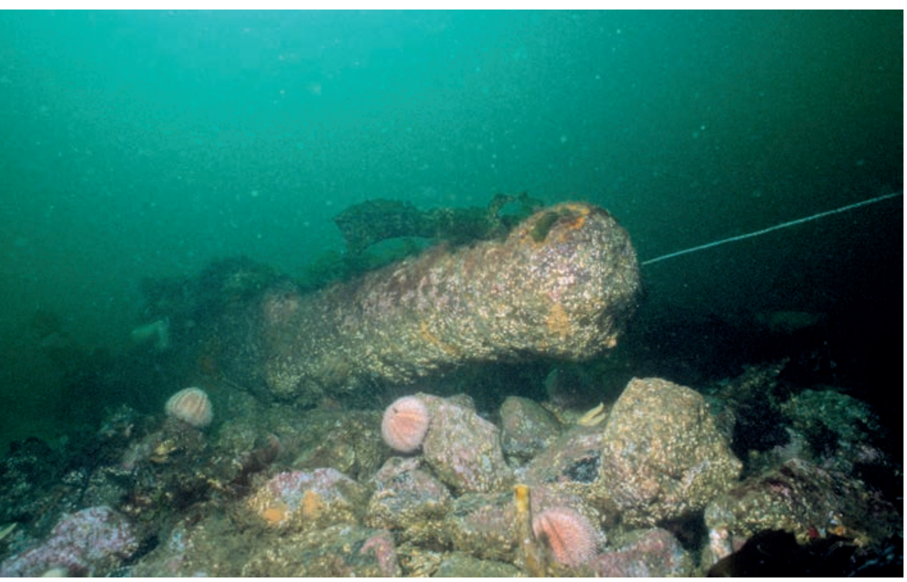


Illustration 17
One of the cast-iron guns (Gun 3) lying prominently on a pile of ballast-stones. This drew John Dadd's attention to the wreck (DP 173689)

Illustration 18
The Archaeological Diving Unit's research vessel *Xanadu* anchored over the site in 1991 (DP 174724)

left, the site was visited by unknown divers and significant disturbance occurred, during which it is probable that artefacts were removed (Steve Liscoe pers comm). The existence of the wreck then became known to a group from the Dumfries and Galloway branch of the Scottish Sub-Aqua Club who were staying at the nearby Lochaline Dive Centre. They visited the wreck (quite legally, since at this point it was not protected) and recovered a significant number of artefacts, including pieces of carved decoration, a badly corroded hoard of silver coins, a grindstone, several wooden objects, and the brass lock-plate of a Scottish snaphaunce pistol. These recoveries appear to have involved disturbance to parts of the site. The finds confirmed the earlier conclusion of a mid 17th-century date, and the material was delivered to National Museums Scotland, to which the Club subsequently surrendered its rights as salvors by arrangement with the Receiver of Wreck (five objects had initially been deposited with Dumfries Museum, but were transferred to join the rest of the collection).

In the opinion of the ADU's Director, Martin Dean, the actively eroding areas of sea-bed from which the finds had been recovered required urgent intervention if more items were not to be degraded or lost. A crisis response by Historic Scotland provided resources for a rescue operation by the ADU, and when a general survey of the site had been completed exposed objects were photographed in situ, extracted, recovered and taken to the conservation laboratories of National Museums Scotland in Edinburgh. The operation was carried out between 11 and 27 June 1992 with the support of the Dumfries and Galloway Club, assisted by students and staff from the Scottish Institute of Maritime Studies at the University of St Andrews and conservators from the National Museums. The recovered material is now in the ownership of National Museums Scotland, together with all subsequent finds from the wreck.

Early surveys of the wreck

No measured surveys from reliable datums were conducted on the wreck before the ADU's survey of 1992, but impressionistic sketches (as defined in Bowens 2009: 116–17) were conducted from memory by John Dadd during his 1991 visit, by the Dumfries and Galloway Club following their visit, and by Steve Liscoe of the ADU after his first dive on the site in 1991. While the data they record cannot directly be integrated with subsequent measured plans, comparison with the latter allows many of the features observed to be located in general terms. When this can be done with reasonable confidence the features have been given an appropriate four-figure grid reference within the system later established for the wreck as a whole, though these should be regarded as approximate probabilities rather than precise certainties. The three early surveys are summarised below. Full information and illustrations of the finds can be found in the relevant chapters.

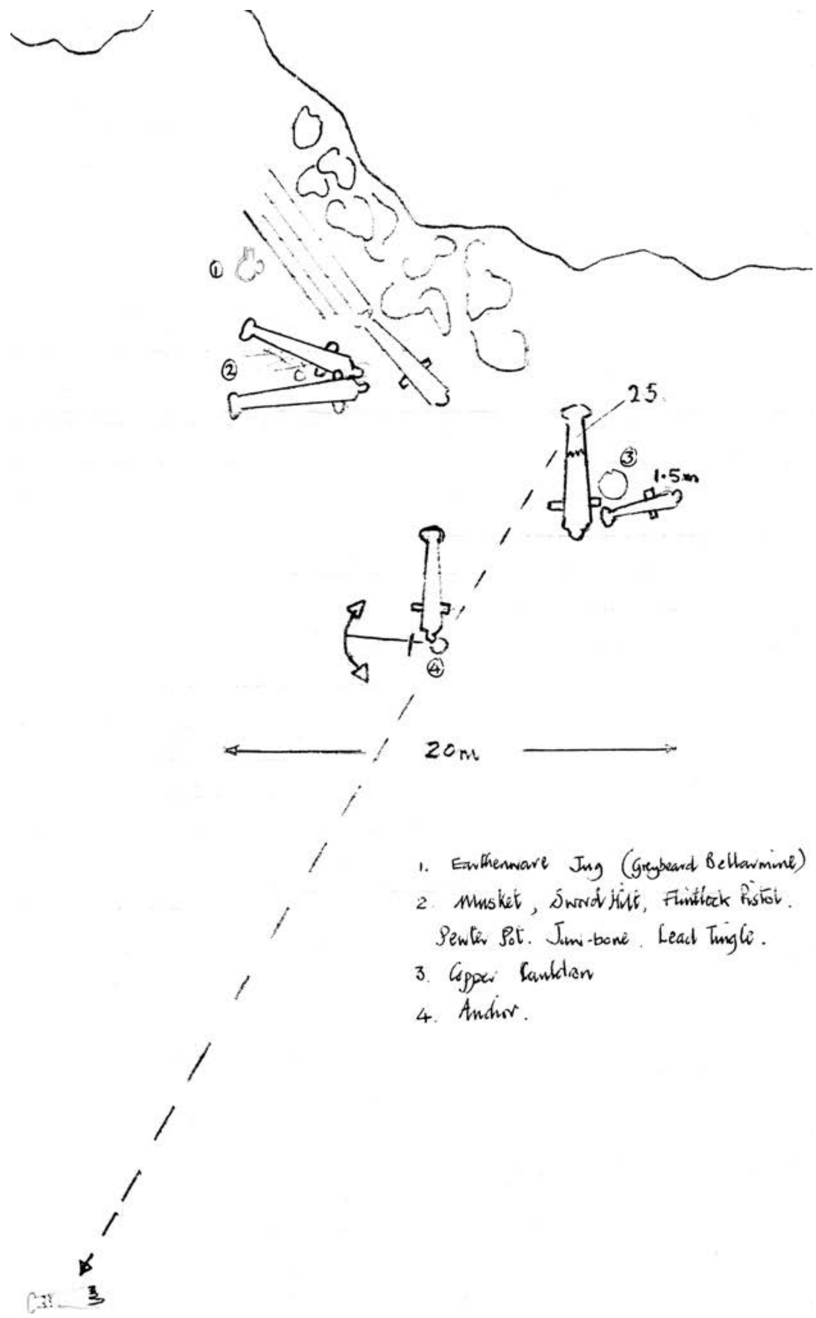


Illustration 19
Sketch-plan of the wreck-site by John Dadd, drawn in 1991 recalling what was visible on his first visit in 1979 (ADU Collection BD 161/1)

John Dadd (1991)

No orientation or scale is given, but the extent of the observed remains – 20m – is broadly accurate (Illus 19). The plan clearly shows the line of the cliff-face, and the tumble of boulders along its foot. The mouth of the gully running in towards the shore is also recognised. Parallel runs of timber are indicated in an area which can be identified as the collapsed stern complex, and adjacent to it the location of a Frechen stoneware flagon is noted, and site-grid references can be estimated based on this information (**08.10**). Six guns are recorded. One, next to the tumbled stones at the base of the cliff, is clearly Gun 1 of the later survey (**12.10**). There is no indication of the adjacent Gun 5, which may well have been buried at the time of the visit. Guns 2 and 3 are clearly identifiable, centred on **14.07**, though the orientation shown is different from that observed today. Gun 3 may have been turned to its present axis to investigate the adjacent deposit, recorded on the plan as including a musket, a sword-hilt, a pistol, a pewter flagon, a human bone and a lead tingle. Gun 4 (**28.02**) is clearly identified by its proximity to the anchor, while Gun 6 lies beyond it, at **28.09**. It is shown with its muzzle apparently broken, though when excavated in 2000 the gun was found to be intact. Beside Gun 6 the location of a copper kettle is indicated. Almost abutting Gun 6 a much smaller gun is shown, its length of 1.5m being marked beside it. This gun is no longer at this location.

A dotted arrow runs from the end of Gun 6 to what is clearly depicted as the broken end of a gun. The number 25 at the start of the arrow clearly records the distance involved, and in this approximate direction, though only 15m and not 25m away, there is a gun-shaped concretion 1.2m long (Gun 7). The swell of its breech is evident, and it is certainly not a broken-off muzzle end. It may with some confidence be identified as the missing small gun identified in John Dadd's plan and it was this piece, not the muzzle of Gun 6, that he shifted in 1979.

Dumfries and Galloway branch, Scottish Sub-Aqua Club

This plan (Illus 20) was completed by club members following their independent discovery of the wreck in 1991. There are two versions, one in manuscript form and the other enhanced by computer. The latter is initialled DJS and dated 1.5.92. The computer version is symbolic, and all the guns and the anchor are aligned either horizontally or vertically, whereas in the freehand sketch their positions are closer to actuality. The northerly orientation is broadly correct, and the extent of the site observed during the visit is recorded as 25m × 8m.

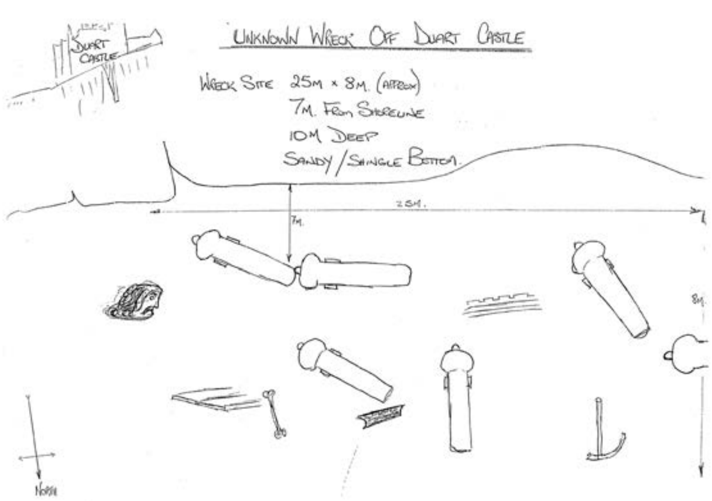


Illustration 20
Sketch-plan of the wreck-site by members of the Dumfries and Galloway branch of the Scottish Sub-Aqua Club, 1992 (ADU Collection BD 161/2)

The cliff-base is shown, with Guns 1 and 5 identifiable. Gun 5 appears to have been completely uncovered. It does not appear in John Dadd's survey, its breech end is covered in the ADU's survey, and it has been almost completely buried since the pre-intrusion survey of 1993 until the time of writing (2016). Guns 2 and 3 are identifiable, though their relative positions are questionable, while Guns 4 and 6 are likewise skewed somewhat from their actual positions. The anchor is recorded, as is the run of exposed frame-ends and planking along the port midships side of the wreck. An object which looks like the bottom part of the carved badge of the Heir Apparent is shown on both plans, close to the muzzle of Gun 2.

A number of finds are noted on the computer-generated plan. These include the warrior's head carving, a hoard of silver coins together with a touchstone, musket ball, and wooden board (a bone and planking are also indicated on the drawing), and a note to the effect that an excavation to a depth of 24 inches was conducted along the run of exposed frame-timbers and planking. It is likely that the majority of small finds recovered by the Club in 1992 came from this excavation.

Archaeological Diving Unit

This plan (Illus 21) is signed by S Liscoe and dated 21 September 1992. Though noted as being 'not to scale', a metre scale and north-pointer are provided, and comparison with the subsequent measured survey shows it to be reasonably accurate and spatially sound – an exemplar for preliminary sketch-plans of this type. It is based on Liscoe's 1991 sketch-plan, but with the ADU's site datums (A–R) added later.

This is the first plan which clearly identifies the nature and extent of the two ballast-mounds, the axis of the wreck as defined by the orientation of the keelson, and the extent of the recently exposed collapsed upper-stern complex. Timber features which were subsequently excavated and identified include the lower-stern complex and the full extent of the port-side bilge framing. A deposit of major timbers, however, possibly associated with the transom stern, was unfortunately swept away by the current before a detailed record could be made. The environmental topography of the site is also reliably recorded. A detail sketch by Steve Liscoe also indicates the locations of the pocket-watch, the lion's head bracket and three silver coins.

During the ADU's visit in June 1992 18 datum-points were established across the site and tied in to a baseline on shore. The latter survey was conducted by plane-tabling with reference to the castle to construct a baseline A–B on the shore adjacent to the wreck-site, and these in turn were linked to

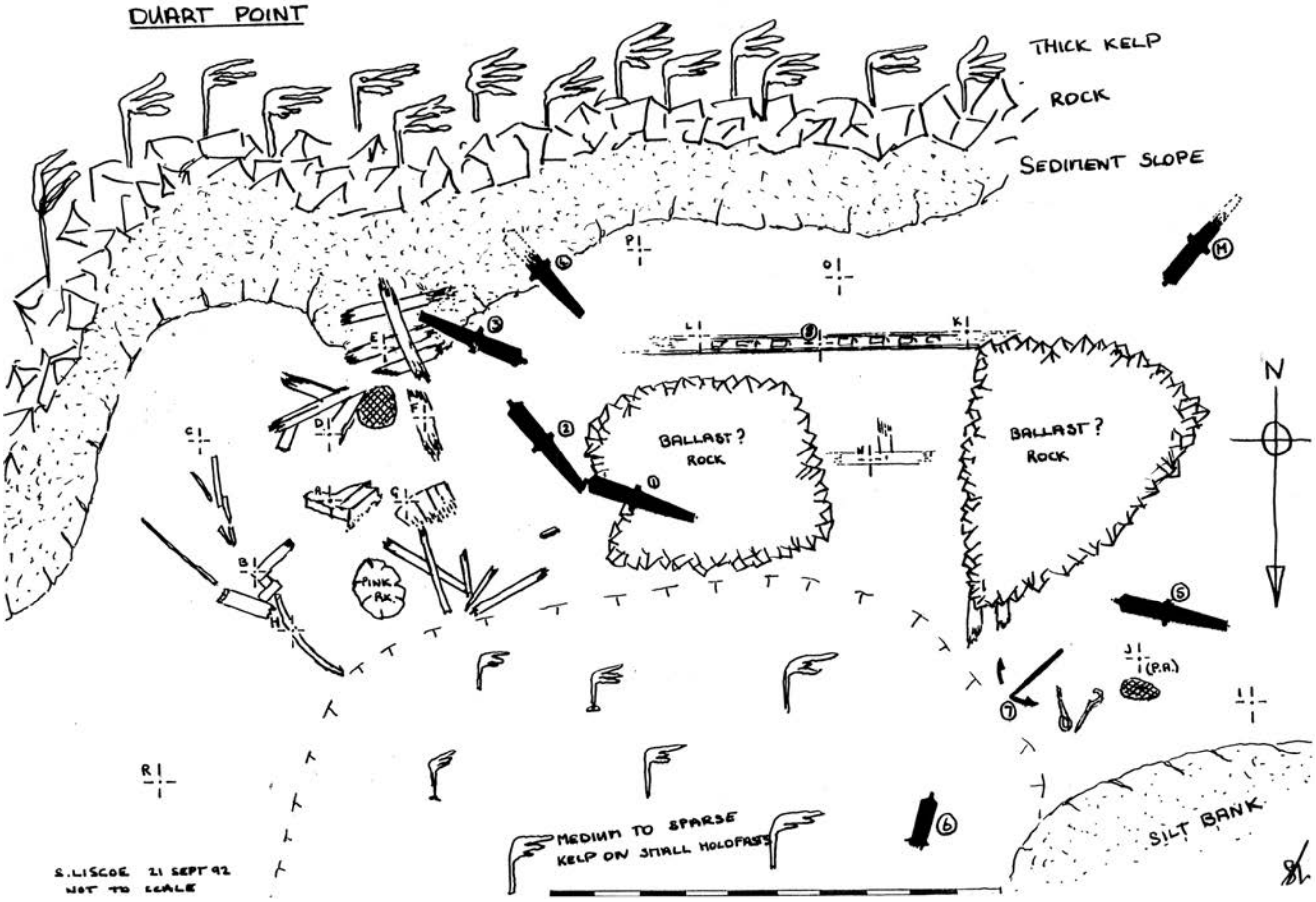


Illustration 21

Sketch-plan of the wreck-site by Steve Liscoe of the Archaeological Diving Unit, made after his first dive in 1991, revised after the addition of datum-points in 1992 (SC 1316316)

seabed datums via vertically stretched buoyed lines (1:200 plane-table survey by Mark Lawrence, 25 June 1992, HES Canmore site 80637). This plan was supplemented by a survey of the seabed datums and referenced findspots, subsequently plotted in plan form by Steve Liscoe (1:50 Duart Point datum distribution, 6 January 1993 and 1:10 Duart Point wreck-site – eastern area distribution, 8 February 1993, HES Canmore site 80637). These data have been integrated with the subsequent site-grid so that the key finds recovered by the ADU can be assigned grid references.

Project development

Following the site's designation under the Protection of Wrecks Act (1973) (Designation Order No 3, 1992, which came into force on 15 May), and the ADU's rescue operation, the future of the wreck was uncertain, since no resources or trained personnel were available in Scotland to continue surveying and monitoring the site, or to take whatever further action might be necessary to stabilise and protect it. After consultation with interested parties, including National Museums Scotland, which undertook to take into possession and conserve any further material that might be recovered, Colin Martin of St Andrews University was granted a licence by Historic Scotland to assess the site's characteristics and archaeological potential, and determine what might be done to restore its former stability. Over the winter of 1992–3 several visits were made under his direction by a team from the Scottish Institute of Maritime Studies, with members of the ADU assisting in a personal capacity. The visits were supported by members of the Dumfries and Galloway Club, who provided boats, divers, and other resources. Travel and subsistence costs were met by Historic Scotland.

Further active erosion was noted, especially in a sediment-filled gully which slopes up towards the shore at the eastern end of the site. Here a small but complex deposit had been exposed, consisting of rope, a wooden block, components of wooden pumps, a shoe, barrel-staves and well-preserved elements of wooden panelling with applied decoration (Illus 22). This was recorded before gravel aggregate, lowered by bag

Illustration 22
Freshly exposed artefacts observed and recorded during a monitoring visit in the winter of 1992–3. They include a leather shoe, pieces of rope, a wooden sheave, two lower pump-valves, and part of a cartridge-box. Scale in centimetres (Steve Liscoe, DP 173698)

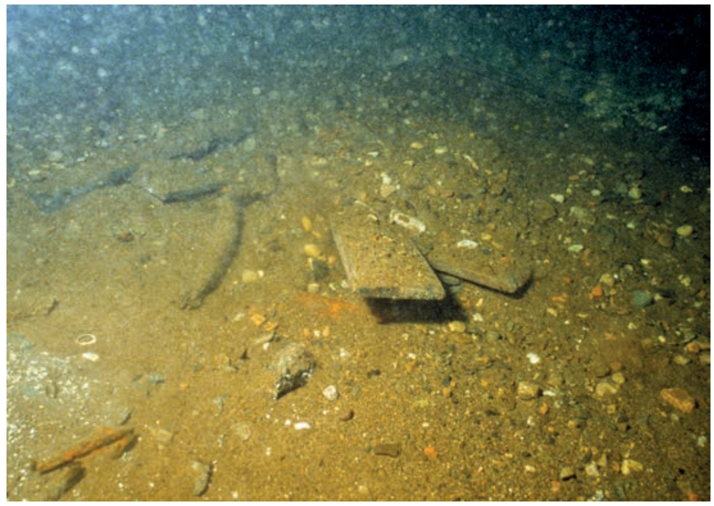


Illustration 23
The exposed deposit shown in Illus 22 in the process of reburial with fresh gravel. When this area was excavated nine years later all the items were in good condition, and remained in their original locations (DP 173696)

from the surface, was spread over the eroded area to replicate as closely as possible the original sea-bed configuration (Illus 23).

After a successful fund-raising campaign to develop the project, a Field Research Unit affiliated to the University of St Andrews was established in early 1993. This was operationally self-contained, with a Land Rover, compressors, diving gear, an inflatable boat, and a full suite of archaeological equipment including still and video cameras. A semi-permanent base was established close to Duart Castle, with caravans providing accommodation and archaeological facilities, including a drawing office and darkroom. An adjacent marquee housed a small workshop and equipment-store. In the first instance self-contained underwater breathing apparatus (SCUBA) was used, consisting of twin 10-litre compressed-air cylinders with a 3-litre cylinder and separate regulator in reserve. This equipment supported individual dives of up to 2 hours; less if heavy work was involved. Diving took place either from the rocks adjacent to the site or from a moored inflatable boat, following commercial-diving protocols laid down by the Health and Safety Executive. Because a current flows across the site at up to 2 knots during the ebb tide but is generally slack during the flood, diving operations were restricted to the shifting six-hour window between Low and High Water.

The SCUBA system was not ideal because of the unproductive and heavy work of handling and charging cylinders on a daily basis, while the equipment was awkward under water and did not always allow the full bottom-times permitted by decompression schedules for such shallow water. In 1994 it was replaced by a surface-supply system, in which a low-pressure compressor on shore fed air directly to two divers via floating air-lines. This was combined with the use of full-face masks and a through-water communications system which allowed the surface supervisor and divers to speak freely to one another. Although primarily a safety measure this greatly facilitated the archaeological work. To enhance the safety and efficiency of the shore operation (the possibility of falling on the slippery rocks was judged to be the greatest risk factor on this site) concrete platforms were built to accommodate the compressors and a supervisor's hut, while steps and ledges were provided to improve diver access to and from the water, and generally make movement across the rocks easier and less hazardous. Two wooden gantries, on which garden-hose rollers were hung, kept the air-lines from chafing and made them easier for the tenders to handle. An independent high-pressure reserve cylinder was coupled into the air-line system, and the divers carried 3-litre SCUBA cylinders and regulators as a back-up. Radio contact was maintained with the local coastguard, and an emergency evacuation plan was in place to convey decompression casualties by boat to the recompression facility at the Scottish Association of Marine Science Research Laboratory at Dunstaffnage, 15km distant.

Between 1993 and 2003 a total of 64 weeks' diving took place on the site, during which 1,645 diver-hours were logged.

The seasons from 1993 to 1996 were devoted to survey, assessment, and site consolidation. Four diving archaeologists were employed, working in pairs in two consecutive shifts. Each pair when not diving acted as tenders to the other, while a commercially qualified supervisor had overall charge of the operation from a communications hut on shore. During the survey phase 25 weeks were spent on site, and 823 hours of underwater work were completed.

In 1997 the excavation phase began, and the diving team was reduced to two, with a supervisor and two tenders supporting them from the shore (Illus 24–5). The field-base was moved to Lochaline, where a house was obtained, and the daily trip was made either by ferry and road or by inflatable boat, distance to the site by sea being 12km. The decision to reduce the number of divers was taken because a single daily dive, with two archaeologists working in adjacent areas, normally yielded enough data and finds to require the remainder of each day for the processing of results. The house provided better facilities for these tasks. To have worked a second diving shift would have doubled the data-recovery rate and unacceptably reduced the time available for processing. Between 1997 and 2001 excavation took place each summer except 1998. Twenty-eight weeks of underwater work were completed, during which 459 diving hours were logged. Two further seasons totalling 11 weeks were completed in 2002 and 2003. SCUBA replaced the surface-demand system for the two last seasons. The reasons were twofold. In 2002 a two-week season was sponsored by Chanel 4's *Wreck Detectives* programme and our diving regime had to be adjusted to accommodate their presenter's needs, while the last season, in 2003, required the greater flexibility of SCUBA to finalise archaeological work on the site and secure its long-term protective consolidation. By this time, moreover, the surface-demand equipment was in need of major maintenance or replacement, which in the closing stages of the project was not financially justifiable. During the two final seasons three divers completed a total of 363 hours under water.

2.2 Date and identity of the wreck

It is appropriate at this point to summarise evidence for the date and probable identity of the wreck. An approximate mid 17th-century date had been determined by an assessment of the associated archaeological material, on the assumption that it represents a closed and uncontaminated group (no evidence has been found to suggest otherwise). Detailed analyses of the relevant objects are presented in the descriptive catalogues of finds, and at this stage only the diagnostic significance of selected artefacts is considered. The latest identifiable coin is a crown of Charles I 229 minted at Exeter in 1645–6. Of the ceramic evidence, clay pipes 145–60 are the most sensitive indicators of date, and the group of 14 bowls typologically suggests an English origin and a date-range of *c* 1640–60. Five of the six stamped heel-marks contain the letters NW within a heart. Although these initials have not been linked with a named pipemaker, the distribution of pipes thus marked occurs almost exclusively in the vicinity of Newcastle. A search of the literature has revealed only four recorded occurrences outside Newcastle; at St Andrews, Kirkwall, Belfast, and now from the Duart Point wreck. Newcastle was a major supply base for Cromwellian operations in Scotland between 1650 and 1653, and it is reasonable to see these 'outlier' NW pipes as indicators of troop-movements at this time.

Corroborative evidence of a mid 17th-century date is provided by a concreted pocket-watch 118, which Three Dimensional Computed Tomography X-ray scanning has revealed was made by Nicholas Higginson of Westminster (Troalen et al 2010), who was admitted to the Clockmakers' Company in 1646 – confirmation of the *terminus post quem* provided by the Exeter coin.

The clay pipes suggest that the ship had a strong English association, for these are ephemeral objects and none is likely to have been in its owner's possession for long before being broken or discarded. It is noteworthy that no Scottish or Dutch pipes, both common in Scotland at this period and recognisable by their distinctive forms and marks (Martin 1987), can be identified in the group. That the weight-standard in use aboard the vessel was the English avoirdupois pound of 454g is indicated by the find of three lead balance-pan weights 209–11 which conform to this standard and are stamped with control-marks which bear the royal monogram of Charles I

Illustration 24
The shore base, with the boat moored over the wreck. From left, the supervisor's hut, the air-hose gantries leading from the surface-supply compressor, and the high-pressure SCUBA compressor (partly visible with green cover in the foreground) (DP 173470)

Illustration 25
An archaeologist with excavation tools and drawing-board about to enter the water, assisted by his tender (DP 173580)

together with the symbols of the Guildhall and the Plumbers' Company in London. This weight-unit is distinct from the contemporary Scottish pound of 496g. However, a Scottish association of some kind is suggested by three pewter liquid measures 119–21 which conform to the Scots pint of 1.7 litres, or parts thereof. This measure is unrelated to the English standard pint of 0.57 litres. Scottish connections are also indicated by the lock-plate of a snaphaunce pistol 104 with the initials of the Edinburgh maker George Turner (fl 1639–61), and a Hebridean *crogan* pot 144.

Carvings from the vessel's stern decoration demonstrate an association with the English or Scottish crown (during the 17th century the two kingdoms were ruled by the same monarch, but had separate parliaments). The dates suggested by the archaeological evidence (*c* 1640–60) cover the reigns of Charles I (1625–49) and Charles II (1650–85). However, the presence of the badge of the heir apparent 8 indicates that the parent arms were those of Charles I, since his son, Charles II, had no legitimate male children (his brother, who succeeded him as James II, was heir presumptive, so was never entitled to use the ostrich feathers and coronet badge).

Further indications of the ship's history and associations come from an analysis of non-artefactual material associated with the wreck. Studies of animal and fish bones suggest that the vessel had been provisioned largely, if not exclusively, from the resources of the area in which she was wrecked, a possibility reinforced by the find among debris from the galley of a hand-mill 62. Flour was not normally ground at sea, but carried in processed form, usually as bread or biscuit. The hand-mill implies an intention to obtain grain from the local countryside, a practice commonly adopted by campaigning armies. This in turn suggests that the ship was lost around harvest-time, in late summer or early autumn.

Geological analysis of the ballast suggests that the ship had operated along the length of Scotland's western seaboard prior to her loss. The eastern ballast-mound is composed of Dalradian stones from the south-west Highlands, while the western mound, though more varied in composition, includes Lewisian gneiss from the extreme north-west tip of mainland Scotland or the northern part of Lewis. Sources of the clay-and-gravel lining which provided a bed of ballast in the central hold are less easy to identify, but the clay probably comes from Ayrshire or the Clyde, while the gravel is typical of deposits around the Inner Hebrides.

The archaeological evidence thus combines to indicate that, some time between 1646 and *c* 1660, a small armed ship which appears to have had associations with the English and/or Scottish crowns was wrecked on Duart Point, probably at harvest-time in late August or September. The Newcastle pipes suggest that she may have been involved in operations connected with Oliver Cromwell's invasion and occupation of Scotland, though her main source of provisions appears to have been local. The geological footprint of the ballast suggests that the ship's movements prior to her wrecking extended from south-west Scotland to the northern Hebrides.

An investigation of historical sources for this region and period reveals only one episode which fits the criteria summarised above (for more detail and fuller referencing see Chapter 1). This was an expedition sent by Cromwell to the Western Isles in August 1653 in response to a Royalist revolt led by the Earl of Glencairn, whose supporters included the Macleans of Duart. It was commanded by Colonel Ralph Cobbett. Three ships, including the merchantmen *Speedwell* of Lynn and *Martha and Margaret* of Ipswich, sailed from Leith via Kirkwall, Stornoway, Skye, and Eilean Donan (on the mainland opposite Skye) to Dunollie Castle, on the mainland close to Mull. At some point earlier, possibly at Stornoway, they had rendezvoused with three ships from the Cromwellian naval base at Ayr. These included a collier, the frigate *Wren*, and a small warship called *Swan*, captained by Edward Tarleton. On their way north the ships from Ayr had called at Castle Sween in Knapdale to collect artillery. The combined force then sailed to Duart Bay, where it offloaded 1,000 troops with artillery and mortars to besiege Duart Castle. The Macleans, however, had decamped, and the castle was taken without a shot being fired.

On 13 September the anchored ships were hit by a violent storm and three were wrecked. They included the two East Anglian supply vessels which had come from Leith, and the small warship *Swan* from Ayr. The remaining ships, which had lost their masts, were taken south under jury-rig for repair. Cobbett and his men crossed to the mainland in boats and eventually reached Dumbarton.

Which of the three ships is represented by the wreck off Duart Point is best determined by a consideration of the ballast. *Speedwell* and *Martha and Margaret* were East Anglian merchant ships which came to Leith before sailing to Kirkwall in Orkney, Stornoway in Lewis, Skye, Eilean Donan, Dunstaffnage and finally Duart. This itinerary would have allowed them to take on ballast containing Lewisian gneiss at Stornoway, but it is difficult to see how they could have obtained the distinctive Dalradian rocks from the south-west Highlands which characterise the wreck's western ballast-mound. A much stronger case can be made for the third vessel, the small warship *Swan*, which came from Ayr and touched at Castle Sween in Knapdale before heading north to rendezvous with the ships from Leith. The ballast footprint fits convincingly – clay from Ayrshire or the Clyde, stone from south-west Argyll, and stone from Lewis. It may also be noted that the royal Stewart iconography associated with the wreck would be quite inappropriate to a workaday pair of conscripted East Anglian freighters, which leaves only *Swan*.

Mystery surrounds this ship and her origins. Initially it was thought that the wreck at Duart was probably the well-documented pinnace *Swan*, built for Charles I in 1641 and captured by Parliament off Dublin in 1645 (Eames 1961; Martin 1995). However it is now clear that the 1641 *Swan* survived beyond 1653, so another candidate must be sought. The only documentation reliably associated with the Duart *Swan*, apart from the account of her wrecking, concerns a 'frigot' of that name which had been purchased for the State earlier in 1653. In June she was at Liverpool, where she was supplied with 'provisions, sails, waist-cloths and colours, tallow and oars' (TNA SP18/55/21 f38r). That this ship appears to have had auxiliary oar power further supports her identification with the Duart Point wreck, which has produced a probable oar-port lid [38] and a disposition of artillery which suggests that the midships part of the main deck was occupied by rowing banks (see Chapter 5.6).

But there is no mention in contemporary English naval lists of a *Swan* other than the 1641 pinnace. However in 1644–5 the Marquess of Argyll, then the principal magnate in the west of Scotland, had three ships operating in the area, one of which was called *Swan*, commanded by James Brown (Campbell 2002: 217). Nothing is known of the vessel beyond this single reference, but the marquess was much embroiled in the confused politics of the time, and though his loyalties shifted from crown to kirk and finally to Parliament during the complex ramifications of the Civil War period in Scotland, by 1649 he was once again a nominal Royalist and assisted at Charles II's Scottish coronation in 1650. If this wreck is indeed Argyll's *Swan*, following her transfer to the Commonwealth (to which by 1653 the marquess had shifted his allegiance), her close association with the west of Scotland, evidenced by the ballast footprint, is explained.

That the Duart wreck is one of the three ships lost in the 1653 incident seems beyond serious question; that she was a small oared warship called *Swan* is highly likely, and that this *Swan* was a private warship once owned by the Marquess of Argyll is a strong probability. These suggestions remain hypothetical, set in descending order of certainty, and in the absence of more definitive evidence the site is best referred to neutrally as 'the Duart Point wreck'. Ruling theory is a dangerous strait-jacket in which to place perceived shipwreck identifications if a measure of doubt remains (cf Rodgers et al 2005).

2.3 Site management and project design

Site management

As explained above, the project's priority in 1993 was to stabilise erosion on the wreck, and this was achieved by placing a single layer of flat-weave polyester bags filled with gravel over the areas where the exposure of archaeological material had been observed (Illus 26–7). The bags were loosely filled with 20mm gravel, which it was felt would be less susceptible to transport by water-movement should the containers split or degrade. The loose fill ensured that the bag shapes would adapt to sea-bed irregularities, lock well together, and present a soft pliable interface against any archaeological material with which they might come into contact. Fifty-bag batches were transported to the site by inflatable boat and dropped in pre-selected dumps adjacent to the wreck but clear of archaeologically sensitive areas. They were moved around the site by divers who, having removed their fins, carried one in each hand and, thus weighted, could walk upright to where the bags were required, guided by a pre-laid line. Once each pair of bags had been set in position the diver, free of the weight, could lie horizontally and pull himself back along the line to the dump for another load. During the preliminary consolidation of the site 500 bags were laid, covering a total area of some 60m^2.

It is probable that the recent erosion on the site was triggered by diver disturbance and the removal of kelp to reveal the wreck's features for recording (for a full explanation of this effect see Chapter 3.1). The clearing of overlying plant-growth prior to the investigation of a site has been normal practice in underwater archaeology, as it is on land, and the consequences of such a procedure at Duart were not

Illustration 26
Sandbags filled with gravel being delivered to the site (Edward Martin, DP 174780)

anticipated either by the original finder John Dadd in 1979, by the Archaeological Diving Unit in 1991, by the Dumfries and Galloway Club in 1992, or by ourselves in 1993. However, it was soon realised that although water-movement across the site during the ebb tide is strong enough to displace sediments, it can only do so if the flow is in direct contact with the sea-floor. Under normal conditions it is not. The mature forest of large-fronded shallow-water *Laminaria* species which normally covers the site provides a boundary layer which reduces water-movement beneath it to negligible levels (Illus 28). Only when the *Laminaria* is removed can moving water make contact with the sea-floor at velocities sufficient to displace sediments. Sandbagging negates this effect, while the bags provide surfaces on which fresh *Laminaria* growth can establish itself and reach maturity, thus re-creating the protective boundary layer. Once this balance is achieved the bags become redundant and can be left to disintegrate, leaving the stable gravel to consolidate naturally.

The ease with which bags can be moved and adjusted allowed a controlled investigation of the site by uncovering small areas of previously sandbagged sea-bed as required, replacing them when work – whether survey or excavation – was complete. From 1993 to 2003 the wreck-site was managed in this way, allowing a research agenda to be built on the rescue imperative. In 2003, after a final season of intrusive investigation, a further 500 bags were laid, and at the time of writing (2016) the site appears to be almost entirely stable, once again protected by a thick cover of mature *Laminaria*.

In parallel with the protective measures to ensure site stability, a survey of the exposed archaeological remains and associated sea-bed topography was conducted as a basis for assessing the condition of the wreck and investigating the dynamics of the site-formation processes involved. This included a contouring of the site at 0.1m intervals. When the survey had been completed in 1996 it was decided, in consultation with Historic Scotland, that areas already destabilised by previous interference and erosion should be

Illustration 27
Sandbags freshly laid over an exposed organic deposit (DP 174786)

Illustration 28
Shallow-water algae cover most of the site, damping water-movement at sea-bed level to minimal velocities. This species, *Laminaria digitata*, covers the shallower and environmentally most dynamic parts of the wreck (DP 173716)

excavated to a depth of not more than 0.5m, to ensure that the disturbed top sediments were removed prior to sandbagging. It was also agreed that the area between the ballast-mounds, where degraded elements of structure were already partially exposed, should be cleaned for recording before protective consolidation. Since these investigations were likely to yield significant information about the structure and internal layout of the ship, some discretion to conduct additional limited excavation was allowed so that aspects of the vessel's characteristics and configuration could be examined. It was decided, however, not to compromise the integrity of the wreck by removing any of the stone ballast which had been responsible for pinning down and preserving much of the vessel's lower structure, other than limited sampling of this material for analysis and the excavation of a small trench to determine the forward extent of the keel. It is likely that most of the structure which survives beneath the ballast is coherently articulated and well-preserved, and under minimal threat.

Project design

The aims of the project were: to survey the wreck and secure it for long-term preservation in situ, and to conduct such limited invasive work as necessary to rescue threatened material and to understand the site-formation processes that have conditioned the site's present state. This information will inform decisions concerning the wreck's future management. Where possible, the work of assessment, consolidation, and stabilisation should be combined with a research agenda designed to determine the ship's dimensions, structural characteristics, and internal layout, and to recover a representative sample of artefactual and environmental material for analysis, study, dissemination, archiving, curation, display, education and public benefit.

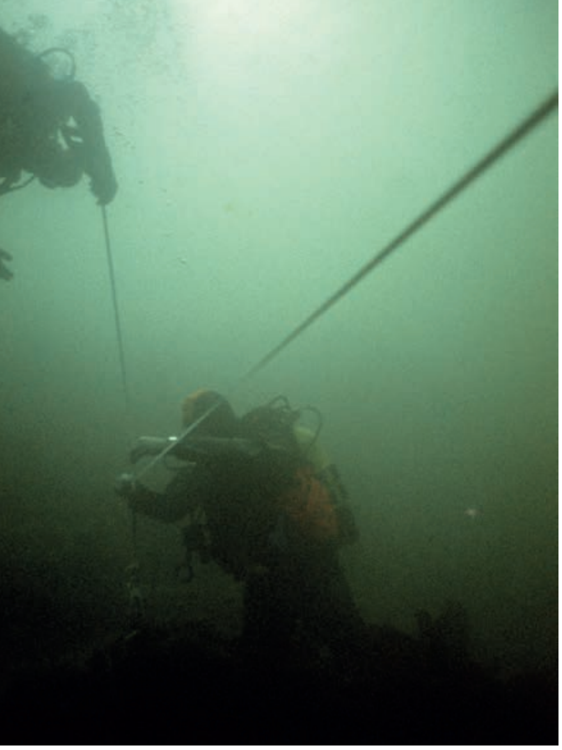
2.4. Survey and excavation techniques

Most of the site lies on a relatively level sea-bed between the −8 and −9m contours measured at Mean Low Water Springs, which allowed a web of triangulated datum-points to be established across the site from a 25m primary baseline A–B, following the general axis of the wreck but slightly to seaward of it, so avoiding the main archaeological areas (Illus 29). Its terminals were fixed by steel post-holders securely driven into the sea-bed, containing short wooden posts topped by pins for anchoring tapes. Secondary points were created either with steel pitons hammered into the rock or with short lengths of aluminium scaffold-pole driven into the sea-bed with a fence-post rammer (Illus 30). 5m and 3m square grid-frames of aluminium scaffold-poles with adjustable legs at the corners were assembled on shore for transport to the site (Illus 31), where they were positioned and levelled as required with reference to a primary depth-datum C located on top of a prominent rock adjacent to the main wreck area.

Within the grids, 1m drawing-frames double-strung at 0.2m intervals with thin elastic lines were positioned by means of bungee-tautened cross-tapes and a simple plumbing device (Illus 32–4). The 1m grid could also be used in conjunction with a tape datum-line to provide reference for an archaeologist hovering above it (Illus 35). Grid-frames were set sufficiently close to one another to allow an archaeologist working in one to remain in visual contact with a colleague in the other, thus providing mutual safety cover on the 'buddy' principle without compromising work output. Each grid-block was recorded to a scale of 1:10 on drafting-film taped to non-floating boards, using replaceable-point plastic pencils secured to the board with thin line (Illus 36).

The initial survey of the wreck and its associated topography covered an area of 35m × 17m, or 595m^2, and took two seasons – 1994 and 1995 – to complete. To ensure the objectivity of what was recorded each feature measuring 5cm or more, including stones, was drawn to scale. Thus, for example, although the two ballast-mounds appear as discrete entities on the finished plan, they are defined not by arbitrarily determined boundary lines drawn around them but as visually identifiable concentrations of large similarly sized stones (cf Barker 1977: 110).

In 1996 contours at 10cm intervals were superimposed on the two-dimensional survey. Trials aimed at determining the best method of doing this had been conducted during the previous season. These included a simple barometric device calibrated against a constant sea-bed datum to accommodate tidal changes (Martin 1983: 43), physical depth-measurements taken in flat-calm conditions from a tape attached to a surface buoy and time-co-ordinated with readings taken from a calibrated tide-gauge on the surface (Illus 37), and finally a digital depth-gauge constantly checked against the primary depth-datum C (Illus 38). Surprisingly, the last technique proved to be the simplest and most accurate. Readings were taken at 1m intervals along tape-lines set parallel with the site-datum A–B. Each series of readings was prefaced by a calibration reading at the primary depth-datum, which lay above the level of any of the contour points. The gauge, which recorded metric depths nominally to one decimal point, was then placed directly on the position to be recorded, and slowly raised up a short vertical scale until the decimal point moved to the next figure. The height at which the changeover occurred was added to the recorded depth, and the reading adjusted against a reading obtained by the same method at the primary depth-datum. It had been anticipated that the results would be accurate enough to permit the plotting of contours at 25cm intervals, but in the event a finer resolution was possible, and 10cm contouring was achieved across the site. Independent checks confirmed the general reliability of



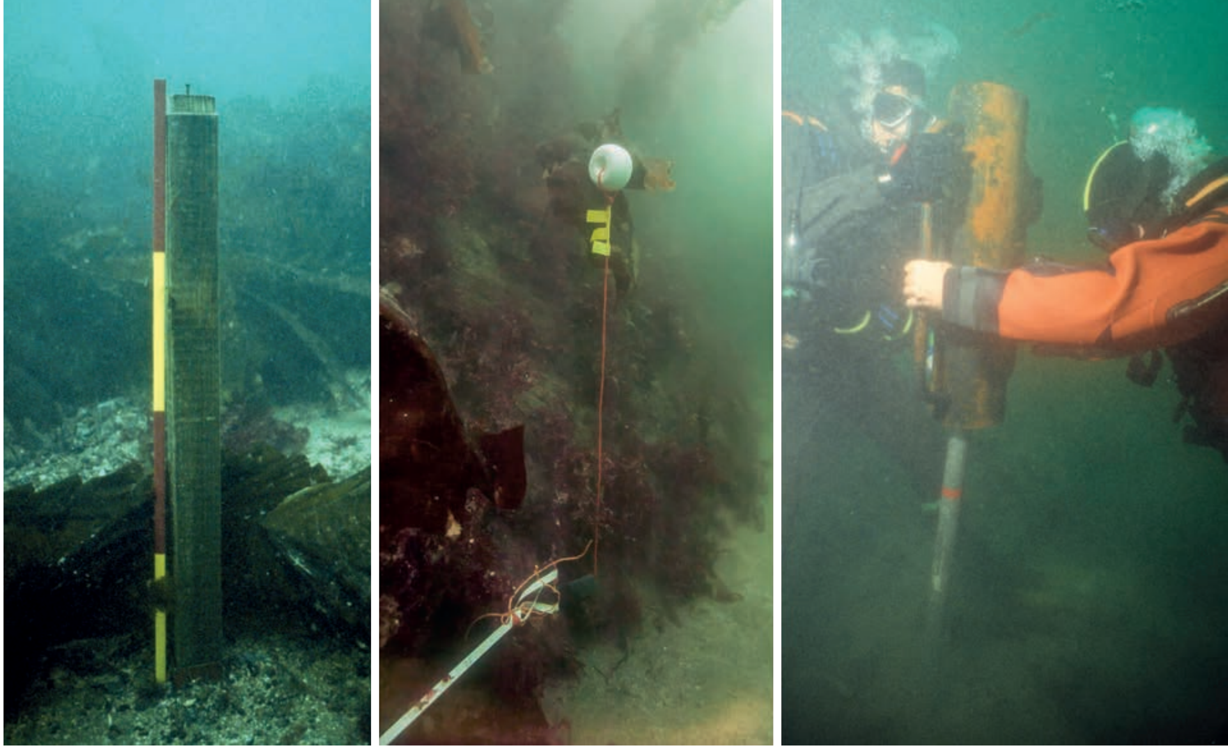


Illustration 29
A network of datum-points being established over the site by tape triangulation from a primary baseline

Illustration 30
Left: datum-post in position on site. Note the nail for securing the ends of measuring tapes. Centre: piton fixed near the base of the cliff, with identifying float (Edward Martin). Right: fence-post rammer being used to drive an aluminium scaffold-pole into sand as a temporary datum (DP 174362)

Illustration 31
Assembled 5m grid of aluminium scaffold-poles being secured to an inflatable boat for transport to the site (DP 174380)

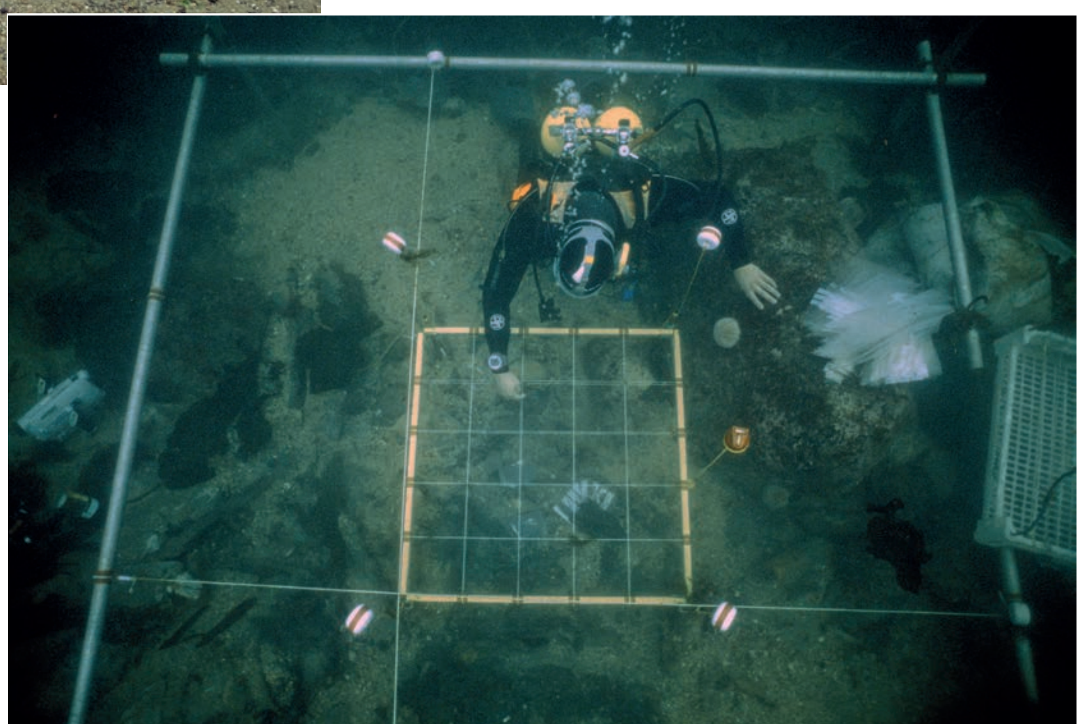


Illustration 32
A 3m grid deployed on the site. Note the stretched bungee datum-lines which have been used to position the 1m drawing-frame (DP 174402)

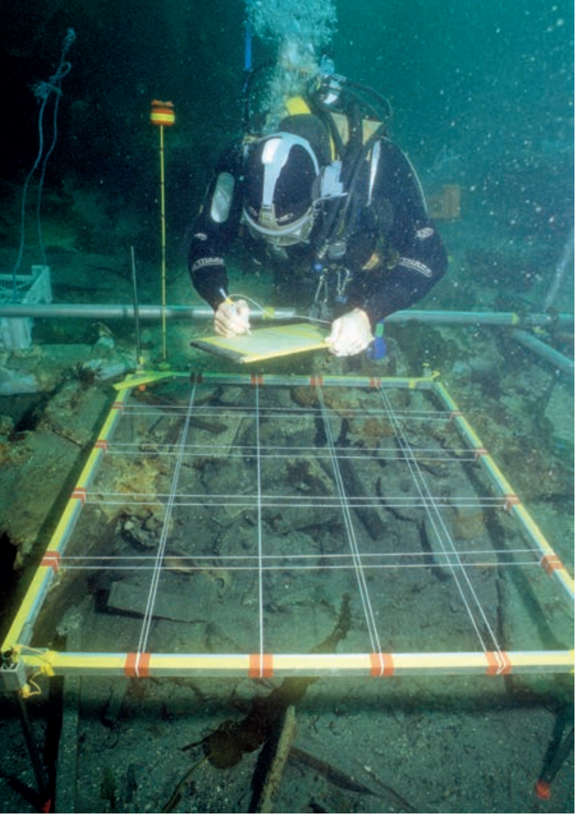


Illustration 33
A 1m drawing-frame, double-strung at 0.2m intervals, positioned and levelled with reference to a grid (DP 174407)

Illustration 34
The underwater equivalent of a plumb-bob is a scaled rod with a weighted bottom and a buoyant top which stands vertically in still water. A two-way spirit-level at the top allows it to be adjusted for accuracy (DP 174391)

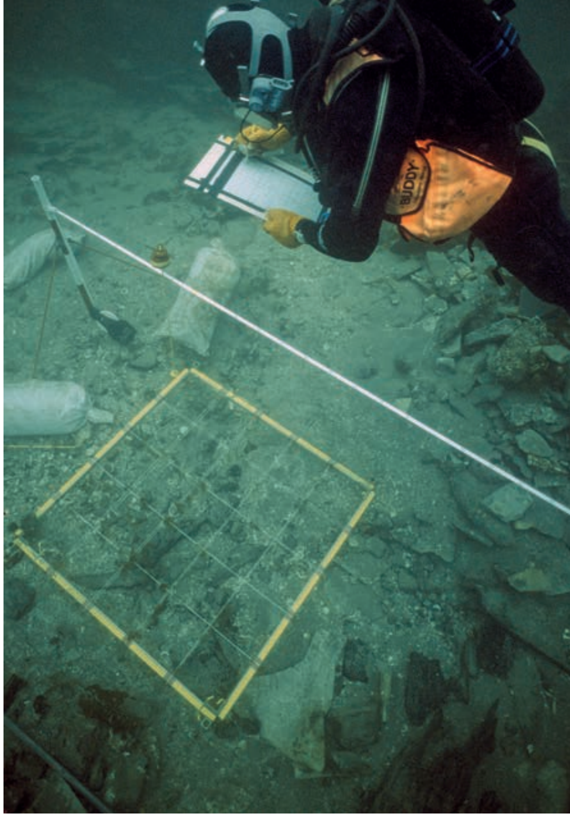


Illustration 35
Recording using a 1m drawing-frame positioned against a tape datum-line. A diver's ability to hover directly above the frame is a bonus of working under water (DP 174425)

Illustration 36
Most primary recording was done at a scale of 1:10 on drafting-film secured to a negatively buoyant board with electrical tape

Illustration 37
The tide-gauge established at the shore/water interface adjacent to the wreck. Its foot is placed at the lowest identified tide level and it rises to a height of 4.5m, covering the full tidal range (DP 174404)

Illustration 38
Recording accurate depths during a contour survey of the site, using a digital depth-gauge (DP 174515)

Illustration 39
Topographical survey of the wreck-site before excavation. Depths below the local site datum, which approximates with Mean Low Water Springs, are shown in red at 0.1m intervals. The primary horizontal datums, from which all subsequent survey has been derived, are indicated as A and B. Vertical datums C and D are also shown

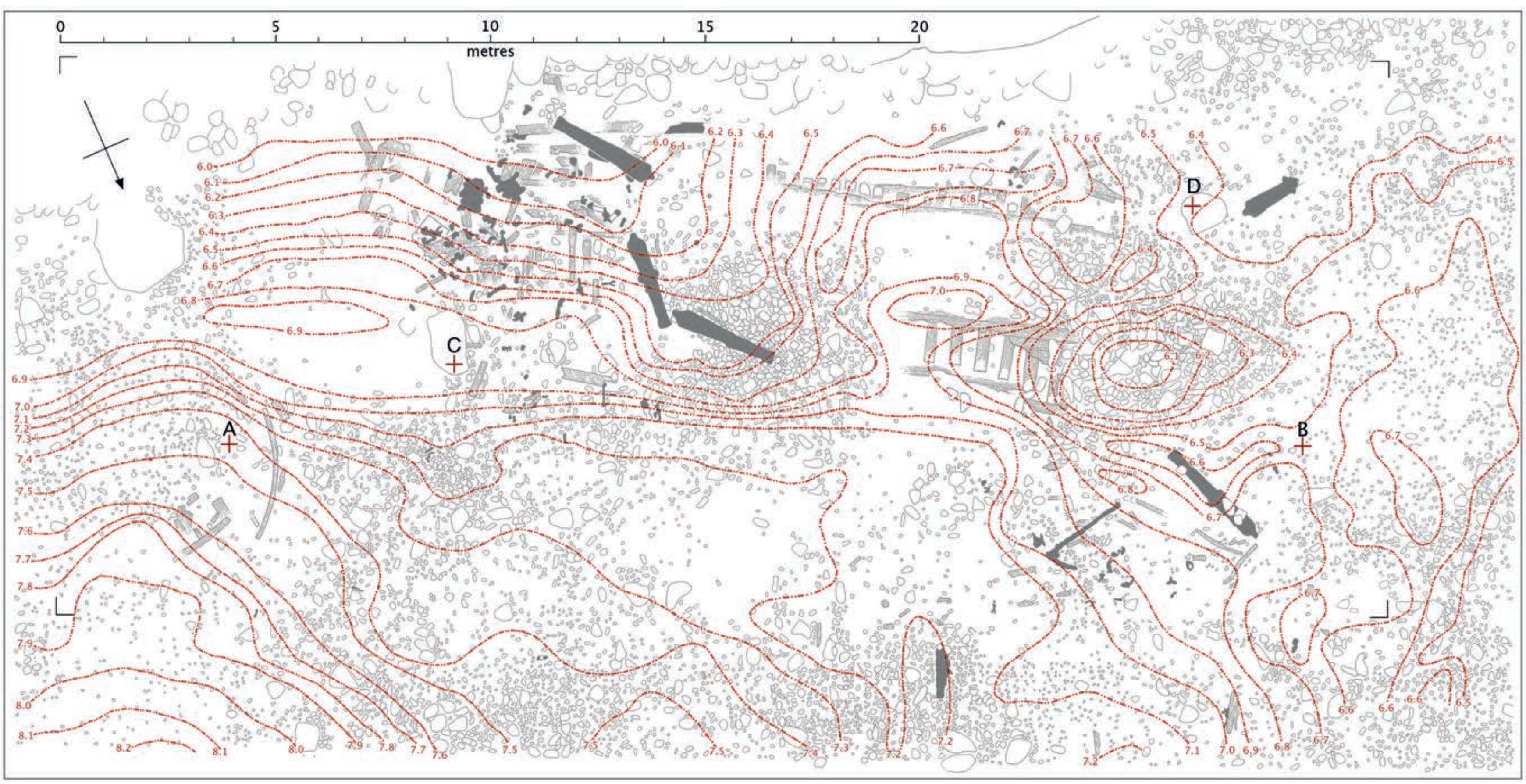
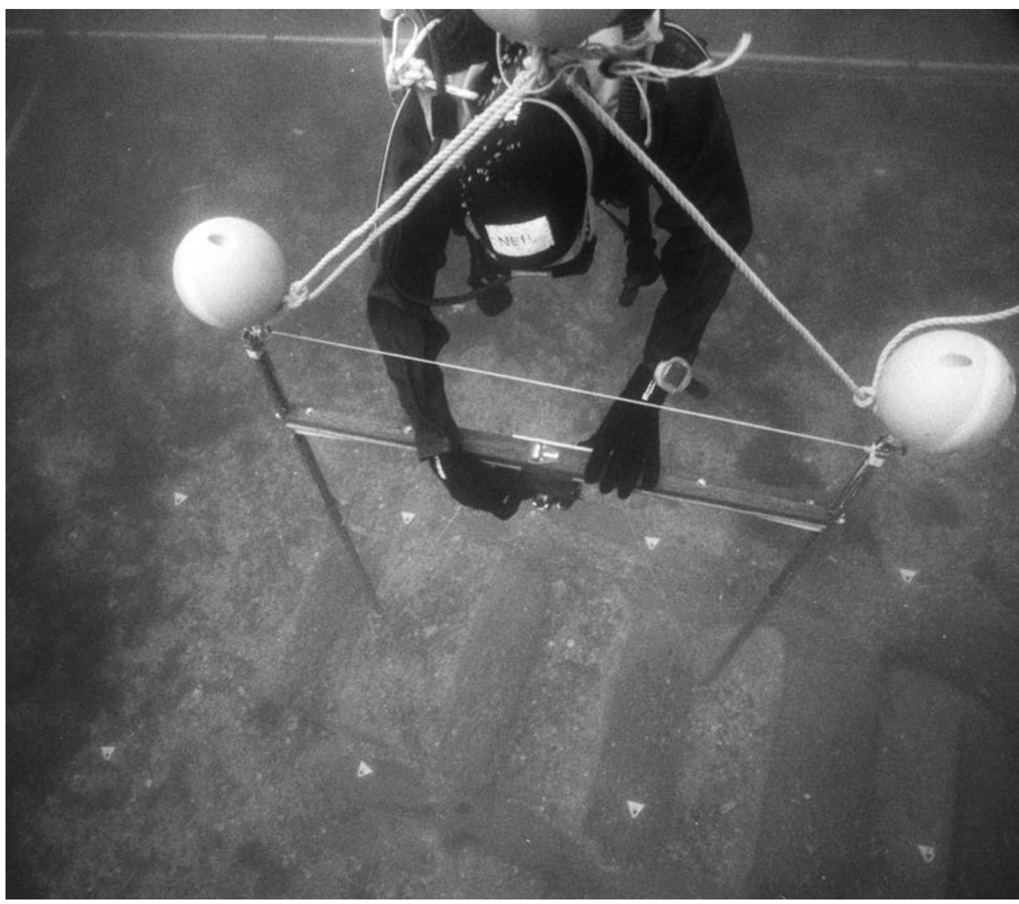


Illustration 40
A photographer recording exposed wreckage (DP 174513)

Illustration 41
A bipod photo-tower was used to record vertical mosaics. Note the run of triangular yellow targets set out at 1m intervals with reference to the site-grid (DP 174466)

Illustration 42
Levelling the bipod photo-tower by means of a two-way spirit-level (DP 173135)



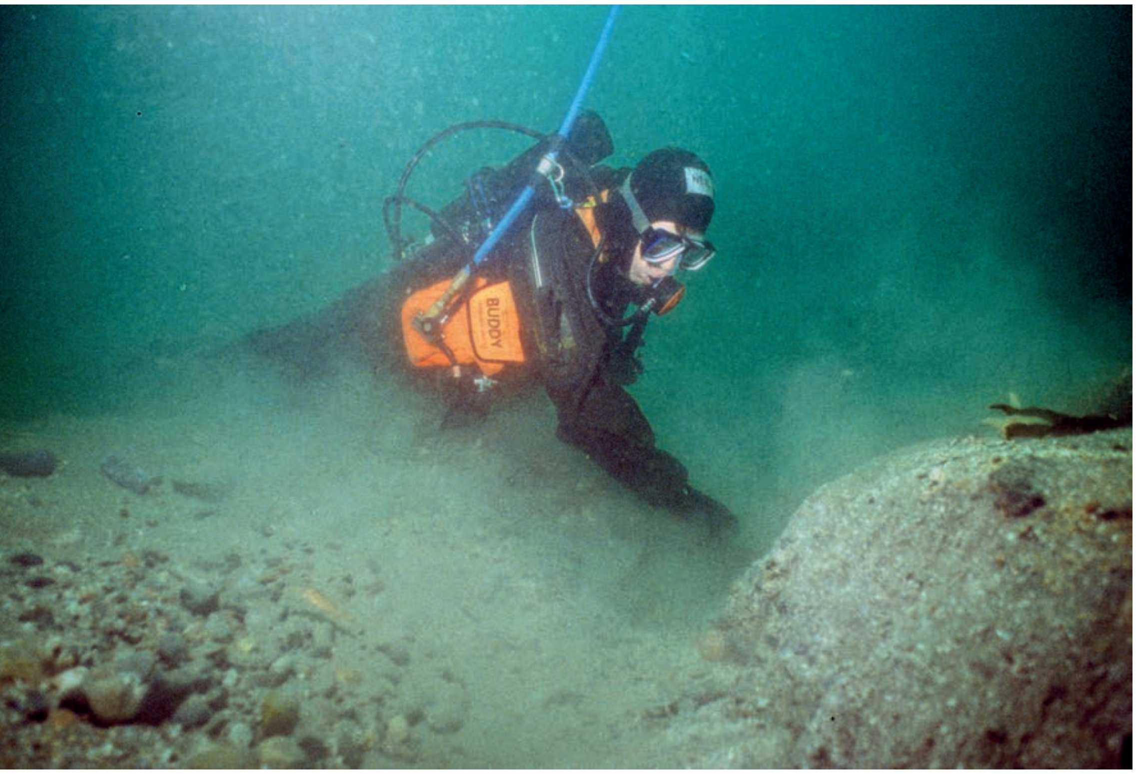


Illustration 43
The hand-fanning technique of area excavation (DP 174477)

the method, and the result conveys the actuality of the sea-bed configuration with remarkable subtlety (Illus 39).

Photographs were taken at all stages of the work, to record features, artefacts in situ, and general activities on the site (Illus 40). Nikonos V cameras were used under water, with 35mm, 28mm, 20mm and 15mm lenses, flash and close-up attachments as required. Attempts to produce mosaics from free-swimming runs of vertical photographs were of limited success, so a free-standing photo-tower was developed which allowed accurate control of height, positioning, and verticality (Illus 41–2). The photographs were subsequently rectified and joined in Photoshop (Martin & Martin 2002). A video record of operations above and below the water was made throughout the project.

Although the same principles of archaeological excavation on land can and should be followed under water (Bass 1966), there are some practical differences in applying them. On many sea-beds, including that at Duart Point, loose material at the sediment/water interface is generally in a semi-fluid state. Surface-levels are therefore prone to disturbance by water-movement, whether of natural or anthropogenic origin. However this characteristic can be exploited by the excavator, using a hand-fanning technique to displace the sedimentary matrix (Illus 43). Applied vigorously, this is akin to using a shovel to shift spoil on a terrestrial site, while a gentle waggling of the fingers is equivalent to a sensitively applied trowel or brush for delicate work. Water is an excellent sorting medium, and with practice hand-excavation under water can be conducted to at least as high a standard as can be achieved on land (Barker 1977: 92–5).

The down-side is that it is difficult, and sometimes impossible, to expose and clean discrete areas for leisurely recording. For one thing the angle of repose of the excavated sediment (typically 45° in loose sand) militates against creating vertical sections. For another, intrusion into the sea-floor creates an environmental imbalance which nature strives to reverse. Loose weed and silt are apt to gather in trench-bottoms between dives. Suspended sediment will fall constantly on features cleaned for recording or photography. Stable deposits, once

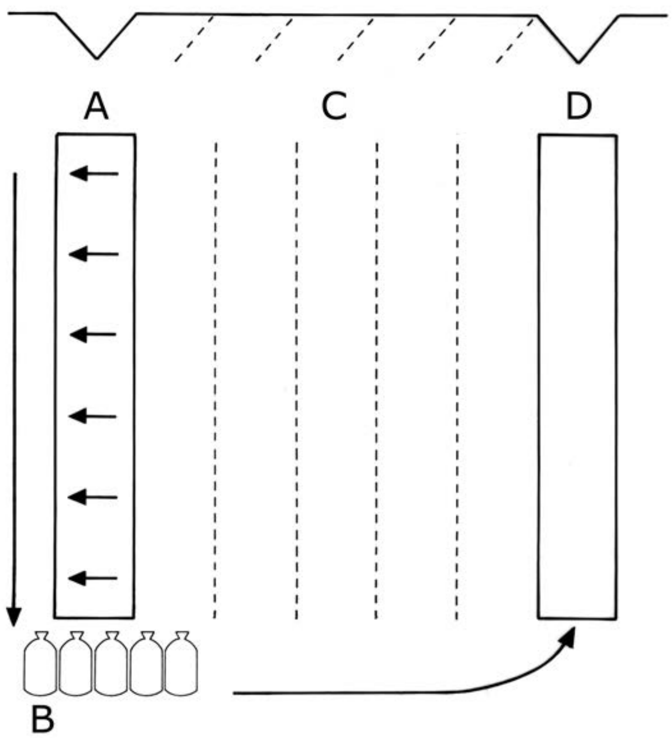


Illustration 44
Diagram explaining the 'advancing front' method of area excavation. Arrows indicate the transport of spoil. (A) is the initial trench; (B) the spoil from it; (C) the faces in which stratigraphy can be recorded; (D) the final trench, which can be filled with the bagged spoil (B)

Illustration 45
Tray containing items for finds management, including bags of lead pellets for securing delicate objects during retrieval, bandages, photographic scales and targets, various sizes of polythene bags for finds, and stretched bungee lines for securing bagged finds with clothes-pegs. The archaeologist is detaching a uniquely numbered label for insertion with a find (DP 174494)

uncovered, often become unstable. Spoil can build up and inhibit excavation, and even if dumped some way distant may still be prone to unpredictable redistribution. Finally storms, or unforeseen events such as yachts anchoring or fishing tackle dragging across sensitive areas, may seriously disorganise or damage an underwater archaeological site, especially when areas are exposed during excavation.

Most of these difficulties can be mitigated by appropriate procedures and good management. Spoil can be dealt with by removing it to a safe place by hand-shovel and bucket, or bagged and stacked in temporary dumps (at Duart this was a convenient way of filling sandbags for stabilisation purposes). Area excavation is only practical when a large coherent feature

Illustration 46
A fragile leather shoe immediately after excavation. Scale 15 centimetres

such as an element of hull-structure or a substantial deposit of compacted wreck-material is to be uncovered. A revetment wall of sandbags can be used to stabilise the edges of the opened area, and help to keep out weed and silt. Another approach, suitable for excavating loose deposits containing

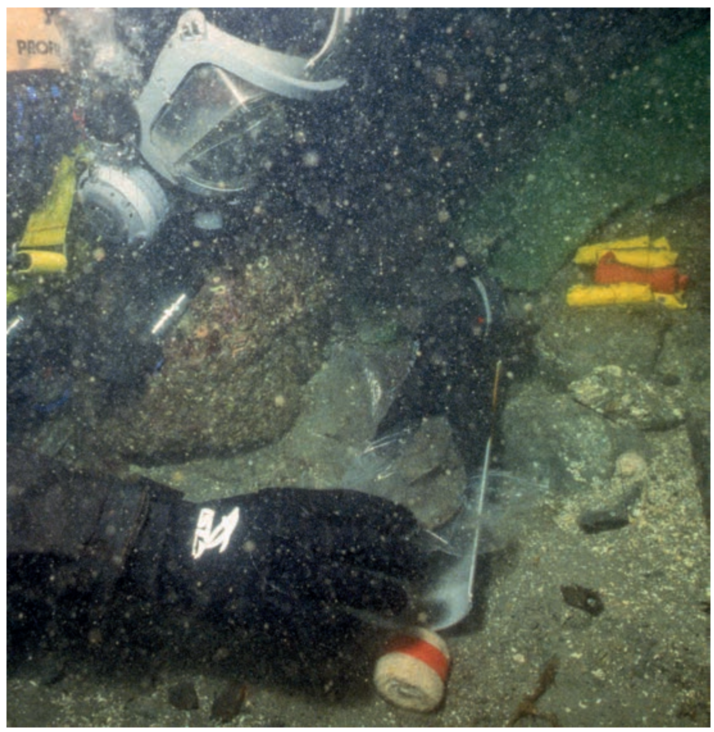


Illustration 47
The shoe, now in a polythene bag, is placed into a short length of plastic guttering before being secured with a bandage. The rolled bandage, with a lead weight at its inner end to ballast it and an easily detached wrapping of electrical tape, is placed close to hand (DP 174486)

Illustration 48
Part of the wooden gun-carriage 83, secured to a supporting former with bandages, is prepared for lifting. The rope strops are surrounded by expanded polystyrene tubing to avoid damage to the wood (DP 174580)

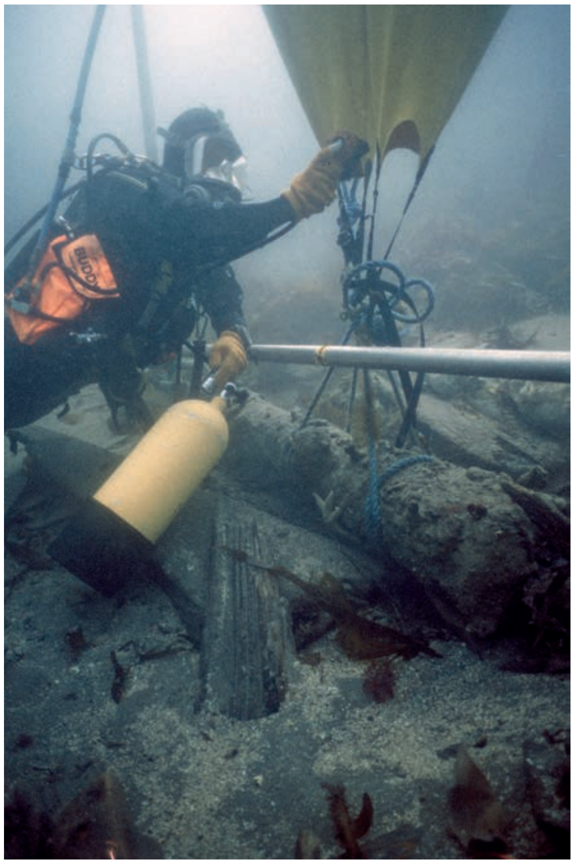


Illustration 49
Raising the concreted iron gun 82 by means of an air-bag, inflated from a high-pressure cylinder (DP 174543)

Illustration 50
The iron gun 82, its concretion removed, in the hands of conservators at National Museums Scotland (DP 174570)

scattered archaeological features, is to cut a trench across one end of the proposed excavation area to the depth required. The amount of spoil to be removed will depend on the angle of repose. Material from the initial trench is bagged and set aside. The trench is then taken forward on an advancing front, its face presenting a running section which provides stratigraphic reference for features located within it. When the end of the excavated block is reached a trench of the same dimensions as that created at the beginning will remain, and this can be filled with the bagged spoil, leaving the sea-bed in the same configuration as before, much as a garden plot is dug in a series of spits (Illus 44).

Spoil can also be removed by suction devices such as a water-dredge or air-lift (Martin 1983: 50–2), but the outfall is difficult to predict or control, and after some experiments with a dredge at Duart Point it was decided that the hand techniques described above were better suited to the requirements of this site.

Finds-management under water requires simple and well-organised routines. The system used at Duart Point involved a plastic baker's tray, ballasted with lead to ensure negative buoyancy. It was strung with stretched bungee cords to which bagged finds were attached with plastic clothes-pegs, and provided with strops to ensure a level lift to the surface. Swatches of self-sealing polythene bags of various sizes were secured to the tray with cable-ties so that individual bags could be torn off as required. Lead tags faced with plastic insulating tape on which unique finds identification-numbers were written were strung on a length of line so they could be accessed sequentially. For robust finds, the tags were inserted directly into the bag; while for delicate items the tape bearing the number was peeled off the lead backing and inserted on its own. A swatch of drafting-film notelets was provided for recording information for inclusion with the bagged finds (Illus 45).

These procedures were adequate for a majority of finds, but on occasion large or delicate items required individually tailored approaches. Objects such as leather shoes were undercut for the insertion of a supporting plastic sheet or piece of guttering pre-cut to size, to which they were secured with bandages before removal and placement into suitably sized containers (Illus 46–7). Larger items, such as a wooden gun-carriage and a complete framed-and-panelled door, were placed on pre-constructed wooden stretchers ballasted with lead, to which they were secured with crepe bandages (Illus 48). Foam cushioning was provided at points of contact. Heavy lifts, such as the cast-iron gun raised for further study, were accomplished with the aid of air-bags and flat webbing strops (Illus 49).

Finds were processed and documented before being stored wet or dry, as appropriate, prior to transport to the National Museums' conservation facility in Edinburgh (Illus 50). Where their condition allowed they were drawn and photographed before conservation, so that subsequent dimensional or other changes could be recorded.

Chapter 3

ARCHAEOLOGICAL INVESTIGATION

3.1 Site description and topographical survey

Duart Point touches the line of the Great Glen Fault, a geological divide which extends from a point south-west of Mull via Loch Linnhe, Loch Ness, and the Moray Firth to the Shetland Islands. It is the most seismically active fault-line in Britain, with 60 tremors recorded in the past 200 years, the strongest of which was in 1816 (Gillen 2003: 72–3). The site is adjacent to a volcanic caldera of great complexity (Emeleus 2005: 473), and Duart Point is characterised by earlier basaltic lavas which formed around the periphery of this caldera (Illus 51–2).

The wreck-site is sheltered by high ground from most directions. The south-west quarter is protected by the central mountains of Mull, some 6km distant and rising to 950m. Much of the north is screened by the lower and more distant hills of Morvern, while winds from the east are moderated by the mainland Highland massif, 20km away. The site's main exposure to wind comes from the narrow sea-loch corridors which extend to the north-west and north-east. To the north-east Loch Linnhe presents a 30km fetch of open water, but although strong winds from this direction can generate significant wave-movement down the loch, it is moderated by the island of Lismore, beyond which it tends to pile into steep and short configurations. When these partly dissipated waves encounter the complex tide-rips north of Duart they mingle in low-energy confusion before reaching Duart Point, and appear to have little effect at sea-bed level on the wreck-site. The 30km fetch which extends north-west up the Sound of Mull (Illus 51) behaves rather differently. Wind from this direction is funnelled by the hills on either side to generate longer and more regular wave-pulses with higher energy-potential, which is released when they break on Duart Point and around the shallow margins of Duart Bay (Illus 53).

Duart Bay is a sheltered anchorage in winds from the south-east to west, though it is exposed to the north-west and north-east quarters. For this reason the Maclean galleys were traditionally kept in the largely land-locked Loch Spelve on the south-east side of Mull, some 15km from Duart (Turner & Finlay 1971: 21; RCAHMS 1980: 120). Close to the castle, however, a natural inlet with a beach at its head is still known as Port na Bírlinn (galley harbour) and here no doubt the chief's personal vessel was drawn up when not in use (Illus 54).

There is little water-movement around Duart Point during the flood tide, but throughout the ebb a strong current flows from north-west to south-east, reaching a surface speed of up to 2 knots during spring tides. This movement is evidently caused by the large volume of water which accumulates in Duart Bay as the tide rises, entering on a broad front from the north until high water is reached. During the ebb, however, some of the emptying water is deflected eastwards to flow in a clearly defined stream across Duart Point, eventually discharging into the confused waters where the Sound of Mull, Loch Linnhe, and the Firth of Lorn meet (*Admiralty Chart 2390* 1976). Just to the east of the Point, where the wreck lies, the inner run of the stream breaks off to eddy shorewards (Illus 55). When the ebb-current coincides with strong north-westerly winds a secondary effect is triggered. The pulses of waves which build up as they move unimpeded along the Sound break violently in the shallow fringes of Duart Bay, displacing large quantities of sand during the rising phase of the tidal cycle. Much of this material remains in suspension when water drains out of the bay on the ebb, to be carried with the stream which runs across Duart Point. Under such conditions the discoloured flow is clearly visible, its offshore edge sharply distinct against the clear water beyond (Illus 56). This phenomenon has had a significant effect on the wreck's site-formation characteristics, as explained below.

East of Duart Point a fissured rock-face slopes from the surface at an angle of *c* 35° to a sea-bed of gravel, sand, pebbles and shells among which the remains of the wreck lie at a depth of *c* 7m below Mean Low Water Springs (Illus 57–8). There are some intrusive boulders and larger rocks, most of which were probably carried to the site by glacial action. The more substantial of these appear, from their relationship to archaeological deposits in their vicinities, to have been stable during the recent geomorphological past, and were probably in the same locations when the wreck took place. This was subsequently demonstrated by the way in which archaeological remains sometimes appear to have been

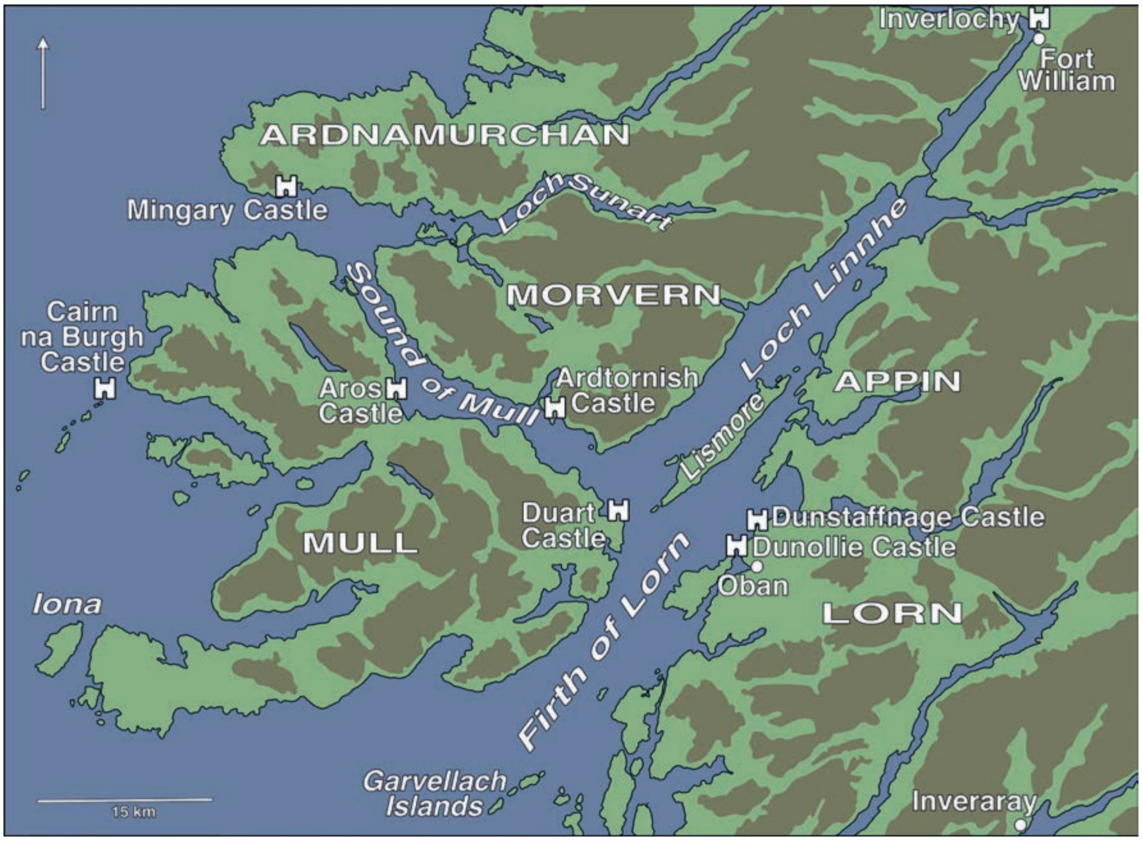


Illustration 51
The Sound of Mull and adjacent seaways (Edward Martin)

Illustration 52
The geology of Mull (Edward Martin, adapted from Gillen 2003: 157 & Emeleus 2005: 72)

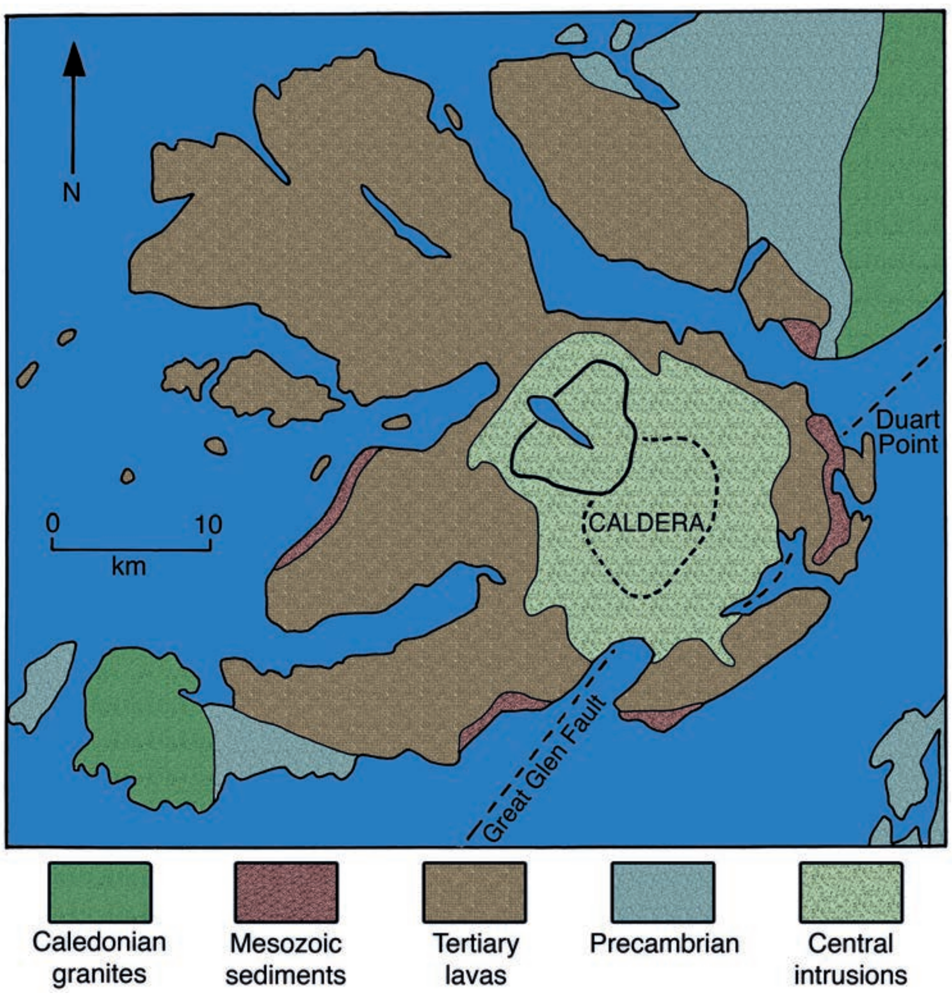


Illustration 53
Duart Point and Bay from the east, photographed at low water. Note the Bay's wide and shallow sandy fringe with deep water beyond (DP 173096)

Illustration 54
Duart Point and Castle from the south, with the wreck-site arrowed. The sandy beach at the head of Port na Birlinn is at far left (DP 173100)

Illustration 55
View from the shore adjacent to the east end of the wreck, looking north-east. The strong easterly run of the tide is evident in line with the inflatable boat, with eddies curving from it towards the shore (DP 173709)

restrained or deflected by a rock, and are not trapped beneath it. This is particularly evident around the large boulders at Datums C and D (Excavation Plan). Various mechanisms may, however, have displaced smaller stones, while the semi-fluid sediments which characterise much of the site are clearly susceptible to rapid and significant removal, accumulation, and redistribution by water-movement.

Illustration 56
View from the top of the castle looking north-west across the wreck-site at mid ebb tide in a Force 7 north-westerly wind. The inshore run of silt-laden water, with its sharply defined seaward edge, is strikingly evident (DP 173703)

Depth at low spring tides at the foot of the slope is *c* 6m, increasing to *c* 8m at the seaward extremities of the wreck. Thereafter the sea-bed slopes gently seawards across a relatively featureless bottom to reach the –10m contour 12m from the shore and the –50m contour some 200m further out. The tidal range at springs reaches 4m. There is a pronounced sediment drift eastwards along the base of the cliff, particularly towards the eastern end of the wreck. The general environment of the site, as indicated by its biological regimes, includes low-, mid-, and relatively high-energy zones as categorised by Erwin and Picton (1987) (Illus 58). These are conveniently defined by the distribution of *Laminaria* species, with *L digitata* dominating the high-energy zone, represented by the inshore rock-face, *L hyperborea* defining the mid-energy zone which covers the main wreck area, and *L saccarina* occupying the low-energy sedimentary zone which slopes gently to seaward. Where no algae are present, the latter zone is also readily defined by the habitat limits of creatures such as sea-pens (*Pennatula*) and the common scallop (*Pecten maximus*).

When first investigated in 1991–2 the visible remains comprised seven heavily concreted iron guns, a small iron anchor, various iron concretions and concretion complexes, two distinct mounds of stone ballast, and considerable quantities of wholly or partially exposed organic material, including elements of articulated structure lying between the two ballast-mounds and clearly continuing beneath them. Some abraded loose timbers, evidently recently displaced, lay scattered across and down-tide of the main wreck area.

It was presumed, and later confirmed by excavation, that the western ballast-mound defines the forward end of the wreck, while the eastern mound lies towards the stern. The latter extends some 5m along what proved to be the longitudinal axis of the ship, and measures *c* 4m athwartships. Its starboard (seaward) edge rises *c* 0.6m above the adjacent sea-bed, while on the port side it merges into a rising spur of drifted silt along the cliff-base, leaving its edge and height on this side uncertain. The western mound is more clearly defined, with a distinctly rounded forward edge. It measures 5m × 4m and rises 0.4m above the mean sea-bed level. Within the central hollow between the mounds a run of structure was partly exposed at the time of discovery, its axis defined by a much-abraded longitudinal member which proved to be the keelson. Associated with it are further structural components. Their starboard (seaward) ends are angled upwards, and plainly undergoing active erosion. These timbers include frames, outer planks, and ceiling planks.

A further group of timbers is exposed 3m to port. These comprise a closely spaced linear run of frames set at right-angles to the keelson, heeled towards the shore at about 15°. Their abraded upper ends are ground to flat conformity with the sea-floor. They too are associated with ceiling and outer planking, and appear to follow the upwards curve of the bilge, where floor and futtock timbers overlap.

Two concreted iron guns lay on either side of the western ballast-mound, one beyond each of the port and starboard quarters (Guns 6 and 4). A small anchor also lay off the starboard side. There was a lack of ordnance around the midships area, where the main complement of a warship's armament would normally be located. Two guns lay atop the aft ballast-mound (Guns 2 and 3), with a further two (Guns 1 and 5) on its port side, one of them (Gun 5) partly buried in the drifted silts at the base of the cliff. A seventh piece (Gun 7) was located some 7m beyond the starboard edge of the wreck, where it had evidently been dropped during an early salvage attempt (John Dadd pers comm). This gun is either very small (the concretion measures only 1.25m long), or broken.

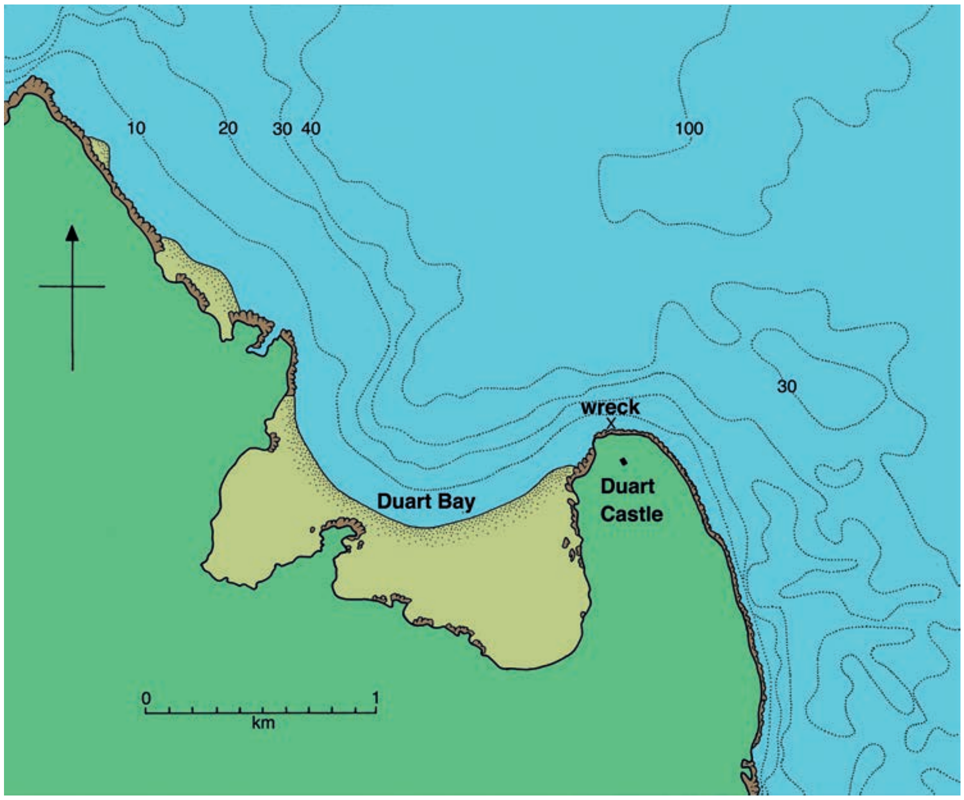


Illustration 57
Duart Point and Bay. Depth contours in metres (Edward Martin, adapted from *Admiralty Chart 2390*, 1976)

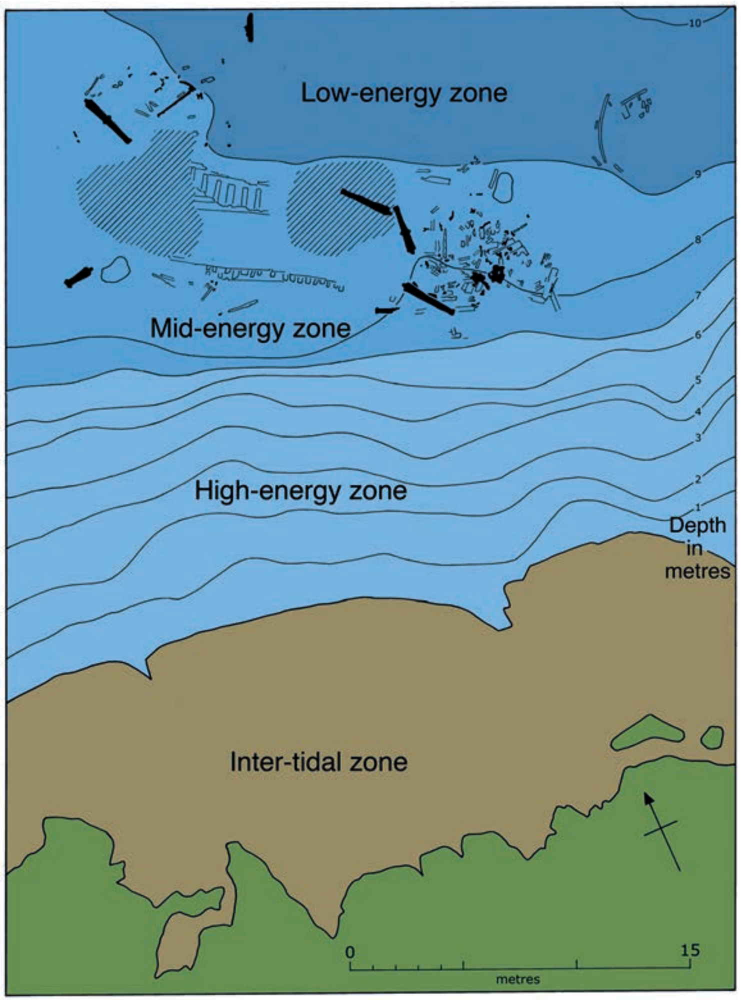
East of a line defined by Guns 1 and 2 the base of the cliff is penetrated by a broad, shallow gully which rises southwards towards the shore. Beyond the wreck area it is blocked by a tumble of large boulders. In the sediments around the mouth of this gully the main exposure of organic material was observed in 1992, and it is here that the eddying effect of the ebb-tidal current, noted above, is at its most pronounced. Further loose timbers and articulated panelling were recorded at the time, including a large curved piece which has since disappeared (Steve Liscoe pers comm). Just down-current a more stable sub-formation of timbers had been partially uncovered by the falling sea-bed levels. Some 10m north-east of the main wreck deposit another small and apparently isolated eroding organic deposit centred on **01.01** was noted.

3.2 Excavation

The phases of excavation are described progressively from the grid origin at its north-east corner (**000.000**) (Illus 59). The sequence of sub-units moves from the outlying deposits identified down-current of the main wreck area (lower left on the plan), and proceeds from the collapsed stern of the ship to the hull's forwardmost identified extremity beyond the western ballast-mound (far right). Descriptions of the archaeological deposits and their stratigraphical relationships with natural features follow the same sequence, and inform the interpretation of site-formation processes developed in Chapter 4. For descriptive convenience the excavated areas are divided into eight sub-units, described sequentially below. Each sub-unit plan is reproduced at a scale of 1:40, with associated sections. A plan of all the identified frames and floor-timbers is also provided (Illus 60). Because a complete run of frames is obscured by the two ballast-mounds, they cannot be numbered in sequence. Accordingly each frame has been identified by the distance in metres from its centreline to the centreline of the Master-Frame ⊗, followed by the letters A for aft or F for forward. The final Excavation Plan at a larger scale can be found at the back of this volume.

Area 1: south-east sub-formation

During the site assessment by the Archaeological Diving Unit in 1992 recently exposed panelling and eroded timbers were noted some distance to the south-east of the main wreck complex. Excavation in 1996 revealed a small sub-formation of material which had evidently become detached from the stern at an early stage of the wrecking process (Illus 61). The deposit was dominated by a heavy oak timber, 3.5m long, running from **011.003** to **041.022**, which despite heavy abrasion on all its surfaces could be identified as an external transom-beam

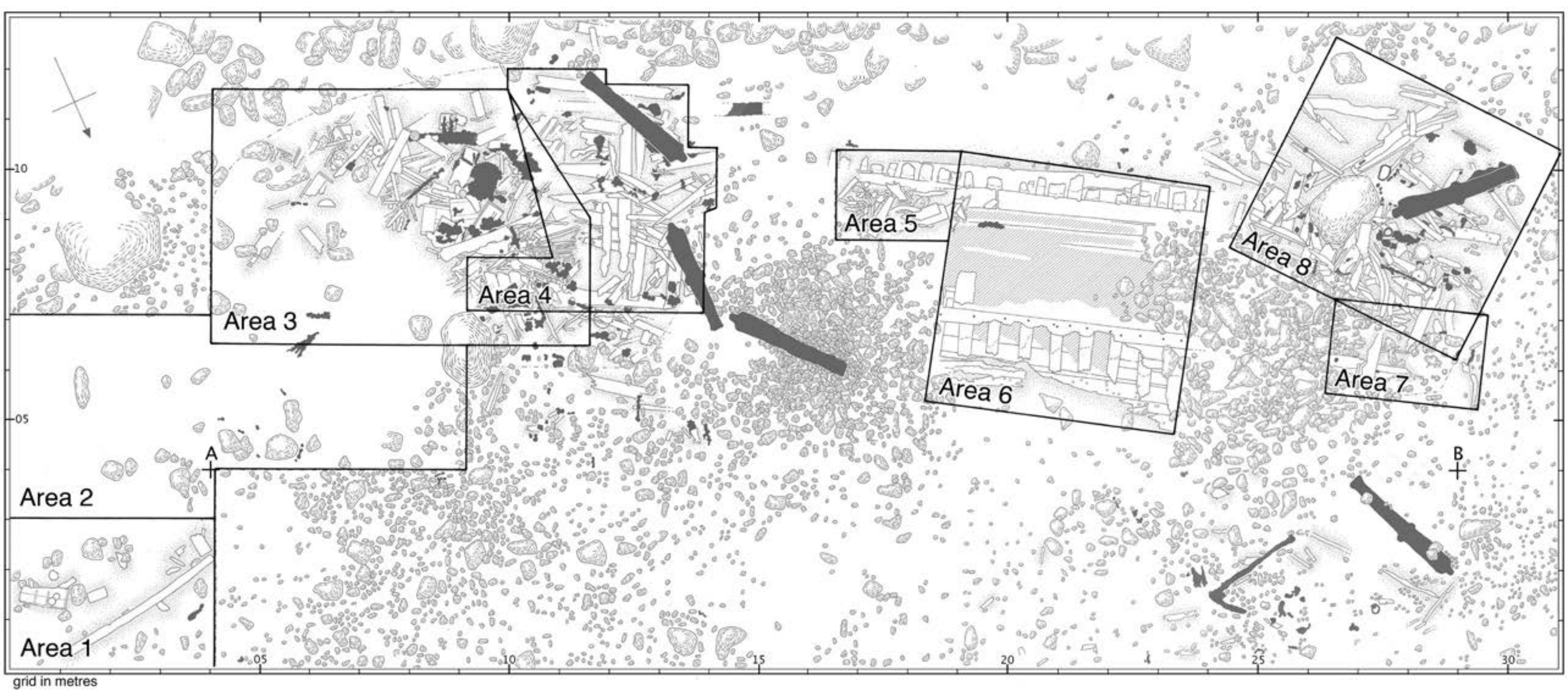


from the upper-stern structure [1] (Illus 62). Traces of raised decoration were visible near its presumed starboard end, while the outer surface showed evidence, in the form of unabraded joint-faces with fastening-holes, of six uprights which had been attached along its length. A fragment of one of the oak uprights remained in place. The unabraded character of these faces contrasts with the degraded surfaces everywhere else on the timber, suggesting that the uprights had remained in place for some time after deposition, and may have become detached quite recently.

Associated with this object were other presumed structural timbers, all heavily abraded, and half a barrel-end which showed little evidence of abrasion. Adjacent to the transom-beam, between **002.015** and **012.014**, were the remains of a box-like structure [88] with three compartments (Illus 63). At one end was the base of a mariner's compass. The box was identified as the rear part of a binnacle cabinet (see Chapter 8.1), in which two compasses and a central lamp or candle would have been housed. Although in its original state the binnacle cabinet would have been some 30cm deep to accommodate the gimballed compass-bowls in their compartmented housings, only 12cm now survives, quantifying the extent to which the front part, lying uppermost, had once intruded into and above

Illustration 58
A simplified representation of the wreck features visible on discovery and their relationship to the shore. Contours below Mean Low Water Springs are shown at 1m intervals. Blue tinting represents high-, medium-, and low-energy zones as indicated by the distribution of *Laminaria* species (Edward Martin)

Illustration 59
Numbered excavation areas



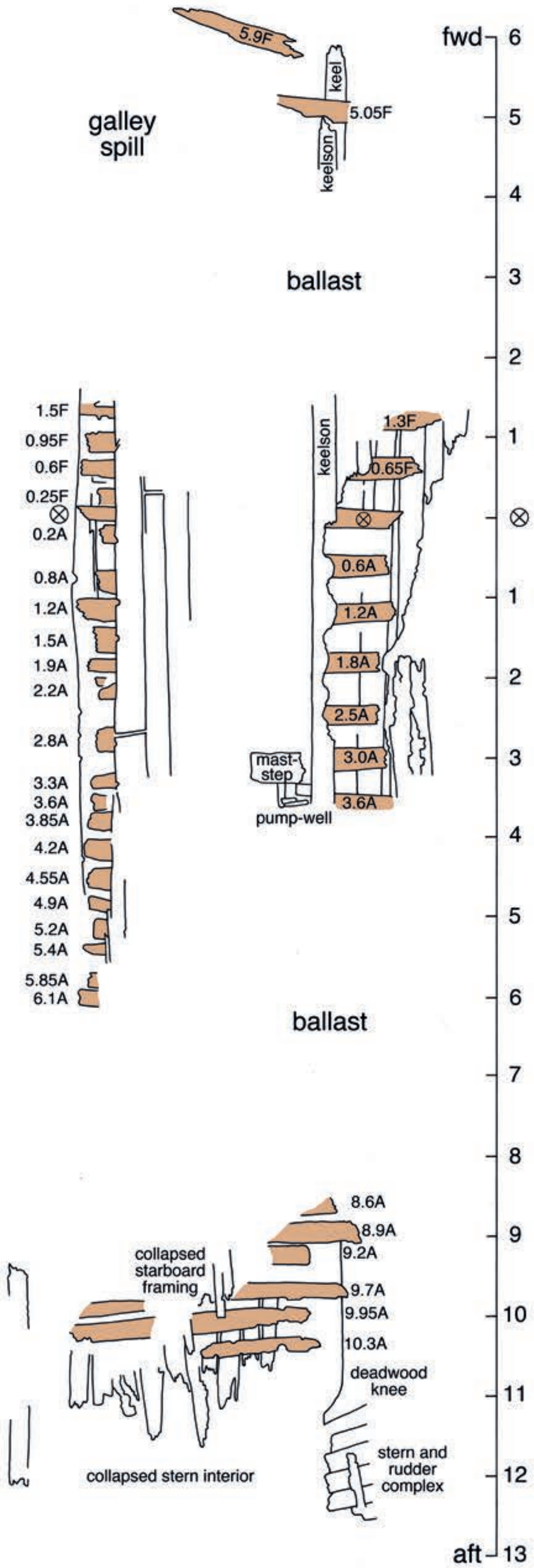


Illustration 60

Plan showing the surviving floor-timbers and frames (tinted). These are identified by their distances in metres forward (F) or aft (A) from the Master-Frame ⊗

the mobile-sediment zone, where it would have been lost to biological attack and abrasion.

The stratigraphy of the first 0.5m is presented in Illus 61. Seven layers can be recognised. Layer 1 at the sea-bed/water interface is composed of fine grey silt, with a few inclusions of small pebbles and shells. Its condition suggests that it is mobile from time to time in currents and surges. Layer 2 is also grey, and consists of a band of silt similar to Layer 1 but with more shells and small pebbles. Layer 3 is a thin spread of larger pebbles. Below it, Layer 4 is a band of fine grey silt similar to Layer 1, while Layer 5 resembles Layer 3 with a spread of larger pebbles. Layers 1 to 5 are penetrated by razor shells (*Ensis siliqua*), including a flourishing live population. Layers 6–8 follow a pattern similar to the upper sequence but without the live razor shells, and are presumably stable. It is not unreasonable to suppose that the fine silts represent transport and deposition during relatively mild storm events as discussed above, while the pebble layers derive from more robust sea-bed agitation during rare 'super-storms' such as the one on 13 September 1653.

The upper edges of both the binnacle and the transom-timber lay at the interface between Layers 1 and 2, while the interior of the binnacle-box appears to have attracted a filling of rather larger pebbles which may have helped to protect it. Though the surviving upper parts of the binnacle have suffered some biological and mechanical degradation, its lower parts are relatively well preserved, the rear planking showing clear tool-marks on its surface. It seems likely that the bottom of Layer 3 represents the sea-bed profile at the time of the wrecking, and that the material above (Layers 2 and 1) is composed of post-wreck sedimentation. This interpretation broadly reflects the interpretation of stratification in an open wooden chest 110, discussed below.

Area 2: between Area 1 and the main wreck complex

In 1997 excavation continued south-eastwards from Area 1 on an advancing front to determine whether a debris-field extended down-current from the main wreck deposits. No archaeological material was encountered, apart from a few small concretions. The relative sterility of this area indicated that the primary wreck formation along the base of the cliff was tightly contained and archaeologically coherent, a conclusion later borne out by excavation. It was from this area that the ADU made some of their surface recoveries (Steve Liscoe pers comm), but this may be material which had migrated down-current from the eroding main deposit.

Area 3: collapsed upper stern and aft interior

Area 3 incorporates the major organic deposit partially exposed by erosion in 1992, and subsequently systematically excavated in 1997 and 1999 to a depth of 0.5m (Illus 59, 64). As

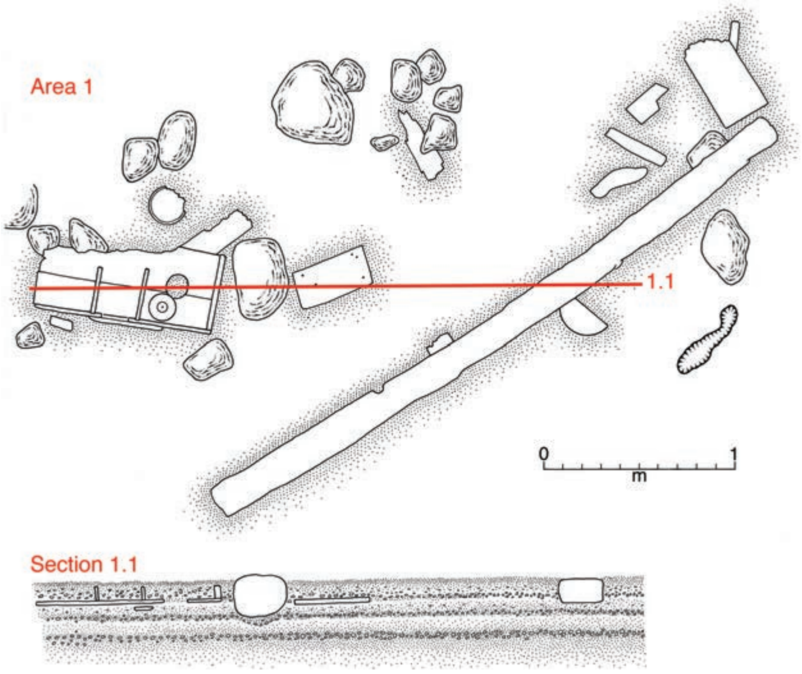


Illustration 61
Plan of Excavation Area 1 and Section 1.1

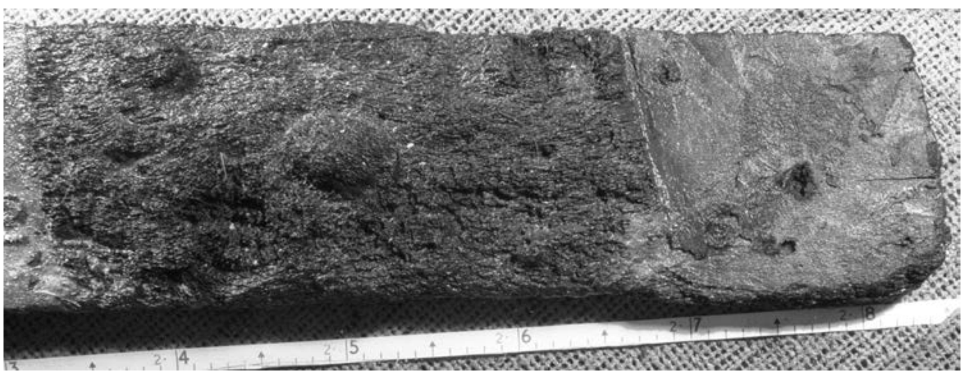


Illustration 62
Starboard end of the transom counter-timber [1] from Area 1. Note that in spite of the heavily abraded surface, relief decoration of a central boss and four smaller corner bosses remains visible. The end is slightly recessed, and shows a joint-face with an unabraded surface, revealing five nail-holes in a quincunx pattern (DP 173183)

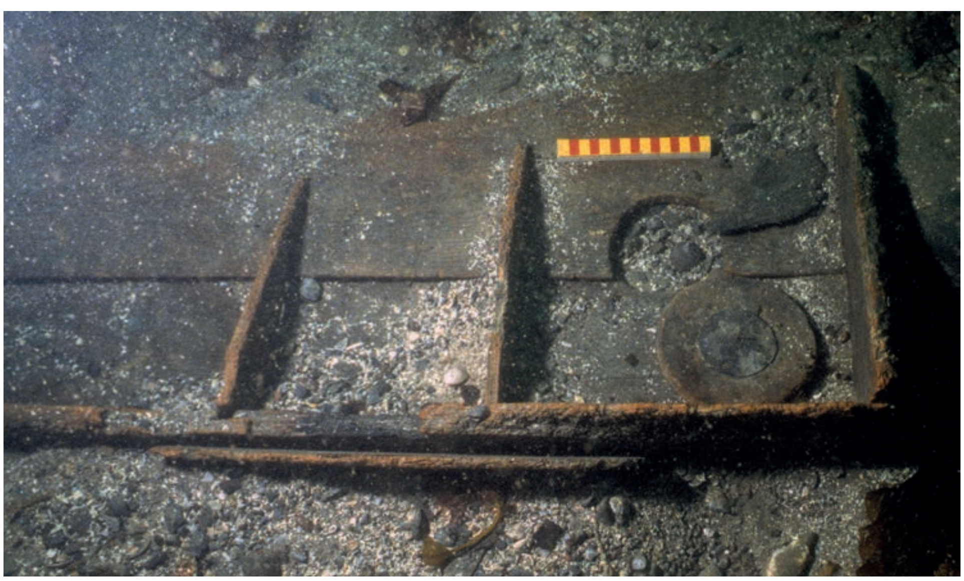


Illustration 63
The remains of the binnacle after excavation. Note the unabraded condition of the lower planks and the compass-base in the right-hand compartment, in contrast to the active biological and mechanical damage along the upper edges. Scale 15 centimetres (DP 174234)

excavation proceeded beyond Area 2, two concretions centred on **058.065** and **063.071** were encountered. Beyond these, at **055.087**, a wooden bowl [179] exposed by erosion was recovered during a winter monitoring visit in 1993. Close by, a substantially intact mariner's compass [91] was found beneath a partly disarticulated wooden structure at **060.095**, which did not appear to be another binnacle. The compass was in good condition. It was inverted, and the remains of its shattered glass face lay beneath it. The base of the instrument had evidently been pushed by water-pressure into the air-filled compass-bowl as it sank, causing it to crack inwards.

Just beyond this deposit, and running in a line from **060.110** to **095.074**, the clearly defined edge of the main organic deposit was encountered. This deposit consisted mainly of substantial and well-preserved timbers from the interior of the ship (Illus 65–7). It included edge-moulded pine planks (Illus 68) and associated turned decoration (Illus 69). A complex stratified deposit comprised a gun-port lid at **088.087** lying on top of a framed-and-panelled door [17] and a run of panelling [21] incorporating four articulated muntin-and-panel sections (Illus 70–2).

Although excavation was not continued below the level of the door, it was evident that more material lay further down, confirming that the deposit was over 0.5m deep and consisted of stratified material almost certainly derived from the interior of the stern cabin. Close by were two small framed-and-panelled cupboard doors [18–19] at **094.096** and **077.103** (Illus 73–4). Other features adjacent to the complex included an oval wooden port-surround (**091.095**) (Illus 75), part of a carved face [6] (**086.095**), and a notched timber [12] identified as a quarter-gallery roof-frame (**085.095**) (Illus 76).

At **093.087/098.094** the remains of a wooden chest [110] lay immediately on top of a run of framed panelling, and was itself partly overlain by a structural timber running from **087.083** to **107.090**. The bottom-board and one end of the chest survived almost intact, while one side was preserved to its original height at one end but had

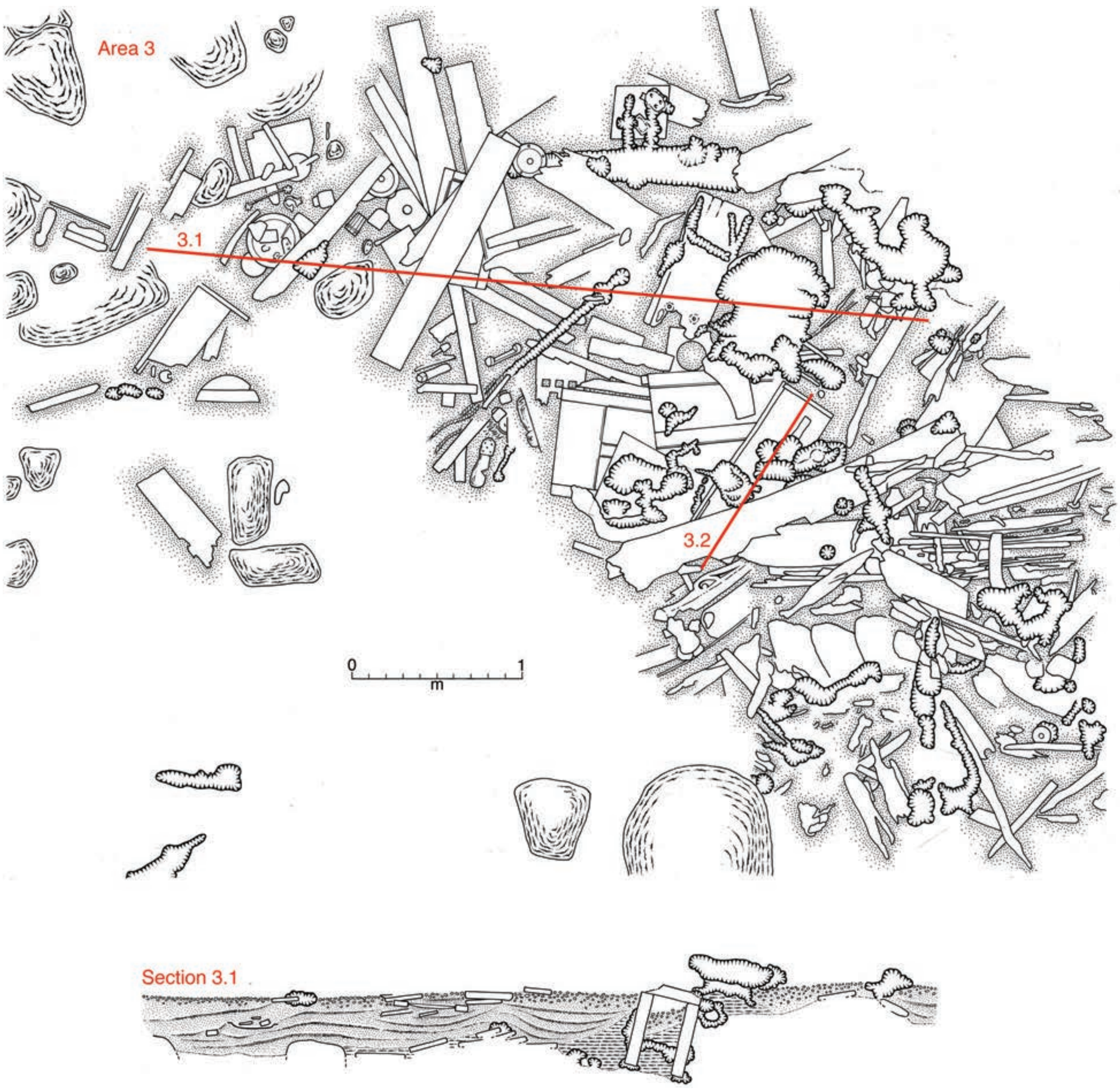


Illustration 64
Plan of Excavation Area 3 and Section 3.1. Section 3.2 is in Illus 78

been almost wholly reduced by abrasion towards the other (see Chapter 8.4) (Illus 77). There was no lid, and no trace of the second side, while only a fragment of the second end survives. In its original state the box would have measured *c* 1.06m × 0.37m × 0.27m deep. Its internal stratigraphy is illustrated in Illus 78. The chest had either been almost empty when deposited, or perhaps had contained perishables of some kind. Lying on its largely intact bottom-plank were two concretions containing three pieces of cast-iron roundshot 86 (the only examples recovered from the site), three lead musket balls, and small pieces of wood and fibre. These finds were associated with a layer of fine grey silt mixed with fragmented organic matter (Layer 3). Above it, and continuing almost to the top of the chest, was a homogeneous matrix of similar grey silt without organic inclusions (Layer 2). On the top surface of Layer 2 was a single musket ball. The top layer (Layer 1) was a semi-mobile cover of sand, pebbles, and shells characteristic of the natural sea-bed at this location. Its occasional movement will have been responsible for the erosion of the upper edges of the chest.

A small cast-iron gun 82 lay buried between **080.107** and **094.106** (Illus 79–80). Concreted to it, at **087.109**, was an

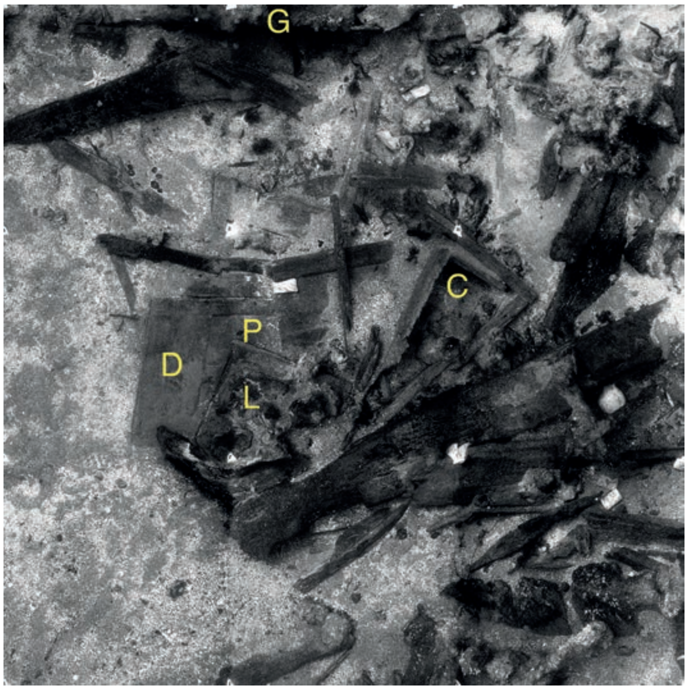


Illustration 65
Vertical mosaic showing the framed-and-panelled door 17 (D), gun-port lid (L), run of panelling 21 (P), open chest 110 (C) and Gun 8 82 (G)

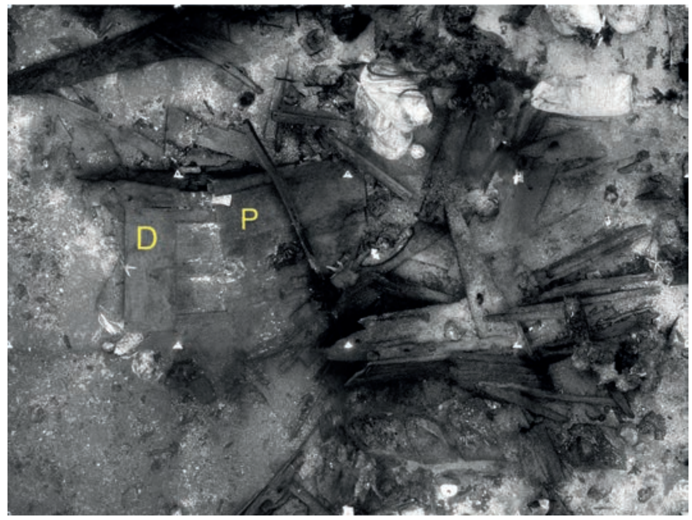


Illustration 66
Vertical mosaic showing door 17 (D) and panelling 21 (P) after removal of the gun-port lid and chest. 1m grid indicated by triangular targets

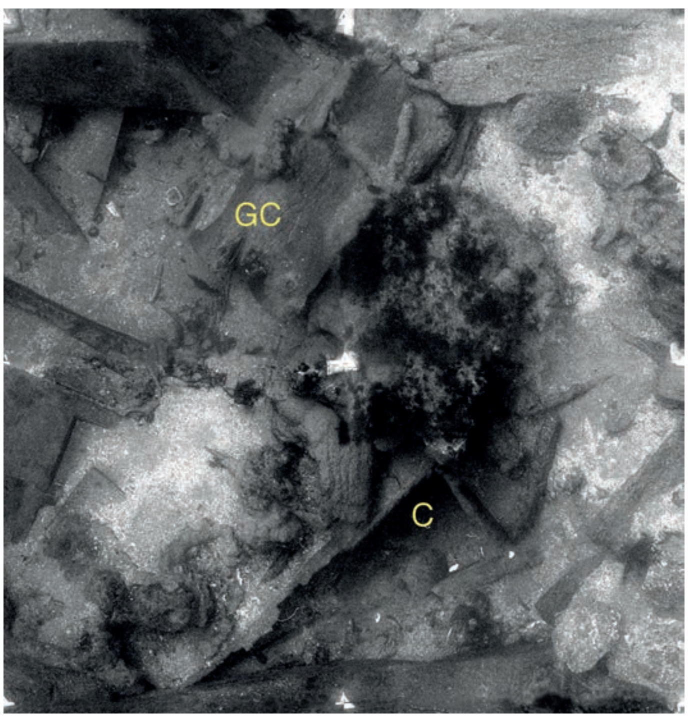


Illustration 67
Vertical mosaic showing detail of the inverted gun-carriage 83 (GC) and the open chest 110 (C)

iron-studded wooden lid with strap-hinges 38, identified as an oar-port lid (Illus 81). Concreted to the cover's ironwork was a wooden deadeye 65 and a square piece of window-glass surrounded by the lead cames by which it would have been joined to its neighbours. Other loose cames 16 were found close by. Adjacent to the gun, at **090.096/093.104**, lay its inverted carriage 83. This area also contained several dislocated elements of the ship's external decorative carving and parts of the outer structure.

Among the collapsed stern deposit various loose artefacts were found (Illus 82–5). These included a wooden lantern-top, sheaves, leather shoes, pump-valves, a pewter plate, and a powder-cartridge box. This deposit also yielded high-status items including a pocket-watch 118, a gold-and-silver sword-hilt 107, and part of a high-quality pistol 104. Most of the decorative carvings came from this area. Lead musket shot and human bones were also present in the silt (Illus 86).

Section 3.1 was recorded between **070.102** and **100.096** from the upper corner of the collapsed stern deposit across the inverted gun-carriage (Illus 64). The timbers lay horizontally within a stratigraphic matrix which consisted of a top layer of mobile sand, pebbles, and shells (Layer 1), beneath which grey silt was interleaved with darker discontinuous bands (Layer 2). It is surmised that the grey silts had accumulated within the wreck from suspended sediments brought in by the current, and that the darker bands derive from rotted seaweed deposited sequentially on the top surfaces of the sediments as they built up (cf the process postulated on the wreck of *La Trinidad Valencera*, Martin 1979: 26–7). Layer 2 was largely devoid of wreck-related material, apart from a small deposit

Illustration 68
Edge-moulded pine planking near the inshore end of Area 3. Note the relatively unabraded state of the lower timbers, in contrast to the highly degraded condition of the rising upper piece, which has clearly lain within earlier unstable levels. The plank in the foreground shows no evidence of degradation apart from the stains of corroded iron nails and, at its top left-hand edge and corner, infestation by barnacles. This pattern is continued by the moulded-edged plank which extends towards the upper left, where the 'tide-mark' between infested and uninfested zones is very clear. The infestation, however, is relatively slight, and may reflect a recent short episode. The edge of a wooden lantern-top 200 can be seen towards top centre: this lies within the previously buried zone and is well preserved. Scale 20 centimetres (DP 173727)

Illustration 70
Collapsed aft interior deposit associated with the framed-and-panelled door 17. The door is overlain by a run of panelling 21 (top, just left of centre) which in turn is overlain by a gun-port lid partly obscured by concretions associated with its iron strap-hinges. On the left is a notched frame-timber 12 from a quarter-gallery roof. Scale 15 centimetres (DP 173890)

Illustration 69
Pine planking in Area 3 showing a turned decorative piece in situ. Scale in centimetres (Steve Liscoe, DP 173695)

containing a pewter plate, a human jaw, and some wooden objects at **067.102**. Beneath it a further stratified level of substantial timbers was encountered (Layer 3). This cut into a thickly matted deposit of wreck-derived organic fragments (Layer 4), particularly around and within the inverted wooden gun-carriage.

Some material from the top of Layer 1 was evidently removed by erosion during the 1991–2 destabilisation episode, revealing previously buried organic deposits and precipitating the rescue intervention of September 1992. The unabraded condition of most of the items exposed at this time suggests that they had been buried shortly after deposition, though some timbers which protruded upwards showed evidence of later episodes of exposure and reburial towards their upper ends.

In summary, it appears that this deposit is derived from the collapsed upper-stern interior, together with elements of the decorated transom and associated structures including a quarter-gallery. Although individual components within the deposit appear disarticulated and confused, the complex as a whole demonstrates high levels of coherence, as indicated by the sharp line which defines its eastern boundary. This is

Illustration 71
The framed-and-panelled door complex after removal of the gun-port lid. Three segments of framed panelling 21 lie on its upper half. Scale 15 centimetres (DP 173139)

Illustration 72
The framed-and-panelled door 17 with the framed panelling above it removed. Scale 15 centimetres (DP 173893)

Illustration 73
Framed single-panel cupboard door 18 overlain by moulded-edged planks. Scale 15 centimetres (DP 173904)

Illustration 74
Framed two-panel cupboard door 19. Scale 15 centimetres (DP 173908)

Illustration 75
Oval port, possibly one of the stern hawse-holes. Scale 15 centimetres (DP 173141)

Illustration 76
Quarter-gallery roof-frame 12. The lower part of a carved moustachioed face is above it, and the bottom corner of the articulated run of framed panelling 21 lies to its right. At top right are the partially excavated remains of the drake gun-carriage 83 with its resident crab inside. Scale 15 centimetres (DP 174043)

best explained as reflecting the rake of the aft transom structure which, it may be presumed, remained in place long enough to restrain the contents of the collapsed interior while they became buried and stabilised within a matrix of deposited silt. The consequences of the subsequent break-up and dispersal of the transom may have included the transportation and deposition of the transom-beam and associated components to Area 1, as described above. Finally, the dislocated but tightly contained nature of the stern deposit as a whole is confirmed by the distribution of bones from a single human skeleton which, though scattered randomly within Area 3 and the adjacent Area 4, do not extend beyond them.

Illustration 77
The remains of a wooden chest 110 after excavation. It was filled with silts which had accumulated following its deposition. Scale 15 centimetres (DP 173925)

Area 4: lower stern structure and collapsed after-framing

Separate phases of excavation in 2000 and 2003 investigated the lower stern structure to the north and west of the collapsed aft interior to determine its relationship to other parts of the surviving hull-remains (Illus 87–8). Because this involved the removal of features associated with the analysis of Area 3, the two areas partly overlap, as shown in Illus 59. The lower structure consists of a complex of articulated oak timbers which can be identified as the fragmentary forward edge of the rudder, the sternpost, and two inner deadwood posts (Illus 89). The concreted remains of what are evidently the articulated lower gudgeon and pintle of the rudder assembly were still in place.

Three upper layers of stratigraphy (Layers 1–3) can be recognised. They consist of alternating bands of stones and shells separated by deeper layers of grey silt, and presumably represent successive episodes of silting and stabilisation. Apart from fragmentary structural timbers and a few small concretions these levels did not contain organic debris or artefacts.

The rudder and sternpost complex had evidently been attached to a heavy oak timber angled upwards at its after end, from which it is now separated by a gap of 0.3m (Illus 90). This may be identified as a deadwood-knee, reinforcing the join between the keel and the sternpost. Excavation to a depth of 0.15m beneath the sternpost/deadwood-knee assemblage failed to locate the top surface of the keel, from which it had evidently become detached. This level comprised a rich organic deposit (Layer 4) around and under the assemblage, containing well-preserved wooden artefacts (Illus 91) together with quantities of fish bones and some animal bones. Three pieces of a human cranium lay beside the rudder. Search for the keel was abandoned because further excavation would have intruded unjustifiably into stable archaeological horizons, but it almost certainly survives in situ at a lower level, since the orientation of the

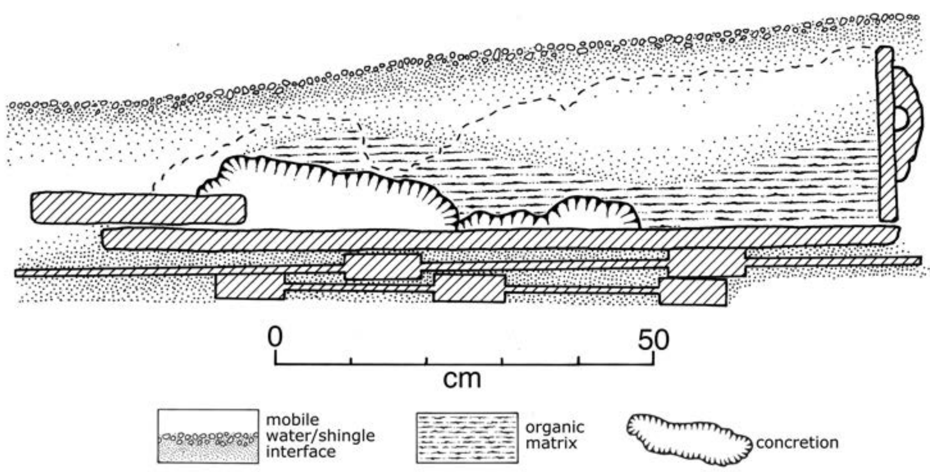


Illustration 78
Section 3.2, showing post-wrecking sedimentation within the chest 110. The dotted line indicates the extent of the surviving side

Illustration 79
The concreted minion drake [82] during excavation (the 15cm scale lies along its top axis). Note that the slanting timber above it is eroded at its top end, which indicates the level to which it has previously been exposed, but lower down the lack of erosion confirms burial since deposition. The gun therefore lies within the zone of permanent burial, which partly explains its excellent preservation. The edge of the oar-port lid [38] is visible at centre left (DP 174275)

Illustration 80
The minion drake [82] after excavation. Scale 15 centimetres (DP 174277)

Illustration 81
A wooden oar-port lid [38] with iron strap-hinges concreted to the side of the minion drake [82]. The surface of the gun runs along the bottom of the photograph. A wooden deadeye [65] is concreted to the oar-port lid's upper right corner, while below the 15cm scale is a small square of glass surrounded by corroded lead, which can be identified as a quarry from the glazing of the stern-cabin windows (DP 173937)

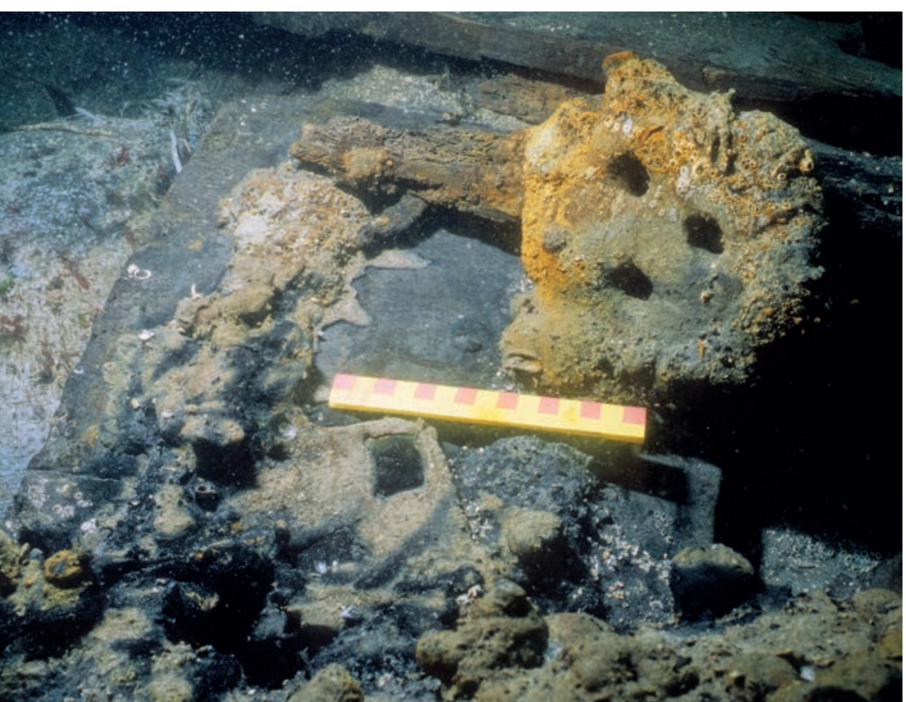


Illustration 82
A wooden lantern-top [200] (to left of 15cm scale) and hardwood sheave (to its right) among collapsed timbers of the upper stern complex. The slanting timber at upper right clearly shows the interface between stable and unstable deposits (DP 173931)

Illustration 83
A shoe, wooden sheave and two pump-valves (far left) incorporated in the stratigraphy of the collapsed interior stern structure. Scale 15 centimetres (DP 174022)

Illustration 84
Parcelled rope, sheave, and pump-valves. Scale 15 centimetres (DP 174021)

Illustration 85
Parcelled rope and a segment of a wooden gunpowder cartridge-box [84].
Scale in centimetres (Steve Liscoe, DP 173946)

Illustration 86
Deposit with lead musket shot, a turned panel decoration and a human finger-bone. The grey silt is typical of the drifted material common across the site.
Scale 15 centimetres (DP 174036)

stern assemblage closely aligns with the longitudinal axis of the keel and keelson at the midships and forward parts of the hull, described below (Areas 6 and 7). The forward end of the deadwood-knee continued under the eastern ballast-mound, beyond which it was not followed. It was noted, however, that a cushioning of heather had been placed between the timbers and ballast-stones in this area, and samples were recovered (Illus 92).

Excavation continued south-eastwards at right-angles to the sternpost/knee assemblage, following six partially dislocated and abraded oak timbers which run at right-angles to the presumed keel-axis. These are evidently frames approaching the stern, and are numbered 8.6A, 8.9A, 9.2A, 9.7A, 9.95A and 10.3A (Illus 60). Their centreline spacings are approximately 0.3m (1ft). Their lie suggests they have fallen onto their sides and stabilised on the sediment slope at the foot of the rock-face. Frames 8.9A and 9.2A are associated with trapezoidal chocks or cross-pieces which, though now displaced (Illus 93–6), evidently coupled them to the

Illustration 87
Plan of Excavation Area 4

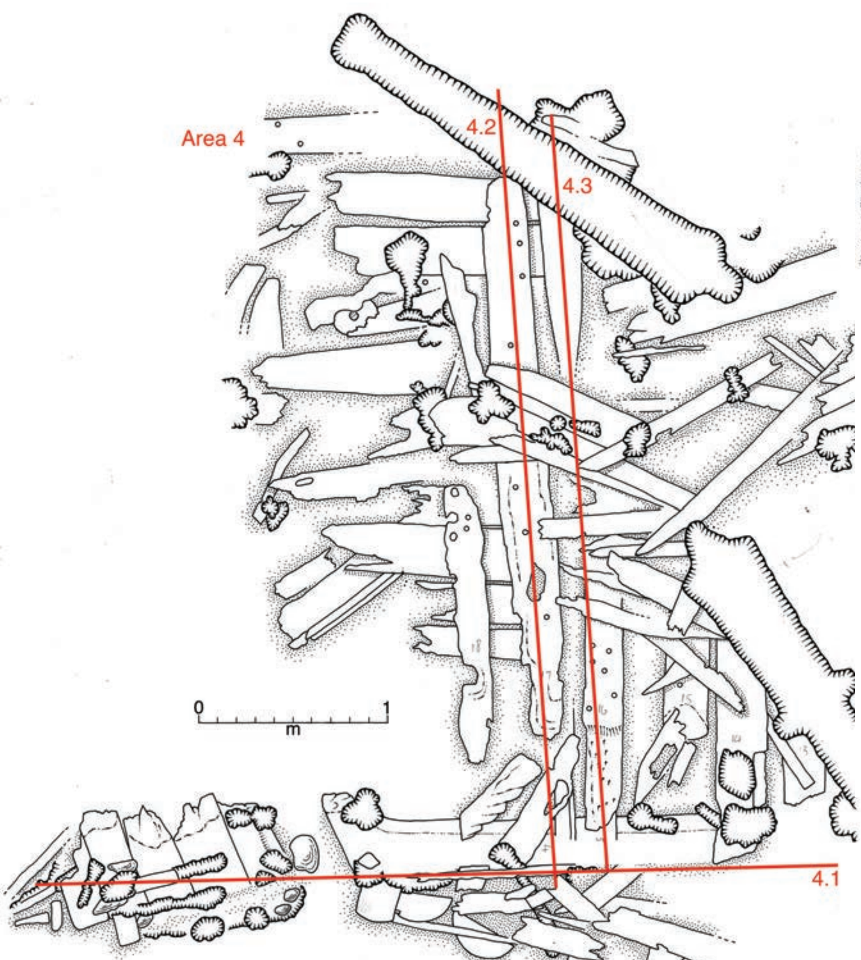
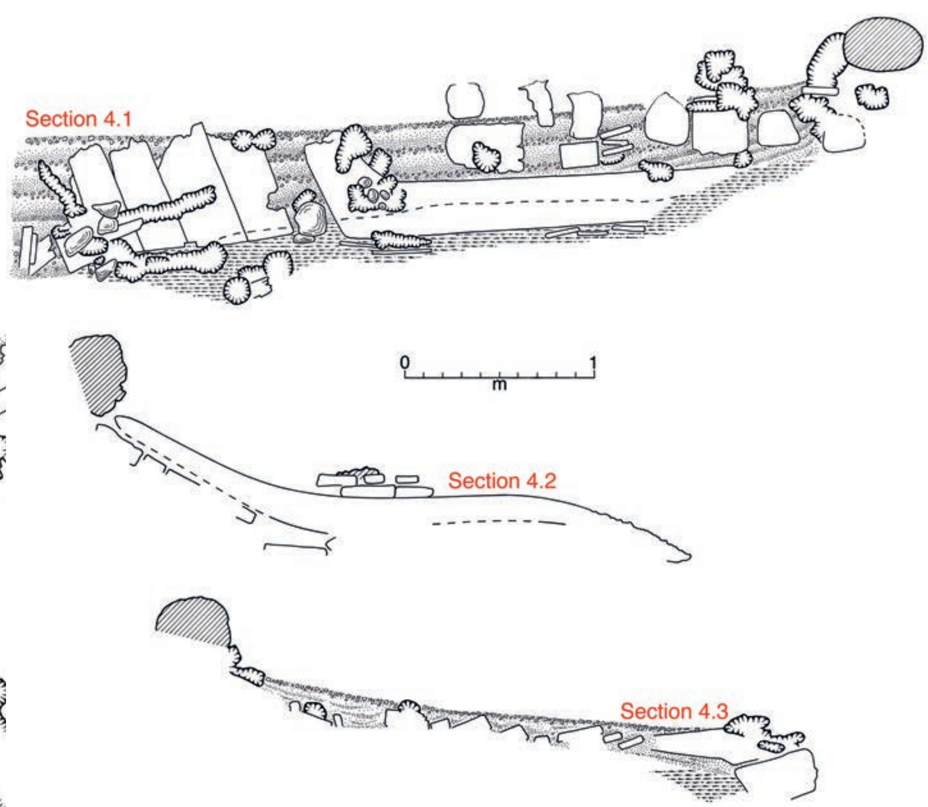


Illustration 88
Sections 4.1, 4.2 and 4.3



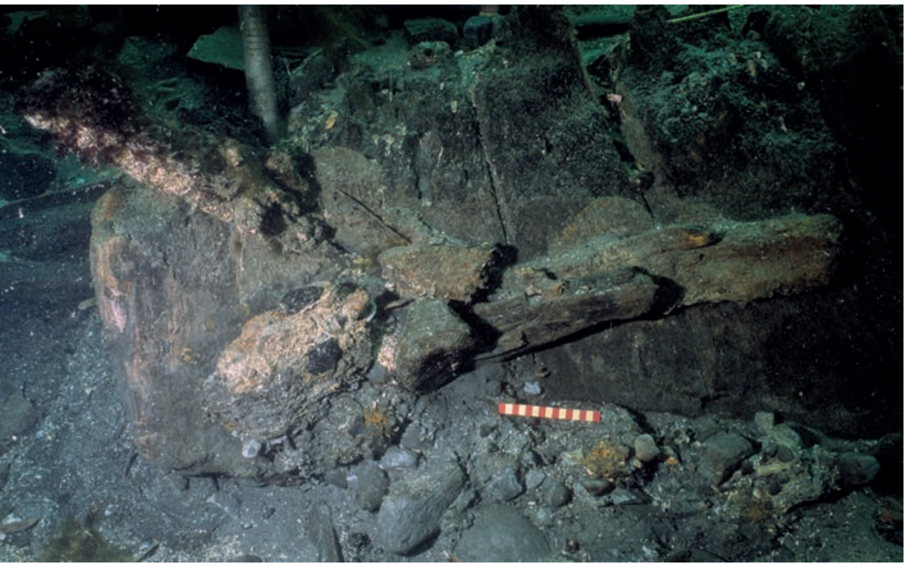


Illustration 89
Lower stern structural complex. The left-hand element is the bottom of the rudder's inboard timber, the upwardly bent iron concretion rising from it being a pintle strap. The next timber to the right is the foot of the sternpost, followed by two pieces of vertically set deadwood. The concretion joining these three timbers is the strap of the lower gudgeon. Scale 15 centimetres (DP 173804)

Illustration 91
Wooden butter-crock lid 189 and part of a cask-end 45 in the organic matrix beside the deadwood-knee. Scale 15 centimetres (DP 173942)

deadwood-knee, indicating that the frames were crutched; that is, their grain followed the angle required at this point between the rising port and starboard sides, and they must therefore have been grown timbers derived from a suitable part of the parent tree. Frame 9.95A extends 3m from its inboard to outboard end, and retains the outboard profile of the hull along this length, although details of its attachment to the deadwood structure have been lost to abrasion.

Two iron guns (Guns 1 and 2) have evidently helped to protect the upper parts of this structural complex and hold it in place. Some damaged and dislocated timbers on top of the frames are probably the remains of ceiling planking, while beneath the frames a series of eight or nine planks, whose degraded and fragmentary nature makes an exact count uncertain, run parallel with the longitudinal axis of the hull. They are clearly part of the outer planking. Their heavily abraded aftermost ends extend beyond Frame 10.3A, suggesting that the port-side hull has broken along a line running from about **115.070** to **105.120**. This reinforces the suggestion that the aft section of the ship, including the

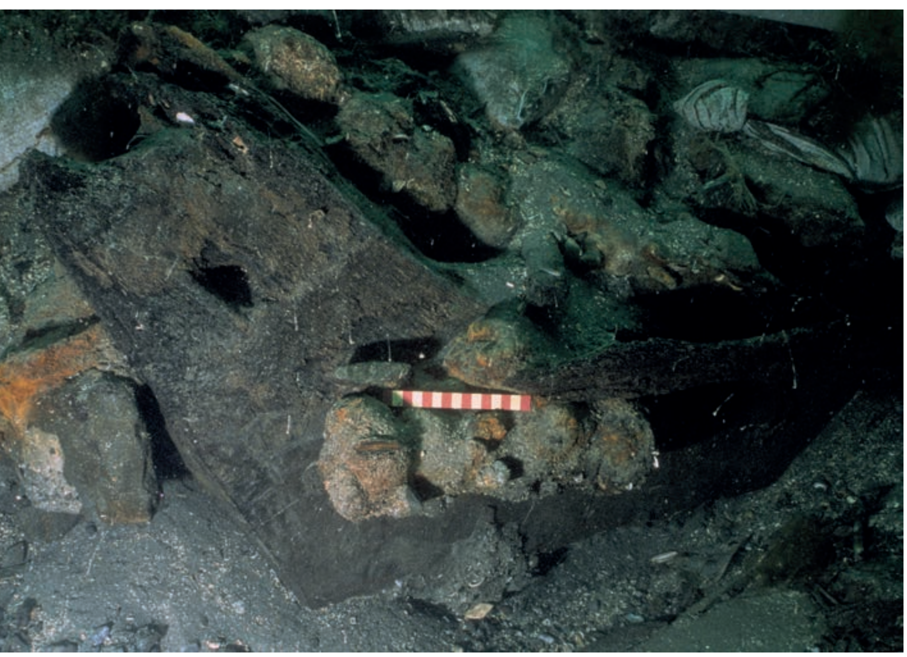


Illustration 90
Deadwood-knee. Scale 15 centimetres (DP 173822)

Illustration 92
Heather dunnage associated with ballast towards the stern. Scale 5 centimetres (DP 173764)

transom and elements of the interior, broke away to collapse onto its side as a partially intact entity, creating a discrete organic deposit which encapsulated interior fittings, external carvings, and other elements connected with the stern. Scattered within the deposit, but not apparently extending outside it, was the major part of a single dislocated human skeleton (see Area 3 above).

Area 5: port bilge aft of the mainmast

Although the aft ballast-mound precluded excavation along the keel-axis forward of the stern complex described above, a trench was opened in 2001, inboard of the aftermost surviving frame-ends exposed on the port side just beyond the edge of the ballast, to determine the nature of the structure at this point (Illus 59 and 97). A run of frame-timbers was identified (Frames 3.6A to 6.1A). All terminated in abraded heads at sea-bed level, and some had lost substance to erosion lower down, but the best-preserved examples had sided dimensions averaging 0.2m, and moulded dimensions between 0.17m and 0.27m. The nine frames covered a run of 2.7m, giving an average room-and-space division of 0.6m (2ft). This compares with the 2ft spacing observed for the floor-timbers amidships (see below), and suggests that these timbers are alternately floors close to their outer ends, or 'rung-heads', and the lower ends of the associated first futtocks. In no instance were the timbers joined by transverse fastenings, which indicates that the ship was not built in a frame-first manner (see Chapter 5).

It was not practicable to excavate these frames more than a few centimetres below their abraded heads, so their angle of set could not accurately be determined. However an approximation of 50° from the vertical can be estimated which, allowing for the 15° tilt established for the ship forward of the twisted-out stern, suggests that the timbers in Area 5 angle upwards at some 35° from the lateral plane of the hull. This indicates that they follow the narrowing curve of the bilge as it runs aft.

Along with the frame-heads, a 1.6m run of 70mm (3in) outer planking was also exposed, together with pieces of abraded, but evidently slightly thinner, inner or ceiling planking. An attempt was made to follow the ceiling to the lower part of the bilge curve, although the presence of spill from the immediately adjacent ballast-mound precluded full excavation. Nevertheless, intact and unabraded timbers running parallel with the orientation of the ship were encountered at a depth of 0.5m below sea-bed level, suggesting that beneath the ballast the structure is coherent and well preserved.

As well as loose ballast-stones, the curve of the bilge was filled with a jumble of fragmented and dislocated wood, rope, and other artefacts. These included two stoneware jars (Illus 98), a pewter 'tappit hen', several heavily degraded silver coins, a wooden oil-box, and a tapered circular-sectioned wooden

Illustration 93
Detail of construction at Frame 9.7A (see Illus 60). The top face of the keelson (or possibly part of the deadwood) is seen running forwards from the lower right. Bolted to it is a chock with flared sides (identified by the 15cm scale lying on it). From this the upwards-curving port side of Frame 9.7A rises towards the left. Nothing remains of its starboard side, which because of the ship's heel would have been above the stable sediment zone. Whether this was a separate piece or a 'grown' timber whose grain structure matched the required shape is unknown (DP 173873)

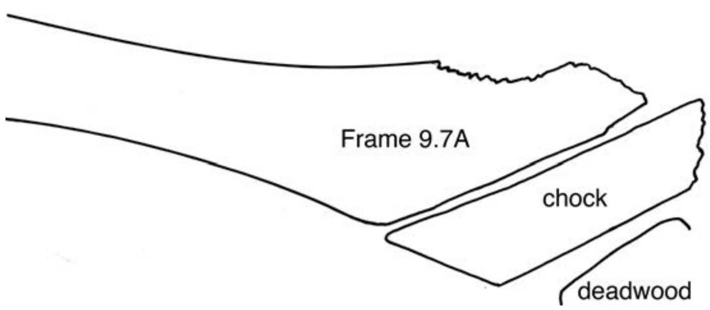


Illustration 94
Diagrammatic representation of chocked Frame 9.7A

Illustration 95
Inboard ends of the aft port-side framing, looking to starboard. From the left they are Frames 8.9A (with concretions at the end), 9.2A, 9.7A, 9.95A and 10.3A. Part of Gun 2 is visible at lower left (DP 173818)

object measuring 0.9m × 0.23m × 0.1m, which was left in situ. In contrast to the fragmented organic material the artefacts (apart from the corroded silver coins), were in unabraded and undamaged condition, and probably fell into the bilge from the collapsing upper parts of the ship some time after detritus from the initial wrecking process had accumulated there.

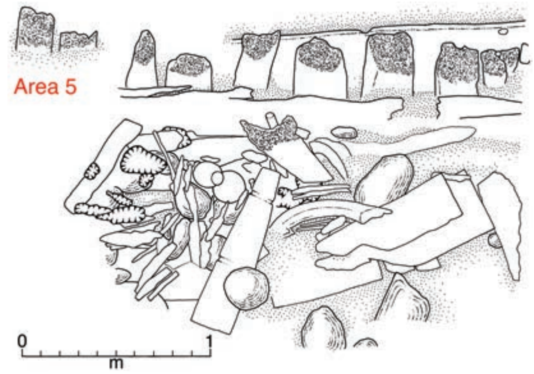


Illustration 97
Plan of Excavation Area 5

Area 6: lower midships hull

Much of the lower hull is held down by the two ballast-mounds, and where it is buried beneath them the surviving structure is probably well preserved. Between the mounds, however, the partially exposed timbers are in poor condition, having been subjected to periodic episodes of exposure and abrasion. The midships area, measuring some 5m on the longitudinal axis and 4m laterally, still retains most of its structural cohesion. This provided an opportunity to examine a key part of the hull in 2001 without significant excavation. As much of the structure as could be exposed without compromising its integrity was cleared by hand-fanning, so that the remains

Illustration 96
The abraded and partly dislocated upper stern framing and planking, looking towards Gun 1 (top centre). The curvature of the framing is evident. Scale 15 centimetres (DP 173819)

Illustration 98
The deposit in Area 5, with two stoneware jars 129–30 exposed. Scale 15 centimetres (DP 174200)

could be planned, and two partial cross-sections obtained (Illus 99–101).

Beneath the run of the keelson nine exposed floor-timbers were rebated into its underside. All are of oak. They show a constant moulded dimension of 0.25m (10in), and while the sided dimensions vary between 0.2 and 0.3m (8–12in) the frames are placed with their centrelines a constant 0.6m (2ft) apart. This 'room-and-space' dimension can be projected fore and aft to the extremities of the keel, which lie an estimated 18.3m (60ft) apart. The position of the master-frame is not on the mid-point of the keel but some way forward of that. On a ship of this type a position one-third aft of the keel's forward extremity would be appropriate, and this indeed appears to be the broadest and flattest part of the Duart Point ship's lower hull. On these criteria the third visible frame aft of the forward ballast-mound has been designated the Master-Frame ⊗.

The sections (Illus 99) were taken across Frame 3.0A and the Master-Frame ⊗, consistent with minimising disturbance to the articulated structure. The hull at both sections is heeled to port at an angle of *c* 15°, so that most of the exposed starboard side has been removed by abrasion, but the buried port structure survives to the start of the rising curve at the bilge. In both sections the stratigraphy contained within the slight concavity of the lower hull's profile is similar. The top level (Layer 1), as elsewhere on the site, is characterised by a semi-mobile cover of pebbles, shells, and sand. Beneath it (Layer 2) is a more stable level of greyish silt, interspersed with darker bands. Layer 3 is a distinctive layer of dark gravel containing water-worn sherds of pottery, which has been interpreted as a ballast component (see Chapter 6.1). It lies on top of another layer of ballasting material, Layer 4, made up of light clay, which in turn lies directly on the ship's ceiling planking. Within the voids created by the frames and the inner and outer planking a thick viscous sludge of organic material (Layer 5) has accumulated. Analysis shows that this contains fragments of wood, fibre, leather, and bone, but no animal or vegetable waste, and it is interpreted as detritus which accumulated in these gaps during the initial phases of the wrecking process, rather than rubbish associated with the drainage system of the ship (see Chapter 6.4). Similar material was also present in the inner bilge area of Section 2.

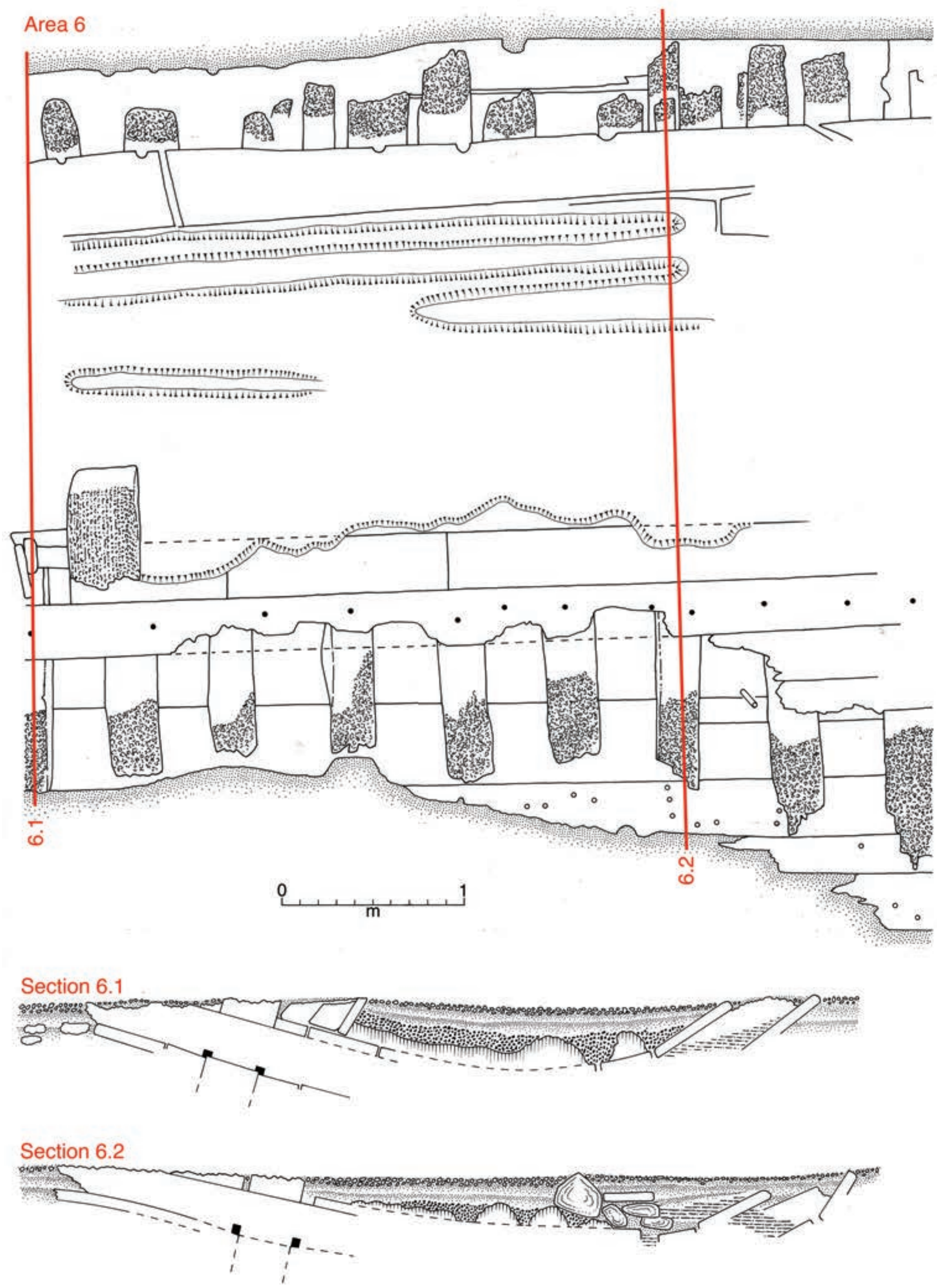


Illustration 99
Plan of Excavation Area 6 and Sections 6.1 and 6.2. Section 6.2 is aligned along the Master-Frame ⊗

The longitudinal axis of the vessel is defined by the abraded keelson, visible between **181.071** and **237.065** and continuing beneath the ballast at each end (Illus 99–100). This much-

Illustration 100
Vertical mosaic of the central hull-structure

eroded component, which runs from stem to stern along the inner axis of the ship, across the frames and above the keel, is 0.3m (12in) wide. Because much of its upper substance has been lost its depth could not be ascertained. Like all other identified components of the hull it is of oak (*Quercus* sp). Along the 5m exposed length of keelson were 12 25mm (1in) diameter round iron bolts, now identified by their corrosion-stained holes, which clamped it to the keel and floor-timbers. The bolts are usually, though not always, positioned to engage with a floor-timber. In two instances bolts are doubled-up on single frames, and are perhaps later additions intended to tighten loose joints. The underside of the keelson is rebated with recesses 20mm (¾in) deep to accommodate the frames.

Only the top surface of the keel between Frames 3.0A and 3.6A could be examined. Like the keelson its moulded width is 0.3m (12in). It was not possible to ascertain its depth, but it is likely that it is the same as the moulded width, or perhaps slightly more (Lavery 1988: 15). The rather larger *Dartmouth* had a keel 13in (0.33m) square, to the underneath of which a false keel 8in (0.2m) deep had been added (Martin 1978: 42–4).

Along the outer port side of the surviving structure, between **190.100** and **240.096**, a run of 12 closely spaced squared timbers continue the line of nine frames described in Area 5. Their sided and moulded measurements range from 0.17 to 0.22m (6¾ to 8⅔in) and 0.17 to 0.29m (6¾ to 11½in) respectively (Illus 102). These timbers are angled some 55° from the vertical, and their top ends show an increasing upwards curve as they progress aft. Elements of outer and ceiling planking were present on either side. The rising curve clearly represents the turn of the bilge, where the relatively flat bottom of the hull bends upwards towards the ship's side. Here the outer ends of the floor-timbers overlap with the curving lower ends of the first futtocks, the points of contact of alternate pairs being staggered to avoid a single line of joints. Although some of the first futtocks appear to be missing – no doubt pulled out during the disintegration of the hull – enough remain to suggest that each floor-timber matched a rising futtock.

Directly beside the keelson on the port side, centred on Floor-Frames 3.0A and 3.6A at **188.074**, are the lower parts

Illustration 101
Detail of the central midships area showing (from bottom) fragmentary starboard-side planking, starboard-side floor-timbers, the abraded keelson, the port-side pump-sump and box (top left), and the abraded remnants of the transverse mainmast-step to its right. The yellow triangular targets are at 1m intervals (DP 173806)

Illustration 102
From left: Frames 0.6A, Master-Frame ⊗ and 0.65F on the starboard side just aft of the forward ballast-mound (DP 173803)

Illustration 103
Oblique view of the central midships section. The abraded keelson is notched over the starboard-side floor-timbers, and the outer planking is visible between them. The yellow triangular targets are at 1m intervals (DP 173779)

Illustration 104
Oblique view of the pump-sump and mast-step complex looking to port. The abraded and shipworm-damaged surface of the keelson (across bottom of picture) and transverse mast-step (top right) are clear. Scale 15 centimetres (DP 173777)

Illustration 105
Starboard limber-hole in Frame 3.0A. The 15cm scale is resting on the top surface of the keel, the sharp edge and smooth surface of which is evident (DP 173778)

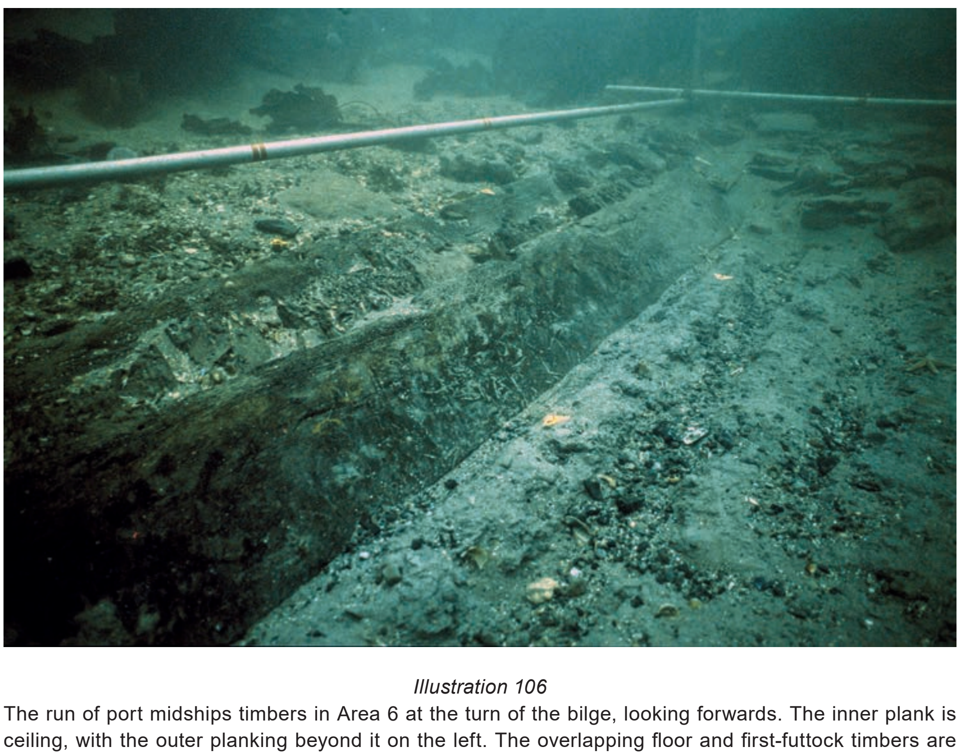


Illustration 106
The run of port midships timbers in Area 6 at the turn of the bilge, looking forwards. The inner plank is ceiling, with the outer planking beyond it on the left. The overlapping floor and first-futtock timbers are sandwiched between them. The clay and gravel ballast in the hold obscure the structure beneath. Targets set at 1m intervals (DP 173776)

of a pump-sump (Illus 103–4). It consists of an open box measuring 0.2m × 0.3m (8in × 12in) made up of short pieces of 50mm (2in) plank. A corresponding sump appears to have been provided on the starboard side. Though its components have been destroyed by erosion, a shallow rebate has been cut on the forward face of the adjacent frame (**187.068**), presumably to accommodate the side-planking of a box replicating the port-side one. As both sections show, 40mm (1½in) square holes have been cut through the bottoms of the frames on either side of the keelson (Illus 105). These are limber-holes, which allowed water to flow freely along the lower axis of the ship towards the pump-wells (Manwaring & Perrin 1922: 180). No trace was noted of the light limber-ropes normally threaded through the limber-holes so that blockages could be freed along the length of the framing (Manwaring & Perrin 1922: 180). The ship's pumping arrangements are discussed more fully in Chapter 6.3.

The run of ceiling planks along the port edge of the keelson is made up of shorter pieces than elsewhere in the inner hull (Illus 106), the one closest to the port-side pump-well being only 0.85m long. These are limber-boards (Falconer 1780: 177), designed for easy removal to clear out the waterways via the limber-holes. A similar run along the starboard side is indicated by a single surviving board at the edge of the forward ballast-mound.

At **191.076**, lying transversely just forward of the pump-well on the port side of the keelson, is a much-abraded oak timber 0.4m × 0.65m (15¾ × 25½in). Its outboard end is chamfered at an angle of about 60°. It seems likely that before reduction by abrasion this timber was a much longer and thicker piece straddling the keelson but, because of its upwards set to starboard due to the 15° heel of the wreck, that side has

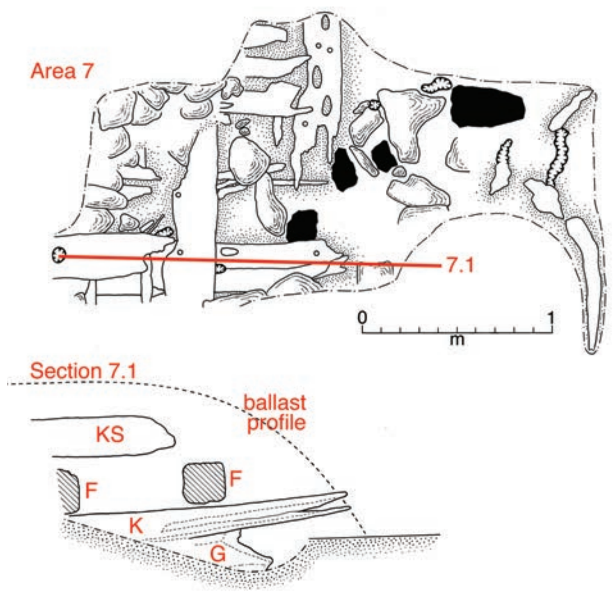


Illustration 107
Plan of Excavation Area 7 and Section 7.1. KS = keelson; F = frame; K = keel; G = gripe

been worn away. Assuming symmetry, the original length of the timber would have been *c* 1.8m (6ft). The piece can confidently be identified as the surviving part of a transverse mainmast-step.

Area 7: lower forward structure

Notwithstanding a general policy not to disturb the ballast, it was felt that a small excavation at the forward edge of the western ballast-mound, aimed at locating any surviving elements of the ship's bow structure, would be justified in view of the information it might provide (Illus 107). In 2002 stones were accordingly removed (and subsequently replaced) from a 2m × 2m area centred on **275.070**, on an axis subtended by the keelson along the midships part of the hull, described in Area 6. This revealed a complex of timbers which, although much abraded and partially displaced, could be identified as including the forward surviving ends of the keel and keelson (Illus 108–10). The keelson, which allowing for abrasion measures *c* 0.3m (1ft) square where it emerges from the ballast, survives to **271.062**, up to which point it runs level with the axis of the ship. The keel, which is also *c* 0.3m (1ft) square, extends *c* 1m further forward, to **280.060**, by which point it begins to show an upward curve. This suggests that its forward end is at, or very close to, the point at which the lower part of the sternpost assembly would have been scarfed into it, although details of the jointing carpentry have been lost to abrasion. The distance from this point to the sternpost at the after end of the wreck is 18.4m (60ft 4in), and this figure may be regarded as defining the length of the keel. Beneath the rising keel-end a much-abraded timber may be part of the gripe or forefoot of the lower bow.

A substantial timber passes between the keel and keelson at right-angles, crossing the keel at **272.060**. It has a shallow rebate on its underside where it would have straddled the keel, from which it is now slightly dislocated. This timber is *c* 0.3m (1ft) square at its centre, but flares and curves slightly upwards on either side. The more fragmentary remains of a similar timber lie 0.6m further forward, and although its inboard end has been removed by abrasion it would originally have spanned the keel at **280.059**. These two pieces, separated by the 2ft 'room and space' dimension established for the floor-framing amidships, are probably the forwardmost frames of the main hull-structure (5.05F and 5.9F). Fragmentary pieces of outer and ceiling planking were present in the trench, together with several large pieces of coal. There were no other finds.

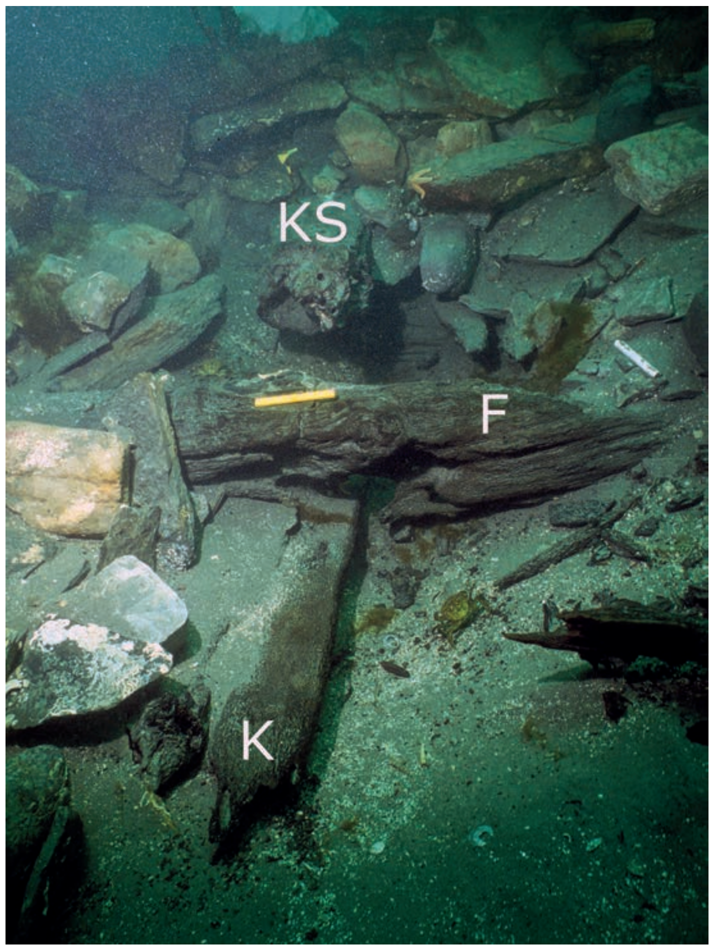


Illustration 108
Surviving forward structure, looking aft. K = keel; KS = keelson; F = frame. Packed stone ballast from the forward mound is in the background. Scale 15 centimetres (DP 173827)

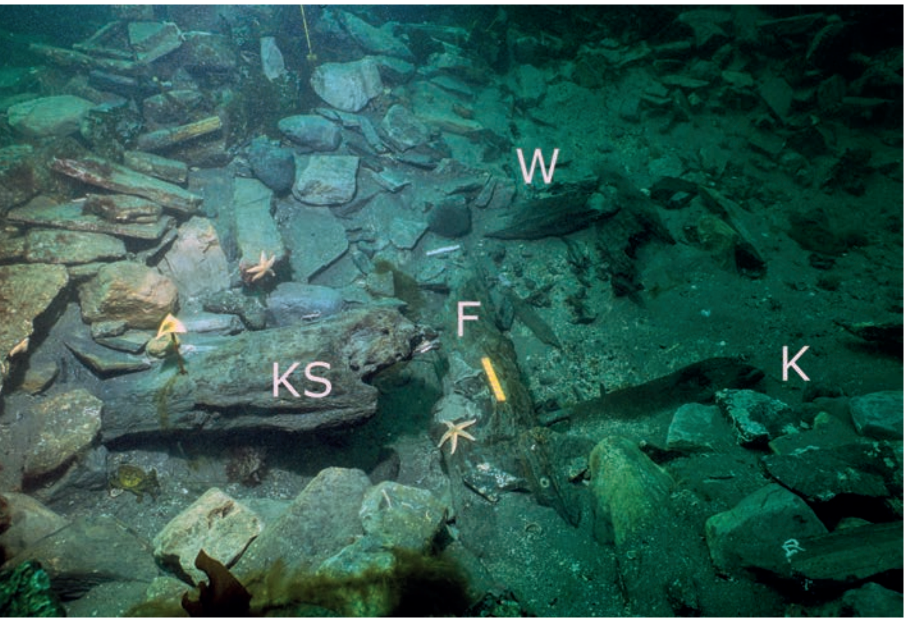


Illustration 109
Surviving forward structure, looking to port. KS = keelson; F = frame; W = wale; K = keel. Scale 15 centimetres (DP 173830)

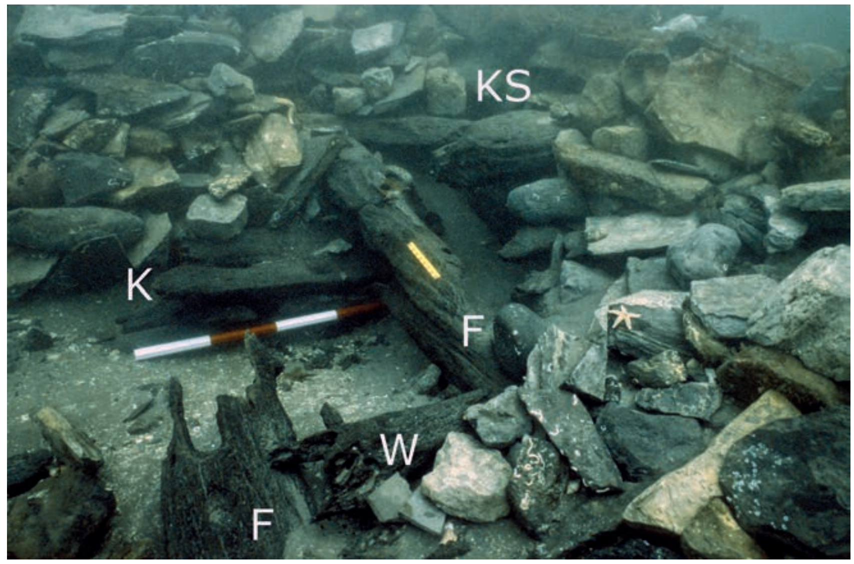


Illustration 110
Surviving forward structure, looking to starboard. F = frame; W = wale; K = keel; KS = keelson. Scales 1 metre and 15 centimetres (DP 173832)

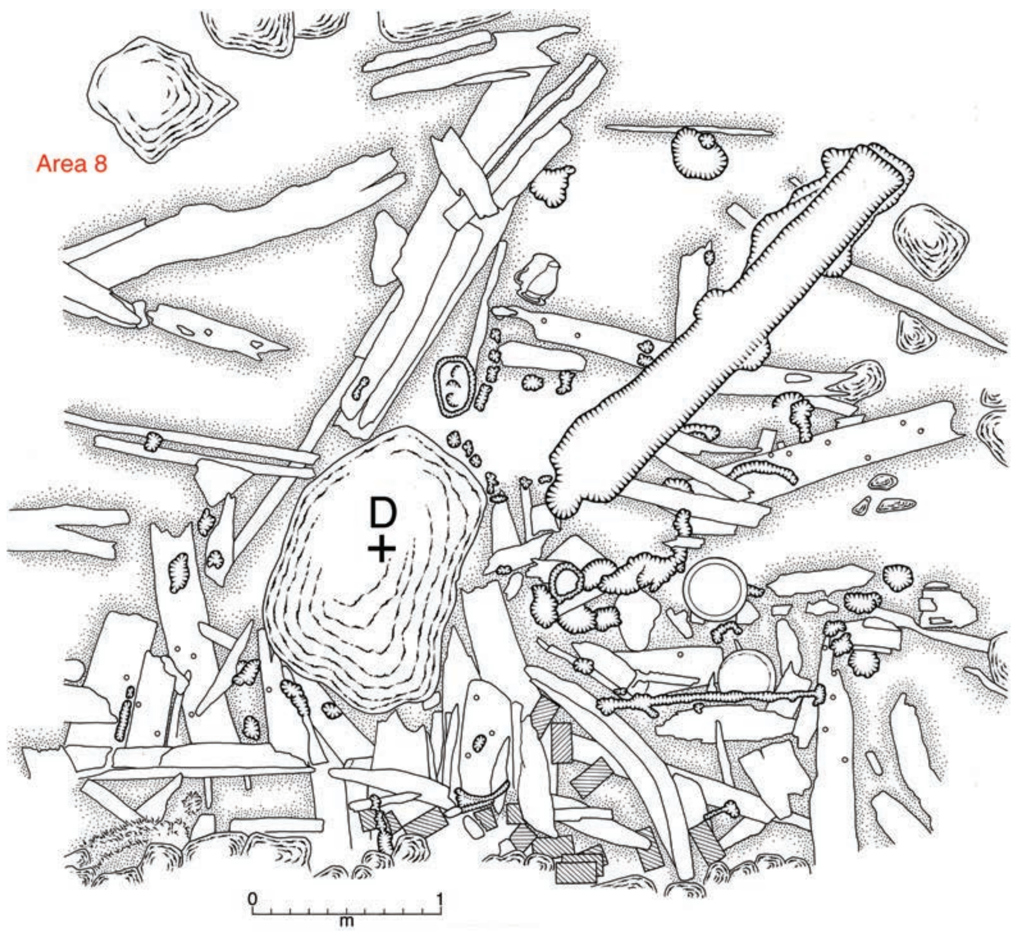
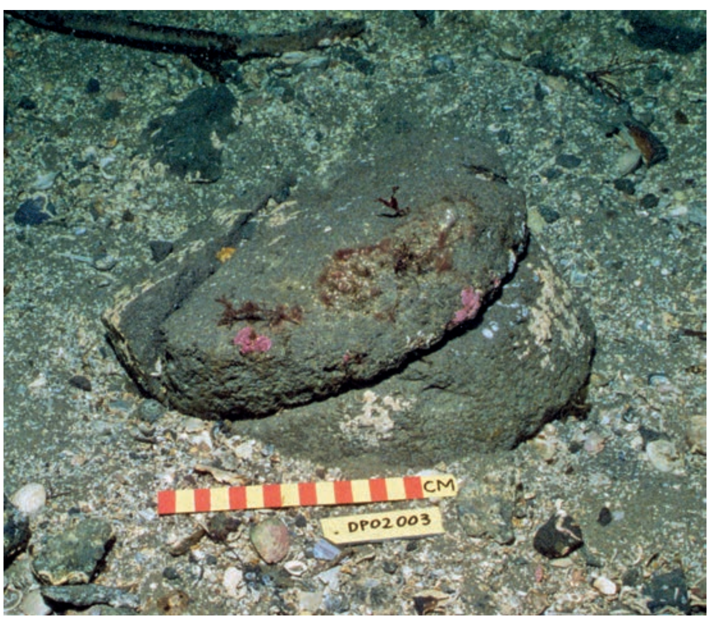


Illustration 111
Plan of Excavation Area 8

Illustration 112
Bricks, coal and collapsed timber debris in the galley deposit. Scale 15 centimetres (DP 173996)

Illustration 113
Pewter plate 124 and fragment of pottery (DP 173932)

Illustration 114
The two conjoined halves of a rotary hand-mill 62. Scale 15 centimetres



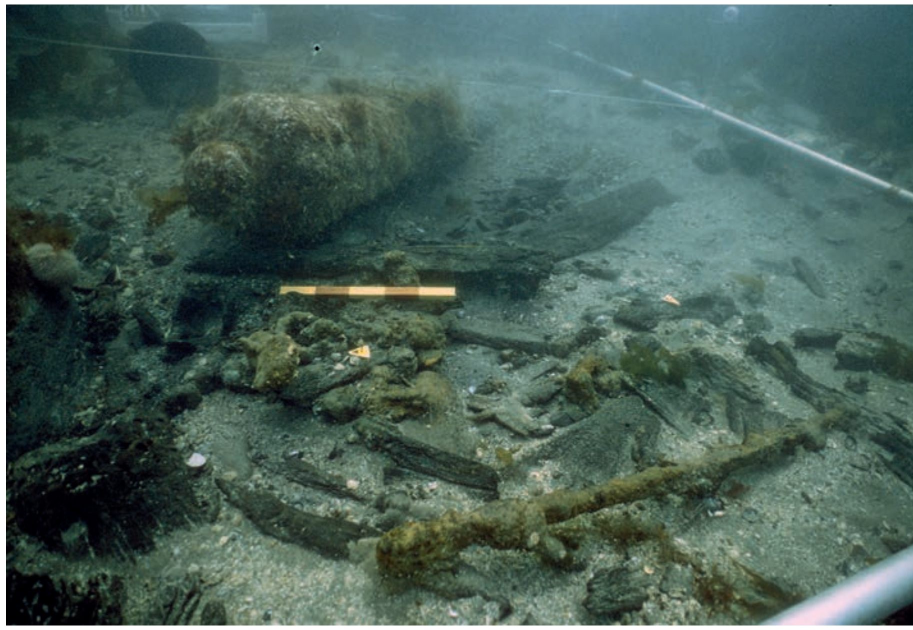


Illustration 115
Eroded debris from the forward collapse of the hull around Gun 6. The long concreted object in the foreground is probably a chain-plate for securing the shrouds. Scale 50 centimetres (DP 173837)

Area 8: collapsed forecastle and galley remains

To complete the investigation of the wreck it was decided in 2002 to excavate an area from a line just shorewards of Gun 6 to the edge of the western ballast-mound, a 4m × 5m rectangle, where it was anticipated that outfall from the collapse of the forward structure might have stabilised (Illus 111). The area is dominated by a large rock at Datum D, centred on **266.093**, which rises about 1m above the sea-bed. A complex of dislocated timbers clusters around, but not beneath, this rock, suggesting that it had been there at the time of the

Illustration 116
Eroded debris from the forward collapse of the hull around Gun 6 (top). Scale 15 centimetres (DP 173795)

wrecking and that the port bow quarter had been massively punctured by it, presumably when the ship settled to port. Some of the timbers continue under the ballast, where higher levels of preservation and cohesion may be expected. Among the dislocated timbers were items associated with the ship's galley, including bricks and tiles, coal, a ceramic butter-crock 137, a pewter plate 124, and the upper and lower stones of a rotary hand-mill 62 (Illus 112–14). It was hereabouts that the copper-alloy kettle 61, believed to be the galley cooking-pot, was found in 1979 (John Dadd pers comm).

Excavation was extended northwards from Gun 6 (Illus 115–16) to reveal further dislocated structural elements with few associated finds apart from scattered concretions, one of which, at **276.100**, is probably a barrel-hoop.

Chapter 4

SITE-FORMATION PROCESSES

4.1 Site-formation processes

Wreck-formation processes are infinitely variable, because the complex and interacting factors which constitute the surrounding environment and its evolution through time, the nature of the wrecked ship, and the circumstances of its loss, all combine to create a set of attributes unique to each site (Muckelroy 1978: 158–9; Martin 2011). But some general categories can be recognised. At one end of the scale a vessel may survive virtually intact, with its contents complete and more or less in situ, as was the case with *Vasa* (Hocker 2006). At the other end a ship may be so broken up and dispersed, and its component parts and contents so reduced by mechanical, chemical, and biological degradation, that there comes a point at which it effectively ceases to exist (Martin 2005).

In a majority of cases, however, wreck-formations lie somewhere between these extremes, and in reaching a state of balance within the environment they normally undergo three evolutionary phases. The first is characterised by dynamic anthropogenic input before and during the wrecking event. A phase of dynamic environmental input follows as the wreck and its natural surroundings interact physically, chemically, and biologically. Finally there is a stable phase in which the wreck's residual substance and distributive associations have become incorporated into an environment which, though modified by the wreck's intrusion, is once again balanced and stable. It should be noted that stability is never achieved in absolute terms, since some dynamic processes will continue slowly but inexorably. It is also possible that a stable situation may for various reasons revert to an unstable one, perhaps moving cyclically between one condition and the other. Nor will a single formation process be applicable to all parts of a wreck-site at any given time, and it is best to regard each wreck as a complex mix of many interrelated and interacting sub-formations.

A wrecking is an essentially human event, caused ultimately by the failings and misjudgements which lie on the debit side of our species's unique qualities of forethought, ingenuity, collaboration, invention, and enterprise. As a phenomenon it cannot therefore be analysed in purely predictive or abstract terms. It is human error, usually compounded by nature, which causes wrecks, and human cognition, resourcefulness, and the instinct to survive which seeks to avoid them or mitigate their consequences (Gibbs 2006). Human choices and decisions, which may be varied and sometimes irrational, must therefore be considered when seeking to understand the nature and consequences of the events which initiate wreck-formation processes.

This anthropogenically influenced phase leads to shipwreck, when the organised entity represented by a vessel's structure, contents, and functioning crew, together with its systems of propulsion, control, and management, breaks down as a consequence of ultimately catastrophic inputs. There follows an irreversible process of change, during which the ship leaves the world of human artifice and reverts to nature. At this stage the wreck can be characterised as a massive unstable anomaly within the environment into which it has been deposited, and nature will react until a state of balance has been restored. This phase may be extremely violent and short-lived, as when a ship strikes a reef in heavy seas and disintegrates in a matter of seconds, or it may, as in the case of a hull which has settled gently into a benign environment of soft anaerobic sediments, continue for years or even centuries (for example *Mary Rose*, Marsden 2009: 20–31; *Vasa*, Hocker & Wendel 2006).

In both cases, however, the dynamic phase is characterised by the wreck's status as an anomaly: it is unstable, it lacks integration with its surroundings, and it is prone to further disintegration and dispersal by external influences. Heavy items will trend downwards until they stabilise. Lighter objects, by virtue of their buoyancy, may relocate within the wreck or float away. Tides, surges, currents, and wave-action can induce movement which may result in the break-up of structures and the transport elsewhere of their fabric and contents. Scour may create depressions or build up deposits which can influence the destruction or preservation of wreck material. These effects will be influenced by the geology and sediment regimes of the sea-bed on which the wreck lies. The chemical composition and physical properties of the water, especially

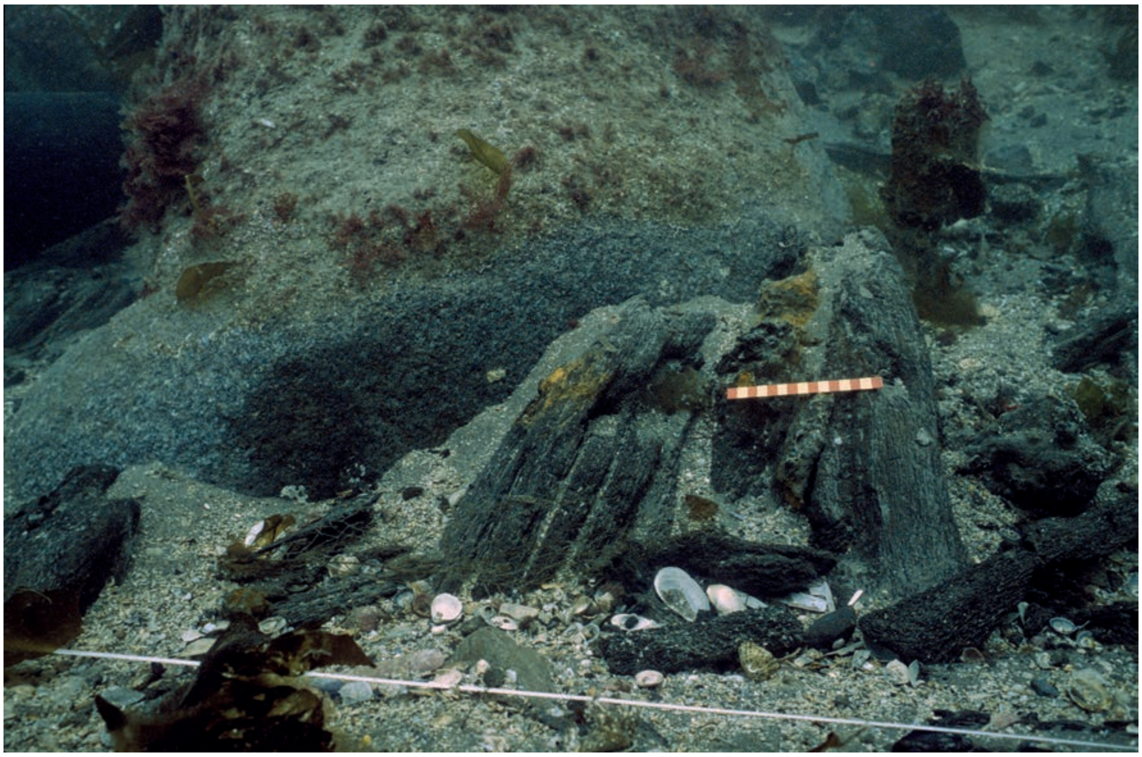


Illustration 117
The large boulder (Datum D) close to the forward bow quarter of the surviving wreckage. Note that the displaced and broken timbers rise up its side, and none was trapped beneath, indicating that the boulder was in place when the wreck was impaled on it (DP 173836)

seawater, its temperature, and the amount of dissolved oxygen it contains, will cause reactions of various kinds, particularly to metals (Gregory 1995; MacLeod 1995). Complex networks of electrolytic couplings between dissimilar metals, activated through seawater, will protect or corrode metals according to their relative corrosion potentials.

Organic materials will be susceptible to the effects of water-penetration, light and biological attack. Sea-bed movement may cause mechanical degradation, while rock-falls, the laying down or shifting of sediments, and other processes of geomorphological change may further influence the dynamic phase of wreck formation. Post-wrecking anthropogenic activity, particularly salvage or archaeology, may also be regarded as dynamic influences in the evolution of a wreck formation, while the deposition of unrelated material by rubbish-dumping, constructional work, or even the intrusion of a subsequent wreck, may further influence the formation characteristics of a site. Finally, sea-level change, geological upheaval, or land-reclamation may in various ways affect the environment and hence the nature of a wreck formation.

Once the dynamic phase of a wreck's integration with the sea-bed is complete, a static, or stabilised, state will normally follow. This can happen quickly, and perhaps with little change to the ship's original form, as when a vessel sinks into and is encapsulated by semi-fluid mud. A broadly similar situation may obtain when a ship founders in mid-ocean and arrives more-or-less intact on a deep sea-floor where there is effectively no water-movement, oxygen, or light (Bascom 1976: 105–18). On the other hand the dynamic phase may be short-lived but so violent that much of the vessel's substance and most of its coherence is lost by the time stability is achieved (Martin 2011). But however reduced and dislocated the surviving elements of a stabilised shipwreck may be, their placements and associations will not be fortuitous or random, but logically explicable in terms of the processes by which they have been modified and distributed. Theoretically, if these processes are correctly interpreted, it should be possible to work backwards through the sequence and so draw conclusions about the ship before it became a wreck. Though this is rarely possible in absolute terms, most wreck formations, if the archaeological and environmental evidence is intelligently recorded and studied, are capable of significant reconstructive understanding through the medium of formation-processes analysis. This has certainly been true of the Duart Point shipwreck.

4.2 Observed site-formation mechanisms

Because the potential range and complexity of wreck-formation processes, and their interacting relationships through time, are almost infinite, a total understanding of them on any site is usually beyond human comprehension or available resources. But general trends and influences can often be observed and to some extent quantified and tested, while specific phenomena, often encountered serendipitously in the course of investigation, provide snapshots of particular processes in action which may help to inform the wider picture. During 12 seasons of field investigation at Duart Point an intimate familiarity with this small site was engendered among those who worked on it. From this, in conjunction with the routine procedures of recording and interpretation, regular exposure to an often-changing marine environment, and a questioning and discursive culture within our close-knit team, an empirical understanding of some of the factors driving particular formation processes has emerged. Before applying this evidence to the wreck as a whole, it will be helpful to present some examples of particular processes at work.

Stability of large boulders

This is apparent around the two large boulders (datums C and D) close to the aft and forward extremities of the wreck. Smashed structure impacted against the rock centred on **092.064** (D) has been pushed up against its side but is not trapped beneath it (Illus 117), while the extensive organic deposits to the west of the boulder centred on **266.093** (C) stop abruptly beside it and do not extend beneath or beyond it. These two boulders seem to have locked the hull in place at its forward and aft extremities when the ship arrived on the sea-floor, thus contributing significantly to the wreck's positional stability during the break-up sequence.

Cherub deposit

Among the exposed organic deposits noted during the rescue operation by the ADU in 1992 was a wooden cherub [5], one of the ship's decorative carvings, emerging from the sand (Illus 118). Its right wing (as viewed from the front) was propped against a plank so that the object lay at an angle of about 15° from the natural level of the sandy sea-bed, within which the left wing remained buried. The upper wing had been colonised by common barnacles (*Balanus crenatus*), with the heaviest infestation clustered around its upper parts. Less-intensive colonisation was evident on the right face and hair, while the left cheek and curls remained largely unaffected. The left wing, when excavated, was entirely free of biological infestation and its pristine surface condition indicated that it had never been attacked. None of the barnacles associated with the object was more than about six months old.

Illustration 118
Top: partly buried wooden cherub's head [5] photographed during the ADU's rescue and recovery operation in 1992. In the foreground are the remains of a staved costrel [184], collapsing as the sand-level falls. Between the two objects is a human ulna (Kit Watson, DP 173909). Bottom: the wooden cherub after recovery, showing the distribution of barnacles. Scale 25 centimetres (DP 173176)

From these observations it may be concluded that the cherub was buried shortly after its initial deposition and remained encapsulated in an anaerobic environment for 339 years, during which time it became waterlogged and fragile but suffered almost no biological or mechanical degradation. It was not visible during the Archaeological Diving Unit's first visit in 1991. During the following year the surrounding sediments dropped to levels below which they had not fallen since deposition, progressively exposing more than half the object and allowing biological colonisation on its previously unavailable surface. Had this process been allowed to continue the object would probably have become completely uncovered and all its surfaces exposed to attack. Once free of the encapsulating silts it would, almost certainly, have been displaced by the tidal current and carried eastwards from the site into deep water where – loose, fragile and vulnerable to further biological and mechanical degradation – it would rapidly have been destroyed.

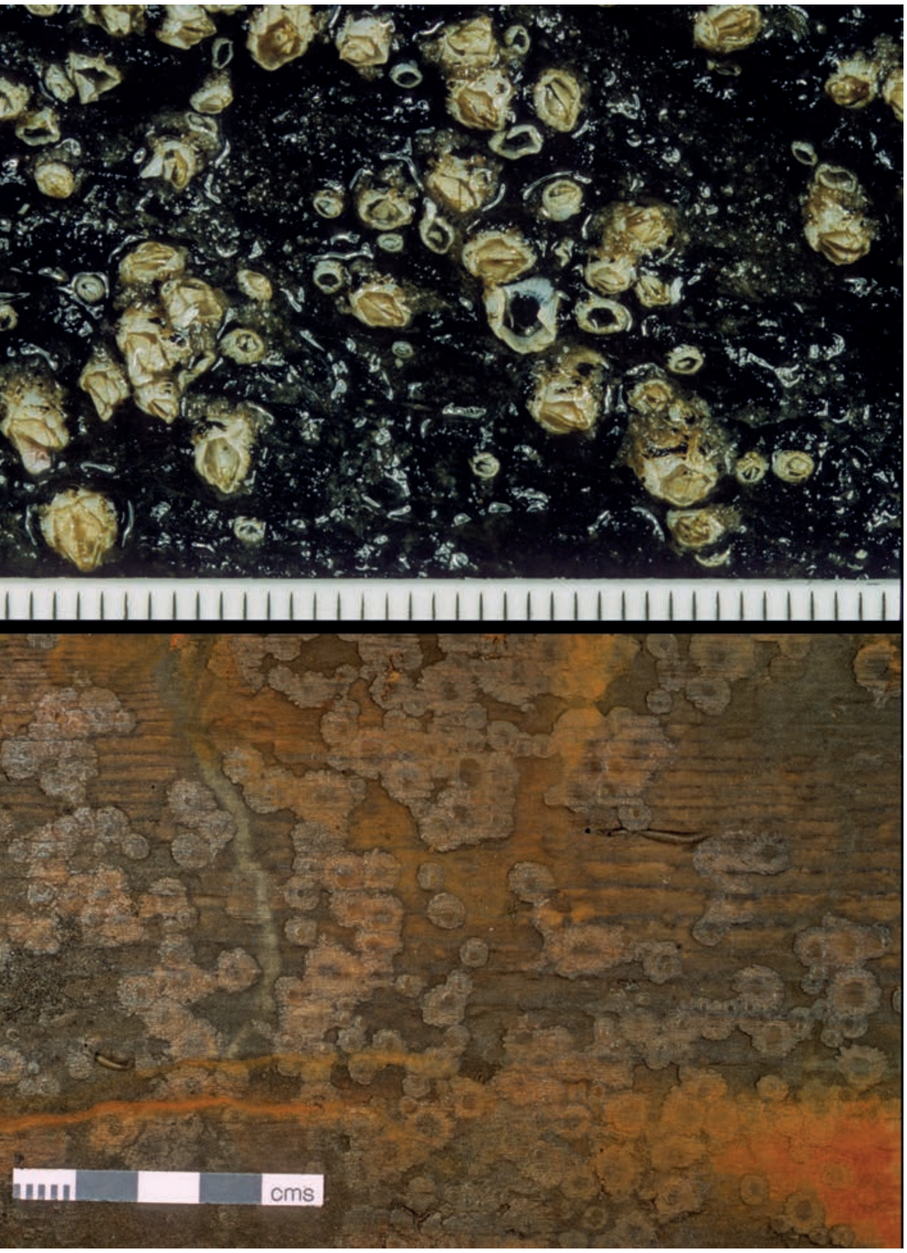


Illustration 119
Top: detail of barnacles colonising the exposed surface of the cherub carving. Scale in millimetres (DP 173722). Bottom: detail of a piece of pine panelling showing evidence of what was probably a short-term episode of barnacle colonisation before anaerobic burial. Scale 5 centimetres (DP 173723)

Such a fate appears to have befallen the upper staves of a small wooden costrel 184, the remains of which lay partly buried immediately in front of the cherub. For as long as the surrounding sediments were deep enough to cover the cherub, the costrel too would have been buried, its staves held together by the matrix of sand even though the withy hoops which bound it had become waterlogged to a point at which they retained virtually no mechanical strength. But as soon as the top of the object was exposed by the lowering of sediment levels its upper staves, no longer held together other than by the ineffectual hoops, were carried away by the current. The still-buried elements remained intact and in good condition, as was evident when the remains of the object were finally excavated and recovered.

Between the cherub and the costrel was a human ulna, part of a single skeletal assemblage scattered throughout the aft interior of the wreck. The distribution of this individual's bones was restricted to a deposit identified as the collapsed interior of the stern, which suggests the following hypothesis. Soon after death the corpse is likely to have become buoyant from gases produced by the early stages of decomposition, and that it did not then float away suggests that this part of the ship's interior remained sufficiently intact for long enough to trap and retain it. When the body eventually sank back into the accumulating sediments within the ship it would have been in a condition ripe for dismemberment by scavenging fauna, explaining the random distribution of bones within the context of the collapsed stern interior. Though the time taken for these processes to take place cannot be quantified with any precision, they do suggest that the stern structure remained at least partially intact for a significant period after the wreck's initial deposition.

A piece of wooden panelling, found securely buried at **099.098** among other material which had not been biologically attacked, showed evidence of previous barnacle infestation, although no live animals or shells were present on its surface. It may be presumed that this piece had been exposed for some time before becoming incorporated in a deposit of uninfested material (Illus 119).

A more complex depositional sequence can be postulated for the framed-and-panelled door 17 at **083.090/094.088** (Illus 70–2). Most of its surfaces are unabraded and free from biological infestation, apart from a band of heavy barnacle colonisation beneath a run of panelling in direct contact with the door's upper surface. Part of the door was also overlain by a gun-port lid. Neither side of the panelling, or the gun-port lid, shows any sign of infestation. The conclusion must be that these objects had been disposed elsewhere before final deposition, perhaps because of their proclivity to float before becoming waterlogged. If still buoyant but trapped inside the hull, the door may have exposed part of its surface to barnacle colonisation before sinking and integrating with other items to take up the configuration in which they were found.

Transom and binnacle complex

The archaeology of this isolated organic deposit has already been described (Chapter 3.2, Area 1). From a wreck-formation perspective the relevant factors are that the binnacle 88 appears to have been deposited in a partially abraded state on a sea-bed of loose gravel, where it stabilised *c* 100mm below the present sediment surface (Illus 63). Its upper surviving elements, only the top edges of which show evidence of continuing abrasion, lie >20mm below the surface, a depth which thus defines the lower limit of post-wrecking sea-bed movement in the area. Parts of it, however, have been subject to attack by shipworm (*Teredo navalis*) and gribble (*Limnoria lignorum*). There is no means of knowing how much more deeply it may once have been buried. The adjacent transom-timber, though buried to the same lower horizon as the binnacle, with its top surface uncovered in places, is heavily abraded on all faces. This suggests that it had undergone a more prolonged episode of exposure prior to final burial and stabilisation. Under the transom-timber, and in contact with it, was an unabraded barrel-end, indicating that abrasive mechanisms had not penetrated to this lower horizon since deposition. The main phase of the transom-timber's degradation must therefore have taken place somewhere else.

The most likely explanation is that the timber, which had once been an integral component in the framework of the stern, had survived as part of an articulated structure which remained proud of the sea-bed for a substantial period following the wreck's initial deposition, leaving it exposed to biological degradation exacerbated by the strong current. We may surmise that within this structure a significant number of organic objects had become trapped and protected, including the binnacle, compass components, and a barrel-end, and that in due course part of the stern with some of its contents broke away to be transported down-current where a sequence of secondary break-up and deposition occurred. During this process much was probably carried away and lost, but the temporary intrusion of a substantial piece of structure probably induced the scour and infill which assisted in the burial of this isolated sub-deposit.

Wooden chest deposit

Within the collapsed stern deposit, at **092.084/098.093**, were the buried remains of an open wooden chest 110. Its excavated state is shown in Illus 77, and its stratigraphy in Illus 78. The significance of this isolated receptacle of sedimentary deposition is that it provides a closed stratigraphical snapshot of the post-depositional burial sequence which occurred at this part of the wreck. It suggests that after an initial period during which a limited amount of silting took place concurrently with the distribution of organic debris across the site (Layer 3), there was a major deposition of clean silt uncontaminated with wreck material which filled the chest to a depth of at least 0.3m (Layer 2). This has a bearing on the interpretation of site-formation processes in the stern area which will be discussed later.

Illustration 120

Top: inverted mariner's compass 91, in situ after excavation. Its base is cracked and imploded (DP 174253). Bottom: shattered glass face of the compass after removal of the bowl. That it retains its circular shape indicates that it broke when the compass reached the sea-bed, and that neither object has moved since. Scale 15 centimetres (DP 174255)

Illustration 121
The surviving starboard floor-timbers 1.8A, 2.5A and 3.0A. The keelson, running diagonally from top centre to centre right, has been reduced to its bottom few centimetres by a combination of shipworm (*Teredo navalis*) attack and abrasion. The sectioning effect of the abrasion shows the extreme honeycombing produced by *teredo* borings. This is also seen in the eroded ends of the floor-timbers (DP 173768)

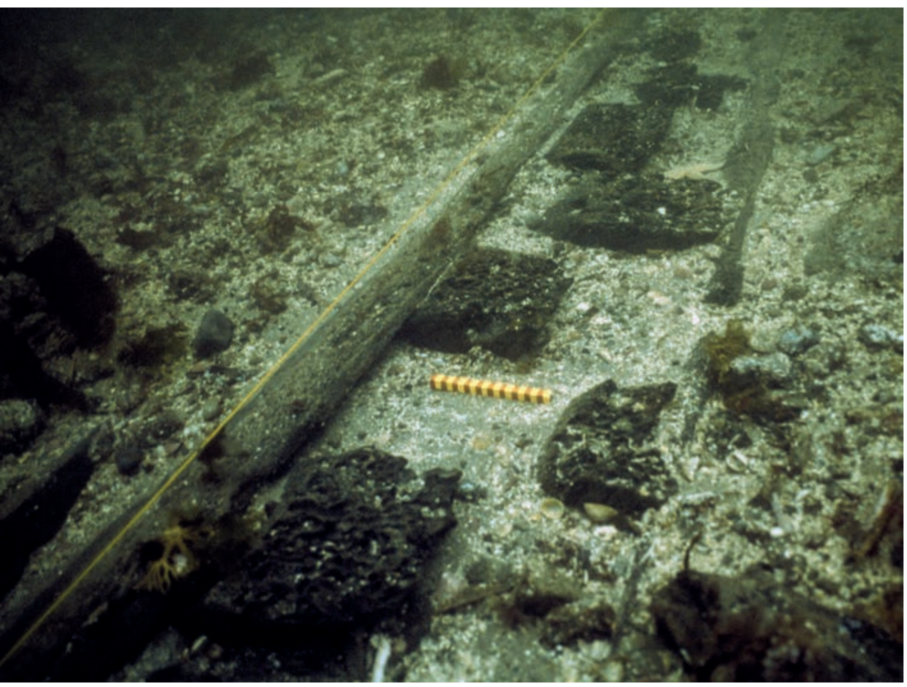


Illustration 122
Exposed frame-timbers, ceiling planking (along the yellow line), and partly buried outer planking (towards right) at the port midships side of the surviving structure, looking aft. Although the ends of the planks have been reduced to a flat conformity with the sea-bed by biological attack and erosion the longitudinal timbers are relatively unaffected, showing that the deposits on this side of the wreck are more stable than on the starboard side. Scale 20 centimetres (DP 173773)

Protection and exposure of the collapsed stern deposit

A major part of the stern structure appears to have remained partly intact for a significant period after deposition. This no doubt explains the exceptional condition of items from the collapsed stern interior. In this connection it is relevant to describe a destabilising event which occurred during the second-highest spring tide of 1993 (tidal range at Oban 4.2m) on 20 August, and the three days that followed. The high tidal range, with its concomitant increase in current flow during the ebb, coincided with a north to north-westerly wind which rarely dropped below Force 4 and frequently reached Force 5 or 6 for the next three days. By 4pm on the 23rd it was gusting occasionally to Force 8. During Low Water on 21 August it was observed that waves breaking on the shallow western end of Duart Bay were displacing considerable quantities of sand, which discoloured the water up to 500m from the shore. At the start of the ebb tide this discoloured water moved eastwards in a distinctive narrow band around Duart Point, reaching the wreck-site about an hour after slack water.

Team members on site at the time, who were on the point of terminating their dive because of the increasing run of the ebb, experienced a sudden and severe loss of visibility, from *c* 8m to *c* 2m, caused by the transport of suspended sand across the site. They also noted that previously unexposed organic material was being uncovered on the up-slope (shoreward) side of the wreck, particularly towards its eastern end. The following day, when conditions had moderated, it was noted that a substantial area of organic wreckage, extending across *c* 4m × 4m, had become uncovered (Illus 68). Most of the material, which included fine panelling and part of a wooden lantern, was in a condition which suggested that this was the first time it had been exposed since it became incorporated into the environmental matrix shortly after wrecking. However some areas close to the pre-exposure surface showed evidence of light infestation by barnacles (*Balanus crenatus*), no longer active, which indicated that here there had been at least one previous, though relatively brief, episode of exposure and reburial. Adjacent to this deposit, and rising above it, was a structural timber whose upper part was heavily abraded, indicating the horizon above which sediments were more mobile. That it had survived at all, however, suggests that for much of the time it too had been buried. These observations indicate cyclical episodes of exposure and re-burial of varying intensity, although the August 1993 incident was one of unprecedented severity. The probable reason for this is considered below.

Stability of deposition

An intact mariner's compass [91] in excellent condition was found at **060.096**, towards the eastern extremity of the wreck, buried some 0.15m deep in sediment and covered by

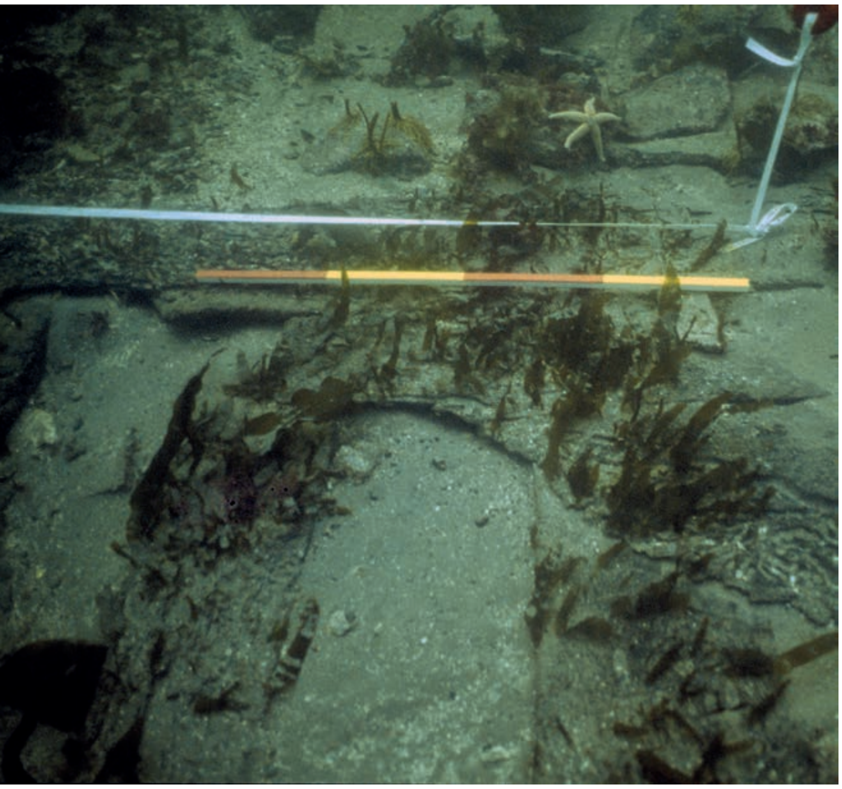


Illustration 123
Heavily eroded starboard-side frame-timbers at the Master-Frame ⊗ (left) and Frame 0.65F (right). Eroded ceiling planking, reduced to wafer-thinness, is indicated by the tape-axis. These timbers are in the early stages of colonisation by juvenile *Laminaria hyperborea*, which indicates that in spite of the extreme erosion they had until recently been buried, showing that this part of the wreck is subject to cyclical episodes of exposure and reburial. Scale 1 metre (DP 173719)

a wooden plank. The bowl was inverted and the base had imploded, indicating that when the object sank it had been air-filled and air-tight, and must therefore been held down by some container or structural element (Illus 120). Its sealed glass front must have remained intact until at some time during its progress to the bottom, some 10m down, where the external pressure would have doubled, the wooden base gave way. That the broken glass and the compass were still in close association when found demonstrates that neither has moved since primary deposition, and that burial was rapid.

Cycles of exposure and reburial

Beneath the two ballast-mounds substantial elements of the bow and the aft-of-midships parts of the lower hull are probably well preserved in secure anaerobic environments, though to protect the site's integrity these areas have not been excavated apart from a limited intrusion close to the hull's forward extremity. Between the ballast-mounds some 8m of the surviving midships section of the lower hull is partly exposed, though towards the port-side bilges it is covered with a lining of clay and gravel associated with the ballast. Extensive abrasion and biological activity has removed much of the upper substance of the wood, suggesting that it has been subjected to a succession of exposure episodes (Illus 121–2). A similar process was noted on the lower hull-remains of *Dartmouth*, just across the Sound of Mull (Martin 1978: 39–40). It was clear that some of these timbers had been in a buried state within the comparatively recent past, since their eroded surfaces were in the early stages of colonisation by juvenile plants of *Laminaria hyperborea*, for which the heavily degraded but hard surface of the wood provided good adhesion for the holdfasts (Illus 123). No adult specimens were present. These observations suggest that this part of the wreck has been affected by cyclical episodes of exposure and reburial, probably over a long period, and that, to judge by the developmental stage of the indicator growth, these previously eroded timbers had been in a fully buried state within the previous year.

A similar conclusion can be drawn from the characteristics of a small wooden bowl 179 which became exposed at **055.087** during the winter of 1992/93 (Illus 124). On recovery it showed evidence for at least three episodes of partial exposure: a recent one indicated by a clean break (mid-front in the photograph), an earlier one indicated by a slightly eroded fracture-line (to the right), and an area of degradation towards the left which has allowed at least one barnacle to colonise the surface.

Corrosion of guns as indicators of site-formation processes

Ian MacLeod

The amount of water-movement across the site is the primary determinant of the rate at which iron guns corrode, since the rate of decay is controlled by the flux of dissolved oxygen to the concreted surface (MacLeod 1995; 2006). The corrosion

Table 4.1
Corrosion rates observed on the Duart Point guns

Gun no	*Corrosion rate mm/year*	*Water depth (m) low water springs*
1	0.180	6.0
2	0.183	6.3
3	0.189	6.5
4	0.066	6.6
5	0.019	6.6
6	0.121	6.2
7	0.124	7.0

Illustration 124
Turned wooden bowl 179, largely intact and unabraded but showing evidence of three episodes of partial exposure: a recent clean break; earlier biological attack and abrasion around the rim; and a single colonising barnacle (DP 173699)

rates observed on the guns at Duart Point are summarised in Table 4.1, where it can be seen that the average corrosion rate of Guns 1, 2 and 3 is approximately 50% higher than that observed for Guns 6 and 7, while Gun 4 demonstrates roughly two-thirds of the corrosion rate of the first three guns, and Gun 5, which lies half-buried under the cliff-face, shows only 10% of the corrosion rate of Guns 1 to 3. It has been found that the corrosion rate of iron is logarithmically dependent on water-depth, and for an open-ocean wreck the calculated mean corrosion rate for the Duart guns would be 0.186 ± 0.002 (MacLeod 2006). Inspection of the data in Table 4.1 shows that Guns 1 to 3 are corroding at the expected rate, and that all the other guns are corroding at lower than expected rates.

Overlaying the depth-contour map (Illus 39) on the location of the guns it can be seen that the first three pieces are lying proud of the sea-bed on a somewhat elevated natural platform. Guns 6 and 7 are located in low depressions of the sea-bed and are therefore not fully exposed to the same water-movement as Guns 1–3. Since the corrosion rates have been determined on the long-term depths of decay (depth of graphitisation) it is clear that Guns 6 and 7 have been buried under sediment for *c* 30% of the time since deposition. On the same basis Gun 4 can be seen as having been buried for *c* 65% of the time and Gun 5 for *c* 90% of the time. This interpretation is based on the assumption that the guns suffer negligible corrosion when fully buried. It is understood that guns buried on a wreck do continue to corrode, but at a greatly reduced rate, so the relative corrosion rates indicate that defined parts of the wreck have been buried for significant periods since their original deposition. Thus the corrosion profiles of the guns on the Duart Point wreck-site represent clear evidence that the site has been subjected to significant changes since 1653. The data from the guns also assist in the interpretation of the site-formation processes and the general distribution of the decay-patterns which have been observed with the wooden structure and artefacts and the rates of colonisation by marine organisms such as kelp.

Recent work by Jacobsen et al (2013) on the corrosion of the American Civil War submarine *H L Hunley* (1854) has shown that deterioration of the cast iron of the bow and sections of the turrets and hull-plates has been controlled by the combination of erosion and corrosion in the fast-flowing and sediment-rich waters of Charleston Harbour. In the case

Illustration 125
Top: biological infestation at the surviving edge of the wooden binnacle 88. The single shipworm tunnel (*Teredo navalis*), about 10mm in diameter, bores into the interior of the wood, dwarfing the surface nibbling of gribble (*Limnoria lignorum*) (DP 173733). Bottom: characteristic infestation by gribble, following the grain on the surface of the wood. Scale in millimetres (DP 173734)

of the Duart wreck the corrosion of the guns is as predicted on the basis of the depth of the site (MacLeod 2006) and so it is apparent that despite the strong currents and the amount of sediment movement at Duart Point this mechanism does not apply to the guns. Gun 8, which appears to have been completely buried until its exposure by excavation in 2000, had suffered minimal corrosion.

Evidence of biologically induced mechanisms

It is clear that the biological ecosystems associated with the site are varied, interactive, and complex. Our understanding of their effect on site-formation processes is based largely on empirical observations made during the course of the work, so of necessity it is over-simplified and partial. This aspect has, however, proved helpful in constructing archaeologically based hypotheses which seem to explain various site-formation mechanisms, and it is hoped that our experience will stimulate more systematic research into this largely neglected topic.

Exposed wood in sea-water inevitably suffers biological attack. Two species of wood-devouring animals predominate on the Duart Point wreck, shipworm (*Teredo navalis*) and gribble (*Limnoria lignorum*). The former is not a worm but a bivalved mollusc which bores into the interior of the wood leaving a hole *c* 10mm in diameter, often lined with a calcareous deposit (Illus 125). The latter is a very small isopod crustacean, seldom more than 3mm long, which attacks the outer surfaces of wood along the grain. The two species often operate together. The activities of non-wood-boring animals, mainly crustaceans, may also, by exposing wood through burrowing, induce shipworm and gribble infestation (Illus 126).

Active biological transport

On occasion direct biological activity can lead to the movement of archaeological material. An observed example involved half of a Hebridean *crogan* pot 144, which was found lying loose on the sea-bed some 20m down-current from the eastern end of the site (Illus 127). Since the object no longer retained an identifiable archaeological association with the wreck, the possibility that it is intrusive cannot be discounted, although the chances that it derives from another source are slight. Closer inspection revealed the pot's recent history. It had been buried save for a circular area some 150mm in diameter, revealed by a dense patch of barnacle

Illustration 126
Top: burrow-scrapes thrown up by creatures seeking shelter beneath the hull-timbers. Scale 15 centimetres (DP 173749). Bottom: a long-clawed squat lobster (*Munida rugosa*) in its lair beneath eroded ship timbers (DP 173740)

Illustration 127
Hebridean *crogan* pot 144 with the attached kelp plant (*Laminaria hyperborea*) which acted as a sail in the current to drag it off the site. Scale 20 centimetres (DP 173721)

Illustration 128
Top: section through sediments close to the binnacle deposit showing alternating levels of gritty sand and gravels. A razor shell (*Ensis siliqua*) has been exposed next to the upright 25cm scale (DP 173697). Middle: the highly aggressive velvet swimming crab (*Liocarcinus puber*), which abounds on the site, may have been responsible for the dispersal of human remains in the collapsed stern area (DP 173741). Bottom: partly collapsed shoe 205 with human vertebrae and a clay-pipe stem within it (DP 174136)

growth. This provided a convenient surface for a young kelp plant (*Laminaria hyperborea*) to establish itself and begin to grow. As it prospered the sediment level fell, as indicated by light barnacle colonisation across the rest of the pot's surface. In due course a point was reached at which the drag of the plant's developing fronds in the current overcame the pot's diminishing hold on the sea-bed, and this unusual symbiotic partnership of vegetable and anthropogenically modified mineral began its journey away from the site, as indicated by drag-marks.

During excavation it was noted that the deeper deposits of sand and shingle, particularly at the eastern end of the site, carry large populations of razor shells (*Ensis siliqua*). These burrow vertically into the sediment and feed through a tube which extends into the water and retracts when threatened (Illus 128). The animals appear to have little detrimental effect on the archaeological deposits into which some had penetrated, but when exposed they are defenceless against predation. In particular they excite a voracious feeding-frenzy among the numerous velvet swimming crabs (*Liocarcinus puber*) (Illus 128), which swarmed into the area being excavated to seize the exposed razor shells by their muscular 'feet' and scurry off to nearby lairs. Such behaviour might explain the dispersal of the skeletal remains of the only known human victim of the wreck, whose substantially complete bone assemblage was recovered disposed randomly throughout the aft organic deposit but not extending beyond it. This suggests that the after hull was still partly intact when this activity took place, providing predators with numerous secure lairs within it but restricting their movement beyond. One even appears to have taken up residence in a shoe (Illus 128)

Apocryphal stories of hermit crabs (*Pagurus bernhardus*) adopting artefacts such as clay-pipe bowls as mobile homes have long been current among underwater archaeologists, though I know of no positively authenticated example. However this mechanism might provide a plausible explanation for a phenomenon observed on the site over two successive monitoring visits in 1992. In October of that year an eroding area in which an organic deposit had been uncovered was consolidated by the application of sterile gravel obtained from a local quarry. A month later a clay-pipe bowl of mid 17th-century date was noted lying on the gravel surface (Illus 129). The pipe was of the same type as others found on the wreck, and the possibility that it had been contained within the intrusive gravel can be discounted. Transport by an animal such as a hermit crab seems the most likely explanation.

4.3 Interpretation of site-formation processes

The wreck lies on a shingle bottom with some intrusive rocks and smaller stones at the foot of the rock-face which slopes from the shore just east of Duart Point. The forward and aft ends, as argued above, seem to have been held in place by two large boulders. A primary axis, with a mean bearing of *c* 300° (T) viewed from aft, is represented by the keel which is probably largely intact throughout its *c* 18m length, defined by its estimated forward extremity at **280.060** and the lower

Illustration 129
Top: a hermit crab (*Pagurus bernhardus*) which has adopted the shell of a common whelk (*Buccinum undatum*) as its home (DP 173747). Bottom: clay-pipe bowl of distinctive 17th-century form, similar to others recovered from secure contexts on the wreck-site, lying on top of gravel derived from a quarry on shore and laid as a consolidant a month earlier. This object can only have come from elsewhere on the site, and transport by a young hermit crab is a possibility. Scale in centimetres (Steve Liscoe, DP 173666)

sternpost at **096.074**. Forward of the mainmast-step the lower structural complex is heeled some 15° to port, while the lower stern assembly is heeled in the same direction to *c* 25°, suggesting that a twist or fracture has occurred somewhere beneath the aft ballast-mound. Notwithstanding this, the lower structure appears to be substantially articulated along the full axis of the keel.

The keel-axis runs nearly parallel with the shore, with the Low Water Mark 15m distant from the stern and 21m from the stem. Documentary sources reveal few details about the circumstances of the wrecking, except that it took place during a violent storm lasting '16 or 18 hours'. Since Duart Bay is the only viable anchorage in the vicinity, this implies that the wind came from the north-west quarter, so as to carry the vessel from its anchored position in the bay to Duart Point. It may be postulated that the vessel hit the rocky shore broadside-on with her bow towards the north-west, sustaining catastrophic damage to the lower port hull (though none was identified in the limited areas available for inspection). It is likely that those few still on board (the majority of her people having already landed) took this opportunity to escape, though at least one individual remained within the aft interior. Sinking would quickly have followed and the ship, weighed down by ballast and guns, trended down the rock slope as a largely coherent entity to settle on the shingle bottom at its foot, heeling towards the shore at the angle she would normally have adopted when beached.

During the initial trauma of wrecking much will have floated away and further structural damage been caused by the ripping-out of masts and rigging and the displacement of heavy items such as guns. Then the ship probably settled in a damaged but relatively complete state, held in place by the well-packed ballast which had barely shifted throughout the episode. We have no means of knowing whether the current was running when the wreck occurred, but the first ebb tide would have pivoted the hull into its present heading of 300° if it had not already adopted this orientation. That same ebb would have brought with it an initial flow of suspended silt which, as we have seen, characterises tidal behaviour across the Point during strong north-westerly winds. Normally this material would not affect the morphology of the sea-floor, where mechanisms of deposition and removal had reached a state of balance which maintained a more-or-less constant bathymetric profile, to which (apart from minor cycles of change) it would subsequently revert when the stable phase of the site-formation process had been reached.

When the wreck arrived, however, it would have presented a massive anomaly, which would rapidly have accumulated silt on the open decks, and within the hull through ports and hatches, and perhaps breaks in the structure. The effect would have been greatest towards the stern where, as we have seen, the flow of the current eddies inshore. It was probably during this phase that the first layer of material, consisting of fine grey silt interspersed with fragmented organic material (of which vast quantities will have been generated during the wrecking process), fell into the open chest in the aft interior of the ship. During the early phases of deposition much fragmented organic matter from within the hull, consisting of wood, fibre, leather and peat, also gathered in the interstices between the frames (Chapter 6.4).

Within the ship considerable dislocation of loose or inadequately secured items will have occurred during the sinking and its aftermath. Heavy objects will have trended downwards, while buoyant material will have floated upwards until it reached the surface or was restrained by intervening structure. Such material will have tended to accumulate in natural traps beneath the decks, especially where deck-structures met bulkheads or the ship's sides and stern. Although these floating organic deposits will have been internally chaotic and upwardly displaced, they will not normally have moved far from their original locations before escaping altogether or becoming trapped. Such accumulations will have been particularly heavy inside the after part of the ship, where the panelled compartments will not only have acted as efficient traps but will also, when their lightly pegged fastenings decayed, themselves have contributed to the richness and substance of the organic deposits observed during the excavation of this part of the wreck.

This hypothesis explains the presence within the aft deposit of material from the collapsed transom and stern interior, the formation processes of which we may now attempt to interpret. While the ship remained substantially intact and heeled some 15° to port, the interior of the hull would have continued to accumulate silt rapidly, indicated by the clean grey deposit – Level 2 – in the open chest. We may surmise that an equally rapid build-up was occurring throughout the hull, particularly towards the stern, where there were more places for silt to accumulate including, probably, an additional upper deck. This extra weight, and its higher distribution, would have exacerbated the twisting moment of the stern to port, already induced by the angle at which the ship sat. Whether gradually or as a single episode, this in time broke or distorted the aft keel and allowed the stern to rotate a further 10° to port, greatly increasing the twisting moment and eventually precipitating a partial collapse of the aft structure, during which its upper port side broke away from the keel and deadwood and fell onto its side. As it did so the organic deposits trapped inside, separated into at least two layers by the deck sequence, together with accumulated silt now filling the interior, slid onto the collapsed structure beneath to form a kind of archaeological lasagne in which waterlogged organic deposits and silt horizons became interlayered.

The distinctive hard-edged eastern boundary of this deposit implies that during its formation it had been restrained by a structure, now lost, which had lain in a straight line on the sea-bed, at a raking angle to the keel-axis and extending vertically upwards. This can only have been the flat transom stern, lying on its side. It has been suggested above that elements of the transom structure remained partially intact for long enough to suffer heavy erosion and biological degradation before breaking free to deposit a transom-timber and other material some 10m down-current from the location of the collapsed stern. A comparable break-up sequence in which a transom stern has detached itself from the longitudinal axis of a ship and stabilised on its side has been noted on the wreck of the Nämdöfjärd *kravel* near Stockholm (Adams & Rönnby 2013: 76–82).

The above hypothesis does not explain the occurrence of well-preserved and unabraded material indubitably associated with the outside of the transom structure within the layered stratigraphy of the collapsed stern interior. These include decorative carvings, window-lights, and components associated with a roofed quarter-gallery, a window-arch and a stern hawse-hole. It is possible that carvings directly associated with the Stuart regime had been removed from the exterior of the ship and stowed below, but most lack the symbolic associations that would have been offensive to republican sensibilities, and in any case their removal would probably have compromised the ship's structural integrity. A more likely interpretation is that during the break-up of the stern much of the starboard-side transom collapsed inwards and downwards along with the starboard side of the after hull, leaving part of the port transom complex, still attached to the rolled-out port side of the hull, to retain the stern contents along the angled line which defines the edge of the organic deposit. In this way elements of the outer stern structure and decoration might have become incorporated within the organic matrix. The deposit may have for a time been capped by fallen starboard-side elements of the collapsed stern when they disintegrated, which would perhaps account for the gun-port lid at **088.087**.

The formation processes operating at the forward part of the wreck appear to have been less complex. Forward of the aft ballast-mound the surviving structure retains a constant 15° heel to port, which is the natural sit of the hull. Some 5m of the keelson, its top surface much reduced by abrasion, defines the central axis of the ship from just aft of the mainmast-step to the point at which it becomes covered by the forward ballast-mound. Because of the heel to port relatively little structure on the starboard side has survived, amounting for most of its length to 1m or less from the axis of the keelson, but widening to just under 2m as it approaches the forward ballast-mound. The port side, however, survives to more than 3m from the keelson-axis along the full length of exposed timber between the ballast-mounds. This length incorporates the lower turn of the bilge and a complete run of overlapped floor-timbers and first futtocks. Excavation extended this run 2.5m further aft, confirming the deepening of the bilge as the hull began its flare towards the stern.

The clearly defined edge of the forward ballast-mound, the well-packed appearance of its stones, and its position along the ship's central axis, suggests that its post-wrecking displacement has been minimal. Its width and shape, coupled with its considerable mass (estimated at 6 tons), therefore indicate that the ship had a bluff-ended bow, a conclusion reinforced by the evidence recorded at the forward extremity of its surviving hull. The heavily abraded nature of keel, keelson, and frames at this point suggests that the lower forward hull had been unburied for an extended period, and this suggests that most of the bow structure – and by implication the remaining hull as far back as the postulated break beneath the aft ballast-mound – had remained substantially intact for some time after deposition. This would have generated significant scour, particularly around the bow, facing directly into the current.

Excavation beyond the port-side edge of the forward ballast-mound identified spill associated with the upperworks of the ship at this point, particularly bricks and tiles from the galley structure. This area also included Gun 4, which closely reflects the matching position of Gun 5 on the starboard side. They were probably paired forward-facing bow pieces, as argued in Chapter 7.4.

Hypothesis of the wrecking event and its aftermath

On 13 September 1653 the ship lay with five consorts and two smaller vessels at anchor in Duart Bay. Most of her complement was ashore, and much of the vessel's cargo of military hardware and provisions had been unloaded. With little warning the fleet was struck by a severe north-westerly gale during which three of the ships broke free from their anchors and were wrecked. One came ashore at Duart Point, broadside-on with her bow pointing approximately NNW. With her lower port-side hull extensively holed she filled rapidly with water and sank, bumping down the 35° rock slope still largely intact. At the foot of the slope she settled with her keel resting on the gravel sea-bed, heeled to port at her natural sit of about 15° (Illus 130). Her forward port quarter was impaled on a large rock (**266.093**), which stove in much of the adjacent structure, while her lower stern was restrained from movement seawards by another rock at **092.064**. Significant damage was probably sustained during the wrecking event, and over the following few days, by the movement of heavy items within the hull and the tearing out of masts, spars, and rigging by wind and water action. Further, though probably limited, damage may have been caused by rescue or salvage attempts from the shore.

Notwithstanding the violence of the primary event, the hull remained at least partially intact for a considerable period. It represented a destabilising intrusion within the balanced dynamics of current and sediment transportation peculiar to this location, and its presence generated rapid and massive accumulations of silt, much of which entered the hull. Silting was particularly heavy towards the stern, where the eddying current entered gaps in the hull, filling the decks with silt which trended towards the downwards-tilted port side. As the weight of silt increased, and the structural integrity of the hull diminished, a point was reached at which the entire stern complex twisted a further 10° to port, distorting or perhaps breaking the keel and keelson some 6m forward of the sternpost. This movement would have tipped the silt deposits further to port, and at this point the mixing of silts with partly waterlogged organic material which had become trapped in the stern during the initial wrecking process may have begun.

After an unknown but perhaps quite short period the heavy, and now structurally weak, silt-laden upper-stern structure, upon which the increased angle of heel had induced an even greater turning moment, broke away from the keel, keelson, and aft deadwood and collapsed onto its side, carrying the transom with it. Much of the port-side transom remained intact, lying on its side and still partly attached to the after-framing. Four pieces of the ship's main armament (Guns 1, 2, 3 and 6), which appear to have been mounted in broadside pairs on each side of the main deck towards the stern, were also deposited during this process, as was the small minion drake, which may have been mounted at the stern pointing aft through the transom (see Chapter 7).

As the stern collapsed onto its side the mixed silt and waterlogged organics slid across the decks and accumulated in layers to become recognisably stratified archaeological deposits, restrained at their after ends by the remains of the transom. Some of the starboard-side transom structure, including elements of decorative carving which had probably dropped off when their iron fixings corroded, became incorporated in the general collapse and deposition of the stern complex. This material, as evidenced by its generally pristine condition, was probably deposited quite soon after the wrecking event. Other parts of the transom, however, appear to have retained a level of structural coherence in an exposed environment before their eventual dislocation and transport elsewhere. This is indicated by the abraded condition of the decorated transom-timber which became

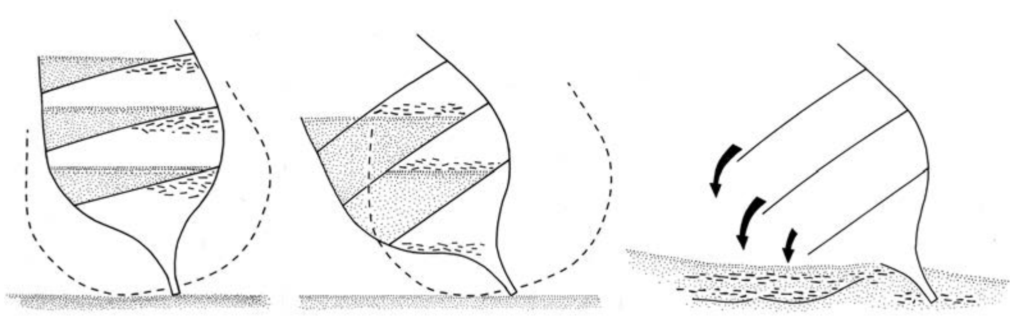


Illustration 130
Hypothetical deconstruction process of the ship's after structure following initial deposition of the wreck

relocated some 8m north-east of the main stern deposit. That it had once been part of a larger structure containing other material from the wreck is evidenced by its association with a less-heavily eroded binnacle, compass-base, and barrel-end.

The processes which conditioned deposition of the wreck's forward parts were less complex. That at least the lower part of the bow had remained substantially intact for some time after deposition is evidenced by the scour-induced erosion identified at the lowest forward structural extremity. However, at the outset significant damage had been caused to the lower port quarter by being impaled on a large boulder, while Guns 4 and 5, which seem to have been situated on the main deck close to the bow, probably fell to the sea-floor during or soon after the initial wrecking event, as the survival of primary hull-structure immediately beneath Gun 4 appears to suggest.

Although silt will undoubtedly have accumulated in the forward hull through ports and hatches, this area is less affected by eddying and so the build-up would have been less rapid and acute than at the stern. Nor was the progressive twist and collapse to port which had occurred at the after part of the hull evident here. Gradual decay, in which the mechanisms of mechanical abrasion, biological attack, and water-movement played their inter-related parts, is the more likely scenario, culminating in environmental balance and a largely restored configuration of the sea-bed broken only by the intrusive mounds of the two ballast-piles. The process involved a relatively cohesive deposition of material from the galley, which would have been located in the forecastle at main-deck level, among and just beyond the port-side edge of the forward ballast-mound. Allowing for the 15° tilt of the hull, its present position lies beneath its postulated original location.

Stabilisation and adjustment

After the stern and forward sections of the wreck had stabilised as described above, the natural processes of silt-deposition and -removal reached a state of balance, creating a sea-bed configuration adjusted to accommodate the surviving wreck features now incorporated within it. This was probably significantly deeper, particularly towards the stern, than the pre-wreck configuration because of the build-up of silt around and on top of the deposited material, as postulated above. In reaching this conclusion I am indebted to the suggestions of Steve Liscoe, a former member of the Archaeological Diving Unit, whose recorded observations of the site's condition in 1991–2, and subsequent discussions, have been invaluable. The site's stability would have been maintained by the cover of *Laminaria hyperborea* which flourishes over the main wreck area. The thickly clustered stout stems and broad fronds of this robust alga present a strong resistance to water-flow, slowing it to negligible levels at the interface between the water and the sea-floor. This boundary layer minimises the effects of erosion, and probably over time encourages a limited build-up of sediment.

It is likely, however, that later major north-westerly storms, following the one recorded on 13 September 1653, from time to time damage or remove the protective cover of *Laminaria*, and it is probable that on such occasions temporary destabilisation occurs. This is evident in the archaeological record through indications of exposure and subsequent reburial in some parts of the site. It may also help to explain the major episodes of exposure in the early 1990s which precipitated the present project. It is also possible, though unlikely, that seismic events along the Great Glen fault may have had occasional destabilising effects. However it is probable that the extreme nature of the recent destabilisation was unintentionally exacerbated, if not caused, by human intervention.

It is clear that the site was significantly disturbed following John Dadd's initial discovery in 1979, and by unknown divers in 1991–2 after the Archaeological Diving Unit's first visit in 1991. Further disturbance occurred during the visit by the Dumfries and Galloway Club in 1992, although this was mitigated by their subsequent responsible and selfless behaviour. This conclusion has emerged with hindsight. No irresponsibility or malice was involved, and no criticism of anyone is intended. As a preliminary to investigations on the site, however – by John Dadd in 1979, by the ADU in 1991 and 1992, by the Dumfries and Galloway divers in 1992, and subsequently by our team – it was routine, as it has been elsewhere, to clear away the cover of *Laminaria* to reveal features for investigation and recording. This is akin to the cutting down of vegetation on a terrestrial archaeological site. However, as we now know, such removal on this site can trigger erosion, especially if the sea-bed had previously been disturbed by indiscriminate excavation. Fortunately the trend can readily be reversed by the application of appropriately placed sandbags. Not only does this provide protection for the exposed deposits but it also creates a surface on which *Laminaria* quickly grows, thus re-establishing the site's natural stability.

Chapter 5

THE SHIP: STRUCTURE AND LAYOUT

5.1 Basic hull-form

The Duart Point wreck is beyond full reconstruction as a complete ship. Most of the hull is no longer extant, and much of what remains has been displaced, randomly re-deposited, and juxtaposed within the natural environment in ways rarely definitively explicable in spatial or quantitative terms. Moreover, since the primary aim of the project has been to stabilise the site with minimal intrusion, much structural evidence which might have been revealed by a more robust excavation strategy remains uninvestigated. This is particularly so of those parts of the lower hull buried beneath the two ballast-mounds, and the collapsed side of the upper stern structure presumed to lie beneath the remains of the aft-cabin interior.

Despite these constraints, enough data from structural remains and artefact distributions are available to support a number of general and sometimes specific conclusions about the dimensions, proportions, structure, and internal layout of the ship. These cannot be stretched so far as to inform a full reconstruction of the vessel's shape and constructional details, or the use of space within the hull, but they do permit the creation of what may be termed a three-dimensional envelope within which aspects of these topics can be hypothesised at various levels of probability and detail. What follows should be read with reference to Chapters 3–4.

The aftermost section of the lower stern structure is substantially intact, with the bottom parts of the rudder, sternpost assembly and deadwood-knee surviving as an articulated complex. The evidence suggests a fine run to the hull, with crutched timbers raised above the deadwood, and chocks used to maintain a slim profile. The entire aft part of the hull, including an associated section of the keel, appears to have twisted to port and detached itself. Its upper timbers collapsed onto their sides where some are now stabilised in a way that retains elements of their former structural cohesion. The end of the lower stern assembly can thus be regarded as representing the aftermost point of the keel-axis and is therefore a convenient starting-point in the reconstructive process.

A projection forwards along this axis aligns closely with the well-preserved remains of the keel and keelson as they pass through the articulated midships section of the lower hull, eventually to emerge from beneath the front edge of the forward ballast-mound where they demonstrate the beginnings of the upwards curve into the stem. While recognising that the slight displacement of the aft structure caused by a longitudinal twisting moment near the stern, and the eroded condition of the forward ends of keel and keelson, may have caused some imprecision in defining the distance between the keel terminals, its length can with reasonable confidence be estimated as 18.25m (59ft 10½in). For comparison with contemporary sources this has been rounded to 60ft.

Sternposts of ships of this period typically had a rake of 20° from the vertical (Lavery 1988: 19). This matches the angle of the surviving stump of the Duart Point sternpost, and a continuation of the line is reflected, though at a greater angle (*c* 50° from the present lie of the keel), by the eastern edge of the interior stern deposit, which, as argued above, probably marks the position of the detached and partially displaced transom during the second phase of the ship's break-up sequence. An aft rake of 20° has therefore been adopted for the sternpost of the reconstructed hull, with the set of the transom angling closer to the vertical in the manner indicated by many contemporary sources. The sweep of the stem (the segment of a circle rising from the forward end of the keel) is less easy to define, but in his reconstruction of *Susan Constant* Lavery (1988: 10) suggests a circle, the radius of which is 0.791 of the hull breadth, rising tangentially from the keel, and this formula has been adopted to give a stem-sweep radius of 6.03m (19ft 8in) for the Duart Point hull. These three elements – keel-length, sternpost-angle, and stem-sweep – combine to give a basic longitudinal profile for the hull (Illus 131).

The two midships sections provide reliable profiles of the floor-timbers and lower bilges extending some 3m (10ft) to port of the keel-axis. From these sections, and by extending the sweep from the bilge to accommodate other available data on a best-fit basis, sections of the presumed Master-Frame ⊗

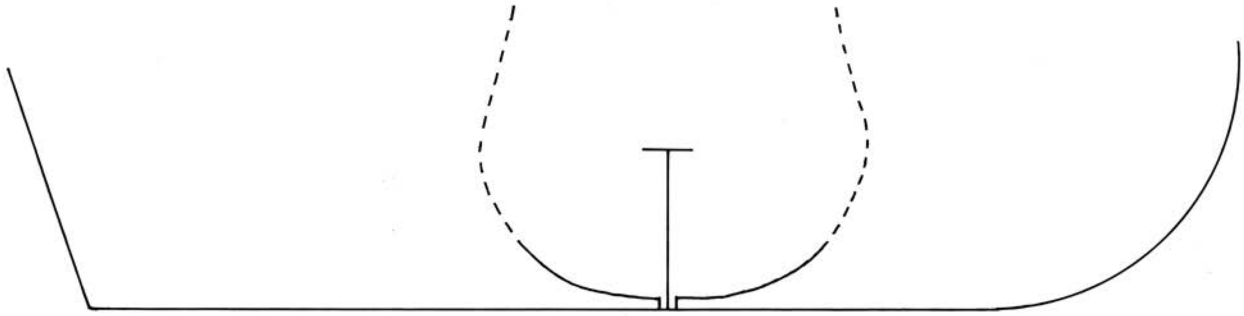


Illustration 131
Reconstructed longitudinal profile and master-frame cross-section

Illustration 132
Top: speculative framework of the hull based on recorded elements. Bottom: speculative half-model faired with modelling-compound

and Frame 3.6A (the mainmast position) can be reconstructed. This defines a maximum beam of 7.6m (25ft), giving a beam to keel-length ratio of 1:2.4.

Six of the rising port-side frames towards the stern run close to the articulated sternpost and associated structures, and, while now separated from it because of erosion at their lower ends, their spacing and right-angled set from the keel-axis suggest that they remain close to their original positions, though they have collapsed downwards and outwards. The longest, Frame 10.8A, extends 3.7m (12ft 1½in) from the keel-axis, bringing its upper end well above the presumed waterline. This, with allowance for distortion, dislocation, and the presumed upper-deck width at this part of the hull, provides a basis for reconstructing a section of the after hull 2.4m forward of the keel skeg. Fortuitously this position accords closely with the postulated location of the reconstructed panelled bulkhead which probably defined the forward end of the stern cabin on the upper deck, and these two elements can be combined to reconstruct a hypothetical profile at this point, up to and including the quarter-deck. The taper of the upper structure aft towards the flat transom is defined by the need to accommodate the reconstruction of the transom layout (see below).

The aft frames continue to show a right-angled set to the keel-axis, unlike the sternwards-angled cant-frames of later practice (cf Steffey 1994: 268, 294–5). The fragmentary remains of structure associated with the forward end of the keel likewise indicate non-canted framing, while the configuration of the forward ballast suggests that the bow was rounded, although the surviving but much abraded Frame 4.5F shows evidence of a reasonably fine entry below the waterline.

These data were extrapolated to create a best-fit framework for a skeletal half-model of the hull which incorporated all the known information and what could reasonably be deduced from it. The framework was faired with plasticine and the hull-lines lifted from it (Illus 132–3). Helpful references were provided by Howard (1979), Lavery (1988), Kirsch (1990), Steffey (1994) and Adams (2013). Kirsch includes as an appendix the invaluable *Treatise on Shipbuilding* of *c* 1620, edited by William Salisbury from a manuscript in the Admiralty Library, originally published by the Society for Nautical Research in 1958.

No attempt has been made to apply formal contemporary rules for developing the hull-shape, since these are varied, often ambiguous, and (one suspects) rarely followed by practising shipwrights (Anderson 1947: 218–25; Naish 1958: 577; Unger 1978: 42). This was certainly the approach of West Country schooner-builders in the late 19th century, of whom Greenhill (1968: vol 1, 85) noted that 'no mathematical formulas … were used to indicate the line of development of various parts of the hull'. Each ship was shaped with reference to successful predecessors, with minor adjustments to enhance particular qualities or in response to a customer's requirements. Though tighter specifications in respect of warships had emerged at an earlier date, even as late as 1668 the 1,200-ton 1st-rate *Charles* had been built, according to the diarist John Evelyn (who was present at her launch), 'by old Shish, a plain, honest carpenter, master-builder of this dock, but one who can give

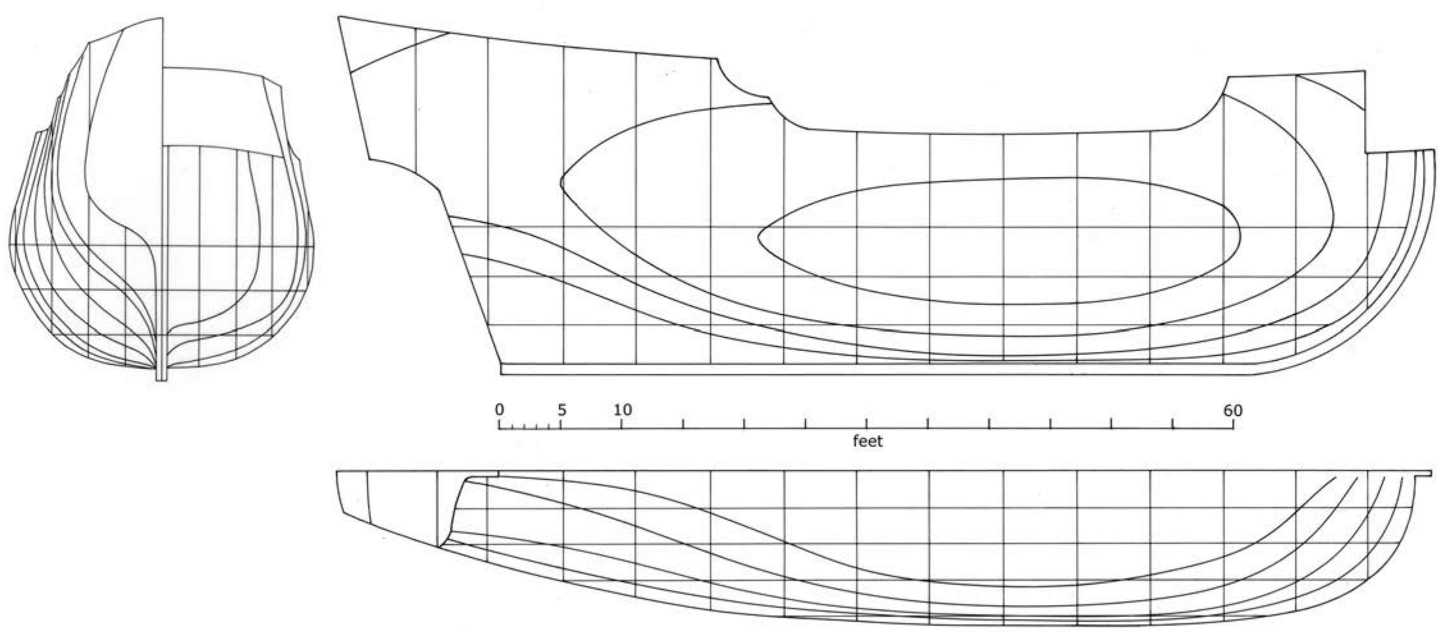


Illustration 133
Faired lines taken off the half-model in Illus 132

very little account of his art by discourse, and is hardly capable of reading, yet of great ability in his calling. The family have been ship carpenters in this yard above 300 years' (*Evelyn's Diary* vol 2: 41, 3 March 1668). It is likely that the Duart Point ship, whatever her origins, was based on a philosophy in which individual designs involved adaptation and adjustment within a familiar and well-tried envelope.

At any event, the vessel that emerges is strikingly similar in proportions and dimensions to the *Lion's Whelps*, a discrete category of small warships built for Charles I's navy (Thompson 1977). Their specifications are defined in a building contract of 28 February 1627/8, '10 pinnaces of aboute 120 tonnes a peece to be built with the most advantage both to row and sail' (TNA SP16/94). Their specifications are set out in Table 5.1 against those calculated for the Duart Point ship. It is relevant to note that the Duart Point figures were calculated before the author was aware of the *Lion's Whelps*' data.

5.2 Hull construction

The ship appears to have been built throughout of oak. The shipwrightry of the hull follows a broadly conventional pattern and is based on transverse frames bolted between the keel and keelson and planked internally and externally. The frames are made up of floor-timbers which run across the bottom of the ship. These are almost flat amidships but rise to accommodate the entry and run of the hull fore and aft. The floor-timbers overlap with futtocks which carry the curve of the hull around the bilge and up the side. Further futtocks and top-timbers may be presumed though none has survived.

Table 5.1
Comparison between the Duart Point wreck reconstruction and the *Lion's Whelps*

	Duart Point wreck reconstruction	Lion's Whelps
Length by the keel	60ft	60ft
Breadth between outside planks	25ft	25ft
Depth in hold (ceiling to deck-beams)	8ft	8ft
Rake forward	17ft (to top of stem	18ft
Rake aft	3ft (to main deck)	3ft
Oars (3 men per sweep)	18?	32
Armament	2 minion drakes 2 minions 4 sakers	2 sakers 4 demi-culverins 4 culverins
Burden ('Mr Baker's old way')*	120 tons	120 tons?
Displacement (calculated from the volume of the half-model)†	133.5 tons	?

* length × breadth × depth ÷ 100 (Oppenheim 1896: 266–9, citing *SPD* lv 1627: 39)

† Confusion has arisen in the past between modern concepts of displacement (ie the mathematically precise deadweight of a floating hull as represented by the volume of water it displaces at a given state of lading) and the arbitrary formulae by which contemporaries calculated cargo capacity or the overall size of a ship. These often-spurious figures, based on simple rules-of-thumb applied for purely administrative purposes, were influenced by many variable factors and different systems of measurement. Accurate estimates of displacement involve complex mathematics which only in modern times have been fully understood. The subject is definitively analysed and explained by Glete (1993: vol 1, 66–76 & vol 2, 527–30). The Duart Point ship's displacement is based on the volume of her reconstructed hull loaded to a draught of 10ft from the bottom of the level keel, calculated in cubic feet and converted to long tons of 2240lbs, seawater weighing 64lbs per cubic foot (Steffy 1994: 251–2). Variations in the draught and trim of the vessel would alter this figure. The displacement of the *Lion's Whelps* is not known, but given their similarity of dimensions it was probably close to that of the Duart Point ship.

Although almost all the frames are paired, in that each overlaps with the end of its neighbour, they are with one apparent exception not joined transversely and so most could not have been pre-erected to form a coherent framework or skeleton before being planked up. The exception is the Master-Frame ⊗. Where it emerges from between the outer and ceiling planks on the starboard side at **225.095** it sits hard against its neighbouring futtock, unlike any other of the paired floor- and futtock-timbers along the exposed starboard run. Although there was no visible evidence of these two timbers being fastened laterally in the short length of the joint-face available for inspection it is entirely possible that they were. If they were, the master-frame, and perhaps one or two others in suitable locations fore and aft, would have been constructed as free-standing entities which were pre-erected to form a template for the projected hull, no doubt defined and faired with ribbands (light battens).

Such a hull could have been assembled without its other frames being pre-constructed in one of two ways. In the first, the process would begin by laying the keel and erecting the stern and stem uprights. It would then be possible to plank up the lower hull without frames, the strakes being held together temporarily with cleats and clamps. Once the lower planks were in place the floor-timbers could be trimmed to fit and fixed to the planks with treenails. Although treenail heads are difficult to see in blackened and abraded timbers, especially under water, enough were recognised to indicate that the primary fastenings had been set diagonally in pairs at each frame/plank junction. The keelson could then be laid and iron bolts used to clamp keel, floors and keelson together. Bolts would be used elsewhere at points of particular stress (cf the plank-fastening pattern on the *Dartmouth* wreck (Martin 1978: 47–8; Batchvarov 2007).

Next the lower ends of the first futtocks would be pegged with treenails to the fixed planking, overlapping the upper ends, or rung-heads, of the floor-timbers. The process would be repeated, framing and planking inserted alternately under the guidance of the control-frames and ribbands, until the hull was complete. Structural cohesion of the developing hull would have been secured by the insertion of knees, deck-beams, and ledges at appropriate stages in the assembly. This type of construction was widely used by the Dutch in the 17th century (Hocker 2004: 82–3), and is well illustrated in a 17th-century print by Sieuwert van der Meulen (Groot & Vorstman 1980: 139) and described by Witsen in 1671 (Hoving 2012: 8).

Alternatively the floor-timbers could have been sandwiched between the keel and keelson along with the free-standing control-frames and bolted together before planking began. The first strake, or garboard, could then be rabbeted into the keel, and successive runs of planking added until the outboard ends of the floor-timbers were reached. Construction would then have proceeded as in the first method, with futtocks and planking built up in sequence. Though definitive evidence is lacking, it is likely that the latter method was used in the Duart Point ship. These techniques, which appear to be Dutch in origin, have been categorised as 'bottom-based' or 'frame-led' (Greenhill 1976: 71 fig 25; Hocker 2004: 82–4; Adams 2013: 58).

Where it could be measured the outer hull-planking was 70mm (2¾in) thick, and fastened to the frames with oak treenails 25mm (1in) in diameter, fashioned with a spokeshave. Driven into pre-drilled holes, these were tightened by oakum inserted into cuts in the outer ends to expand and lock them. The planks conform in general to three widths, 0.2m (8in), 0.33m (12in), and 0.45m (18in). No joints were observed in the outer planks available for scrutiny. Few of the outer planks could be examined other than the abraded ones along the outboard edges of the surviving structure. There are no indications of runs of thicker planks, or wales, which were normally provided for greater longitudinal strength inside and outside the hull, though these had probably been present higher up in the structure. Neither was there any evidence of sheathing, such as the light fir boards and tarred hair observed on the outer hull of *Dartmouth* (Martin 1978: 49–50), perhaps suggesting that the Duart Point ship's operations had been restricted to waters where shipworm attack was unlikely. Notwithstanding this, post-wrecking infestation by both shipworm and gribble has been considerable.

The ceiling planking, where it could be measured, is 57mm (2¼in) thick. Much of it was covered with clay, evidently to provide a cushion for the spread of gravel which served as ballast in the central part of the hold, and this has obscured many of the ceiling timbers. Two joints were noted in the ceiling, a butt-joint at **198.094** (Illus 134) and a diagonal scarf at **235.092**. The short planks on either side of the keelson are loosely fitted limber-boards, which could be removed to clear blockages in the run of water to the pump-wells (see also Chapters 3.2 and 6.3).

5.3 The decorated transom stern

Sufficient evidence has survived to attempt a hypothetical reconstruction of the transom structure and its decoration, and to postulate the breadth and camber of the main deck at its aftermost end. A substantial part of the panelled bulkhead at the forward end of the stern cabin has also survived, allowing an estimate of the breadth and camber of the main deck about 3m forward of its aft extremity. The latter calculation is complemented by an upper futtock or frame-timber at 9.95m aft in the run of the hull and this, together with surviving elements of the lower-stern assembly, allows a tentative reconstruction of the full hull-section at this point.

The artefactual material associated with the transom is considered first, followed by a description and analysis of the interior panelling. This information is then combined

Illustration 134
A butt-joint in the ceiling planking at the port midships turn of the bilge. Clay ballast lining is visible in the foreground. Targets set 1m apart (DP 173772)

with evidence from the lower framing and stern assembly to hypothesise a section of the hull towards the stern.

Carved decoration and related pieces

[1] DP96/010, **011.003/041.022**, transom-beam 3.42m × 0.18m × 0.10m (Illus 135). Heavily eroded curved piece of oak with traces of carved decoration, particularly at the right-hand end, which appear to represent a central rosette in a rectangular field with four pellets in its corners (Illus 62). Mating faces at either end of the beam and four intermediate points at roughly regular intervals indicate six joints to uprights, of which the eroded remnant of one (also of oak) survives (third from left). Traces of hair-and-tar caulking were noted at the interface. The joints show evidence of iron fixings set in a quincunx pattern, while two more-substantial holes for bolts with countersunk heads are present between Joints 2 and 3 and Joints 4 and 5. The two central joints (3 and 4) are set almost vertically, while the outer ones angle progressively inwards (assuming the upward-curved edge of the beam to have been the top), reaching about 8° from the vertical at Joints 1 and

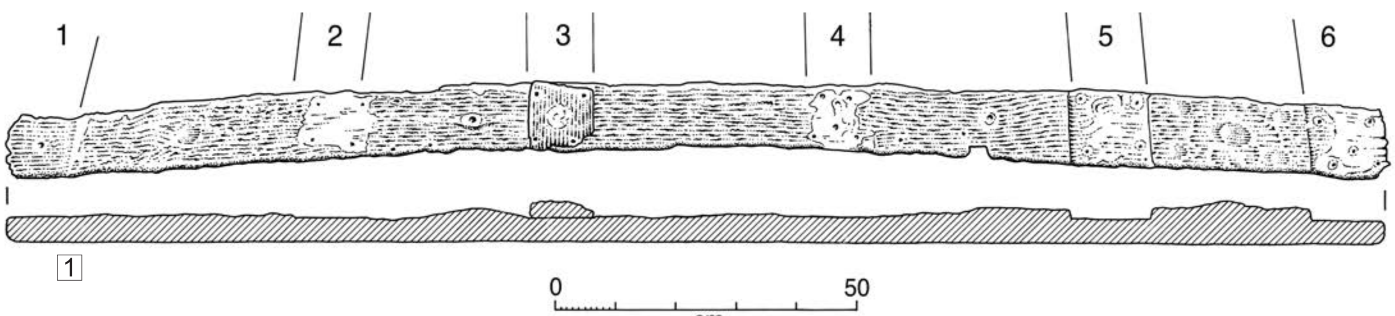


Illustration 135
Transom beam [1] showing six joint-faces. The third from the left retains a fragment of an original upright

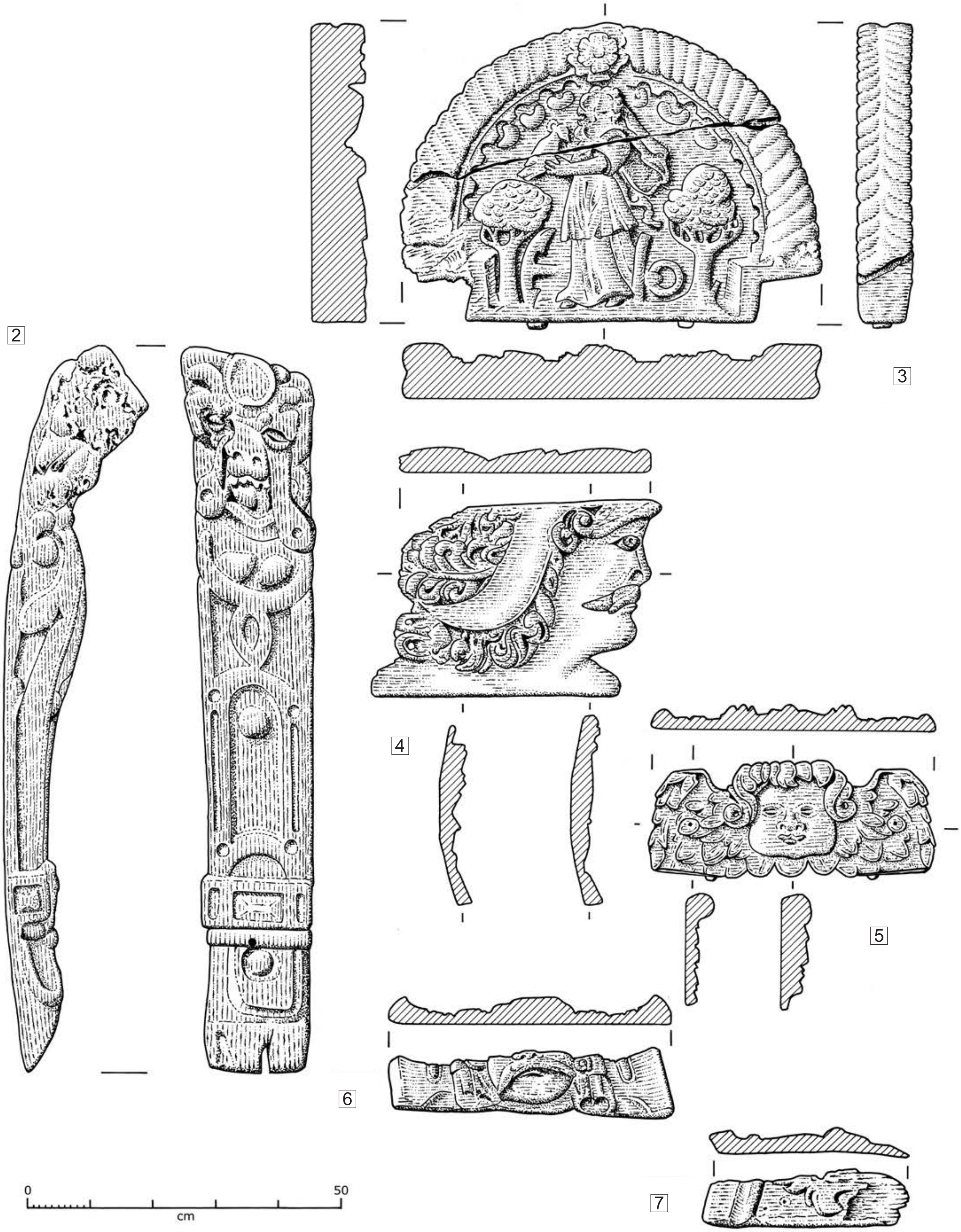


Illustration 136

Upright transom bracket 2 decorated with a lion's head and buckled strap; carving 3 depicting the Virtue of Hope with her attributes of bird, trees and anchor; carved head 4 of a helmeted warrior in the classical tradition; carved winged cherub 5; carving 6 showing the lower part of a moustachioed face with an Eastern-style headdress; fragment of carving 7

6. The decorative treatment of this component, and the symmetrical nature of its curve, identify it as an external stern transom-timber, while its length, at over half the ship's estimated maximum beam (6.28m), suggests that it defines the transom's maximum width and is consequently the main beam across the outer stern structure, close to the level of the main deck.

2 DP00/058, **092.082**, transom-bracket, 1.14m × 0.18m × 0.14m (Illus 136). A well-preserved timber of oak, curved longitudinally down its undecorated back. Its carved front and sides depict an asymmetrically placed lion's head with open jaws, with a buckled strap-terminal below. An abstract design with fluting, pellets and nulling lies between. This piece is closely paralleled by the lion's-head-and-buckle brackets in a contemporary representation of Charles I's *Sovereign of the Seas* (1637) (Illus 137). These support the ends of the stern's lower transom-beam. The curve of this component will thus define the curve of the counter which couples the lower stern to the transom.

3 DP00/081 and 083, **098.084**, tympanum, 0.66m × 0.47m × 0.084m (Illus 136), a substantial deeply carved piece of oak, its semi-circular upper border corded on both front and side. A rosette is placed at the top centre of the cording, and below the cording is an inner field of scalloped decoration. Within the frame stands a female figure in tunic and underskirt, with flowing mantle. A bird perches on her outstretched left hand. On either side is a foliated tree, while an anchor with ring and stock lies behind the figure, its crown pointing towards the left. These are the attributes of Hope as one of the three spiritual Virtues (Faith, Hope and Charity/Love). The bird is probably a dove, representing hope (as in the story of Noah's Ark), the trees symbolise longevity and strength, while the anchor is an emblem of security, its shape echoing the Cross with its message of salvation through divine grace.

This iconography has many parallels in Renaissance art, and a contemporary (albeit rather different) representation of Hope is one of the carved Virtues in the walled garden at Edzell Castle, Angus, which date to 1604 (Simpson 1931: 148–9, fig 36). The symmetrical shape of the piece suggests its placement on the central axis of the transom, while a notch in each lower corner indicates that it had been mounted on a pair of uprights or pillars. Two iron bolt-heads protrude from the underside. The space between the two notches (0.48m) closely matches the distance between the middle two upright joint-faces on the transom-beam 1 (0.44m), suggesting that supports rising from these had carried the Hope panel. A similar central tympanum symbolising Victory is shown on the stern of *Sovereign of the Seas* (Illus 137).

This image has been removed for the online edition. Click here to view the image online.

Illustration 137
The transom decoration of *Sovereign of the Seas*, built in 1637. Detail from a portrait of her builder, Peter Pett (National Maritime Museum, Greenwich, BHC2949)

4 DP92/DG01, *c* **10.10**, associated with the organic deposit exposed on the eastern part of the site (stern) during 1992 (Donald MacKinnon pers comm), an oak carving, in low relief, of a head in profile, 440mm × 310mm × 36mm (Illus 136). A moustachioed warrior of pseudo-classical form, with curled locks emerging from beneath the neck-guard of a peaked helmet, the top of which would have been continued on an adjacent board. An acanthus scroll beyond the neck-guard suggests that the helmet had been garlanded. This motif is common in 17th-century decorative contexts, for example a contemporary plaster-work roundel of a similar head depicting Alexander the Great at Craigievar Castle near Alford in Aberdeenshire (McKean 2001: 229), and another in the House of the Binns, West Lothian (Illus 146). Comparable but more elaborate three-dimensional wooden sculptures in the same *genre* have been recovered from *Vasa* (Naish 1968: 21–3).

5 DP92/169, **080.101** (information from ADU), winged cherub's head carved in oak, symmetrically presented in a frontal pose, 460mm × 192mm × 48mm (Illus 118, 136). In the drawing its partly damaged right wing has been

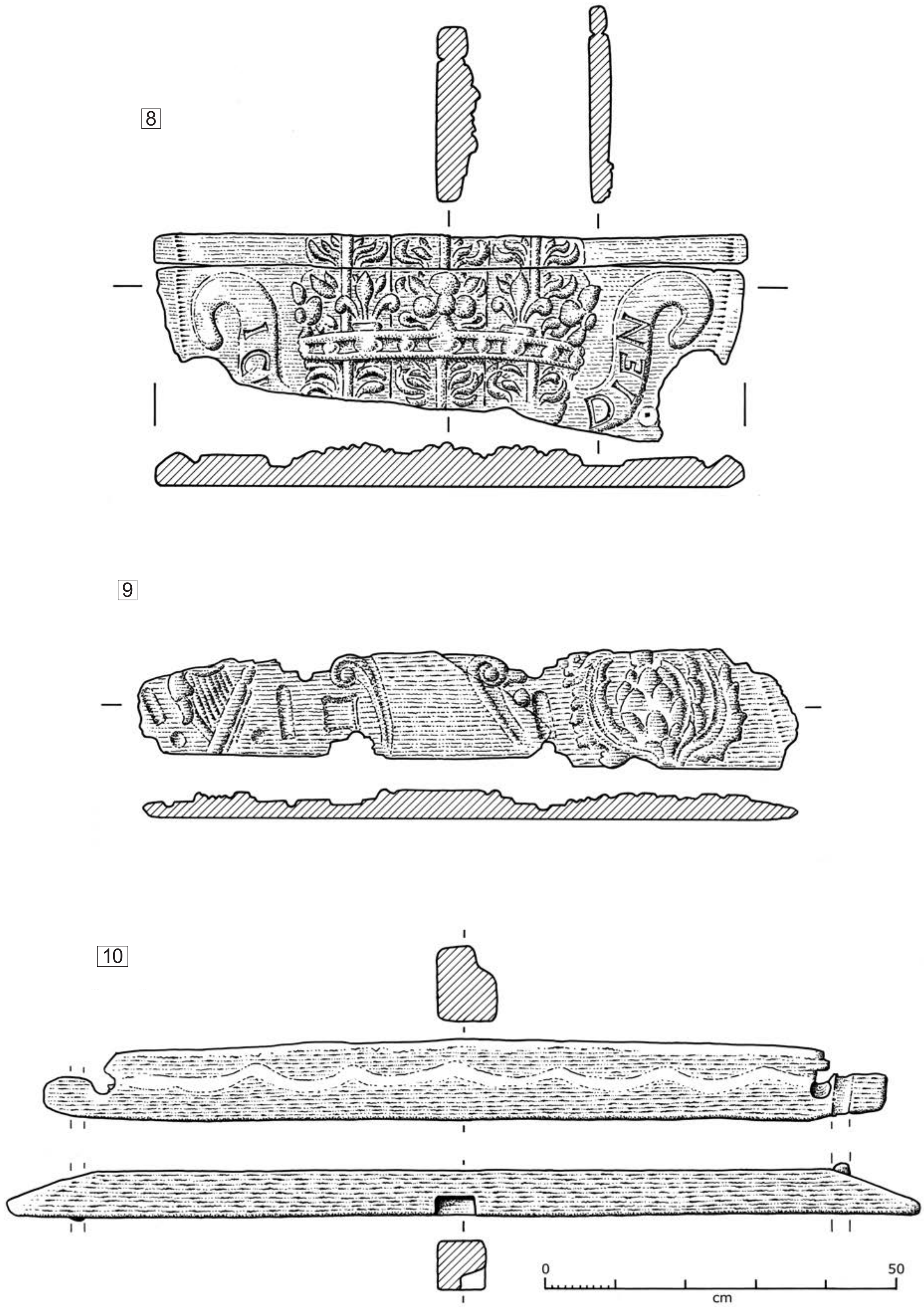


Illustration 138
The lower part of the badge of the Heir Apparent to the British crown 8, with its ICH DIEN motto; carving 9 with the harp and thistle emblems of Ireland and Scotland; two conjoining elements 10 of a support for a centrally placed feature, perhaps the Royal Arms

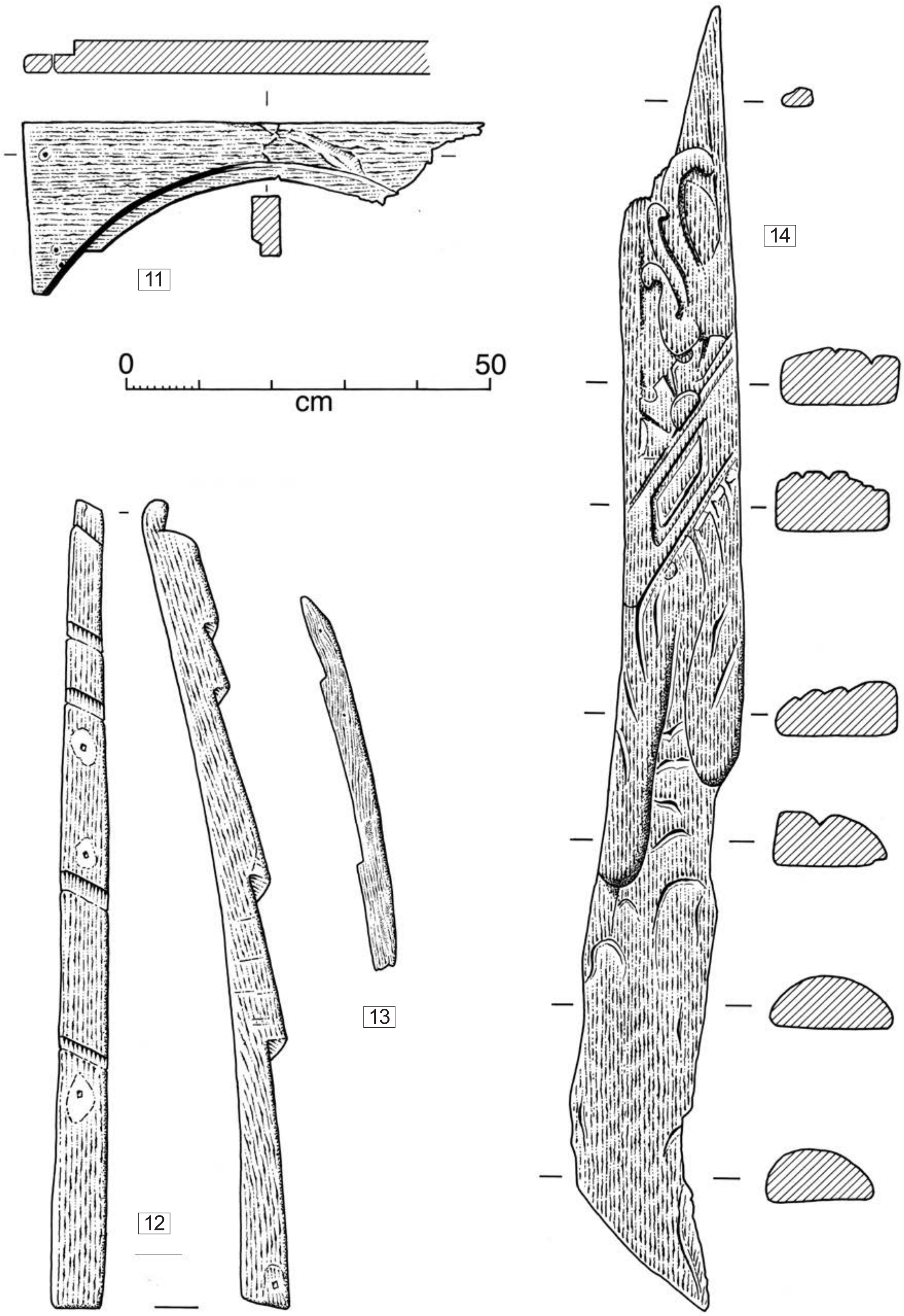


Illustration 139
11 part of a window arch; 12 quarter-gallery roof-frame; 13 smaller notched piece, probably related to a quarter-gallery roof; 14 long carving, probably a decorative transom edging

restored to balance the left. Nail-holes are present on each wing and two concreted bolt- or nail-heads penetrate the underside. Similar cherubs have been noted on the wreck of *Kronan* (1676) (Johansson 1985: 214), and are a frequent motif in contemporary decoration.

6 DP97/A025, **086.095**, lower part of a carved oak panel depicting a moustachioed face with eastern-style head-dress, 460mm × 160mm × 40mm (Illus 136). The angle of the sides suggests that the piece was designed to sit at a slope, perhaps following the camber of the transom.

7 DP03/062, **094.079**, bottom left-hand corner of a carved oak panel showing foliated decoration, 340mm × 88mm × 40mm (Illus 136).

8 DP92/200 and 201, *c* **16.05**, found loose on the eastern ballast-mound during the initial rescue operations (Steve Liscoe pers comm), part of an oak carving, 0.84m × 0.28m × 0.06m (Illus 138). Made up of two conjoining pieces in low relief, it shows the lower parts of three ostrich feathers enfiling a coronet with a scroll bearing the almost complete lettering of the motto ICH DIEN. This is the badge of the heir-apparent to the British throne (Scott-Giles 1958: 218). Its symmetrical character suggests a central location.

9 DP93/007, **225.053**, beneath the hull, close to the keel, two broken but joining oak carvings, 0.93m × 0.17m × 0.04m (Illus 138). On the right is an enfoliated thistle, while on the left is a seven-stringed harp of Celtic form (Scott-Giles 1958: 95–6), the national symbols of Scotland and Ireland. The emblems are separated by scroll borders and the piece is further embellished with deeply indented nulling. The orientation of the symbols suggests their placement in the design at a downward-angled or slightly reverse-curved set. This seems inappropriate for the transom display, and it is likely that the piece was located somewhere on the upper sheer of the ship's side.

10 DP03/079, **112.097**, two pieces of oak, joined when found, with all surfaces significantly abraded (Illus 138). The lower piece measures 1.36m × 0.068m × 0.068m, and is square in section with tapering ends. A rectangular recess 72mm wide and 36mm high is cut into the lower part of the outer face at its centre, penetrating half-way into the timber and tapering towards its inner end. An oak treenail 25mm (1in) in diameter pierces each end of the piece vertically at the inboard part of the taper. The upper piece measures 1.2m × 0.112m × 0.084m and has notched ends with holes which match the position and diameter of the treenails in the lower piece. There are holes for a horizontal treenail just inboard of the vertical treenail at each end. The piece is fronted by a deeply carved frieze of eight scalloped curves. In conjunction these pieces make up a horizontal assembly, and appear to be the supporting base for a major centrally placed decorative element. It seems likely that this would have been the arms of Britain's reigning monarch, the ICH DIEN badge's inevitable complement.

11 DP01/082, **178.093**, stern-window arch, 640mm × 240mm × 46mm (Illus 139–40). The top follows the arc of a

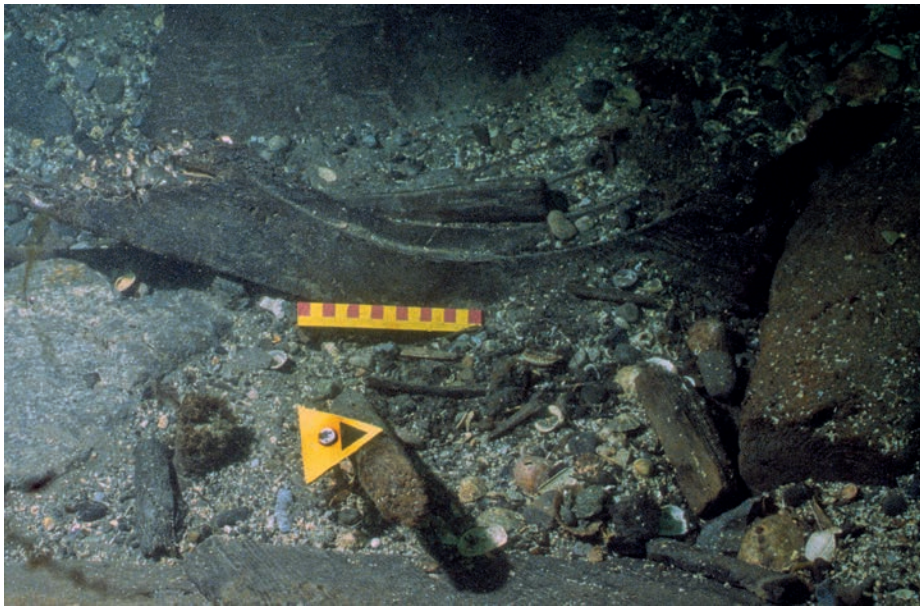


Illustration 140
Object identified as the upper part of a window arch 11, in situ. Scale 15 centimetres (DP 173917)

Illustration 141
Arched windows of the stern cabin of *Vasa*

circle 744mm in diameter, with a 24mm rebated surround 12mm deep. The downwards angle on the left runs 4° inwards from the vertical, and while the right-hand corner is missing, the geometry of the arc suggests that it was close to the present end. It can be calculated that the arc, when complete, encompassed 160°. The tip of the bottom left-hand corner is also missing but a projection of the arc to meet the side suggests that the timber's height on that side was *c* 350mm. Down the back of the left-hand side, and presumably on the missing right also, there is a 20mm × 64mm recess, no doubt for fastening this component to uprights on either side. There is a single nail-hole at the top left-hand corner, and two at the bottom left, close to the point.

A close parallel to this object is seen in the upper stern window range of *Vasa*, immediately above the royal arms (Illus 141), though in the case of *Vasa* these arches are embellished with relief carving. Their downwards angles are splayed to accommodate the flare and camber of the transom's geometry, echoing the deviation from the square noted on the Duart Point example. On these grounds, and the fact that the arc dimensions are virtually identical to the width of the Hope pediment, which it has been hypothesised was set in a central position immediately above the range of windows, it is concluded that this component is part of the top arch from one of the stern windows.

This type of window reflects an architectural tradition rooted in the classical Palladian movement, introduced to Britain in the early 17th century by Inigo Jones following his extensive continental tours. After his appointment as Surveyor General of the King's Works in 1615 he undertook numerous commissions for both James I and Charles I, of which the most important was the building of the Queen's House at Greenwich (1616–35) (Hart 2011: 162–6). The central upper-floor window of its north front is an excellent early example of an arched window in the Palladian style. That the feature was introduced to ships about the same time is evidenced by *Vasa* (1628), *Sovereign of the Seas* (1637), and now by the Duart Point ship (*c* 1640?). It continued well into the 18th century (Gardiner 2012: 40–1).

[12] DP00/199, **085.095**, quarter-gallery roof-frame, 1.13m × 0.076m × 0.072m (Illus 139). This curved oak timber is notched to receive five overlapped planks of varying widths. The (presumed) top end is formed into a hooked protrusion, and the thickness increases from top to bottom. There is a nail-hole in the bottom notch, two nail-holes in the third one up, and another fixing-hole in the lower side. This can be identified as a quarter-gallery roof-frame, springing outwards from the side of the transom to increase space in the after cabin and provide

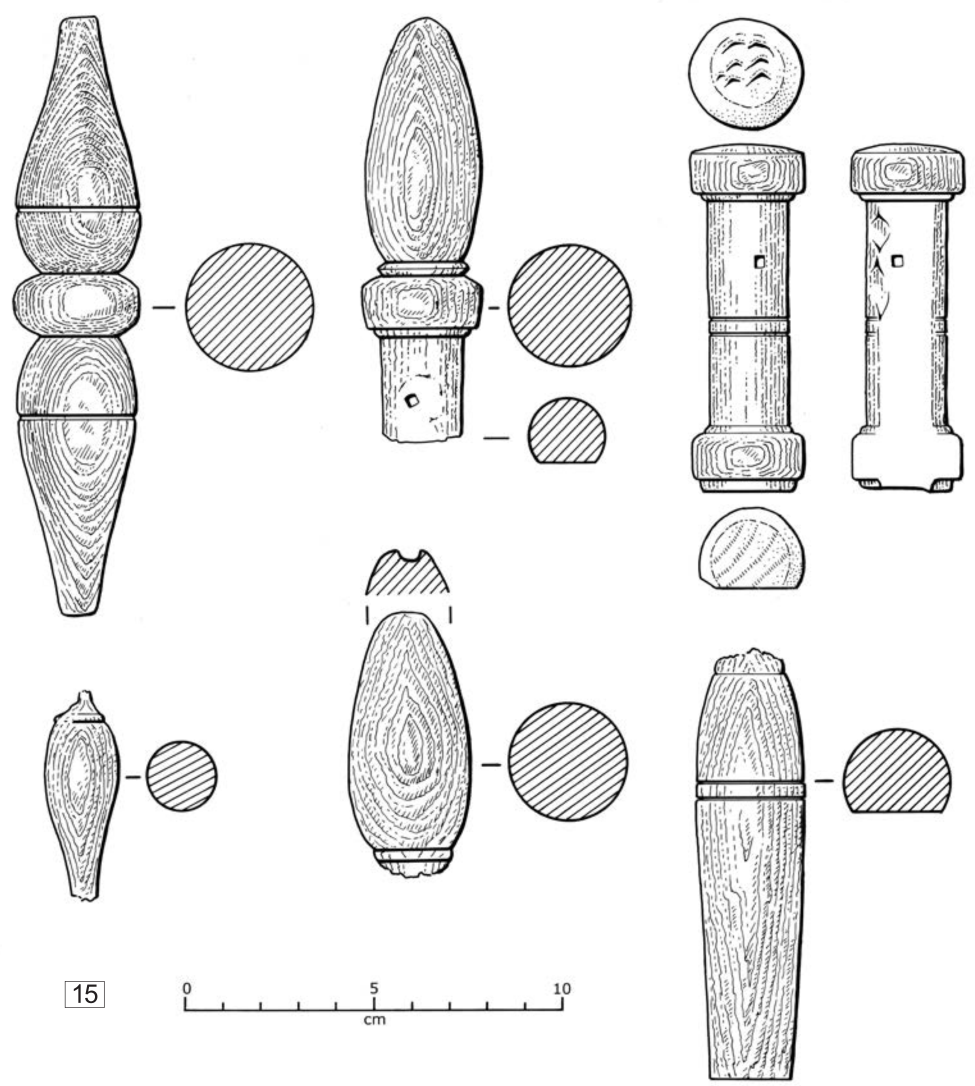


Illustration 142
Turned decorative items [15] (DP 174901)

Illustration 143
H-sectioned window-glass joiners, or cames 16, found in the vicinity of Gun 8 (DP 174189)

its occupant(s) with private sanitary facilities directly through the floor (Simmons 1998: 54–6). Quarter-galleries with overlapping-planked roofs survive on *Vasa* (Cederlund 2006: 165).

13 DP92/???, findspot uncertain, broken curved timber, 530mm × 42mm (max) × 10mm, with rabbets cut to over-ride three overlapping planks (Illus 139). It is best identified as part of an external rib set over the quarter-gallery roofing, possibly related to 12. Decorated ribs fulfilling this function are evident on *Vasa* (Cederlund 2006: pl 5).

14 DP92/161, **061.084/065.099**, long and slightly curved oak piece, carved with a foliar motif and a petalled flower crossed by a diagonal feature, 1.74m × 0.176m × 0.084m (Illus 139). It would be appropriate as an edging to the upper sweep of the after deck, the beakhead, or the transom surround. The context makes the transom the most likely.

15 DP92/DG09, findspot uncertain, five examples from 13 turned decorative elements (Illus 142). The pieces were reportedly found in a discrete and tightly contained group and no others have been found since. All are of black locust (*Robina pseudoacacia*), a North American species. Three are of full circular cross-section, while another has a circular-sectioned finial while the shank below has a slightly flattened face (there is another example without a shank). The fifth example is complete, and is cylindrical with wider collars at each end. The upper collar (as drawn) is of full circular section, but below it a flat face has been created by removing about one third of the circumference and continuing to the lower collar (three other incomplete examples also have flattened collars). These objects are inappropriate for creating the low-relief decoration postulated for the turned pieces applied to panelling, described below (35, Illus 155). They may perhaps have been elements of the ship's external decoration but, in view of their small size and the apparently exclusive grouping in which they were found, they could also be parts of a single decorative feature or a piece of furniture.

16 DP00/018b, **087.109**, concreted to the oar-port lid attached to Gun 8, a 90mm square of window-glass, with its lead surround (Illus 81). Nearby three pieces of lead window-cames (grooved joining-bars) were found (DP99/070 and 102) (Illus 143). Another piece (DP99/117) was visible within a surface find of concretion. These elements undoubtedly come from the stern-cabin windows.

Porthole, no finds number (not raised), **091.095** (Illus 75). During excavation a well-crafted piece of wood 12mm thick and 300mm (1ft) square, with a 150mm-diameter centrally placed circular hole was recorded and left in situ. It lay in a stable layer beneath the breech end of the minion drake gun-carriage and the complex of wreckage which incorporated the panelled door 17 and the associated run of wall panelling 21. It is paralleled by similar pieces set into *Vasa*'s stern (Cederlund 2006: fig 5.15) (Illus 144). They would presumably have been closed with wooden blanks (deadlights) during storms. On the reconstruction below (Illus 147), one on either side has been postulated (there were two each side on the much larger *Vasa*). They may probably be identified as hawse-holes set at each stern quarter for facilitating anchoring operations. Corresponding holes can be assumed at the bow. Contemporaries called them 'cat holes' (Manwaring & Perrin 1922: 122).

Charles I was crowned King of Scots at Holyrood Palace in Edinburgh in June 1633, seven years after his English coronation at Westminster. In preparation for his visit many Scottish notables decorated their houses with loyal plasterwork incorporating Scotland's royal arms and related

Illustration 144
Portholes on the stern of *Vasa*

Illustration 145
The Arms of Scotland, 1633, decorative plaster at the House of the Binns (Edward Martin)

iconography, together with other decorative features. Several examples survive, providing closely contemporary parallels to the Duart ship's carvings. They include Winton House near Haddington in East Lothian and Craigievar Castle near Alford in Aberdeenshire (McKean 2001: 200 and 229). The King's Room in the House of the Binns near Linlithgow, west of Edinburgh, has particularly fine examples of the royal arms (Illus 145), the harp, thistle, and other national emblems of Stewart monarchy, and classical adornments such as a head of Alexander the Great (Illus 146).

Reconstructing the transom

The above elements can be combined to provide a hypothetical reconstruction of the transom assembly which accommodates them within an envelope appropriate to the suggested proportions and dimensions of the ship (Illus 147). It should be emphasised that this is a 'best fit' solution, and other

Illustration 146
Top: emblems of Stewart kingship on a plaster ceiling at the House of the Binns; rose (England), fleur-de-lys (unrealised claim to France), harp (Ireland) and thistle (Scotland). Bottom: roundel with the head of Alexander the Great (Edward Martin)

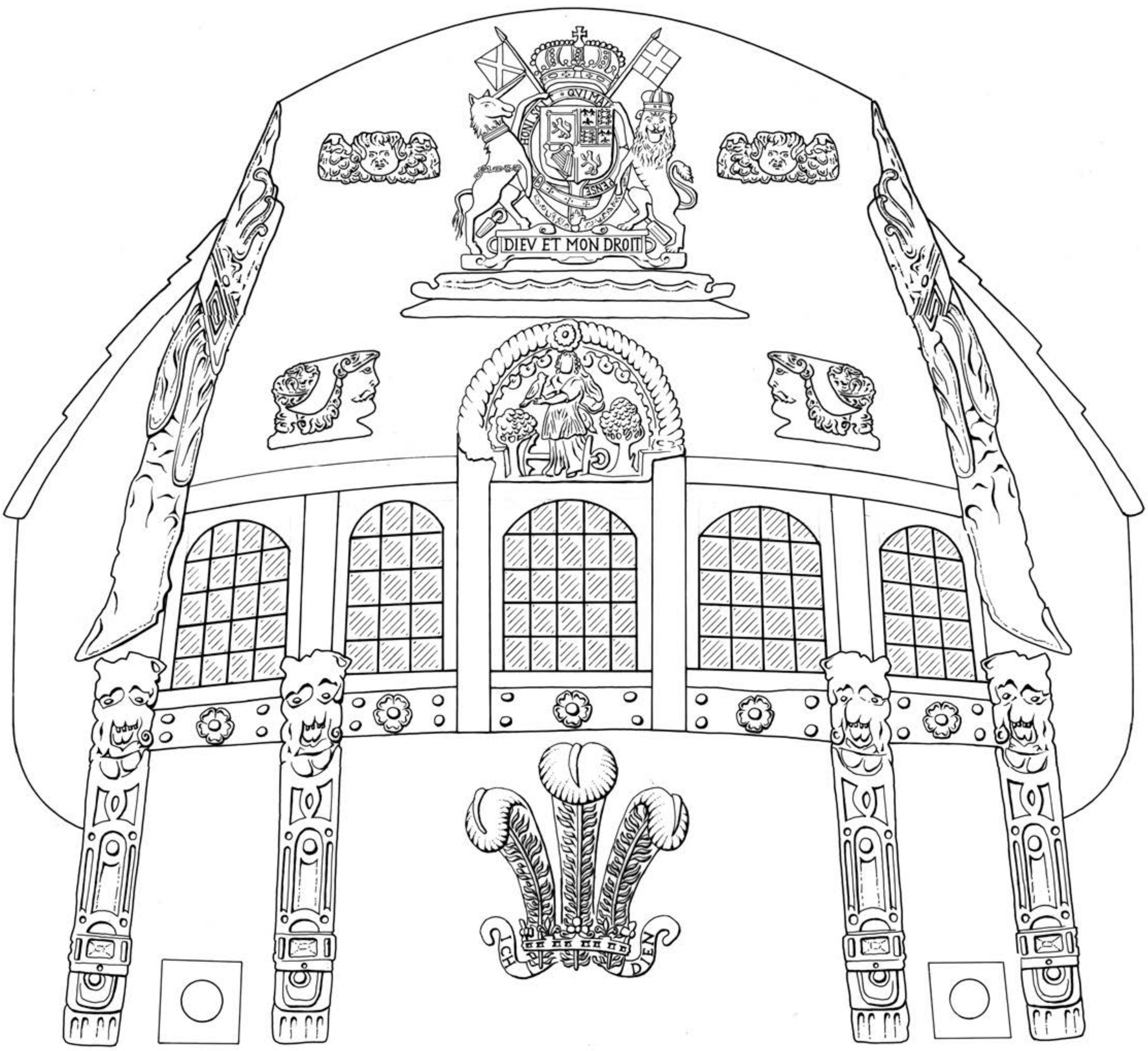


Illustration 147
Speculative reconstruction of the transom decoration

interpretations are possible. The controlling piece is the curved transom-beam. This can confidently be placed athwartships at or close to upper-deck level, where it defines not only the beam at this point but also the camber of the deck. Its starboard joint-face mates naturally with the lion-headed transom bracket, the angles of contact suggesting that the bracket is the starboard outer one (Joint 6). A matching bracket can be assumed on the port side (Joint 1). Two more can logically be placed at Joints 2 and 5. The curved rear faces of these brackets define the curve of the counter. It is suggested that the two centre Joints, 3 and 4, might carry the upright pillars or supports bearing the Hope tympanum. A similar arrangement is shown in an early 18th-century shipwrightry treatise (Sutherland 1711: 98).

This geometry provides a framework for five stern windows of leaded glass. The heir's badge, its symmetrical design requiring a central position, neatly fits the middle of the counter above the rudder-head (its location on *Sovereign of the Seas*) while leaving spaces for a hawse-hole on either side.

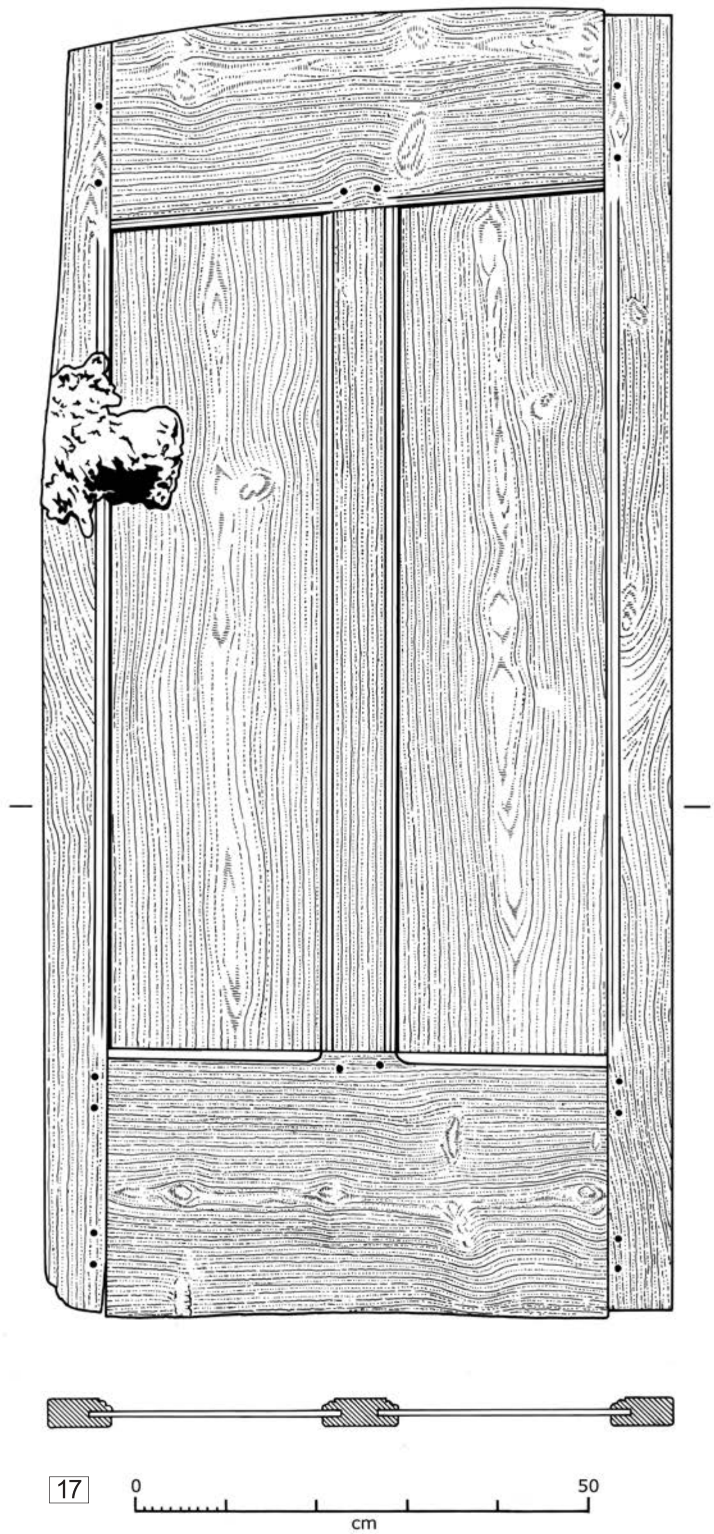


Illustration 148
Framed-and-panelled door 17, presumably associated with the stern cabin

Below, at the stern end of the main gun-deck, we may postulate two minion drakes, pointing aft through the transom. Distances between the decks, and the height of the aftercastle, are determined by calculations of proportions and dimensions considered above. The top of the Hope tympanum touches the level of the upper deck, and above it we may suppose the only other surviving symmetrical element, the scalloped footing above which may be postulated the royal arms. The proportions of the arms will then define the probable extent of the transom at its highest point.

The upper side of the transom is an appropriate location for the decorative edging-piece, here allocated the starboard position with a matching one to port. Rather similar carvings occur in this location on *Vasa* (Hocker 2011: 75). Next the quarter-gallery roof-frame, again seen as one of a matching pair, provides a basis for positioning these outboard structures. Warrior heads and cherubs have been added to fill the empty fields, as they no doubt did on the original, though not necessarily in the locations suggested.

5.4 The aft cabin interior

Panelling

17 DP00/146, **083.090/094.088**, framed-and-panelled door, 1.44m × 0.7m × 0.021m (Illus 72, 148). This intact composite object was located within the collapsed stern complex, overlain by the run of panelling 21 between **091.094** and **094.084**. This in turn was overlain by the gun-port lid at **088.087**, the wooden chest at **096.090**, and the structural timber running between **086.082** and **107.091**.

It is a two-panelled door of pine with deep top and bottom rails (0.21m and 0.29m respectively). The stiles and muntin are 0.08m wide, though the left-hand stile narrows towards the top. The two panels are of carefully selected pine, derived from the centres of mature trees. The grain, however, though balanced, does not match. The panels are of a constant 12mm thickness. Rails and muntins are secured with mortice-and-tenon joints, locked with 8mm oak pegs. 0.96m from the bottom of the door on the left-hand side are the concreted remains of a handle or lock, while there are traces of two hinges on the right. As the entry and exit marks of the moulding-plane show, mouldings on the inner edges of the rails and stiles were shaped after assembly, though the muntin was cut from previously prepared stock. This suggests that the door was built on the spot during the fitting-out process, the dimensions and adjustments to its shape being determined by existing structural criteria as the work progressed.

The door is slightly asymmetrical, its upper curve presumably accommodating the camber of the deck above. Its left side is slightly lower than the right. There is a slant of some 5° in the same direction along the top rail's straight bottom. The lower rail is set horizontally, though its lower edge, which is somewhat worn, has a curve which matches, though rather less sharply, the top curve of the door. The stiles and muntin are vertical.

At 1.45m (4ft 9in) the door seems unusually low for normal use, even allowing for the cramped conditions on board ship. However a deep sill or raised coaming may be postulated beneath it, to stop ingress of water to the cabin when seas encroached on the upper deck. To be effective such a sill would need to be about 0.3m (1ft) high, making the overall door clearance a more respectable 1.75m (5ft 9in). It should be noted that the top edge of the lower rail is not finished with a moulding but with a simple chamfer, to encourage the more efficient shedding of water. Allowing a further 9in (0.23m) for the head of the door-frame, a cabin height of 6ft (1.83m) between the upper and quarter-decks may be postulated.

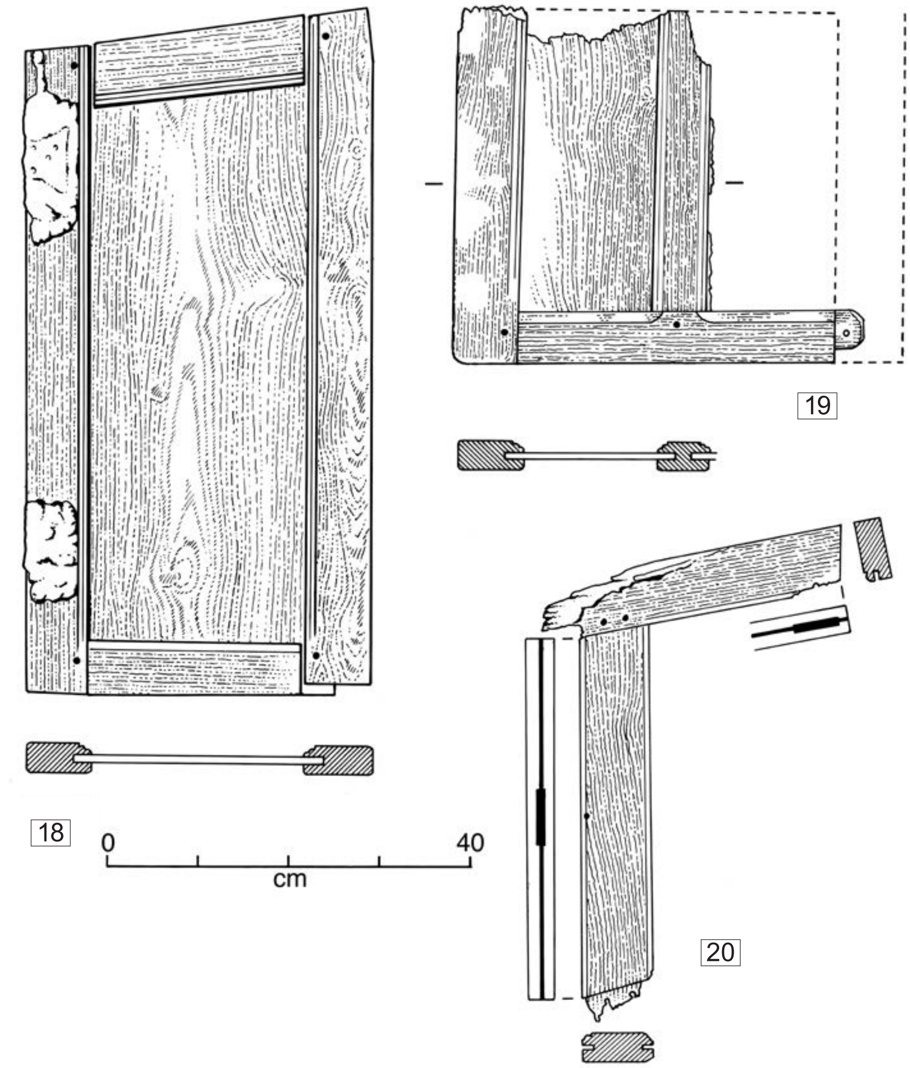


Illustration 149
18 single-panelled cupboard door (DP 174891); 19 surviving elements of a panelled cupboard door (DP 174892); 20 muntin and stile set at an angle to accommodate the lack of right-angles within a ship

18 DP99/004, **077.103**, cupboard door (Illus 73, 149). This small framed single-panel pine door measures 0.74m on its longer stile and has a constant width of 0.38m. It lay among the collapsed stern complex 1m south-east of the door 17 sandwiched between well-finished planks, some of which had mouldings on one or both of their edges, indicating that most of this material came from the interior lining of a cabin. The door has five components – top and bottom rails, two stiles, and a panel 8mm thick. It has pegged mortice-and-tenon joints in the manner of the other doors. Its inner mouldings have been shaped with a moulding-plane with little care taken to stop inside the corners. The panel-board is cut to show the centre grain. There are the concreted remains of hinges on the shorter side. The angle of the top rail is 7° from the horizontal, slightly greater than that of door 17. Otherwise it has been built on the square.

19 DP00/201a, **094.096**, cupboard door (Illus 74, 149) 452mm × 394mm. Part of the lower half of a framed-and-panelled door, buried beneath concretions adjacent to door 17 above. The lower rail (identified by its chamfered bevel) survives, joined to the left-hand stile and lower muntin. The left-hand tenon is intact, while the lower muntin is complete apart from its upper tenon, which has broken off flush with the shoulder. Most of the right-hand panel, which is 9mm thick, is in place, while fragments of the left-hand one remain in the muntin groove. A middle lock-rail can be assumed, suggesting a four-panelled door, and if the upper and lower halves are of the same depth a full height of 0.82m can be calculated. Even with a raised sill this is far too low for human access, a conclusion borne out by its reconstructed width of only 0.5m. It is better identified as a large cupboard door. The lower edge

is angled at 2° from the horizontal, a skew which does not match the 5–7° deck camber postulated for the other two doors, and it may be suggested that this door was not mounted athwartships but on the fore-and-aft axis of the hull. The lesser angle would accommodate the gentle upwards sweep of the deck as it curved towards the stern.

20 DP92/019, **06.07**, articulated muntin and rail with angled joint (100°) (Illus 149). Overall dimensions 0.52m × 0.32m. One complete mortice-and-tenon joint survives, together with two mortice slots and one damaged tenon. The angle of the joint matches the top slope of bulkhead 21.

21 DP00/085, **091.094/094.084**, run of muntins and panels, 1.11m × 0.92m × 0.91m × 0.92m, thickness of panel 8mm (Illus 150). This lay above door 17 and beneath the gun-port lid and wooden chest 110. It consists of three trapezoidal panels linked by three muntins, and the vestigial remains of a fourth. The right-hand panel is angled inwards at 15°, and retains a fragment of a similarly oriented stile. This is evidently the outboard edge of a panel-clad bulkhead associated with the stern cabin, so the angle represents the tumblehome of the aftercastle at this point. All the upright muntins have their upper and lower tenons intact, each *c* 70mm wide and 30mm deep. Each is drilled for two 7mm-diameter pegs.

The top edge of the panelling slopes outboard at an angle of 10° below the horizontal, evidently reflecting the camber of the half-deck that may be presumed to have rested above it, with the missing upper rail secured to one of its beams. The lower edge of the panelling runs at right-

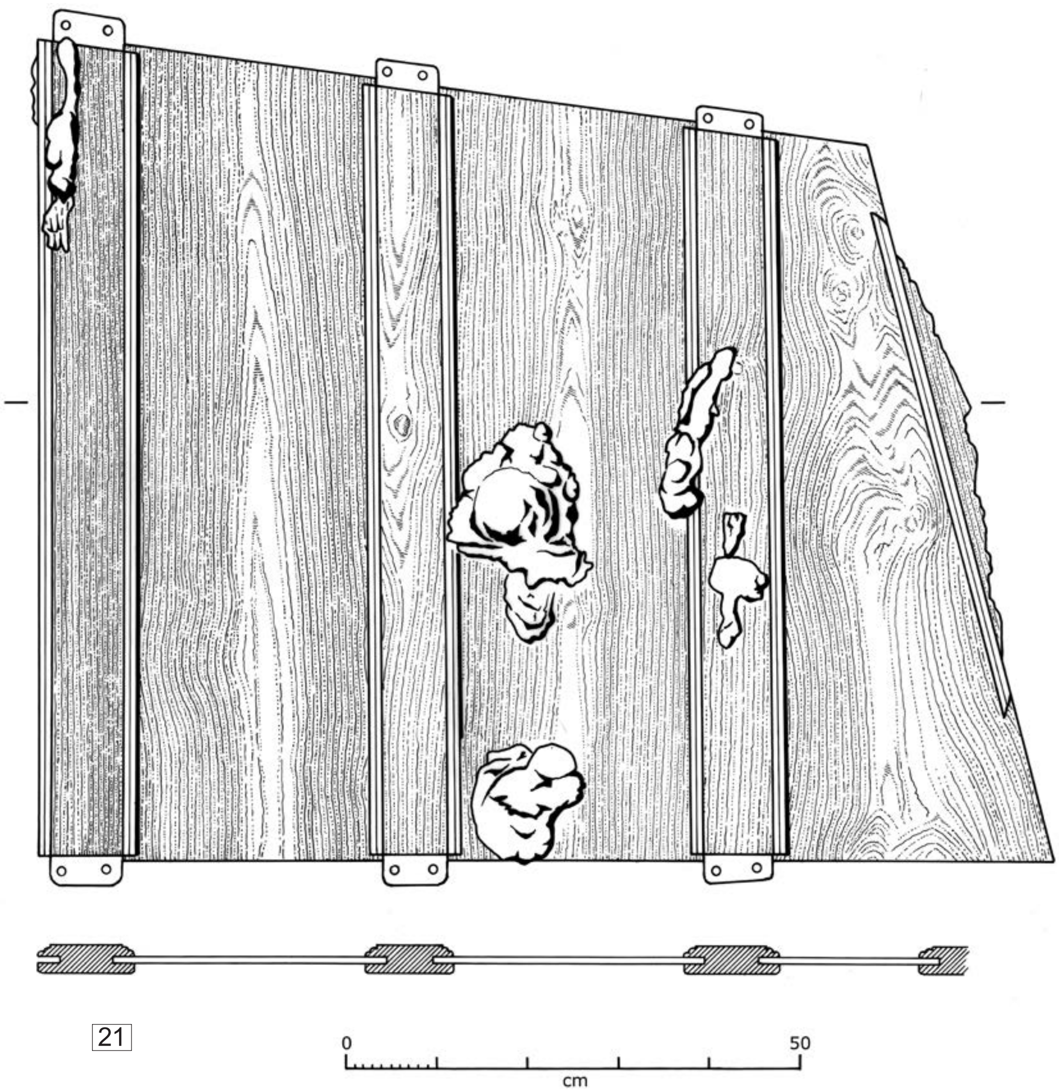


Illustration 150
Run of muntins and panels 21, evidently from a bulkhead (DP 174888)

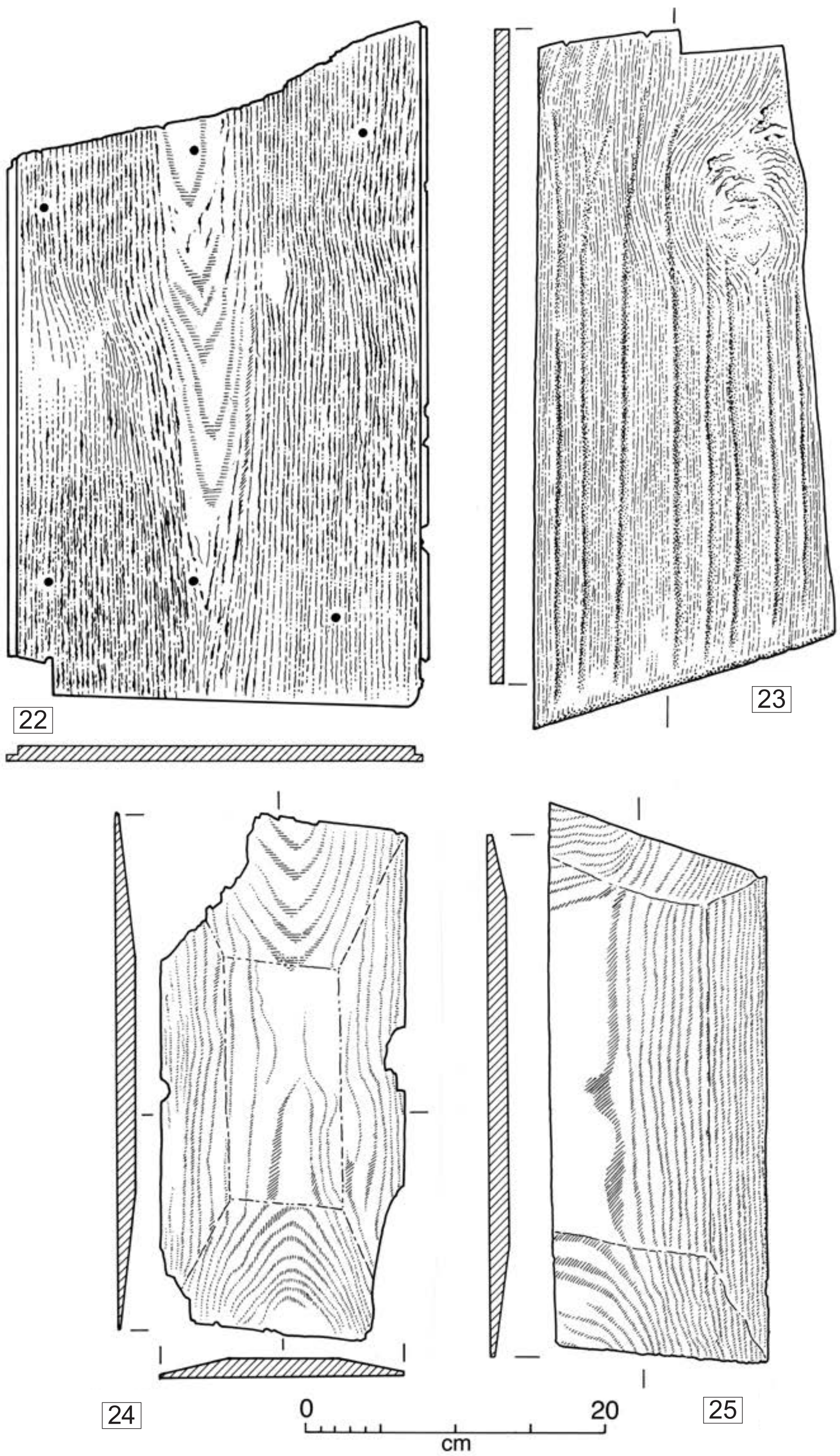


Illustration 151
Pieces of flat panelling 22–3 and raised and fielded panelling 24–5

angles to the muntins, indicating that this was a horizontal line in the construction. A level mid-rail can be postulated to receive the lower tenons, and if there was a run of panelling of similar depth below it, finished with a skirting to match the camber of the deck, the dimensions would closely match those of door 17 and its postulated sill to give a height between decks of around 1.8m (5ft 11in).

22 DP99/055, **067.107**, broken pine panel, one end intact, 450mm × 280mm × 10mm (Illus 151). The long edges are cut to form L-shaped flanges. Six 6mm peg-holes are evident. The use of a centre-grain pattern suggests that the object is associated with decorative panelling.

23 DP95/001, findspot uncertain, broken pine panel with a corner and parts of two edges intact, 450mm × 200mm × 7mm (Illus 151). The face shows evidence of preparation using an adze which has left a pattern of shallow parallel troughs on the surface. A knot has caused the worker some difficulty in maintaining this effect. The surviving corner is angled at 73°.

24 DP99/089, **082.103**, raised and fielded trapezoidal pine panel 340mm × 160mm × 12mm (Illus 151). The grain of the timber has been carefully exploited to achieve a symmetrical pattern.

25 DP99/044, **068.105**, raised and fielded trapezoidal pine panel, one edge broken off, present measurements 340mm × 140mm × 13mm (Illus 151). Patterning of the grain is markedly less balanced than in 24 above.

26 DP92/030, findspot unknown, pine stile, 420mm × 80mm × 26mm, tenons at either end each drilled for two pegs (Illus 152). One edge is moulded and slotted for a 5mm panel; the other edge is squared. In the middle of the slotted edge is a 60mm × 8mm mortice from which the tenon has broken out leaving a tapered oak peg in place (Illus 153). The end tenons are set at an angle of 10°. Probably the side timber of a small panelled door. Two parallel rows of round stain marks may derive from contact with the bristles of a brush.

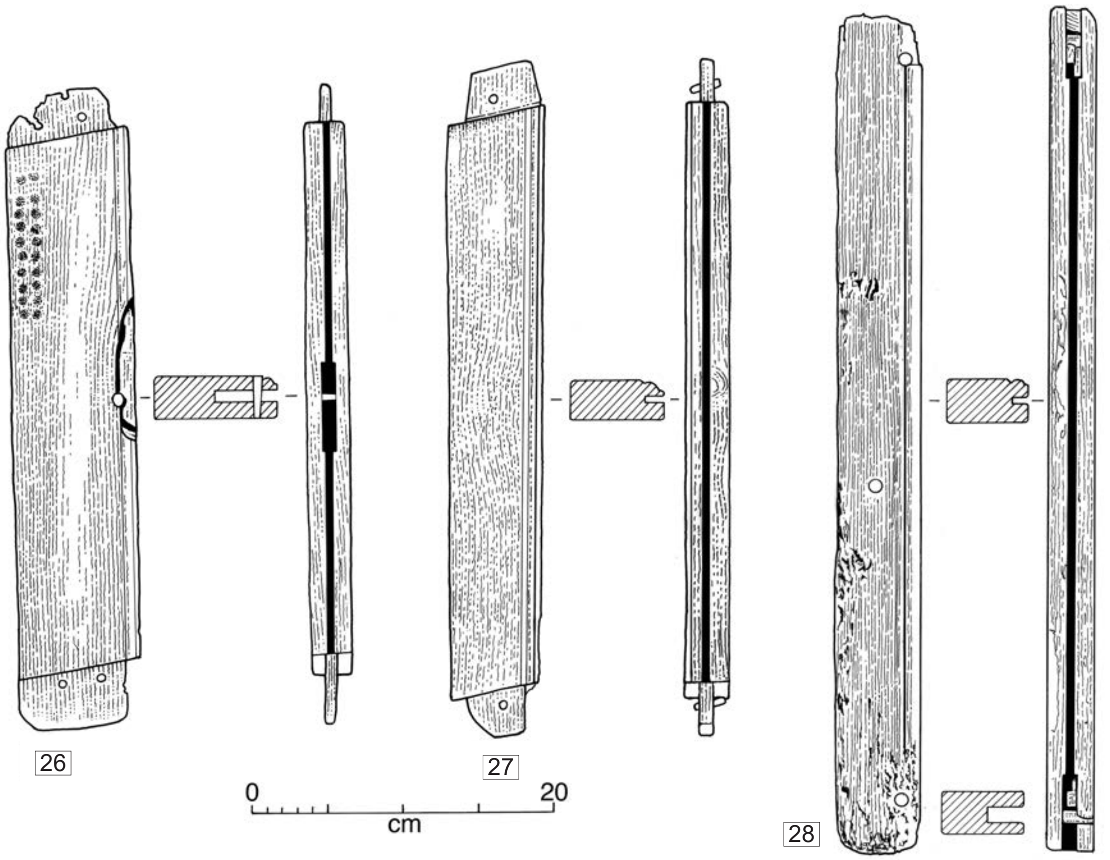


Illustration 152
Elements of moulded panel framing 26–8

Illustration 153
Joint in moulded panel frame 26

27 DP92/173, findspot uncertain, pine stile 450mm × 60mm × 30mm (Illus 152). Similar to 26 except the end tenons are drilled for single pegs, both of which (of oak) remain in situ, and there is no central mortice in the panel slot.

28 DP02/017, findspot uncertain, pine stile, 560mm × 56mm × 32mm, one side has a moulded edge slotted for a 6mm panel, with pegged mortises at each end (Illus 152). The other edge is square, and like 26 and 27 was probably the side of a small panelled door.

29 DP92/036, findspot uncertain, pine muntin 600mm × 58mm × 32mm, slotted on both sides for 5mm panels, and moulded along both upper edges (Illus 154). Fragmentary 10°-angled tenons at each end.

30 DP92/170, findspot uncertain, pine muntin 506mm × 60mm × 32mm, slotted and moulded as 29 (Illus 154). Fragmentary 8° angled tenons at each end.

31 DP92/174, findspot uncertain, edge fragment of pine plank with beaded moulding, surviving length 260mm × 24mm × 10mm (Illus 154). Two nail-holes evident.

32 DP99/013, **054.101**, on top of cupboard door 18, length of pine plank abraded at both ends, 500mm × 600mm × 6mm, with two moulded edges (Illus 154). Three nail-holes evident.

33 DP92/034, findspot uncertain, broken fragment of pine plank 174mm × 60mm × 8mm, moulded on both edges (Illus 154).

34 DP95/004, **091.086**, angled end of pine plank, 340mm × 100mm × 10mm (Illus 154). The moulded edge angles inwards at 25° while the straight edge is flush.

35 DP97/A018, 029, 030, 036, DP99/056 (**069.108**), DP99/116 (**073.096**), five of six decorative wooden pieces associated with the panelling from the collapsed debris of the stern (Illus 155). One of them (top middle) was found in situ on a piece of dressed and moulded wood to which it had presumably been glued, although no trace of the adhesive had survived (Illus 69). All were of pine (*Pinus* sp) and somewhat less than semi-circular in cross-section. They are evidently slices of fully circular pieces turned on a lathe, and it may be suggested that the blanks were made up of two outer strips separated by a shim to which they were glued, the inner strip serving as a spacer while the two outer ones formed paired finished products. It may be supposed that the adhesive was water-soluble to facilitate separation.

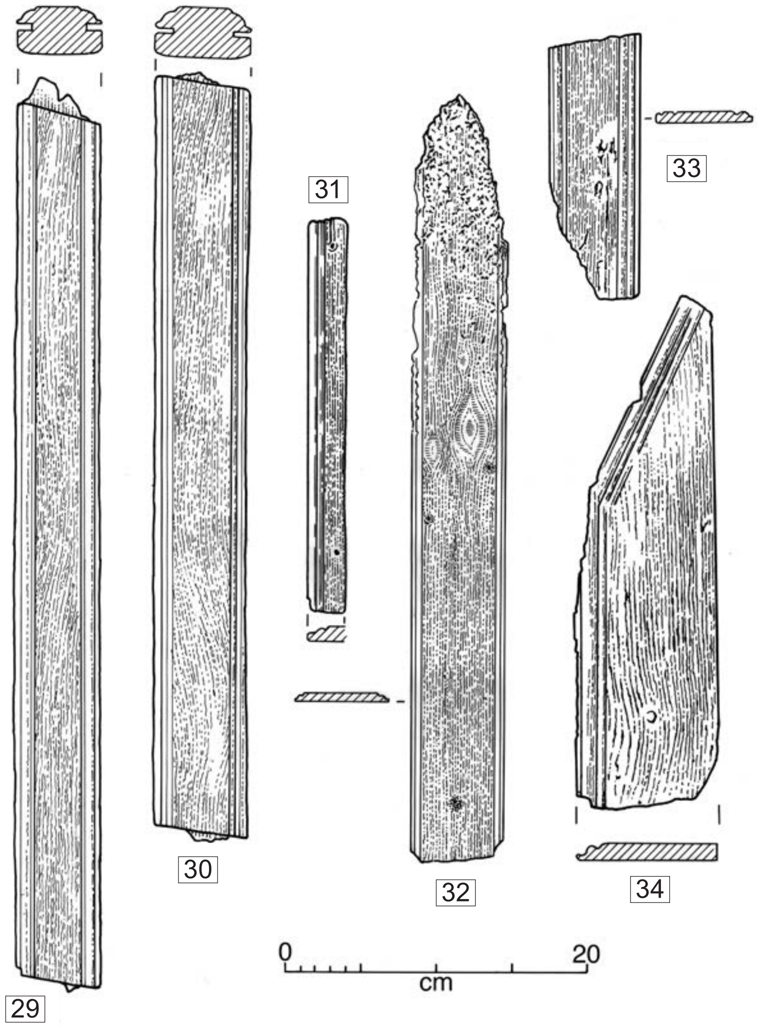


Illustration 154
Moulded panel framing and edge-moulded planks 29–34

36 DP92/124, findspot uncertain, 330mm × 275mm × 26mm, trapezoidal wooden board with evidence for hinges, possibly a lid for a locker (Illus 156).

37 DP92/067, findspot uncertain, 435mm × 200mm × 15mm, trapezoidal wooden board with evidence for hinges, possibly a lid for a locker (Illus 156).

Reconstruction of the forward bulkhead of the aft cabin

As explained above, the framed-and-panelled door 17 can reasonably be identified as the main entry to the aft cabin. Its upper curve shows that it was asymmetrically placed, no doubt to avoid the mizzenmast, which would have occupied the centreline of the deck immediately forward of it. The low height of the door – 1.4m (4ft 7in) – might be explained, as suggested above, by the presence of a coaming to prevent water ingress from the upper deck. A height of 0.4m (1ft

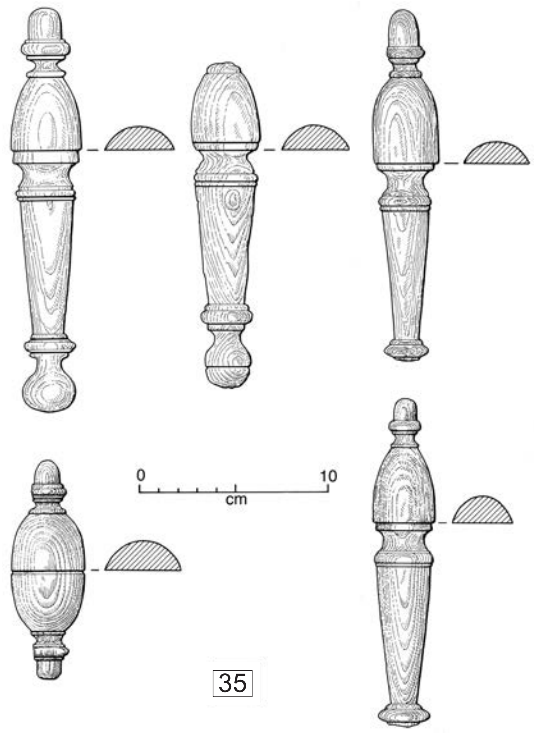


Illustration 155
Decorative elements 35 with flat backs for gluing to panelling (DP 174893)

4in) is hypothesised for this feature, to accommodate a cabin height of 1.8m (6ft). Alternatively the cabin deck may have been stepped down from the level of the upper deck to increase headroom, as postulated in the reconstruction of *Susan Constant* (Lavery 1988: 58–9).

The run of articulated panelling 21, with three complete muntins and the remains of a fourth at its angled outboard end, is clearly part of an athwartships bulkhead. Fragments of a fourth panel survive in the groove of the inboard surviving muntin, indicating at least one further panel before the door is reached. If the panelling thus restored is set beside the offset door, and the high point of the door's upper curve regarded as the centreline of the bulkhead, the insertion of the three outer panels, reversed, would balance the four starboard-side panels of the postulated structure (Illus 157). By projecting the structure downwards against the criteria discussed above, a speculative reconstruction of the bulkhead emerges. This gives a beam (measured internally) of 4.06m (13ft 5in) for the upper deck, and 2.92m (9ft 8in) for the presumed quarter-deck above.

It may be supposed that the sides and stern end of the cabin were similarly panelled. Cupboards represented by the framed-and-panelled doors 18 and 19 were no doubt incorporated, and there would have been access to the quarter-galleries on either side. The placement of the various individual panels, moulded woodwork, and applied relief decoration cannot be determined, but they emphasise the complexity and skill involved in three-dimensional precision carpentry where levels and right-angles are not the determining factors. Smith (1627: 12) notes that cabins were provided with 'many convenient seats or lockers to put anything in, as in little cupboards'.

5.5 Oar-port lid

38 DP00/018a, **087.109**, concreted to the body of the minion drake by its iron hinges, a well-preserved wooden lid made of oak (*Quercus* sp) (Illus 81, 158). The outer part of the lid is composed of a slightly trapezoidal piece 44mm (1¾in) thick, 260mm (10¼in) high, and 324mm (12¾ in) wide. A 58mm (2¼in) strip of the same thickness and width spans the top, making a total height of 318mm (12½ in). On both outer pieces the grain runs horizontally. A third piece of oak, 20mm (¾in) thick, its grain running vertically, is fastened to the front pieces by 24 round-headed nails set diagonally. The inner trapezoid is slightly

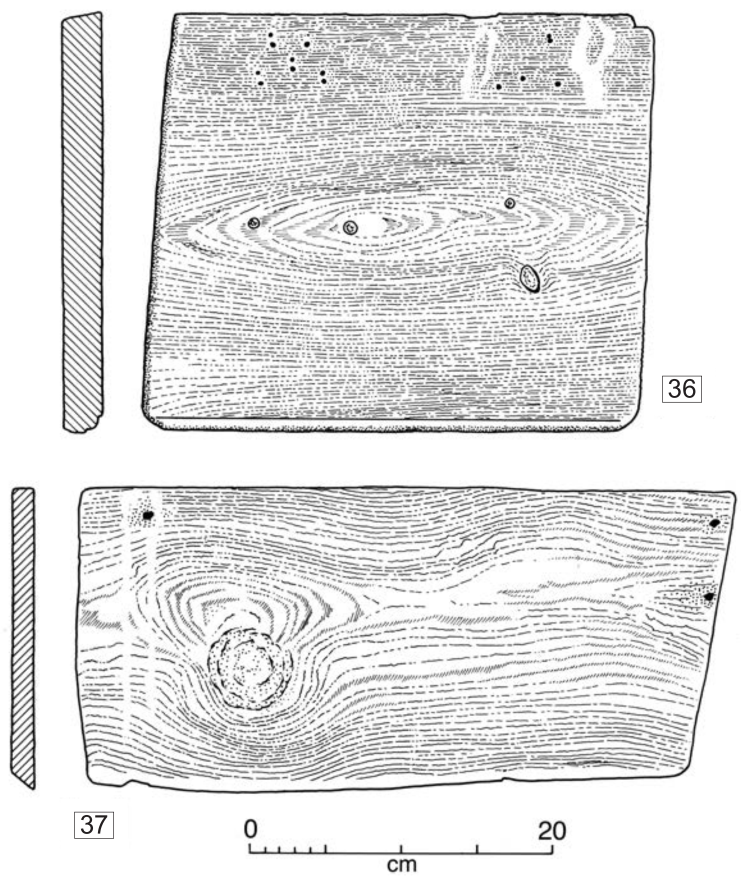


Illustration 156
Two trapezoidal pieces of wood 36–7 with traces of fixings, probably locker lids

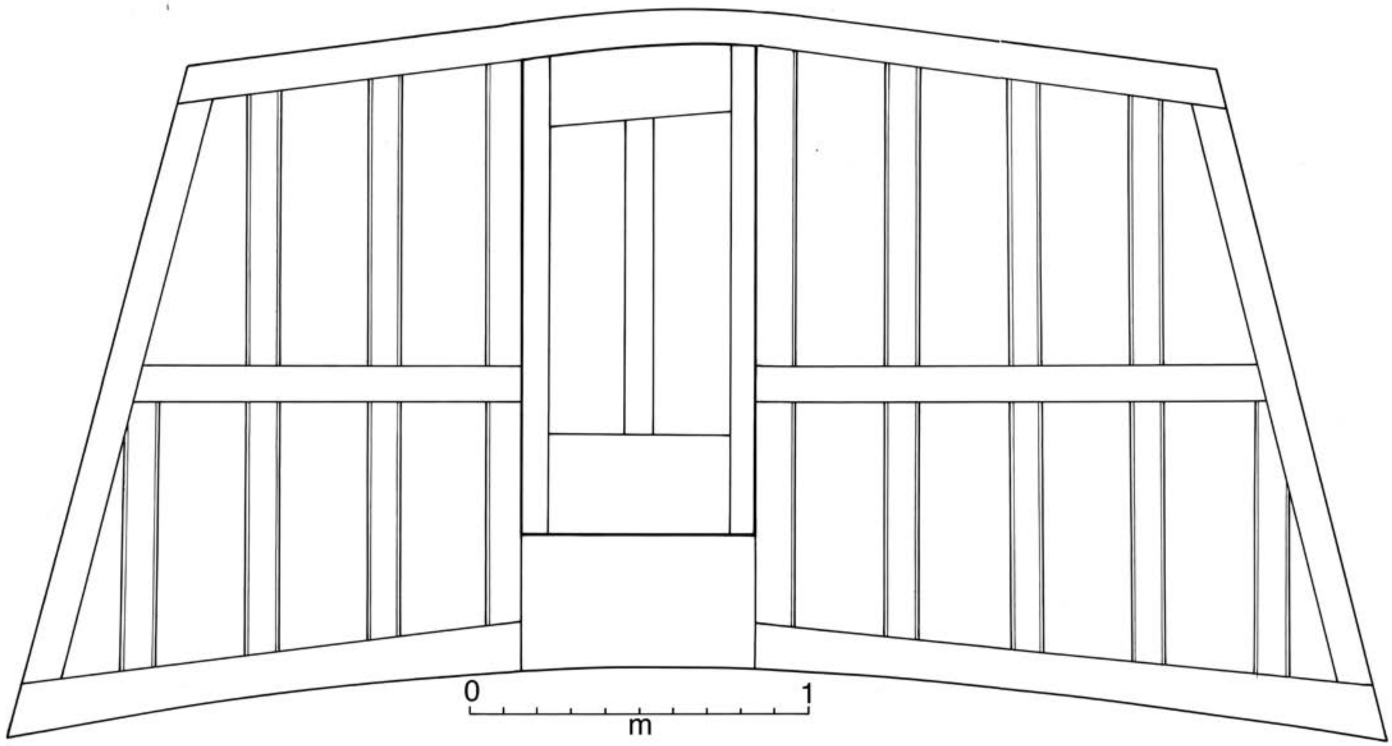


Illustration 157
Speculative reconstruction of the great cabin bulkhead, based on various finds

smaller than the outer, creating a lip of variable width, ranging from 20mm (¾in) at the lower right to nil along most of the left edge. Two wrought-iron straps with hinge-rings at the top, the form of which has been reconstructed in the drawing from their concreted remains, are secured to the outside of the lid.

This method of construction is similar to that of the gun-port lids of the near-contemporary *Vasa* (personal examination) and those of the century-earlier *Mary Rose* (Hildred 1997: 51–2), though on a much smaller scale. The Duart Point lid is designed to cover a 1ft (300mm) port, slightly trapezoidal in shape, which is far too small to accommodate a mounted piece of ordnance. The only likely alternative is an oar-port lid, and of the three ships wrecked off Duart Point only *Swan* is recorded as being equipped with oars (see Chapter 2.2). Square oar-ports of comparable size are depicted in the design for an English frigate of *c* 1625 (Howard 1979: 150) and

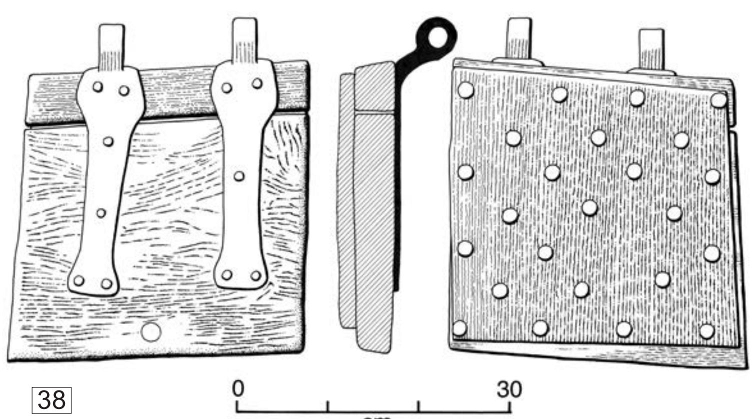


Illustration 158
The oar-port lid 38

are also evident on several contemporary ship-models (eg National Maritime Museum SLR0367, Gardiner 2012: 8–9). The disposition of guns as reconstructed from their present locations on the wreck (see below) suggests that the main deck between the main- and fore-masts was kept free of ordnance to accommodate the rowing-banks.

5.6 Rig and internal arrangements

Within the general parameters set by the reconstructed hull's form and dimensions, other elements derived from archaeological evidence and its analysis can be added (Illus 159). The identification of the fragmentary transverse mainmast-step (reconstructed in Illus 160), confirmed by the adjacent pump-sumps, is 9.5m (31ft) beyond the aft end of the keel, just forward of the mid position. This indicates a full three-masted rig, and the suggested positions of mizzenmast, foremast, and bowsprit, and their angles of set, follow Lavery's arguments in his reconstruction of *Susan Constant* (1988: 11, 58–9). Logic dictates that the mizzenmast was stepped on the upper deck, as it is on *Vasa* (Cederlund 2006, longitudinal section of hull in end pocket) and as Lavery (1988: 58) prescribes for *Susan Constant*.

On the upper deck, aft of the mizzenmast, there is room for a stern cabin extending some 2.75m (9ft) fore-and-aft, with some additional cupboard space and sanitary facilities provided by the quarter-galleries indicated by the stepped frame from a quarter-gallery roof 12 (Simmons 1997: 36). The presence of the mizzenmast immediately forward of the great cabin may explain the offset door in the cabin's forward bulkhead. On either side and forward of the mizzenmast, the space could have been used for subordinate officers' cabins as well as to provide access to the great cabin. Forward of that, facing an opening in the sterncastle's forward bulkhead, the steersman would have had a clear view ahead and aloft. This position is the logical place for the whipstaff and, just forward of it, the binnacle (Harland 2010).

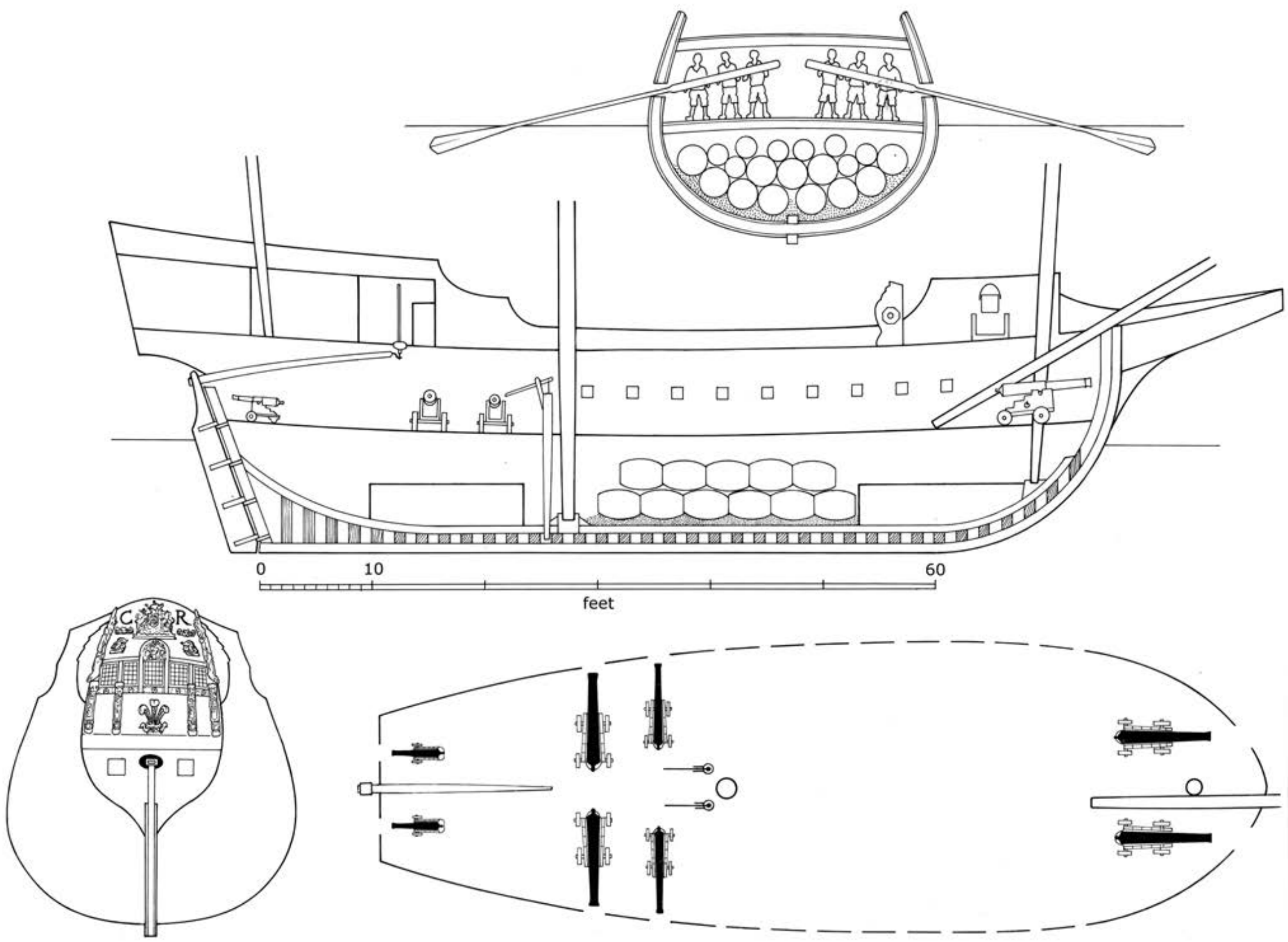


Illustration 159
Speculative reconstruction of the layout of the ship (DP 151192)

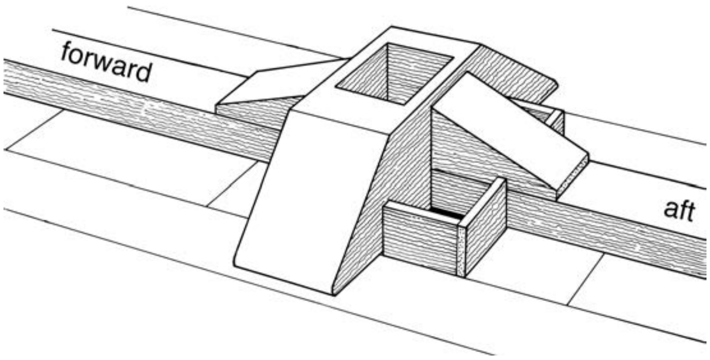


Illustration 160
Reconstruction of the transverse mainmast-step over-riding the keelson. Chocks on top of the keelson reinforced it longitudinally. The boxed features aft are the pump-sumps. On either side of the keelson are short, removable limber-boards (DP 151189)

On the main deck below, the after part would be occupied by the gunroom, accommodating the sweep of the tiller at its upper level and providing space for accommodation and stores beneath. This would be a suitable place for the lightly partitioned cabins of junior officers. The disposition of guns on this deck is significant. As argued in Chapter 4, the ship appears to have collapsed in situ, and heavy items such as guns are unlikely to have moved from where they first fell. Their relative positions on the sea-floor therefore probably reflect their original disposition within the ship (Illus 159).

Nine rowing-banks are hypothesised for each side of the reconstruction, with three men allocated to each sweep (the figure quoted for the *Lion's Whelps*, see Chapter 11). Four men per sweep are shown in the cross-section of a large warship of *c* 1625, bearing Charles I's monogram (plan in the National Maritime Museum, reproduced in Howard 1979: 150). This vessel had a keel-length of 29m (96ft), a beam of 9.75m (32ft), and a burden of 368 tons. The plan also indicates a gap of 1.2m (4ft) between the oar-ports, and this figure has been adopted for the Duart Point reconstruction. Since the inboard oarsmen would have had to travel a considerably greater distance than the outboard ones on each stroke, rowing-benches would not have been practicable, so a standing position for the oarsmen is postulated. The *Whelps*' oars were 9.75m (32ft) long, and this figure is adopted for the reconstruction. When stowed, the oars could have been hung from the upper deck-beams.

Aft of the forecastle, on the upper deck, the ship's main motive machinery for heavy lifting and managing the sails and anchors may be presumed. A capstan would be impracticable, since unless located towards the centre of the waist, where it would have obstructed the main working area of the upper deck and stowage for a ship's boat, there would have been insufficient room to rotate the bars. For a small vessel such as this a windlass, mounted well forwards, is a more likely alternative. When hauling the anchor from this point the cable could drop vertically through hatches in the upper and main decks, to be faked onto a cable-tier of loose boards or possibly a light planked structure lying above the forward ballast (for which, it should be noted, no surviving evidence was recorded). A coiled anchor-cable lay in this position on the wreck of *La Belle* (1686) (Bruseth & Turner 2005: 55), while a forward windlass was recorded on the Stinesminde wreck in North Jutland of *c* 1600 (Gøthche 1994: 183–5).

Between the forward ballast-mound and the mainmast/pump-sump complex, in the broadest part of the lower hull, is space for a 7m × 7m × 3m (24ft × 24ft × 10ft) hold with a stowage capacity, allowing for the curvature of the hull, of 300m^3 (5,430ft^3). The aft ballast-mound was doubtless also covered by light decking, and while the arrangements in this part of the ship can only be speculative, this area of the lower stern was traditionally a location for the bread-room (Smith 1691: 12), while a concentration of fish bones at the after end of the lower hull suggests that the freshly caught consignments of ling were stored here. For reasons of trim, roundshot was normally stored near the middle of the ship, and boarded shot-lockers might conveniently have been positioned on either side of the pump-well. The absence of shot in this area, and its general paucity across the wreck as a whole, may suggest that most of the ship's munitions had been taken ashore.

The pumping arrangements are described in Chapter 6.3. The absence of decomposed food remains and domestic sewage in the interstices between the frames is significant. A ship's 'tightness' or resistance to leaking was gauged, as a contemporary source observes,

> by the very smell of the water that is pumped out of her, for when it stinketh much, it is a sign that the water hath lain long in the hold of the ship; and, on the contrary, when it is clear and sweet, it is a token that it comes in freshly from the sea. This stinking water therefore is a welcome perfume to an old seaman; and he that stops his nose at it is laughed at' (Perrin 1929: 239).

The sweet-smelling Duart Point ship, it may be supposed, was a leaky vessel.

Within the forecastle and on the main deck a brick-built galley fire can be inferred from the debris of bricks, tiles, and food-processing equipment, including the ship's 11-gallon hanging kettle [61]. The back and sides of the fire-box would have been clad with tiles to create a fire-proof screen. Among other equipment stowed in this area was a rotary quern or hand-mill [62], which would have been used for grinding grain foraged ashore. The galley structure was perhaps located towards one side of the forecastle so as to be clear of the foremast and bowsprit, and the spread of collapsed debris suggests that it had been situated on the port side.

Chapter 6

THE SHIP: OPERATION AND MANAGEMENT

6.1 Ballast

Apart from the exposed iron guns, the two mounds of stone ballast were the most distinctive features visible on the wreck-site at the time of its discovery in 1979 (John Dadd pers comm) (Illus 17). The cohesion of these mounds was further demonstrated during survey, when no attempt was made to delineate their boundaries artificially. When all the stones measuring 5cm or more had been plotted objectively across the whole survey area, and contouring at 0.1m intervals applied over the site, the mounds stood out as visually discrete entities, one at the western end of the wreck and the other towards the east (Excavation Plan and Illus 39). Their relationship to the surviving hull-structure, moreover, indicated strong post-depositional stability. A centre-line projected through the two mounds closely follows the axis defined by the keel and keelson (**095.074/280.060**), indicating that there has been little displacement from their original configurations within the hull, except perhaps some limited outwards spill on either side, particularly to port.

Sources of ballast materials

John McManus

Samples recovered from the ballast associated with the wreck-site off Duart Point consisted of boulders, pebbles, mixed gravel of a range of particle sizes, and clay. These materials were derived from identified parts of the wreck, from the west and east ends and also from the central area.

Clay from the central area

The pale-coloured clays were subjected to X-ray diffraction analysis in the School of Geography and Geosciences at the University of St Andrews, by Mr Angus Calder. The resultant graphs (McManus 2004: figs 1–2) were compared with widely used scientific standards and revealed that the clays were principally of the minerals illite and kaolinite, with variable amounts of fine-grained quartz. There are small quantities of smectite, chlorite, calcite, and halite. The latter, which is derived from marine salt waters, is to be expected from wreck-derived material.

The bulk of the clays, being of illite and kaolinite, are most probably from fireclays of Carboniferous age, which are common on the west coast of central Scotland (Ayrshire and the Clyde Estuary). They are not common in Highland regions. Smectites may be derived from volcanic rocks, also common on the west coast of central Scotland, but also present occasionally in soils of many of the Inner Hebridean islands. The assemblage of minerals indicates that these clays are not local to the site and would not have washed into the wreck subsequent to its sinking. However, they are essentially Scottish, for many of the East Anglian clays – which might have been present among the ballast had the vessel come from that area (see Chapters 1.2 and 2.2) are rich in smectite.

Boulders

The two boulders examined were each more than 200mm across (Site 9, Sample 15 ref 229295, and Site 8, Sample 13, ref 143967). Both were of granitic gneiss, pink-coloured due to a high content of potassium-rich feldspar crystals. There is some internal structural layering developed, with biotite, hornblende and quartz-feldspar layers evident in most places. These gneisses are typical of the North-West Highlands and the Outer Hebrides, principally Lewis. Their composition indicates that they are from the Laxfordian division of the Lewisian gneisses, which outcrop on the mainland north of Scourie, towards the north of Loch Laxford. Similar rocks also dominate the northern parts of Lewis.

Pebbles

Two sets of pebbles collected from the eastern and western ballast-mounds have been examined. The identities of some were very evident, but thin sections were made of a total of

23 pebbles partly to enable confirmation of the identifications through detailed petrological microscopic examination and partly to attempt to detect any unusual textures which might help precise source recognition. Photomicrographs of the thin sections, as seen under crossed polars, are given with brief comments in McManus 2004.

Western ballast-mound

The particles are of low-grade metamorphic rocks, principally from the Dalradian rocks of the southern Highlands, notably Argyll and the Cowal peninsula. The rocks are principally of chlorite-zone psammites and phyllites, with a few low-grade marbles and calc-silicates. This is a typical assemblage of the weakly metamorphosed rocks from the Dalradian. Typical among the fragments were:

(a) Uniformly fine-grained metamorphosed quartz sandstone with a few mud pellets, set in a calcite cement (eg 14/W).

(b) Fine-grained muddy metamorphosed limestone with layers of clay pellets and a thin quartz vein. This rock has a weakly developed series of muscovite-lined planes of weakness (eg 15/W).

(c) Medium-grained metamorphic quartzite with silica overgrowths on quartz grains. No calcite in the cement. About 5% of the detrital grains shown in the straining indicate that the parent rocks had experienced a structural distortion event before they were eroded to become the sandstone which was later metamorphosed. A few crystals of twinned feldspars are present (eg 12/W).

(d) Calcite-rich fine-grained phyllite with small mica flakes (eg 16/W and 11/W)

Eastern ballast-mound

There is some variety of pebbles from this part of the wreck.

(a) The pebbles from this section are largely gneisses of acid and basic composition. Many show signs of having been mylonitised (heavily crushed) at some stage in their development. In some cases there is evidence of multiple metamorphic activity with hornblende (a water-bearing mineral) rather than the typical dry pyroxenes of the granulite facies of metamorphism which the rocks certainly underwent early in their history. These are Lewisian gneisses in several of their forms. Typical examples are 01/E, 03/E and 15E.

(b) Two pieces of a well-indurated, possibly weakly metamorphosed reddish-coloured K-feldspar-rich coarse sandstone were recognised. They closely resemble the Torridonian sandstones which are derived directly from the breakdown of the Lewisian gneisses. The grains of feldspar, quartz and rock fragments are very tightly packed, and the resultant rock is very strong. The Torridonian rocks occur along the western Highland coasts, from Rum to Cape Wrath, but do not occur on the Outer Hebrides (eg 03/E and 16/E).

(c) Two pieces of fresh, black, very-fine-grained crystalline olivine dolerite or basalt (eg 04/E), a very common form of the coastal rocks of the northern Highlands and Islands. The basalts are basic, black lavas which took their origin from the ancient volcanoes which were

Table 6.1
The composition of the ballast gravels by particle numbers alone

Rock type	*all particles %*	*>20mm %*	*<20mm %*
Fine-grained basic igneous rock (basalt)	42.5	41	47.4
Pitchstone (deeply weathered)	22.5	29.5	23.0
Quartz sandstone	14.0	13	17.0
Quartzite	8.3	10.5	8.6
Vein quartz	6.6	4.5	1.2
Chert	1.9	5.0	1.1
Pitchstone (fresh)	1.7	4.5	1.0
Slate	0.7	1.0	0.3
Volcanic ash	0.7	0.0	0.4

centred on Mull, Skye, Rum and Ardnamurchan, but associated are doleritic intrusions of similar chemical and mineralogical composition, and which break across the indigenous rocks of the west. They may be found cutting through both the Dalradian metamorphic rocks and Lewisian gneisses, and are therefore not very helpful in seeking to identify a source of supply for the ballast.

(d) Several of the particles from the eastern ballast-mound are similar to those of the western, being of material which appears to be of the Dalradian metamorphic rock assemblage. One pebble of metamorphosed finely crystalline limestone (10/E) shows well-formed cubic crystals of galena, a lead-ore mineral, formerly mined in the Tyndrum and Strontian areas.

Gravel ballast

Five hundred and seventy-four particles have been identified using a hand-lens. Where necessary particles were broken open by hammer to reveal the nature of their interiors. Of the materials analysed, 135 of the particles were larger than 20mm in diameter, and of the remainder none smaller than 4mm diameter was identified. The confidence of identification of smaller particles by simple visual inspection was not believed to be sufficiently high to justify examination of such material. The components and their proportions are listed in Table 6.1.

Part of the problem of identification comes from the rocks themselves. A significant proportion of the material is of pitchstone, which is chemically unstable when left in water for any length of time. The result is that there has developed a kind of patina on the outside of the pebbles. Whereas the original rock is glassy and very darkly coloured, the weathered surface is very pale and rather earthy. A few small glassy pieces were within the sample bag, but very few.

The majority of the pebbles are of basic igneous rocks such as basalt, which is normally black or darkly coloured. This weathers to a reddish colour in an oxygen-rich environment. Fortunately this process takes rather longer to achieve under water than the pitchstone degeneration. There are white sandstones, and pale-coloured quartzites, probably of fairly local origin, possibly brought to the beach by glacial action. Likewise vein quartz, not uncommon; and a few pieces of volcanic ash, possibly of local origin, quite possibly all from one broken pebble. A few particles of slate were recognised and a little 'chert'. The latter could well be pitchstone, which is very similar in texture, but here the material is purple-coloured rather than the black of the pitchstone (Table 6.1).

The rocks represented are mainly those of the Inner Hebrides, and most could have come from the beaches of Mull, Rum, some parts of Skye, or even Arran. From the compositions which I have noted they are certainly not from the Outer Isles, and likewise I would not have anticipated finding most of the materials in mainland Argyll. There are white sandstones, quite possibly from Mull, and pale-coloured quartzites of local origin, possibly of glacial action. The vein quartz could be derived from virtually anywhere among the older rocks, but is not common among the volcanic basalts and pitchstones. Much of the gravel therefore appears to be local and could have come from the beaches of Mull before the final voyage started, perhaps as part of a final trimming.

Conclusions

The variety of materials represented in the various forms of ballast recovered from the wreck attest a history of activity along much of the western Highland seaboard, with material variously added from the Clyde Estuary-Ayrshire area, from south Argyll, from the Outer Isles or North-West Highlands, and gravels from more local sources, perhaps Mull itself. Clays are commonly considered to have been valuable in restricting the movement of casks and other mobile materials such as gravel. The presence of substantial quantities of ballast possibly from the Outer Isles suggests that heavy cargo may have been carried to the Stornoway area, necessitating some re-ballasting to trim the craft for subsequent voyages.

Significance of the ballast

Colin Martin

The two mounds are distinctively different in character. Stones among the western (forward) ballast-mound tend to be larger, and many are angular, flattish slabs which have been carefully packed in levelled strata to enhance stability and minimise packing space (Illus 161). The majority of these stones, as Professor McManus's analysis reveals, are Dalradian rocks from the South-West Highlands. The eastern (aft) ballast-mound, in contrast, is composed mainly of large rounded pebbles or small boulders, many of which are of Lewisian gneisses from the extreme North-West Highlands or the northern part of Lewis (Illus 162). These appear to have been more randomly packed, no doubt because their rounded shapes interlock naturally in a way which minimises interstices.

Excavation at the eastern end of the aft ballast-mound revealed its aftermost extent at **130.075**, where structural evidence indicates that the dead-rise of the stern begins. Significant quantities of cut heather (*Calluna vulgaris*) were noted here between the ship's ceiling planking and the ballast-stones, no doubt inserted as dunnage to protect the wooden structure (Illus 163). Evidence of this practice was not found in the small excavation conducted beneath the forward ballast-mound (**26.06**). Heather or other foliage was frequently used as dunnage in boats transporting cattle from the islands to

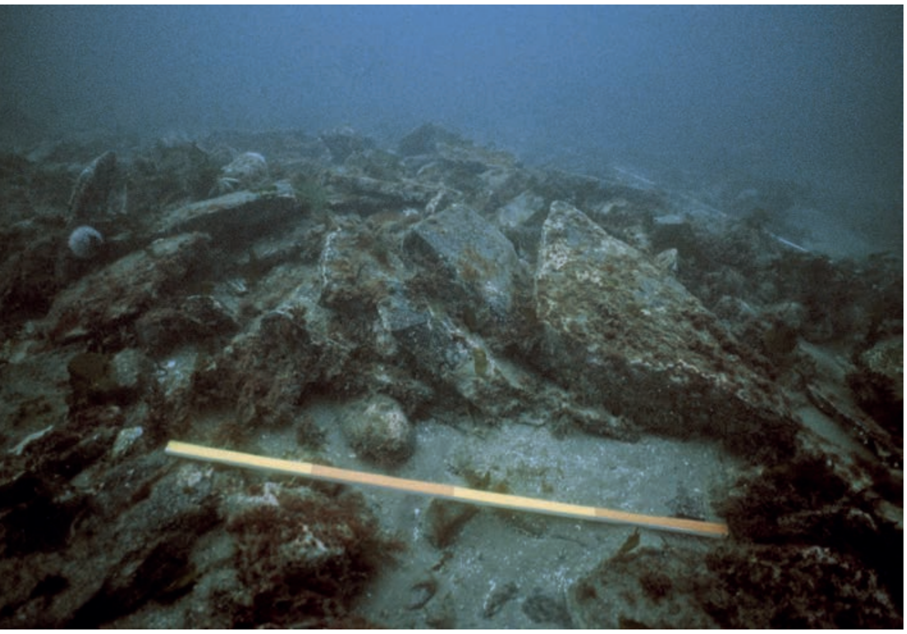


Illustration 161
The forward ballast-mound. Scale 1 metre (DP 173755)

the mainland in the West Highland droving trade, spread in a layer known as *farradh* in Gaelic (Haldane 1973: 73).

Much of the partially eroded floor in the midships section between the two ballast-mounds, above the ceiling planking, had been lined with a creamy-coloured clay. Professor McManus's analysis shows that this material is probably fireclay of the Carboniferous period. This is not common in Highland regions, but it could well have been derived from the west coast of central Scotland. Towards the port side of the hull, just before the upwards turn of the bilge, the clay lining is ribbed with three furrows up to 0.15m deep extending to the ceiling planks of the hull, exposing the longitudinal joints of the timbers (Illus 164). Above the clay is a layer of gravel distinctively different from the natural sea-bed shingle in this area, and this is also presumably ballast. The ribbing of the clay along the bilges may have been intended to stabilise the gravel against sideways movement when the ship rolled; alternatively, the furrows may have been settings for stabilising-boards, recalling Mainwaring's remarks on the securing of ballast, 'they make pouches, as they are called, that is bulkheads of boards, to keep it up fast that it do not run from one side to the other, as the ship doth heel upon a tack' (Manwaring & Perrin 1922: 93).

Illustration 162
The aft ballast-mound with the muzzle of Gun 3 left centre. Scale 20 centimetres (DP 173757)

Illustration 163
Sample of heather dunnage (*Calluna vulgaris*) from the aft ballast-mound at **130.075**. It had been packed between the hull-planking and the ballast-stones. Scale in centimetres (DP 173416)

Samples of gravel were taken from the lower levels of the ribbed furrows to ensure that they were not contaminated with natural material (Illus 165). Professor McManus suggests that the ballast gravel may have come from the Inner Hebrides, but is unlikely to derive from mainland Argyll or the Outer Isles. Among the gravel ten water-abraded potsherds were identified (Illus 166). None of the fabrics matched ceramics found elsewhere on the wreck. The wares represented include olive jars from the region around Seville. One other sherd suggests a Spanish association while others, though not closely identified, appear to be of continental origin and possibly of significantly earlier date than pottery found elsewhere on the wreck (George Haggerty pers comm). The most probable explanation is that the gravel had been taken on board from a deposit somewhere in the Inner Hebrides or the adjacent mainland at which vessels with continental connections had discharged ballast. Because of the need to keep harbours and their approaches stable and free from erosion or silting, taking on and discharging ballast was a carefully regulated activity. Inappropriate dumping or removal was prohibited, and suitable locations were often designated for taking on or discharging ballast, in the course of which discarded artefacts such as potsherds might be exchanged between ships.

In the absence of total excavation the volume, weight, and distribution of ballast cannot be determined precisely. However, the general horizon of the lower hull, and the contour survey, allow the approximate volumes of the two ballast-mounds to be calculated and their weights determined, using a specific-mass factor of 1.5 for well-packed stone. A figure of 2 may be adopted for gravel and compacted clay. The forward mound works out at *c* 4m^3, or 6 tonnes, while the aft one is *c* 5.5m^3, or 8.25 tonnes. The clay lining, if spread to a constant depth of 100mm across the central hold between the bilges, would require 2m^3 of material, or 4 tonnes, while a 70mm topping of gravel (1.5m^3) would account for another 3 tonnes. In all, the total of 'dead' ballast (that is, material stowed for its weight alone) works out by this estimate at *c* 21 tons, or about 15% of the vessel's calculated displacement of *c* 135 tons.

6.2 Casks and stowage capacity

Consideration may now be given as to how this arrangement of ballast may have determined the stowage of other material inside the hold. The midships area, extending some 4m forward of the mainmast and spanning much the same distance athwartships, with its relatively flat floor and resilient clay and gravel lining, will no doubt have been allocated for the stacking of casks and other provisions, as was normal practice (Lavery 1987: 187). In order to estimate stowage capacity two tiers of 491 litre (108 gallon) butts have been assumed. Fifty-two such containers can comfortably be accommodated without encroaching on the mainmast-step or pump-wells, with extra runs of six smaller hogsheads (245.5 litres/54 gallons) filling the rising space above the bilge, outboard of the second tier on either side. This gives a total liquid stowage capacity in the hold of 6,264 gallons, or 28.5 tonnes, though the weight would have varied with the commodities stored. Most provisions, with the exception of bread, would have been contained in casks.

The lower tier would have been well bedded into the gravel ballast and the casks thus stowed would occupy some 1.6m vertical height (5ft 3in), well within the estimated 2.44m (8ft) depth of the hold. Some additional space may have been taken up by firewood dunnage packed between and above the casks (Illus 167). This arrangement is well illustrated in the sectional depiction of a privateer by Henrik af Chapman in 1768 (pl 32), while a plan of the ballast and lower tier of casks in the frigate *Artois* (1794) is reproduced by Lavery (1987: 190). Both these sources show the casks laid belly-to-belly rather than the overlapping 'bilge and cantline' method recommended by the *Admiralty Manual of Seamanship* (Vol. 3, 1964: 82) which is a more logical and secure means of stowage. I have adopted the latter method in my reconstruction (Illus 159). For obvious reasons casks are always stowed bung uppermost.

The stone ballast concentrations fore and aft were spread in the lower hold to a depth of no more than *c* 0.5m (1ft 8in), leaving an estimated 1.96m (6ft 5in) of vertical space beneath the main deck. It is possible that light decking covered the ballast areas, though no evidence for this was found. The forward space no

Illustration 164
Clay lining of the lower hold. The clay has been ribbed longitudinally down to the ceiling planking as it approaches the port bilge, presumably to stabilise the gravel laid above it. Three parallel channels are shown partly excavated here. Scale 15 centimetres (DP 173758)

Illustration 165
Sample of gravel from the channels in the midships clay ballast. Scale in centimetres (DP 173762)

Illustration 166
Intrusive water-worn potsherds found among the gravel ballast (see Chapter 9.3). Scale in centimetres (DP 173763)

doubt accommodated the main cable tier, directly beneath the windlass postulated aft of the forecastle (see Chapter 5.6 above). This area is also likely to have provided stowage for coal and peat, of which traces have been found in its vicinity, perhaps in bunkers ranged around the sides and blunt nose of the bow. The traditional location of the bread-room was in the hold close to the stern, where the rising deadwood raised the frame-timbers well above the keel and so kept this area safe from bilge-water (Lavery 1987: 189). Gunpowder, too, was frequently secured in this dry area, while fish was often stored aft to isolate its strong smell. That this may have been so on the Duart Point ship is suggested by a substantial deposit of fish bones in the area of the lower-stern structure (see Chapter 3 Area 4, and Chapter 6.7). A spirit-room a little further forward

Illustration 167
Scraps of oak brushwood, which may have served as packing for stacked casks. Scale in centimetres (DP 174124)

is hinted at by the find hereabouts of four stoneware *bartmann* jars, and it was usually just aft of the mainmast that the main store of roundshot was located, though no evidence of this was found. That only three pieces of iron shot were found in the course of the excavation may indicate that most of the ship's munitions had been taken ashore with the invasion force.

While it is likely that the ship was designed to carry a considerable quantity of provisions in its hold (the available space between the fore and aft ballast-mounds being estimated at *c* 300m^3, see above), much of which would normally have been stowed in casks, very few pieces of these versatile containers were recovered during the excavation. Various factors may explain their scarcity. When the upper part of the central hull collapsed during the wrecking process (see Chapter 4) any casks stowed in the hold would have been vulnerable to disintegration as their hoops decayed, rendering the loose components prone to dispersal by current.

More probably, perhaps, most of the provisions and other materials stowed in cask had been off-loaded prior to the wrecking to provide logistical support for the task-force when it came ashore. Lead shot would certainly have been present in some quantity on board a warship carrying soldiers, and this commodity was normally transported in small casks (for example on *Vasa*, Cederlund 2006: 368). But we may suppose that it was brought ashore when the troops disembarked. The relatively small quantity of loose shot found among the wreckage (see Chapter 2.2), none of which occurred in large clusters, militates against its being the in situ contents of disintegrated bulk containers. In any case it is likely that had any shot-casks been present the lead bullets within them would have pinned down and preserved their remains. On the wreck of *La Belle* nearly 300,000 lead balls were found, preserved mainly in 33 largely intact small casks (Bruseth & Turner 2005: 95–6).

It should also be remembered that evidence adduced below (sections 6.5–6.7) strongly suggests that supplies of fresh food were routinely obtained ashore, and for the most part this would not involve stowage in cask. Water was also shipped in cask, but the bulk required for a long voyage would not be required for inshore work of the kind engaged in by Cobbett's expedition, where boat-parties could be sent ashore to fill a few casks whenever required, thus ensuring freshness and reducing the ship's deadweight cargo – an advantage which might be exploited either by carrying something else or by enhancing performance, especially under oars.

Another cask-contained liquid usually prominent in the English naval diet was beer. A late 16th-century source indicates that, of the ton of stowage capacity allocated to four men's provisions for a month, no less than half was for beer, a quarter for wood and water, and the remainder for solid food (Oppenheim 1896: 144). But such prodigality was not evident in the Commonwealth navy. In June 1653 beer supplied by the victualling department was so bad that it had to be withdrawn from issue (one of the supplying brewers complained that it was the best he could provide for the money offered), the men concerned being given water and an allowance of two pence per day in recompense (Oppenheim 1896: 326). Given these constraints, and the fact that Cobbett's squadron seems to have relied on the opportunistic gathering of fresh supplies from local resources in the West Highlands, it seems unlikely that the ship would have carried much bulk beer in cask. Although none of these factors is capable of absolute proof, they may together explain the paucity of cooperage-related artefacts, which are described below.

Cask remains

A very full account of shipboard casks and the methodology of their study is provided by Loewen 2007, and see also Rodriguez 2005 for comparative material from *Mary Rose*. All the cask components identified were of oak (*Quercus* sp)

Heads

39 DP01/075, **189.091**, a chamfered centre-piece, broken at one end, from a 560mm-diameter head, 12mm thick (22 × ½in) (Illus 168). The edges are not quite parallel. Complex angular pattern of scored lines of unknown significance. Two dowel-holes on each side. This diameter is appropriate to a 35in tall (0.89m) hogshead with a capacity of 52.5 imperial gallons (239 litres).

40 DP97/A023, **064.094**, chamfered cant-segment (one end broken off) and middle piece of a 420mm-diameter head, 16mm thick (16½ × ⅝in) (Illus 168). Vent or bung-hole 9mm diameter. Towards the right edge of the middle piece the letters 'RP', extending the full width of the board, are neatly cut. The segmental arc of the two pieces indicates a balanced pair of boards on the other side, and a joining centre-piece of similar width to the middle boards. Probably from a barrel of *c* 36 imperial gallons capacity (164 litres).

41 DP03/054, **119.070**, chamfered cant-segment representing half the circumference of a 370mm-diameter head,

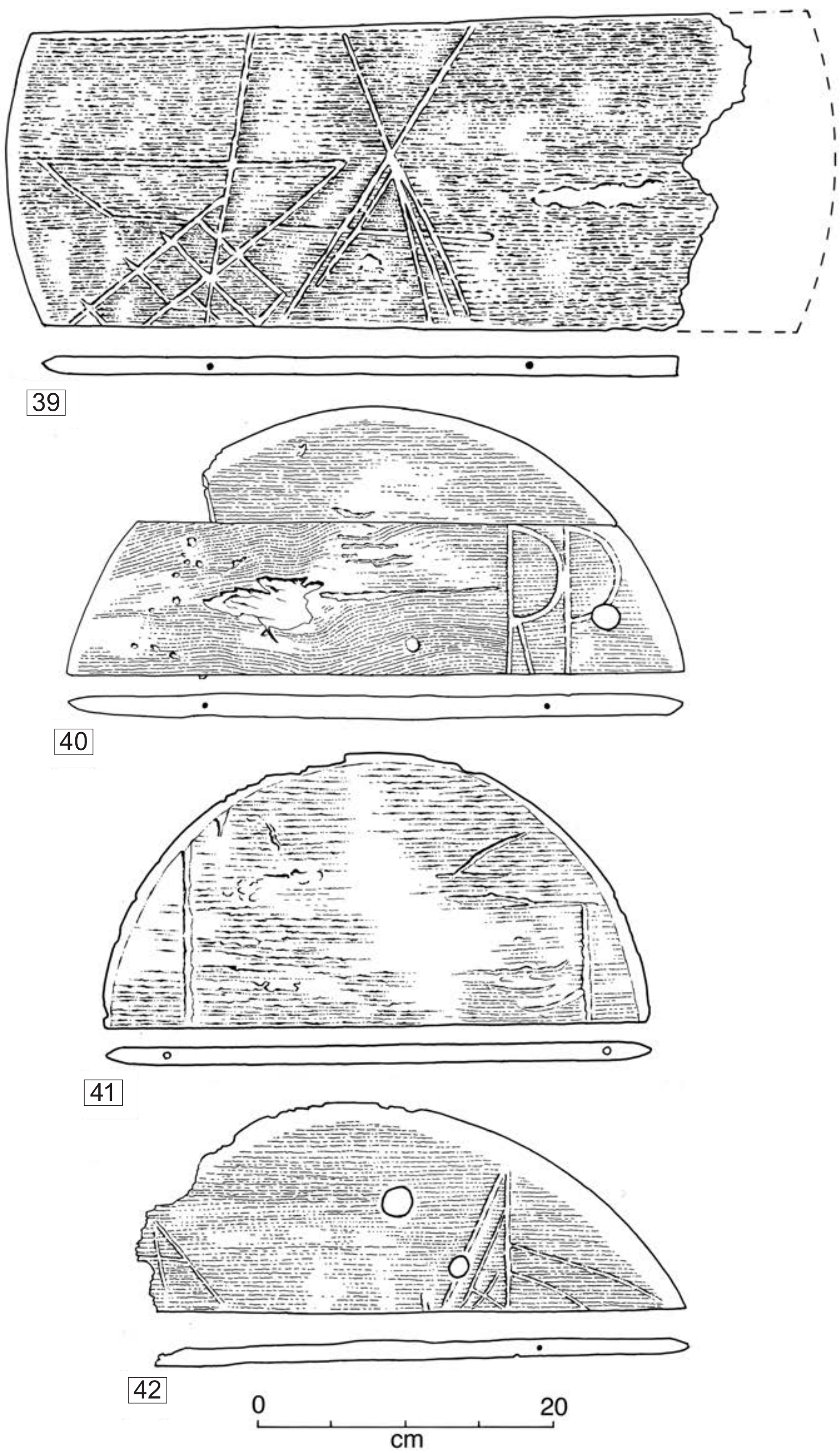


Illustration 168
Marked cask-ends 39–42

12mm thick (14½ × ½in) (Illus 168). Vertical scored lines roughly cut at each end, with some indeterminate marks between.

42 DP01/088, **180.093**, broken chamfered cant-segment from a 500mm-diameter head, 12mm thick (19¾ × ½in) (Illus 168). Vent- or bung-holes 10mm and 6mm diameter. Angular patterns of scored lines at each end.

43 DP01/074, **189.091**, chamfered cant-segment from a 600mm-diameter head, 12mm thick (24 × ½in) (Illus 169). Two dowel-holes.

44 DP01/027, **169.095**, chamfered cant-segment from a 240mm-diameter head, 12mm thick (9½ × ¼in) (Illus 169). Two dowels, one in situ.

45 DP03/048, **113.072**, broken chamfered cant-segment from a 560mm-diameter head, 16mm thick (15 × ⅝in) (Illus 169). Two dowel-holes.

46 DP96/002, **030.013**, chamfered cant-segment representing half the circumference of a 280mm-diameter head, 12mm thick (11 × ½in) (Illus 169). Two dowels in situ.

47 DP03/071 and 073, **121.082**, two conjoining chamfered cant-segments of a 186mm-diameter head, 6mm thick (9½ × ¼in) (Illus 169). Two dowels, one in situ.

48 DP01/047, **077.156**, piece of wood with chamfered edges, slightly more than half a circle, 203mm diameter, 8mm thick (Illus 169).

Staves

49 DP92/264, findspot uncertain, broken stave, surviving length 387mm, head end 104mm wide, width towards booge 124mm. Croze-groove 6mm wide × 4mm deep. Thickness at head 8mm, towards booge 11mm (Illus 170).

50 DP03/074a, **123.070**, broken stave, surviving length 180mm, head end 36mm wide, width towards booge 50mm. Croze-groove 5mm wide × 2mm deep. Thickness at head 8mm, towards booge 8mm (Illus 170).

51 DP03/074b, **123.070**, broken stave, surviving length 220mm, head end 44mm wide, width towards booge 50mm. Croze-groove 4mm wide × 3mm deep. Thickness at head 8mm, towards booge 8mm (Illus 170).

52 DP00/192, **107.083**, complete stave 283mm long, head end 25mm wide, 38mm at booge. Croze-groove 5mm wide × 4mm deep. Thickness at head 8mm, at booge 6mm (Illus 170).

Barrel-wedge

53 DP99/036, **077.093**, barrel head-piece tightening peg, 65mm × 19mm (Illus 171).

No remains of iron hoops were discovered in association with the cask remains (apart from the concretion at **276.100**), and only a few fragments of split-withy hoops (DP01/047a, 058, 072, 078, 081) in association with several of the cask-end segments. None was found elsewhere on the wreck, except in connection with the staved vessels described in Chapter 9.6.

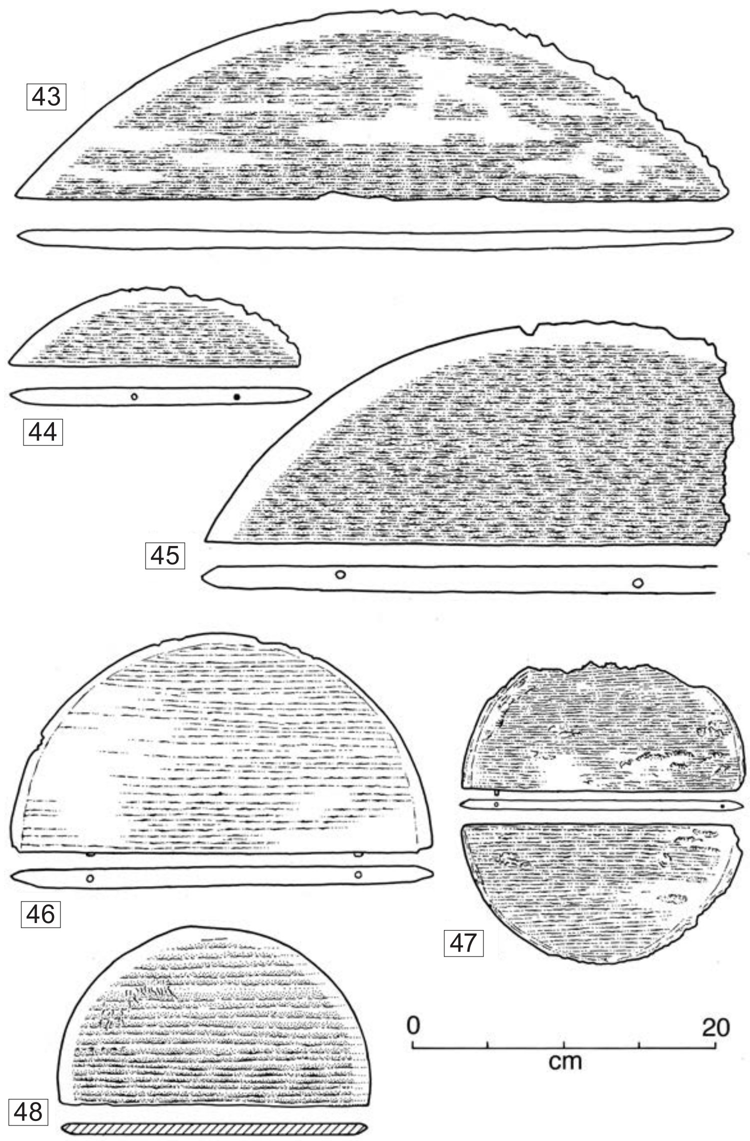


Illustration 169
Unmarked cask-ends 43–8

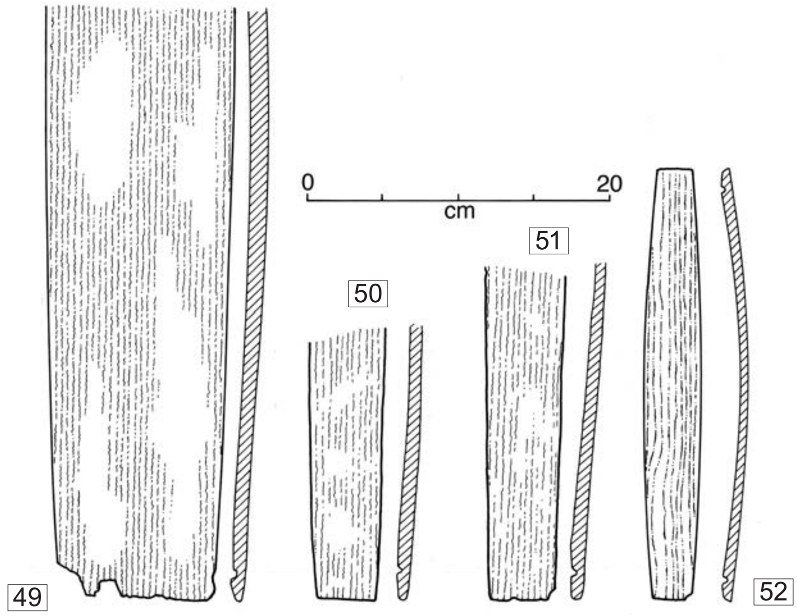
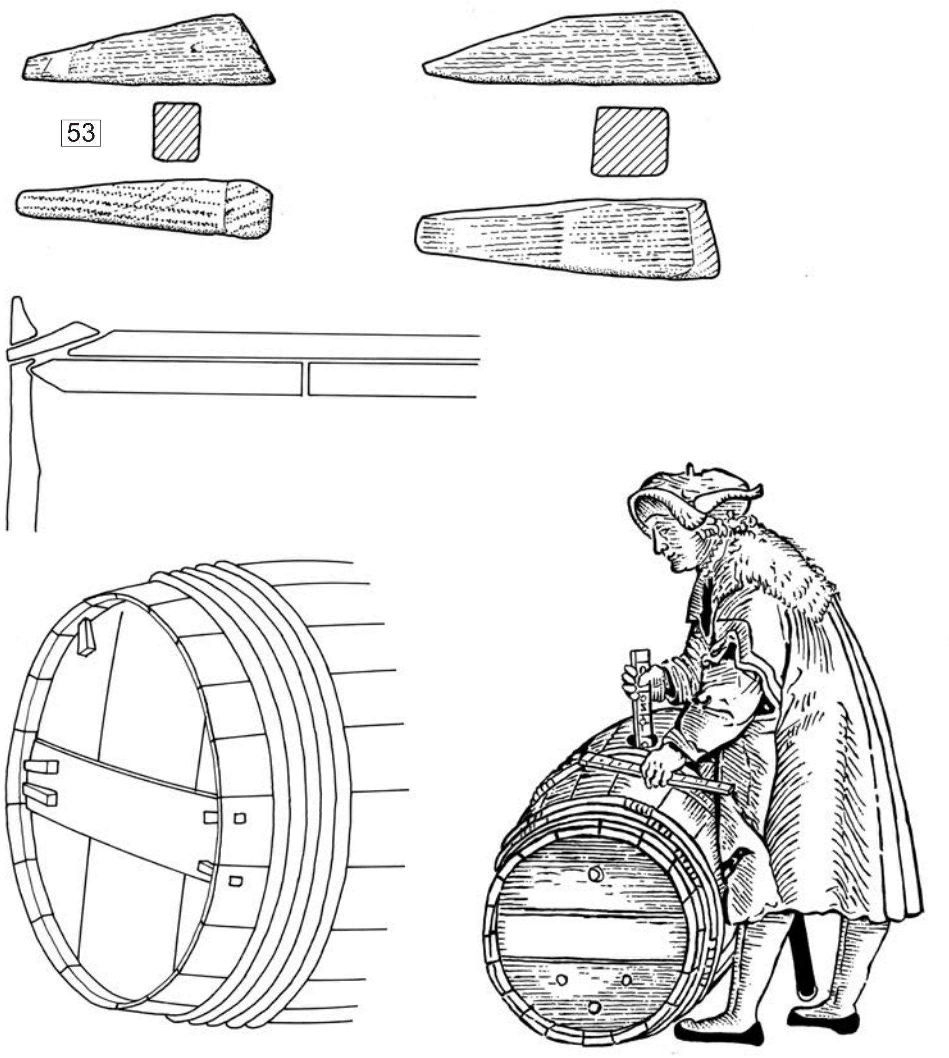


Illustration 170
Cask- and keg-staves 49–52

Illustration 171
Top left: barrel-wedge 53. Top right: a comparative example from the Spanish Armada wreck *La Trinidad Valencera* (both scale 1:2). Centre and bottom left: diagrams showing how the barrel-head was reinforced and tightened with wedges (after Loewen 2007: figs 8.8, 8.4). Bottom right: a 16th-century barrel with reinforced head (adapted from Frey 1531: title page)



6.3 Pumps

It has rightly been observed that pumps are the most important pieces of equipment aboard a ship (Oertling 1996: 9). All hulls leak to some extent, and take on water from spray, breaking waves, and rain. Waterways and scuppers were placed to direct as much as possible out of the ship by natural drainage, but once water percolated below the waterline it had to be gathered and expelled mechanically by human effort. This was a routine chore in all sailing vessels, and no doubt consumed a significant proportion of the available manpower. The crew's ability to pump out water faster than it entered the hull ultimately determined whether or not a vessel stayed afloat.

Several components of wooden pumps were recovered from the wreck, and the structural remains of one of the main pump-wells were recorded. This evidence, read in conjunction with contemporary written sources, allows the pumping arrangements aboard the vessel to be reconstructed in some detail.

Common suction-pump components

54 DP97/A012, **079.092**, lower pump-valve of elm (*Ulmus* sp), 110mm top diameter tapering to 90mm at base, 60mm deep (Illus 172–3). Single groove for sealing-ring around body. Leather claque in place, with roughly squared wooden weight above. Elliptical bore. Concreted remains of an iron staple on top, and corresponding holes beneath.

55 DP99/009, **072.103**, lower pump-valve of elm (*Ulmus* sp), diameter at mid-point 115mm tapering to 105mm at top and bottom (Illus 173). 18mm sealing groove around girth with central raised beading. Elliptical bore. Staple-holes present but lacking claque or weight.

56 DP97/A013; **080.093**, lower pump-valve of elm (*Ulmus* sp), 100mm diameter at top tapering to 87mm at base and 58mm deep (Illus 172–3). Single groove for sealing-ring around body. Wooden top-weight present but no leather claque, though six small nail-holes along one side of the top surface indicate its fixing-points. Elliptical bore. Concreted remains of a staple on top; corresponding holes beneath.

57 DP99/023; **069.104**, lower pump-valve of elm (*Ulmus* sp), 122mm diameter at top tapering to 110mm at base, and 70mm deep (Illus 173). Double groove for sealing-ring towards top; single one beneath. Leather claque with six fixing-holes and wooden top-weight. Elliptical bore. Concreted remains of staple on top and corresponding holes beneath.

Not from the wreck but probably similar to the missing upper component of the Duart Point suction-pump (Illus 173), traditional Irish upper pump-box made by Mr Raymond Grace before 1956 (after O'Sullivan 1969: 112 fig 11). No scale given in the original but is adjusted here to match the 110mm average diameter of the Duart Point lower valves.

Falconer's description of the common suction-pump (1780: 221) cannot be bettered, and should be read in conjunction with Illus 173–4.

Illustration 172
Lower common pump-valves; left 55; right 57 (DP 173310)

> The common pump is … a long wooden tube whose lower end rests upon the ship's bottom, between the timbers, in an apartment called the well, inclosed for this purpose near the middle of the ship's length. This pump is managed by means of the breaks [levers], and the two boxes, or pistons. Near the middle of the tube, in the chamber of the pump is fixed the lower-box, which is furnished with a staple, by which it may at any time be hooked and drawn up, in order to examine it. To the upper-box is fixed a long bar of iron, called the spear, whose upper end is fastened to the end of the break, by means of an iron bolt passing through both. At a small distance from this bolt the break is confined by another bolt between two cheeks or ears, fixed perpendicularly on top of the pump. Thus the break acts upon the spear as a lever, whose fulcrum is the bolt between the two cheeks, and discharges the water by means of valves, or clappers fixed on the upper and lower boxes.

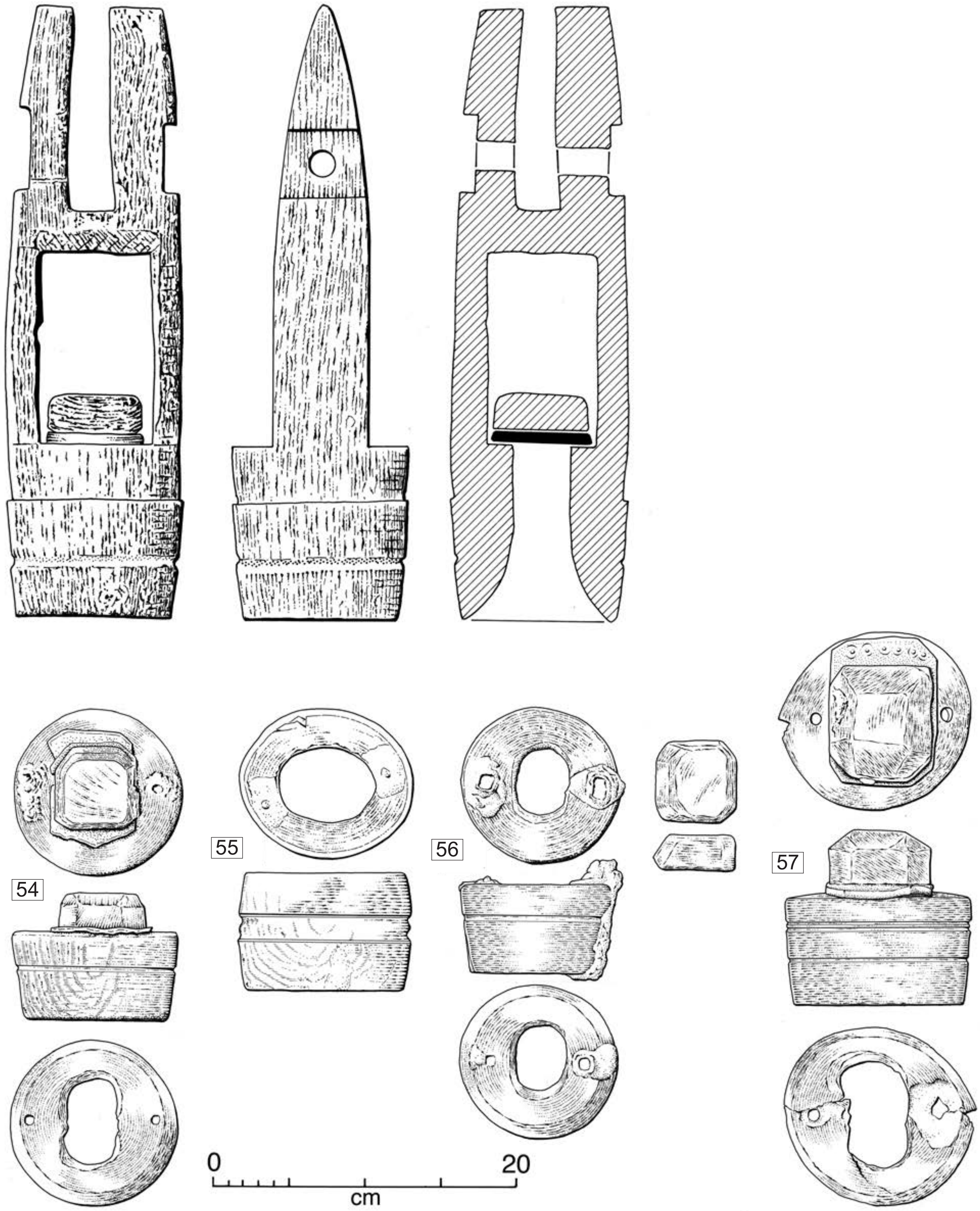


Illustration 173

Top: a modern Irish upper common pump-valve (drawn after O'Sullivan 1969: 112 fig 11), with its scale adjusted to approximate to that of the Duart Point valves. No upper valves were found on the wreck, but they are likely to have been similar to this vernacular Irish example. Bottom: lower common pump-valves 54–7

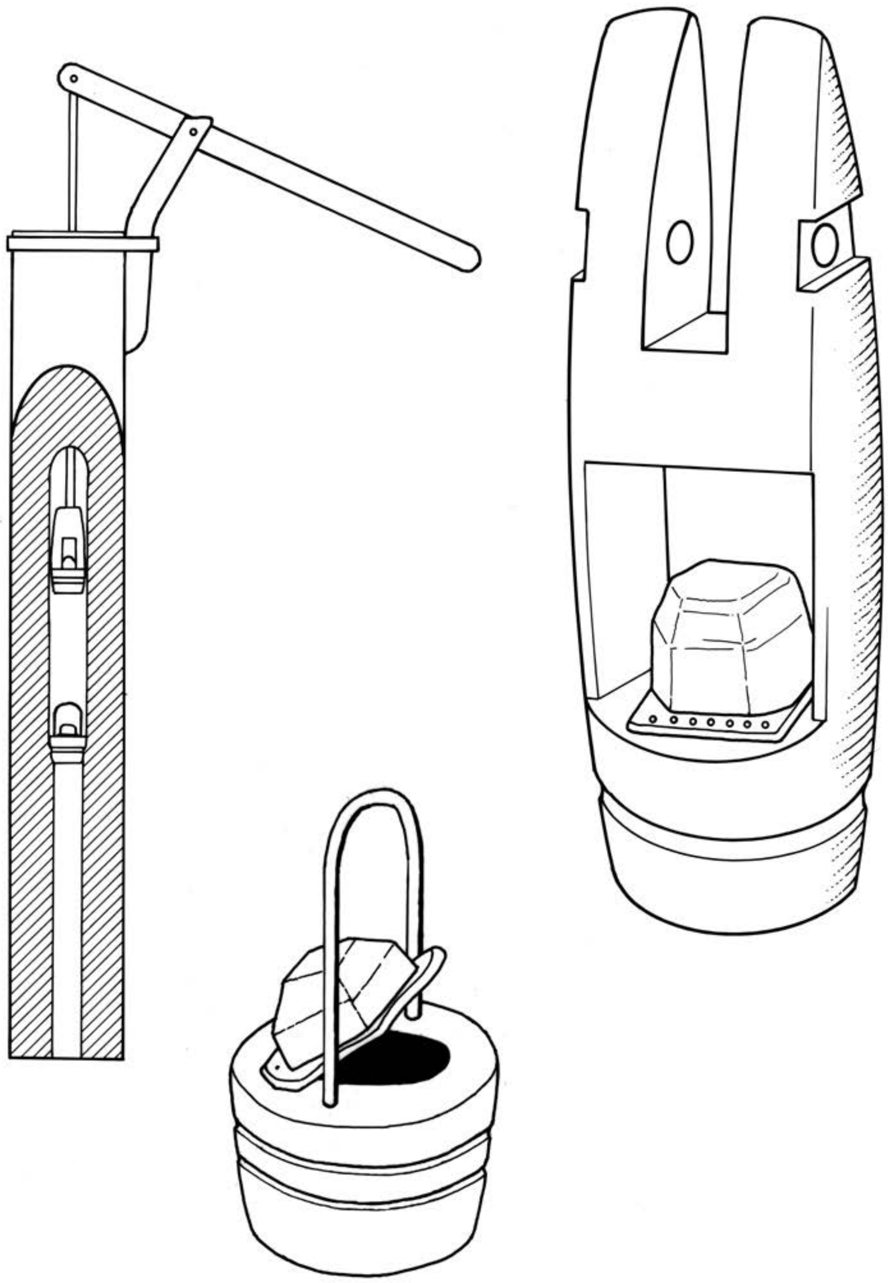


Illustration 174
Diagram showing the working principle of the common suction-pump with details of the lower and upper valves (adapted from Oertling 1996: fig 9)

A pump of this type is limited by physical laws relating to barometric pressure, and can only lift a column of water to a maximum height of *c* 28ft (8.5m) (Oertling 1996: 23). This would be more than sufficient to service the Duart Point ship.

The lower tube of a broadly contemporary common pump was recovered during the excavation of a 16th- and 17th-century saltworks at Port Eynon on the Gower Peninsula of south-west Wales (Lowcock 1998: fig 11). 1.75m (5ft 9in) of the elm pipe survives, including the intact lower end (Illus 175). Its upper 0.64m (25in) is bored to a diameter of 160mm (6in) which reduces to 60mm (2⅓in) at the lower end. There is a taper where the bore reduces, and in here is wedged a slightly tapered lower box-valve of the kind described by Falconer and recorded at Duart Point. Pumps of this type were made in Ireland until the mid 20th century, and in 1965 the last traditional pump-maker, Mr James Reville of Ballyburn, Kilmore, in County Wexford, crafted one for the National Museum of Ireland, the process being recorded in its entirety by John O'Sullivan (1969) (Illus 173 top). The apparatus is in all practical respects identical to the Port Eynon pump and, by implication, to that on the Duart Point ship.

A substantially intact pumping system survived on the wreck of *Vasa* (1628) (Cederlund 2006: figs 11.23, 12.24 and plan 2). The main pump was set well aft, just before the dead-rise, an arrangement which confirms that the ship was designed with a stern-down trim so that water would naturally flow towards and accumulate at this location. The pump-tube was a bored-out alder trunk which discharged on the lower gun-deck, nearly 9m above a sump on the level of the keelson. This is close to the maximum height a common pump could lift. An auxiliary pump was provided amidships abaft the mainmast. This tube was a single lead pipe rising 5m from its sump through the orlop before bifurcating into twin pump-barrels and discharging at the level of the lower gun-deck, just over 7m above the sump.

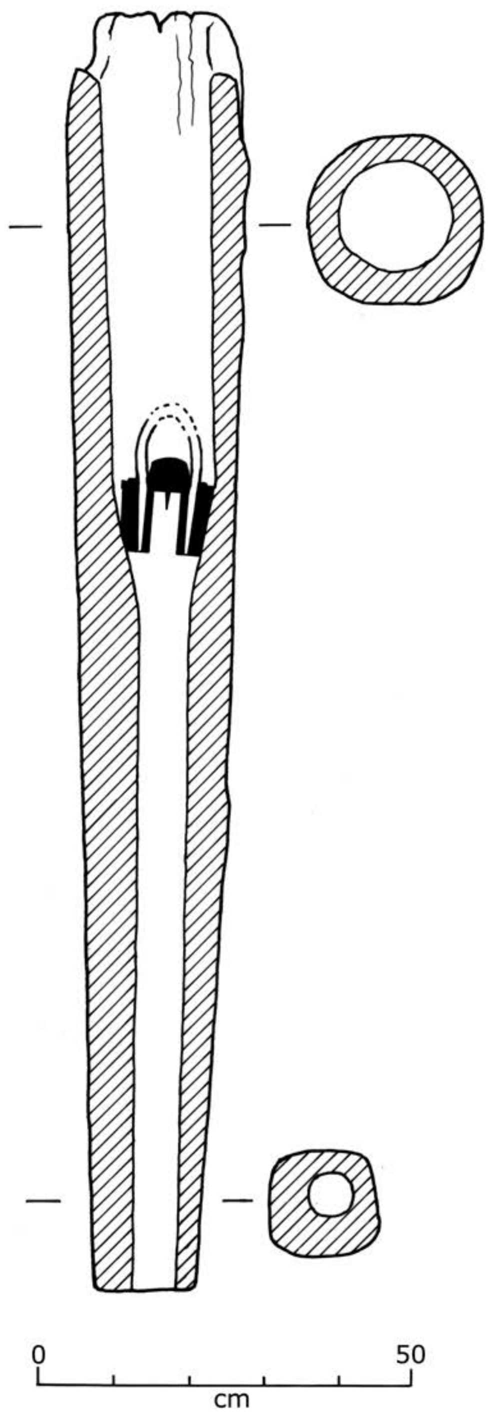


Illustration 175
The Port Eynon lower pump-tube with its lower valve in situ (after Wilkinson et al 1998: fig 11) (DP 174876)

No example of the upper valve required for a common pump or its associated spear was found on the Duart Point wreck, but such items are known from the wrecks of *Machault* (1760) (Oertling 1996: 26–9) and *Invincible* (1758) (Lavery 1987: 77; Bingeman 2010: 75).

Burr-pump spear

58 DP92/046, **078.087**, complete spear of elm (*Ulmus* sp) from a burr pump, 1.424m (4ft 8in) long (Illus 176). The missing upper valve of the pump assembly would have consisted of a leather cone-shaped gasket nailed to the conical butt at the lower end of the spear. No nail-holes could be identified on the Duart Point example, suggesting that it was an unused spare.

The burr pump was a simple machine which probably had earlier origins than the common suction-pump (Oertling 1996: 16–21) (Illus 177). Its main component was a wooden spear which incorporated the upper valve. This was in the form of a truncated cone (the burr), to which an extending leather skirt was nailed. On the downward stroke the skirt collapsed, opening the valve. When pulled upwards the pressure of water extended the skirt, pressing its edges against the sides of the pump-tube to make a seal, creating a pressure-differential which opened an inlet valve at the foot of the tube. In terms of mechanical advantage the design was superior to the common pump, but its disadvantage was that it required many more operators, as described by Mainwaring in the early 17th century:

> [The burr pump] is not used in English ships, but the Flemings have them in the sides of their ships, and are called by the name of bilge pumps, because they have long broad floors that do hold much bilge water. The manner of these is to have a staff some six or seven feet long, at the end whereof is a burr of wood whereto the leather is nailed, and this doth serve instead of the box; and so two men standing right over the pump do thrust down this staff, to the midst [i.e. the top] whereof is seized a rope long enough for six, eight, ten or more to hold by, and so they pull it up and draw the water. (Manwaring and Perrin 1922: 203)

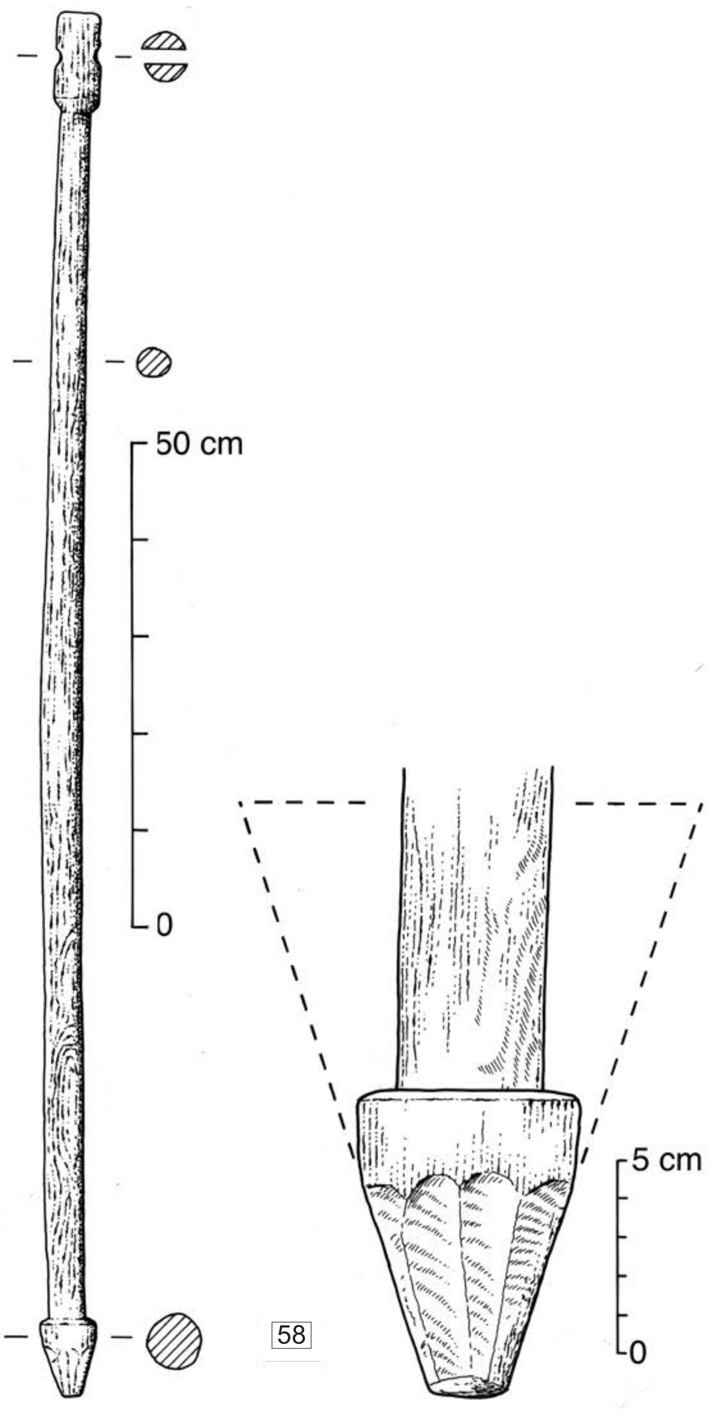


Illustration 176
Burr-pump spear 58, with enlargement of head

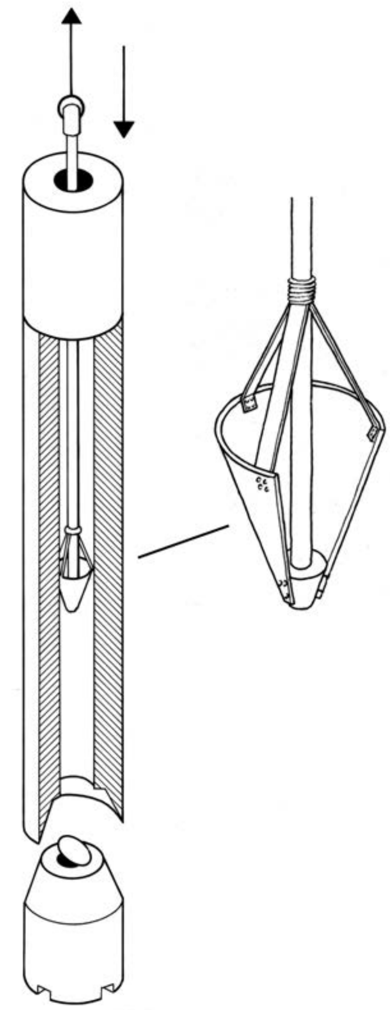


Illustration 177
Diagram showing the working principle of the burr pump with details of the lower and upper valves (adapted from Oertling 1996: fig 3)

A vertical upwards pull would have required the pumping squad to be positioned on the deck above the pump, pulling the pump-rope horizontally via a suitably placed sheave. A second team, standing at the pump-head, would be needed to thrust the spear back down the tube after it had reached the top of its travel. The Duart Point 1.424m (4ft 8in) spear is significantly shorter than Mainwaring's 6ft or 7ft one, so its burr pump's output and crew would be reduced accordingly. A single down-thruster and a pulling team of three or four would probably have sufficed.

The pump-wells

Immediately aft of the transverse mainmast-step, on the line of the limber planking and hard against the keelson on the port side at **188.074**, is a small box-like structure measuring 0.3m × 0.2m (1ft × 8in) (Illus 178) (see Chapter 3.2 area 6). Its forward edge is formed by the side of the transverse mast-step, its starboard edge by the keelson, the port by a short plank fastened to the forward side of Frame 3.6A, and the aft by another short, slightly angled plank. At the forward port-side corner of the box a rectangular hole measuring 200mm × 150mm (8in × 6in) has been cut through the limber-

Illustration 178
The port-side pump-sump and box. The abraded keelson is at the top (with 15cm scale) while the remains of the transverse mainmast-step (eroded almost to extinction) are on the left (DP 173785)

plank immediately above the port-side limber-hole on the underside of Frame 3.0A. Tool-marks on the forward face in a corresponding position indicate that there was a similar feature on the starboard side at **187.068**, now destroyed.

These features were undoubtedly sumps for the port and starboard pump-tubes. Some form of filtration is likely to have been provided at the base of the suction-tube to prevent the pumps from blocking, and while no evidence of this was found, the relatively clean state of the bilges, gaps between the frames, limber-holes and pump-sumps suggest that there was a regular and significant flow of water through the ship's natural drainage-courses. This, as pointed out at the end of the previous chapter, is a symptom of a leaky ship.

Conclusion

That two types of pump – the common suction-pump and the burr pump – appear to have been in use on the Duart Point ship requires explanation. It seems likely that the two midships pumps were of the common suction sort, operated by brakes (levers) on the main deck and discharging athwartships via port and starboard pump-dales. The burr pump, as Mainwaring noted, was characteristically used by Flemish ships, because their flat-bottomed configuration meant that water had insufficient fall to gather in depth at the pump-well amidships, so tended to accumulate in the bilges, especially when the ship was heeled to leeward or lying aground. For this reason burr pumps were often mounted at the sides of the ship. No doubt they could be set up on either side as need arose, and perhaps port and starboard tubes and bottom valves were kept permanently in place, requiring only the insertion of a burr-pump spear to render them operational.

Small warships of this period, if not actually built in Flanders, were much influenced by Flemish design (Thrush 1991), and it seems likely that the Duart Point ship was one such. While not particularly flat-bottomed, her lower hull was fairly shallow and, given the varied sea-conditions she was likely to encounter among the western seaways, an ability to deal with sudden water ingress, whatever sailing attitude the ship might adopt, may have been an essential rather than a desirable attribute.

6.4 Assessment of samples from the bilges

Headland Archaeology, 2003

Three samples were selected as being representative of the whole. A 0.5 litre sub-sample of each was wet-sieved using a 1mm mesh. The resulting material was examined under a binocular microscope and any items of potential archaeological significance noted. The results of this are presented in Table 6.2. The three samples were very different in composition, although all contained fragments of decomposing wood, presumably pieces of the ship's hull.

Sample B

The sample labelled 'B' had all the appearance of a purely natural deposit, being dominated by clean sand with marine shell and crustacean fragments. Two small fragments that had the appearance of cinders were also encountered. There were, however, so small that they could equally be metal corrosion products or natural concretions.

Sample 18/15

The preservation of organic materials in this sample was good, but the concentration was much lower than in DP01 below. Apart from the differing concentrations the two samples had essentially the same character. Moss and monocotyledon stem fragments were present in small quantities. The most important element from this sample was probably several large pieces of leather, some with stitching-holes.

Sample DP01

The preservation of organic material in this sample was extremely good, with fragments of moss stem and leaves and also monocotyledon (probably grass or sedge) stems. While it is known that moss was used as caulking material, much of the bulk of this sample was well humified and its composition would seem more likely to be that of a sedge peat. There might

Table 6.2
Composition of retents, samples from the bilges

Sample no	*Finds*	*Wood*	*Marine shell*	*Moss frags*	*Possible cinders*	*Fish otolith*	*Monocotyledon stem frags*	*Crustacean frags*	*Comments*
B		++	++++		+	+		++	Primarily clean sand
18/15	three large pieces of leather and one large piece of wood	++++	+++	+			+		
DP01	three large pieces of wood	++	++	++			+++		

be many reasons why such material might accumulate in the bilge, but it is possible that is was used as fuel or for the packing of delicate materials.

Comments

This assessment has shown that the preservation of organic materials in these samples is variable but in some cases it is good. In the case of Sample DP01 peat seems to have formed the main bulk of the sample, but given that the preservation is good, other materials might be expected to survive elsewhere in the bilge.

6.5 The galley

Bricks

59 DP96/015, DP00/133, DP01/066, 110, DP02/019 (4 whole, 2 half), DP03/015 (the majority), from around the port-side edge of the forward ballast-mound, 17 complete bricks, two broken ones and a few fragments (Illus 179).

They may be interpreted as parts of the collapsed galley range, which would have been located in the forecastle, probably on the port side of the foremast. The 15° lean to port of the forward hull, determined from the structural evidence, would have tipped the galley and its contents towards that side, depositing the bricks around the edge of the ballast-mound. This area contained other material associated with cooking and food preparation, notably coal, a copper-alloy kettle and a rotary hand-mill (see below). The bricks can be divided into four types, distinguished by their fabrics. These are:

- Type 1. Light purplish fabric, few inclusions (eight examples).
- Type 2. Pinkish-red fabric, no visible inclusions (four examples).
- Type 3. Dark buff fabric with a dark-grey core and large inclusions of broken red brick (three examples, all broken). Straw impressions on the face of one example.
- Type 4. Refractory bricks. Light buff fabric with crushed brick inclusions (four examples).

Between them they show evidence of a smoothed upper face, marks on the upper face indicating that they were scraped lengthwise with a board, and an underside texture that suggests that while wet they had lain on a straw-covered surface. A Proclamation of 1625 specified 9in × 4⅜in × 2¼in (229mm × 113mm × 57mm) as the minimum size of bricks sold in London, though this was by no means universal (Lloyd 1925: 12). The graph (Illus 180) shows median values quite close to this standard, although there are discrepancies of up to 15mm on some bricks. Most of the discrepancies fall below the prescribed standard.

Illustration 179
Top: bricks 59 from the galley area showing the four fabric types (DP 174195). Middle: brick showing marks of the grass on which it was laid while still soft. Scale 10 centimetres. Bottom: the interior of a Type 3 brick revealed by breakage, showing poorly mixed clays and brick inclusions

Tile fragments

60 DP93/005, DP01/002, 022, 034 (2), 135a (3), DP02/019, in the same area as the bricks, fragments of tile in a light yellowish-buff fabric with numerous small dark angular inclusions (Illus 181). Average thickness is *c* 10mm and the edges have a squared finish. The largest fragment includes a right-angled corner within which is a nail-hole *c* 8mm square, set at an angle through the tile. The tiles were probably from a fireproof cladding, hung on a wooden framework surrounding the galley firebox.

Fuel

Small fragments of coal were found scattered across the site, with concentrations of larger pieces in the area of bricks, tiles, and other material among the collapsed galley around grid square **28.07** (Illus 182) and in the adjacent area under the ballast in the vicinity of grid square **27.06**. A total of 8.5kg was recovered. Coal was evidently the main cooking fuel in Cobbett's fleet. The nature of the coal does not allow close geological provenancing (John McManus pers comm) but is typical of the Central Scottish coal measures which extend from the Fife to the Clyde coasts (Unstead 1964: 214), and may well have been taken aboard at Ayr. Its distribution on the wreck suggests that it was stowed close to the bow, no doubt immediately above the ballast.

Degraded fragments of peat were also identified among the bilge debris (see 6.4 above). Beneath the hull, at **230.053**, was found a single almost-intact cut block of peat, *c* 150mm long and 50mm thick, with one rounded and one flat face (DP01/007) (Illus 183). Stratigraphic striations ran longitudinally, indicating that the billet had been cut by breasting; that is, in horizontal slices from the face or breast of the bank using a peat-iron (Grant 1995: 199–200). This traditional method allowed the peats to cohere more positively during the drying process, and has been in use until recent times (Fenton 1999: 125–6). It is uncertain whether the block was additional fuel obtained locally, or whether it derives from an earlier episode in the ship's history. In either case it lends support to the vessel's strong Scottish connections and consequently to its identification as *Swan*.

Among the collapsed aft end of the wreck several oak twigs were found, some with leaves still attached (Illus 167). These may have been firewood, or dunnage associated with cargo stowage. In the latter case they might have been used as fuel once the cargo was consumed or discharged.

Copper-alloy kettle

61 DP79/002, in the area of the forward ballast-mound adjacent to Gun 6 and probably associated with the collapsed galley debris (John Dadd pers comm) (*c* **29.09**),

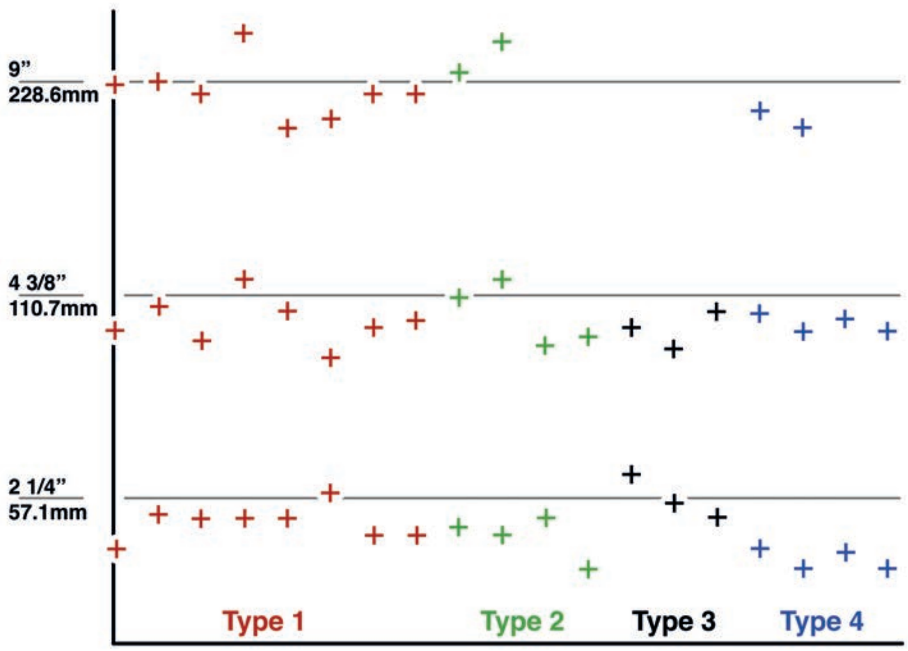


Illustration 180
Graph of the brick measurements, showing the extent of deviation from the standard

riveted sheet-copper-alloy kettle, diameter 400mm, height 412mm, capacity *c* 50 litres (11 gallons) (Illus 184). The body is made of a bottom piece beaten into a shallow pan, to which a sheet metal cylinder is attached. A shallower cylinder with a rolled rim provides the top segment. The overlapping edges are riveted at intervals ranging from 10mm to 45mm. Two loop-handles with their ends beaten into leaf-shaped flanges are riveted to opposite sides of the rim.

Comparable vessels have been found on the 17th-century wreck off Mingary Castle, Ardnamurchan (in NMS collections), *Vergulde Draeck* (1656) (Green 1977: 199) and on Wreck E81 in the drained NE Polder of the former Zuider Zee (Vlierman 1997: 30). The Duart Point kettle would provide servings for the complement to be expected in a ship of this size, and it is reasonable to suppose that it was the main cook-pot in the galley. A 1626/7 survey of the 100-ton warship *Moon* specifies a main kettle 2ft wide and 17in deep, which gives a capacity of

Illustration 181
Examples of broken tiles 60 from the galley area. Scale 10 centimetres (DP 174198)

Illustration 182
Coal from the area of the collapsed galley. Scale 50 centimetres

126 litres (27.75 gallons), and another 1ft broad and 7in deep (13 litres or 2.85 gallons) (Lavery 1988: 26).

Rotary hand-mill

62 DP02/003, **282.079**, the top- and bed-stones of a rotary hand-mill or quern (Illus 114, 185–6). They were found with the two stones face-to-face but inverted, among the galley debris at the port edge of the forward ballast-mound, suggesting that they had been secured as a working pair when they fell from the forecastle deck above. They are of typical coarse sandstone. The upper stone is 610mm in diameter, 156mm deep, and its sides angled slightly downwards. The central hole is hopper-shaped at the top, where it is 176mm in diameter, narrowing to 96mm before flaring out to 128mm at the bottom. There is a hole 44mm deep and 32mm in diameter on the top, its centre 56mm from the edge. Dovetail slots 15mm deep are cut in the underside on opposite sides of the hole. The grinding face is cut with 12 offset groups (known to millers as 'harps') of raised ribs and grooves ('lands' and 'furrows') slanting in a clockwise direction towards the edge. Little wear is

Illustration 183
Peat block retaining the form of the cutting-spade. Scale in centimetres (DP 174127)

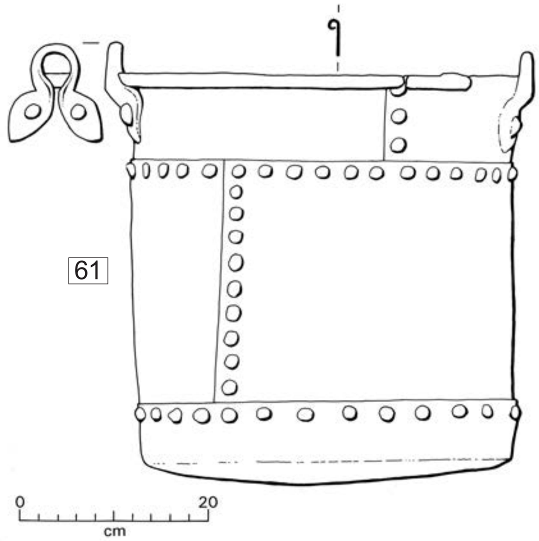


Illustration 184
Riveted copper-alloy kettle 61, probably associated with the galley (DP 174849)

evident. The bed-stone's sides are also angled, though less sharply than the upper one. Its maximum diameter is 572mm, and its depth 126mm. There is a single central hole 18mm in diameter and 64mm deep. The upper face of the stone is dressed in the same way as the lower face of the top stone. It should be noted that the direction of the grooving is opposed when the stones are placed face-to-face.

There are traces of iron corrosion in the dovetail slots on the lower face, together with the lead filling around the edges which had secured a bar spanning the hole. This would have allowed the rotating top stone to turn on a pin set in the hole in the stationary bed, where evidence of iron corrosion was noted. It may be presumed that the lower stone was fixed to a wooden board or tray (known as a 'quern house') from which the ground meal could be collected (Fenton 1978: 389).

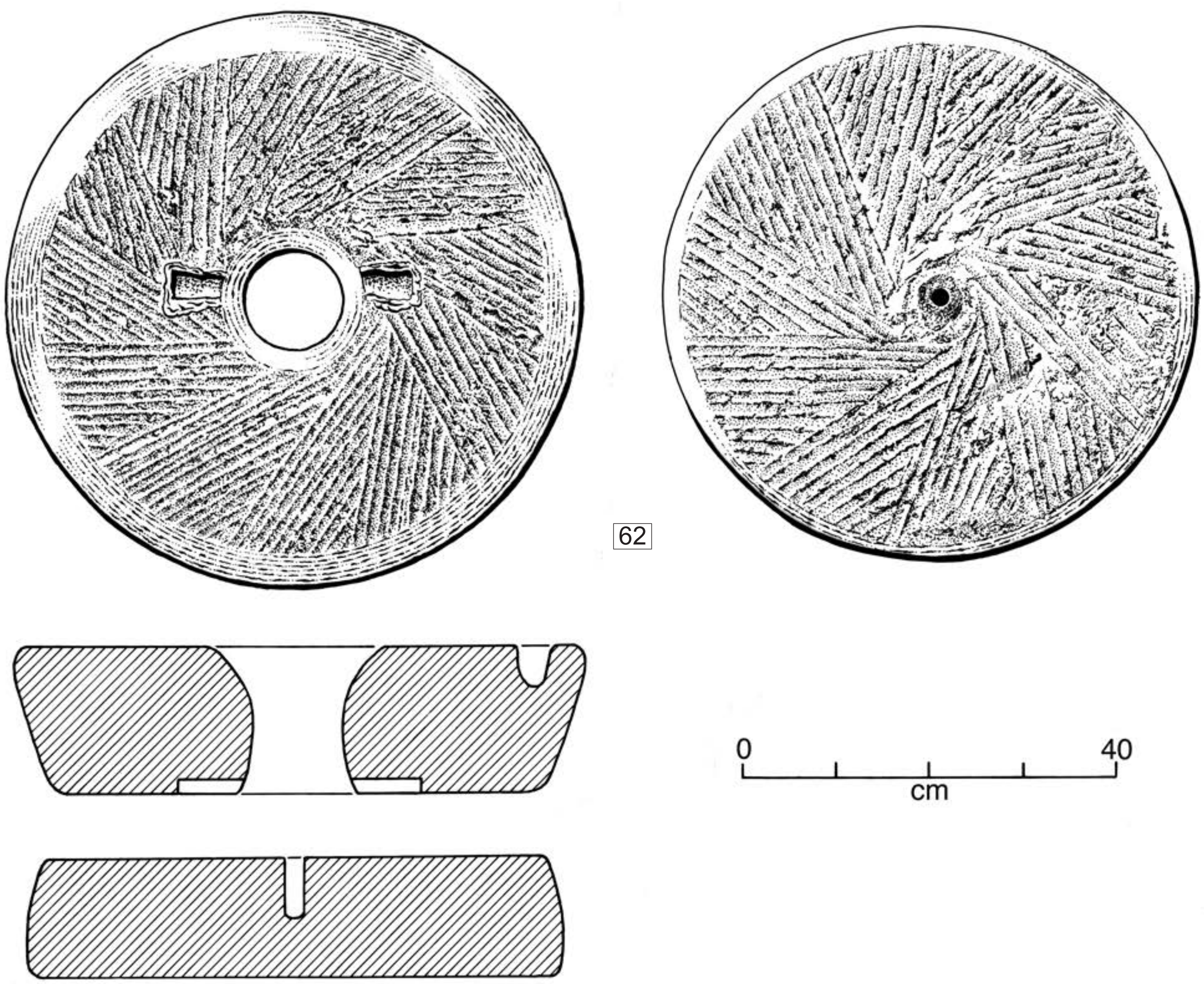


Illustration 185
The two halves of a quern or hand-mill 62, found in the collapsed galley area (DP 174846)

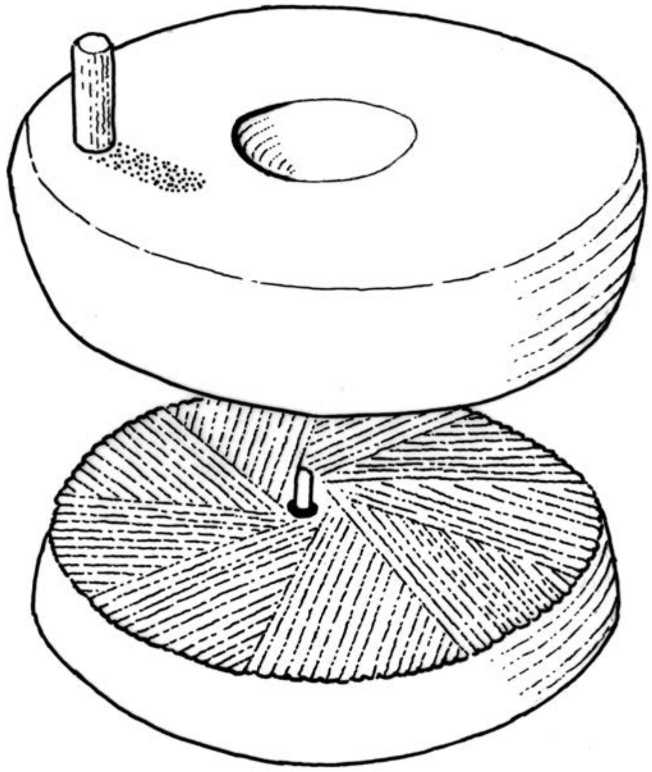


Illustration 186
Reconstruction of the quern or hand-mill (DP 174845)

This simple device has been known in Scotland since late prehistory (Illus 187), though the potential of detailed studies into its manufacture, distribution and use has only recently been recognised (McLaren & Hunter 2008). In more modern times its use has been prohibited in Scotland (or at least driven to clandestine operation) because tenants were 'thirled' to use the powered mill belonging to the landowner, but the use of hand-mills remained widespread in Orkney and particularly Shetland until the modern era (Fenton 1978: 388–410). They were also a regular piece of equipment for armies in the field, for the capacity of the land to feed invading forces was often a strategic consideration when planning the timing of a campaign. That Cobbett's invasion of Mull took place in early September, when the grain crop would have been ripe, is surely significant. But effective foraging required the right equipment. When Lord Inchiquin was on campaign with a Parliamentary army in south Tipperary during the late summer of 1647 he was unable to make use of the abundant grain 'through want of hand-mills' in spite of having 'often and earnestly written' for them (Carey 1842: 352). He spitefully burnt the unharvested fields instead.

The Duart Point hand-mill, presumably supplied by a more efficient Cromwellian commissariat, is of quite sophisticated design. The complex pattern of harps with their lands and furrows on the grinding faces, designed to work more efficiently and throw the flour outwards, is normally found on full-sized millstones rather than querns. Although the ironwork associated with the pivoting of the quern no longer survives the arrangement seems quite elaborate, and may have incorporated some kind of adjustment for regulating the fineness of the grind (Fenton 1978: 389–90). The feed-hole or hopper also displays an understanding of the principles involved, with its funnel-shaped entry for feeding the grain and the restricted central hole which would have pressed it towards the flared bottom, encouraging flow into the grinding cycle.

6.6 Animal bones

Catherine Smith, 9 December 2003

Methods and measurement

The mammal and bird bones were identified with direct reference to modern comparative material and allocated to particular bone and species where possible. Where the bones

Illustration 187
An 18th-century Highland quern in use: detail from an engraving by Moses Grifith (Pennant 1774 vol 1: pl xxxiv, author's collection)

could not be identified as far as species level, the terms ‘large ungulate’, ‘small ungulate’ and ‘indeterminate mammal’ are used: thus all large vertebrae other than the atlas and axis are described as large ungulate, while small vertebrae are described as small ungulate. Ribs are similarly allocated depending on their size. On the basis of probability, large ungulate bones are most likely to have come from cattle, but could also have come from horse or red deer. However, since neither of these two species was positively identified, it may safely be assumed that all large ungulate fragments come from cattle. Similarly, small ungulate bones are most likely to have come from sheep, for no species of comparable size (goat, pig or roe deer) was identified in the collection. All other mammalian fragments for which neither species nor bone could be ascertained are described as indeterminate mammal.

Measurements were made in accordance with the scheme of Driesch (1976). Additional measurements on the humerus follow Legge & Rowley-Conwy (1988: 124). Mandibular tooth wear and eruption patterns were assessed using Grant’s scheme (1982) for cattle and sheep/goats, as well as Payne’s scheme (1973) for sheep/goats.

Table 6.3
Numbers of bones by species

Species	*No of fragments*
Cattle	64
cf Cattle	2
Sheep/goat	21
Large ungulate	91
Small ungulate	13
Indeterminate mammal	14
Domestic fowl	6
cf Fowl	5
cf Goose	1
? Bird	1
Total	**218**

The animal bones

During the excavation of the wreck a number of animal bones and bone fragments was retrieved. The faunal assemblage was recovered during several seasons’ work and was scattered over the site, with the bulk located towards the stern. Close examination of the bones revealed that only a restricted number of animal and bird species was present (the fish remains form the subject of a separate report below). The assemblage is dominated by the bones of cattle (and large ungulate), while sheep/goats are the second most numerous species. Surprisingly, pig bones are absent. No wild-mammal species were present. A small number of bones from domestic poultry was also recovered, consisting mainly of domestic fowl (*Gallus gallus*). One bone was probably from a domestic/ greylag goose (*Anser anser*).

The numbers of fragments from each species are summarised in Table 6.3. A complete catalogue of the animal remains can be found in the archived report (Smith 2003: table 7 and appendix 1). Sixty-six bones from cattle represent a minimum of three different animals (based on the presence of three right innominates (pelves)), while 21 sheep/goat bones represent a minimum number of two sheep/goats (based on the presence of two right innominates). Of the bones recovered, the percentage of cattle/large ungulate bones was 82.2%, while the percentage of sheep/goat/small ungulate bones was 17.8%.

Chaplin (1971: 134) suggests the concept of ‘sheep equivalent’ as a unitary value for calculations of meat quantities involving species of different sizes, notably sheep and cattle. In his scheme, one dressed cattle carcass provides 12 times the quantity of meat of a sheep carcass. Thus the (minimum of) three cattle carcasses aboard the Duart Point ship roughly equate to 36 mutton carcasses. If each mutton carcass has a dressed weight of 25lb (Chaplin 1971: 134), then the bones represent 900lb/408kg of beef and 50lb/22.7kg of mutton. Translated into percentages, this random sample suggests that 94.7% of the meat in the diet was beef while only 5.3% was mutton.

This will in no way reflect the total quantity of meat originally supplied, since waste bones would probably have been discarded overboard once the meat was consumed, while much of the remaining supplies must have been devoured by marine scavengers after the ship was wrecked, along with some of the bones. Indeed several bone fragments showed long scrape-marks which are not man-made but may be the result of scavenging by crustaceans or other marine carnivores. Further factors include the survival characteristics of the bones and the proportion of the total assemblage that has been recovered. Many were probably lost or degraded during the site-formation processes before the wreck stabilised within the sea-bed environment. It should also be remembered that excavation was restricted to those parts of the site which had become exposed in recent times, leaving substantial, though unquantifiable, stable archaeological deposits undisturbed. Even within the excavated areas it is unlikely that all the bones deposited were recovered, so, as on other sites, there is probably a sample bias towards larger fragments. This would tend to favour the recovery of cattle bones rather than of smaller sheep bones.

Age of animals at death

Unfortunately, few mandibles with dentition survived. However one cattle mandible with a mandible wear-stage of 41 according to Grant's scheme (1982) came from a fully mature animal at least five years old. A sheep/goat mandible, on the other hand, came from a young lamb under two months old (Payne 1973).

The state of epiphysial fusion of all available cattle and sheep long bones was also assessed. Epiphyses are the articular ends of long bones, which do not become fully fused to the bone-shafts until the animal has reached maturity. The state of fusion of the articulations to the shafts can therefore be used as a guide to the ages at which animals died or were killed. Although no absolute ages can be stated, age-categories can be assigned. Epiphysial-fusion evidence is summarised in the full report (Smith 2003: table 2). Although the sample numbers are very small, there is evidence that more young sheep/goats than young cattle were present. Since the survival of young bones is usually far poorer than of mature bones, this would seem to be a true reflection of the age-pattern of the animals eaten on board ship.

Size of animals

Where possible anatomical measurements were made on the long bones of cattle and sheep/goats. A summary of measurements is presented in the archived report (Smith 2003: tables 3 and 4). As there are few (if any) comparanda for animals of 17th-century date in Scotland, the measurements were compared with the large body of data available for medieval Scottish animals. The most substantial medieval assemblage, dating from the 11th to the 14th centuries, was recorded at the Perth High Street excavation (Hodgson et al 2011). Bones of cattle and sheep/goat from the Duart Point wreck fall, with only one exception, within the ranges for these medieval animals, and in most cases the cattle were smaller than the averages recorded at Perth. One cattle metacarpal which falls outside the Perth range was slightly smaller than the medieval examples, with a greatest length of 151.5mm.

In some cases it was possible to estimate withers-heights of animals when alive from the lengths of intact metapodia. Two intact cattle metacarpals came from beasts with estimated withers-heights of *c* 0.93m and 1.11m, while a metatarsal was estimated to come from an animal of 1m at the withers. These figures compare with a range of 0.96–1.13m reported at Perth High Street. Thus some of the cattle aboard the Duart Point ship were smaller than those found in Scotland during the medieval period. The source of at least some of these beasts may have been north-west Scotland or the Western Isles, since animals from island populations tend to be smaller than their mainland counterparts. Edmund Burt, an Englishman associated with military activities in Scotland during the 1720s, wrote a series of letters which incorporate many observations on Highland life. He referred to the increasingly small size of the cattle and sheep the further north he went in the Highlands (1754 vol 1: 30). The sheep found on board were similarly small, and would not have been out of place in a medieval population. All of the sheep/goat bones from Duart Point fell within the Perth High Street ranges.

Evidence of butchery

Despite their prolonged immersion the condition of many of the bones was still good enough to reveal butchery-marks. These consisted of cuts made by knives, and chop-marks caused by axes or cleavers. Chop-marks were particularly common on the shafts of the ribs of large ungulate/cattle. The majority of the vertebrae were chopped in the median or sagittal plane, although some were butchered by removal of the lateral processes. Those which had been chopped neatly in half in the sagittal plane indicated that they came from carcasses which had been cut into two equal 'sides' of beef. A small number of small ungulate/sheep vertebrae were found; of these, half were chopped across the lateral processes and half were chopped neatly in two. Sterna and innominates (pelves) chopped in half also indicated the division of the carcass into sides, for example a cattle innominate bore several dorso-ventral hacks parallel to the pubic symphysis, in the middle of the pelvis.

The bones from this site are in contrast to the usual type of archaeological faunal assemblage from an excavation on land, where it would be expected that most of the bones are the evidence of meat which has been eaten. Since it is likely that the ship went down carrying provisions which had not yet been consumed, some of the bones should represent complete, articulated parts of carcasses. As Colin Martin argues below, much if not all the meat on the ship was probably purchased or requisitioned from the local area, which implies that it was either consumed fresh or processed for short-term storage. The size of the rib, vertebral, and innominate fragments, and the presence of intact metapodia, indicates that large pieces of beef were involved. Several articulating fragments, and the presence of paired cattle metacarpals, also indicate the presence of whole pieces of beef or mutton (for example, the paired sheep metacarpals).

Some of the bones do, however, bear knife-cuts around the articulations, indicating that the meat was stripped off, for example a sheep/goat humerus with about ten fine knife-cuts around the distal end. One large ungulate vertebra fragment was calcined by heat, either because it had been part of a cooked joint, or because the remains had been discarded in the cooking-fire.

Summaries of the types of cattle and sheep/goat bones (or anatomical elements) are shown in the archived report (Smith 2003: tables 5 and 6). Almost all parts of the cattle carcass are represented. Low meat-yielding elements such as the metapodia are as common as high meat-yielding bones such as the humerus and femur. Large ungulate/cattle rib and vertebral fragments are among the commonest elements found. The ribs would have been contained in the meat-joints known as flank and brisket: these are considered suitable for salting or boiling (Gerrard 1949: 241). Flank beef is a fatty cut which does not contain much muscle and is best used in soups, while brisket is more meaty. The rib portion (fore-rib) which articulates with the vertebral column is the part which makes the best roasting joint from the forequarter. Since a good proportion of the ribs in the assemblage included an articulation, it might be assumed that at least some of the beef on board was of reasonable, though not high, quality. Bones from the hindquarter, which is considered to be of better quality than the forequarter, were also present; for example, innominates include the cut known as the aitch- or heuk-bone, which is still sold by butchers in Scotland today.

Vertebrae, with the exception of neck and tail vertebrae, are generally to be found in good-quality meat joints such as the sirloin. Lumbar vertebrae were indeed present, while a number of caudal (tail) vertebrae were also found in the assemblage. The latter could only have been used in soups or stews – these are the bones used in ox-tail soup.

One cattle 2nd phalange (toe bone) displayed signs of pathology. The bone was entirely surrounded by extensive new bone growth, with the exception of the proximal articular surface. There was some evidence of eburnation (polishing) of the distal articulation. Since the first interphalangeal joint was affected, the condition may be described as 'high ring bone', defined as any bony exostosis affecting an interphalangeal joint (Baker & Brothwell 1980: 120). The animal from which the bone came may have been lame, possibly a factor in culling it.

Conclusions

with contributions from Colin Martin

The animal-bone assemblage from Duart Point is of great interest, since it represents supplies which went down, mostly uneaten, with the ship. Discarded bones from consumed meat were doubtless thrown overboard. The surviving bones show signs of butchery, in the form of chop-marks and knife-cuts, but the large size of many of the bone fragments and the presence of several intact long bones indicates that they were not heavily processed. Since all parts of the carcass were represented to some degree, a mixture of best and poorer-quality meat joints must have been available. Allocation of the meat probably depended on individual crew members' places in the ship's hierarchy.

Official rations in the English/British navy varied little between the 16th and 18th centuries, and were predicated on a weekly allocation of protein in which meat was issued on four days and cheese and/or fish on the remaining three. This was supplemented by a pound of bread or biscuit and a gallon of beer every day, oatmeal and butter on cheese/fish days, and four issues of dried peas over the course of the week (Oppenheim 1896: 140; Baugh 1965: 365). The meat was generally either salted beef or salted pork, and the ration varied between 1lb and 2lbs per day.

Several intact casks with beef bones inside were recovered from the wreck of *Mary Rose* (Coy 2005). The bones are from all the main body areas except the head, neck, tail, legs and upper haunches. However, although the long bones themselves were absent, the cask assemblages contained processes cut or torn from limb bones during butchery. Some had evidently been chopped off with a cleaver, suggesting that the meat had been stripped from the main bones before they were discarded. The report goes on to suggest that 'the casks, as well as containing many chopped-up blocks of trunk including pieces of backbone and ribs, must have been stocked with prime meat from the fore and hind quarters which had been efficiently, but swiftly, stripped from the limbs with a minimum of butchery cuts' (Coy 2005: 573).

That cattle/large ungulate limb bones were present in the Duart Point assemblage indicates that such a procedure was not followed here, which raises the possibility that fresh meat was obtained locally for immediate or short-term use. This is supported by the small size of the beasts, indicative of a West Highland origin. Burt (1754 vol 1: 124) notes that the local 'small Beef, when fresh, is very sweet and succulent'. We may also note the complaint of Martin Macpherson, minister of Duirinish in Skye, who following the Restoration in 1660 claimed compensation for losses he had incurred during Colonel Cobbett's assault on Skye in 1653, in which *Swan* may have participated, when the soldiers 'plundered the minister most barbarously and inhumanely of his goods, gear, sheep and nolt [cattle]' (Grant 1959: 300).

The relatively small number of sheep/goat bones in the Duart Point assemblage, and the total absence of pig remains, may also be significant. The west of Scotland was predominately a cattle-based economy, which by the 17th century had been stimulated by the droving trade to the Lowlands and the south (Haldane 1973). Sheep were present in the area at the time but relatively rare, while pigs were virtually unknown. Burt explains why pork was not reared there: 'I own I never saw any Swine among the Mountains, and there is good Reason for it: those People have no Offal wherewith to fed them: and were they to give them other Food, one single Sow would devour all the Provisions of a Family' (1754 vol 1: 123–4). On his Highland journey in the 1770s Dr Johnson also noted that pork and bacon were abhorred, and 'accordingly I never saw a hog in the Hebrides, except one at Dunvegan' (Johnson 1996: 53). The problem of rearing pigs in a region of limited arable potential is that they are not grazing animals but eat much the same grain crops as people do.

Since pork is particularly amenable to salted preservation its absence from the assemblage suggests that the ship's provisioning had not come from regular supply depots in the agriculturally productive south and east of Scotland, where Burt (1754 vol 1: 123) affirms that pork was plentiful, but from local resources in the West Highlands, no doubt by forcible requisition of the kind the Reverend Macpherson describes. Beef and mutton were probably obtained fresh, and therefore presumably locally, while the presence on board of equipment for the small-scale milling of grain suggests that this commodity too was 'barbarously and inhumanely' seized from the arable parts of the landscape (see 4.7 above). In terms of provisioning the Duart Point ship may well have been self-sufficient within the confines of her operational area.

This method of provisioning would only be possible in waters adjacent to a coast where crops and livestock were accessible and, in the case of grain, ripe in the fields or in storage. It would also require a political environment which permitted the seizure of such resources, and the availability of sufficient force to do so with impunity. For these reasons the methods by which the Duart Point ship seems to have supplied herself are unlikely to be characteristic of the Commonwealth navy as a whole. Nevertheless such a strategy, in the context of Colonel Cobbett's expedition, would have been convenient, economic, and, from an aggressor's point of view, an effective means of punishing the recalcitrant locals. Certainly, as Professor Black's analysis has shown, the only known victim of the shipwreck appears to have been fit and well-fed (see Chapter 10).

6.7 Fish bones

Rachel L Parks and James H Barrett, 2004

The excavation produced a small assemblage of 789 fish bones, derived during the field seasons in 2000, 2002 and 2003. In 2000, a very small quantity of fish bone (46 fragments, of which only a few ling bones were identifiable) was hand-collected from the ship's bilge and pump-well. These were recovered along with more abundant mammal bone (Colin Martin pers comm), but given the tiny sample and the biases inherent in hand-recovery (Jones 1982; Vale & Gargett 2002) little can be said about them. In contrast, a slightly larger deposit of concentrated fish bone (743 specimens) was identified by the base of the ship's stern in 2002. Some of this material was hand-collected that year, but in 2003 a bulk sample of 5 litres of this sediment was removed and sieved on land using a 1.5mm mesh (Colin Martin pers comm). Fragments of barrels were also found in the vicinity, but the location of the fish-bone deposit is inappropriate for storage, and human bone (probably all belonging to one individual) was also scattered across the area. The base of the stern probably acted as a trap for water-borne flotsam within the wreck until the material was immobilised by sediment. It should be pointed out, however, that the fish could have been stored well aft. The material must therefore be interpreted in terms of both human and natural accumulation processes.

Although the number of bones from the stern deposit is modest, it does show a very narrow species diversity and an unusual element distribution, both of which can be interpreted in terms of cured (probably dried and salted) fish. The assemblage thus adds to the story of early modern maritime provisioning emerging from other broadly contemporary sites (eg Brinkhuizen 1994; Hamilton-Dyer 1995).

Methods

The assemblage was recorded following the York protocol (Harland et al 2003), which entails the detailed recording of *c* 20 diagnostic elements. These bones are identified to the finest possible taxonomic group and recorded in detail – typically including, as appropriate, element, side, count, measurements, weight, modifications (including burning and butchery), fragmentation, texture, and estimates of fish size. Although identified as diagnostic elements, fish vertebrae are recorded in slightly less detail (measurements are not taken and texture is not scored, for example). 'Non-diagnostic' elements (quantification category 0) are typically not identified beyond class. Given the tiny quantity from the Duart Point wreck, however, all identifiable cranial elements were quantified in this case. Fin-rays and pterygiophores make up the bulk of the remaining 'unidentified' specimens, but virtually all of these are probably from ling. The small number of measurements follow Harland et al (2003) and references therein.

The assemblage has been quantified by number of identified specimens (NISP), including all bones or only the diagnostic elements as indicated. The archive will be deposited with the main site archive, the Dr Colin and Dr Paula Martin Collection, HES, as a Microsoft Access database file, and a series of text files that duplicate its content.

Preservation

The bones from the Duart Point wreck were not highly fragmented. Most were over 60% complete and many over 80% complete. This observation may imply little post-depositional disturbance after an initial episode of fluvial transport. However, the preservation of the bone tissue itself was rather poor, with many specimens exhibiting extensive flaky or powdery areas. None of the material showed evidence of burning, but three vertebrae were crushed. One of these also exhibited a tooth-impression, suggesting that the bones had been chewed. The tooth-mark is not characteristic of carnivore gnawing (cf Lyman 1994), and may well be human.

Table 6.4
Taxonomic and element distributions by NISP (all specimens). Elements are listed in order of abundance

Element	*2000*	*2002*	*2003*	***Total***
Salmonidae				
Caudal vertebra		1		1
Gadidae				
Cleithrum			1	**1**
Epihyal			1	**1**
Gadus morhua				
Caudal vertebra Group 2			2	**2**
Caudal vertebra Group 1			1	**1**
Molva molva				
Caudal vertebra Group 1		1	21	**22**
Cleithrum	1	6	13	**20**
Caudal vertebra Group 2			13	**13**
Dentary		5	8	**13**
Supracleithrum		4	3	**7**
Caudal verteba		1	5	**6**
Ceratohyal	1	1	4	**6**
Ectopterygoid		3	2	**5**
Epihyal	1	1	3	**5**
Articular			4	**4**
Vomer		3		3
Abdominal vertebra Group 3			2	**2**
Frontal		2		2
Interopercular		1	1	**2**
Opercular		1	1	**2**
Preopercular		1	1	**2**
Quadrate			2	**2**
Scapula			2	**2**
Basipterygium			1	**1**
Hyomandibular			1	**1**
Maxilla			1	**1**
Parietal		1		1
Premaxilla			1	**1**
Subopercular			1	**1**
Ultimate vertebra			1	**1**
Unidentified (most or all *Molva molva*)				
Fin rays, Pterygiophores, etc	43	17	598	658
Total	**46**	**49**	**694**	**789**

Results and discussion

A total of 789 fish bones weighing *c* 410g was examined (Table 6.4). Of these, 131 were identified cranial, appendicular, or vertebral elements. The remainder were tiny fragments of bone, fin-rays and pterygiophores – most or all of which were from the species (particularly ling) represented by the identified elements.

The assemblage includes a very narrow species diversity. It is almost entirely composed of ling. The only exceptions are one salmonid (probably salmon) vertebra, three cod vertebrae, and two bones that could only be identified as cod family (probably cod or ling). The salmon aside, the bones are all from large fish, even if the hand-collected material is excluded to avoid recovery bias. The cod bones are from fish of 0.5 to 0.8m total length and all the ling bones are from fish of more than 1m total length. The largest ling specimens may have been from individuals greater than 1.5m total length (Table 6.5). Ling are known to inhabit wreck-sites (Wheeler 1978), but the narrow species diversity and size-range represented makes it unlikely that this is a natural-death assemblage – an observation which is corroborated by the presence of cut-marks on at least two of the specimens (Table 6.6). The skeletal-element distribution is also inconsistent with whole fish (Table 6.4).

The three cod bones are caudal vertebrae, but little can be inferred from so few specimens. The number of ling bones is also small, but a distinctive element distribution is nevertheless clear. Firstly, the most abundant elements are caudal (tail) vertebrae of different kinds and cleithra. These are the bones typically left in dried (or salted) cod and ling during storage and transport (Barrett 1997). Two cut-marks on supracleithra, which imply the decapitation of ling anterior to the cleithrum, are also consistent with this distinctive butchery pattern. The assemblage may thus have been partly composed of preserved ling. Stockfish, dried by wind alone, tend to be made from fish of less than 1m total length (Perdikaris 1999), so the Duart Point ship's provisions were either salted or, most likely, salted and dried as a *klippfisk* type of product (split, salted, and dried flat).

Secondly, however, ling dentaries (from the lower jaw) were also abundant, and other cranial elements were present in trace numbers. These bones were from fish of approximately the same size as the cleithra (Table 6.5). Superficially the dentaries look to be from slightly larger fish, but the difference is not statistically significant at this sample size ($T = 2.15$, $P = 0.060$, $DF = 9$). They indicate either that a mixture of whole and cured ling was present on the ship, or that ling heads were also dried and/or salted as provisions. The drying of fish-heads is known among Scandinavian stockfish producers, so the latter interpretation is not unreasonable, but they were typically used for animal fodder (Vollan 1974). It is not surprising that these fish-heads are best represented by dentaries, as they are one of the heaviest and most robust elements in a ling cranium. They would be least susceptible to onward fluvial transport once trapped in the stern, and thus imply an assemblage which has in effect been winnowed (cf Butler 1993).

The Duart Point assemblage can be interpreted in the context of material from other broadly contemporary wrecks. For example, the warship *Mary Rose* (Hamilton-Dyer 1995),

Table 6.5
Measurements and estimated total length (after Jones 1982; Harland et al 2003) for ling cleithra and dentaries from the sieved deposit

Sample	*Element*	*Measurement (mm)*	*Estimated length (mm)*
33.16	Cleithrum	20.96	1182
34.15	Cleithrum	18.16	1080
34.16	Cleithrum	21.32	1194
34.16	Cleithrum	19.46	1128
34.16	Cleithrum	17.12	1040
Mean	Cleithrum	19.4	1125
34.15	Dentary	15.06	1551
34.15	Dentary	10.6	1175
34.16	Dentary	11.7	1270
34.16	Dentary	11.15	1223
34.16	Dentary	11.13	1221
34.16	Dentary	8.81	1015
34.16	Dentary	11.3	1236
34.16	Dentary	15.78	1609
Mean	Dentary	11.94	1287

Table 6.6
Butchery marks and other modifications (all specimens)

Modification	*Element*	*2000*	*2002*	*2003*
Molva molva				
Crushed	Caudal vertebra Group 1			2
Knife cut	Supracleithrum		1	
Knife cut	Supracleithrum		1	
Crushed and possibly cut	Caudal vertebra Group 1			1

and the merchant vessel *Scheurrak SO1*, lost off Holland some time after 1589 (Brinkhuizen 1994). The fish-bone assemblages from both sites are considerably larger than that from Duart Point, and have provided conclusive evidence that the ships were carrying stockfish or a similar product.

The fish-bone assemblage from *Mary Rose* was recovered from a sealed deposit in the first deck and hold area of the stern (Hamilton-Dyer 1995: 577–84). Over 30,000 bones were recovered, the majority of which were cod. The element distribution and butchery evidence was typical of stockfish. In addition to cod, smaller quantities of haddock, pollack and hake were represented by caudal vertebrae only. Hamilton-Dyer suggests that the tails of these species were included to inflate the number of fish. Brinkhuizen's (1994) analysis of the bone from *Scheurrak SO1* also revealed variation in the species and parts of fish included as stockfish. The assemblage was recovered from barrels in the first deck. One contained almost exclusively appendicular elements (such as the cleithrum) and vertebrae of cod. The other contained similarly processed fish, but with a wider range of species, sizes and elements present.

Cured gadid fish clearly played a role in the provisioning of 16th/17th-century shipping. In this the Duart Point ship is not unique. The use of ling, however, may be significant given the ship's apparently Scottish sphere of activity. This species has a northerly distribution (Wheeler 1978) and formed one mainstay of Shetland's salt-fish trade in the early modern period (Goodlad 1971; Smith 1984). To qualify this possible connection, however, it should be pointed out that Shetland's catches were widely exported and ling were also caught elsewhere (Nicholson 1989). Significant fisheries were also operating in the Outer Hebrides in the 18th century (McKay 1980: 81–2). The Duart Point ship need not necessarily have acquired her supplies locally, though it is entirely possible that she did.

6.8 Rigging equipment

Though wind-energy captured by the sails and transmitted through the yards and masts to the structure of the hull provided a ship with its primary propulsive power, human muscle drove the ancillary systems which made it a functioning and controllable entity. These included raising, lowering and adjusting the sails; the management of anchors; steering; pumping; rowing; working the guns; and handling cargo or equipment. In harnessing manpower for these purposes various devices were applied to increase mechanical advantage and reduce friction. Much of this involved rigging, which is categorised as two types – standing rigging which can be tensioned to brace and support the masts, and running rigging which facilitates the raising, lowering and adjusting of the sailing rig, and other activities involving lifting and movement.

Standing rigging

Deadeyes were rigged in pairs as tensioners for ropes, typically used for connecting the shrouds with the chain-plates. They are tear-shaped and pierced with three holes – one towards the narrower end, and two at the broader rounded one. A U-shaped groove is cut around the edge to which the ropes or chains were seized. The lower deadeye was set with its two holes uppermost; the top one with them facing downwards. Both deadeyes were linked by a lanyard secured in one of the lower top holes which passed back and forth through alternate holes until it emerged from the opposite lower one, at which point it could be heaved tight with a mechanical advantage of 5:1. The term 'deadeye' does not derive from the object's superficial resemblance to a skull, but from the fact that it is a block without sheaves, and consequently its holes or eyes are 'dead'.

63 DP99/037, **071.102**, small deadeye 97mm × 70mm × 21mm (3¾in × 2¾in × ¾ in). Holes 11mm (⅜in) diameter (Illus 188).

64 DP00/104, **128.083**, deadeye with part of the bottom missing, 150mm (estimated) × 122mm × 38mm (6in × 4¾in × 1½in). Holes 25mm (1in) diameter. Fragment of three-strand rope in one of the lower holes (Illus 188).

65 DP00/018c, **087.109**, deadeye attached to the oar-port lid within concretion (Illus 81), so has not been drawn.

A euphroe was a narrow block with a single line of dead holes along its axis, used to anchor a fan-shaped setting of lines extending from a single point, such as a crow-foot to support sails or awnings.

66 DP99/019, **067.102**, broken euphroe 128mm × 39mm × 25mm (5in × 1½in × 1in) with four 13mm (½in) holes surviving (Illus 189).

Running rigging

Blocks are contrivances for leading ropes in various directions, singly or combined with other blocks. In combination they can increase mechanical advantage. They are used to increase the power obtained by pulling on a rope rove through them. A simple block consists of an outer shell, usually grooved at top and bottom so that a rope strop can be seized around it. A rectangular slot cut through the shell is called the swallow. This accommodates a lathe-turned pulley-wheel or sheave with a rope-groove around its circumference, which rotates around a pin or axle. The size of a block is defined by its longer axis. Sheaves are measured across the outer face and lengths and diameters are given for pins.

67 DP03/050, **101.075**, elm (*Ulmus* sp) half-shell of a 95mm (3¾in) block with a 40mm × 14mm (1½in × ½in) pin in place (Illus 190).

68 DP92/DG10, findspot unknown, elm half-shell of a 150mm (6in) block with pin and sheave in place. Piece of concretion attached and fragment of 18mm (¾in) rope lodged in throat. Sheave 10mm (4¼in) diameter, 19mm (¾in) thick; oak pin 67mm × 20mm (2½in × ¾in) (Illus 190).

69 DP00/008, **113.104**, elm shell missing part of its top, from an (estimated) 150mm (6in) block with pin and sheave in place. Sheave 100mm (4in) diameter, 22mm (⅞in) thick, oak pin 68mm × 14mm (2¾in × ½in) (Illus 190).

70 DP00/080, **113.087**, oak pin 65mm × 18mm (2½in × ¾in), from a block of comparable size to 68 and 69. Heavy asymmetric wear on running surface (Illus 191).

71 DP00/062, **072.098**, oak pin 95mm × 29mm (3¾in × 1⅛in). Evidently from a large block. Heavy asymmetric wear on running surface (Illus 191).

72 DP03/075, **117.098**, sheave, 132mm diameter, 27mm thickness, hole diameter 26mm, eroded surfaces (Illus 191).

73 DP00/141, **111.082**, sheave 138mm × 25mm (5½in × 1in) with 28mm (1⅛in) diameter hole. There is a pronounced dish (4mm) towards the centre on one face, and pronounced turning-marks (Illus 191).

74 DP97/A011, **074.104**, sheave, 108mm diameter, 24mm thick, hole diameter 21mm (Illus 191).

75 DP00/043, **101.100**, sheave, restored diameter 198mm, thickness 38mm, hole diameter *c* 40mm, badly eroded (Illus 191).

76 DP03/004, loose on surface in Excavation Area 4, sheave, no outer edge surviving, diameter >85mm, thickness 23mm, hole diameter 23mm, badly eroded (Illus 191).

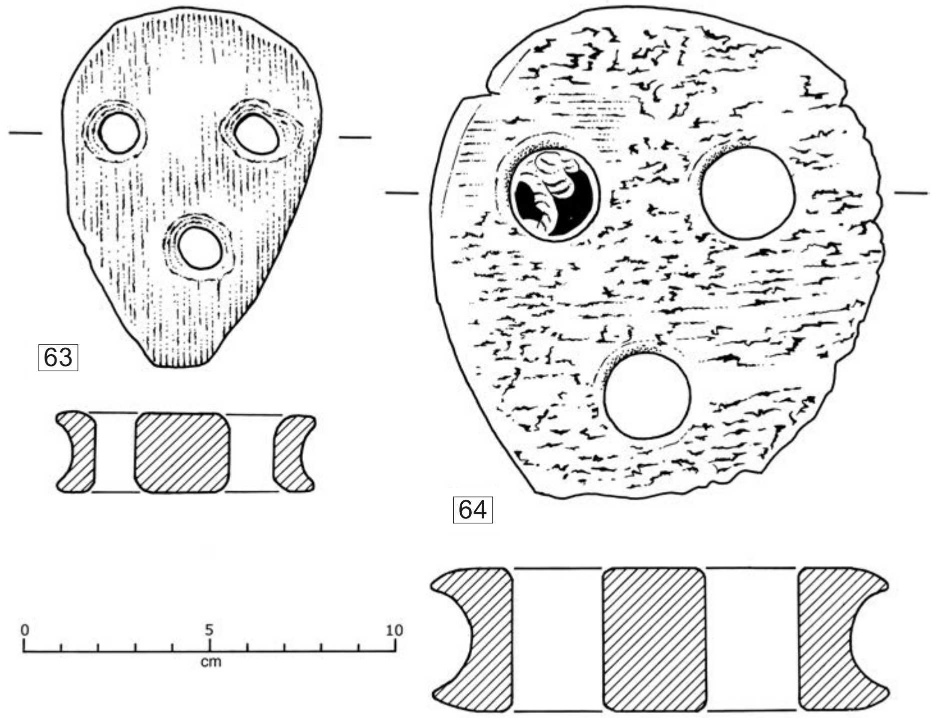


Illustration 188
Deadeyes 63 and 64

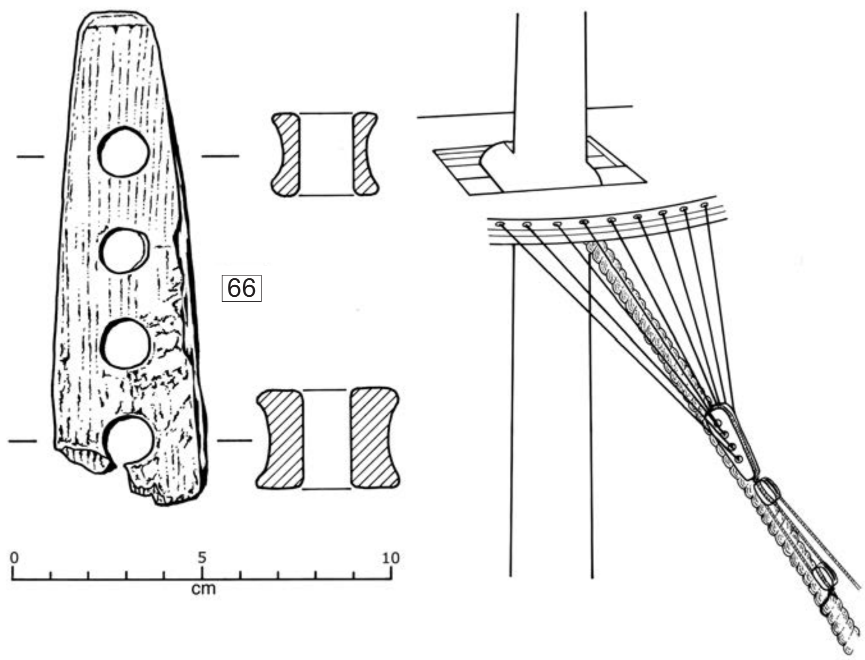


Illustration 189
Euphroe 66, and diagram of its function

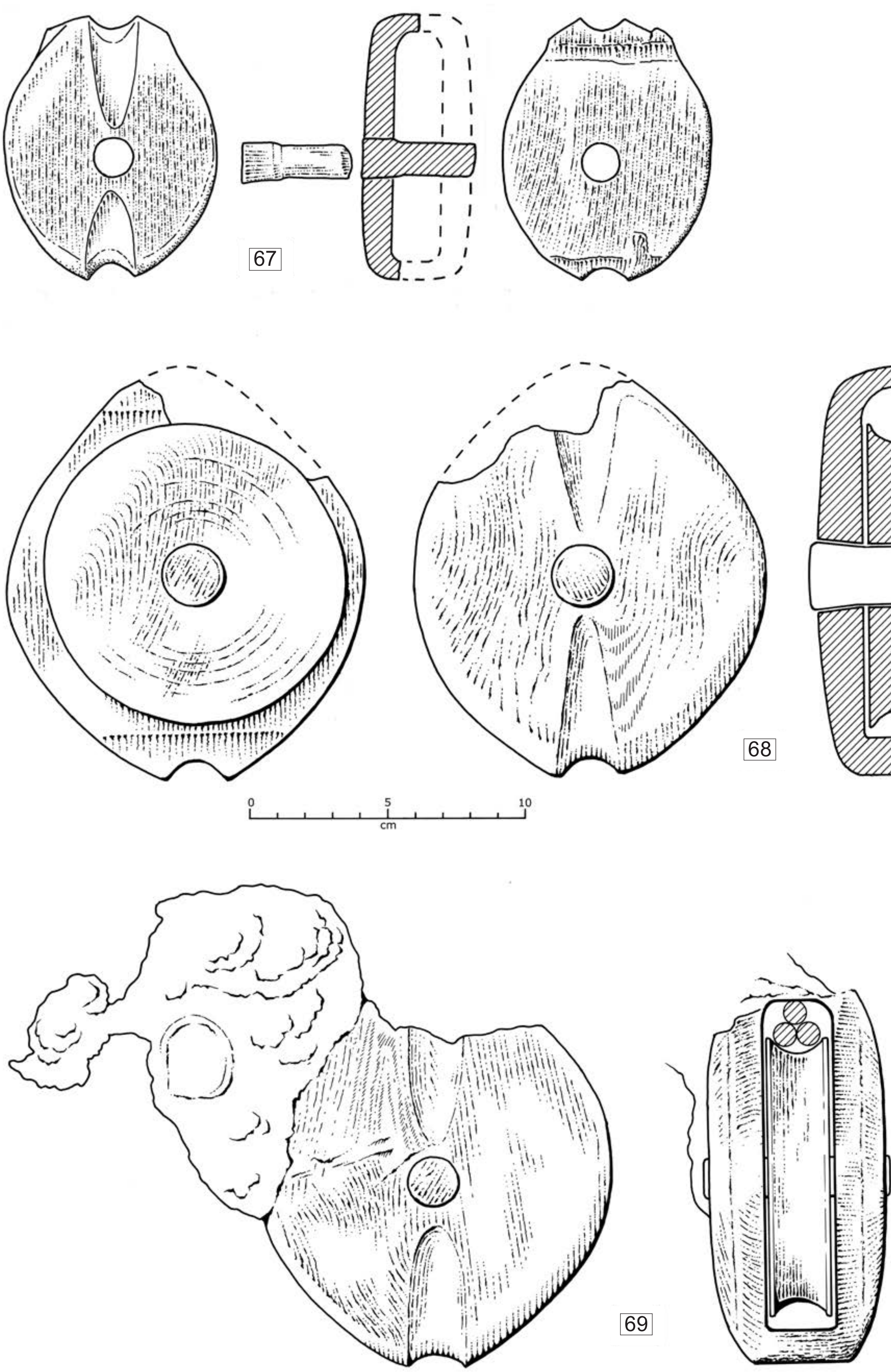


Illustration 190
Wooden blocks 67–9

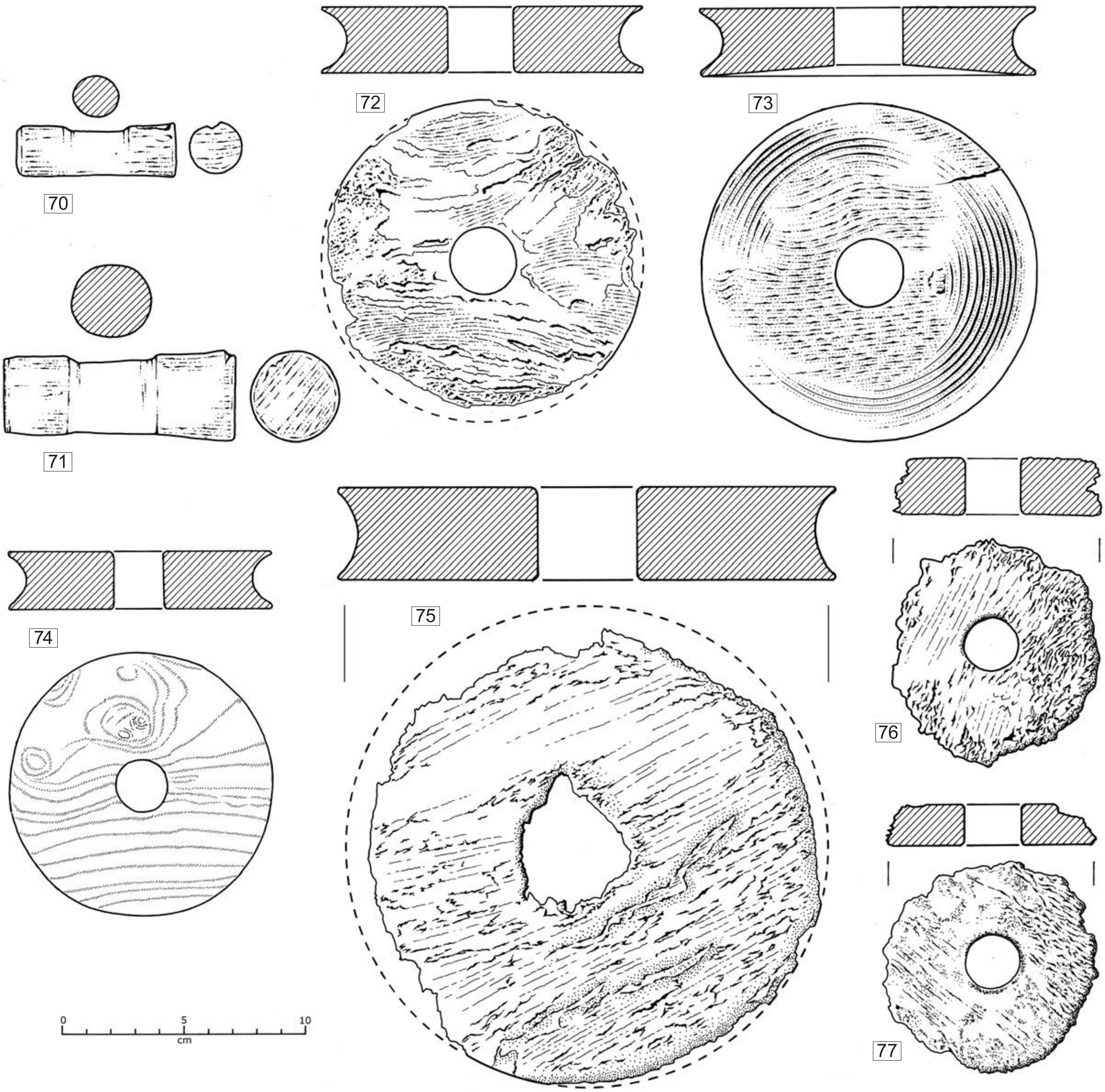


Illustration 191
Wooden sheaves and pins 70–7

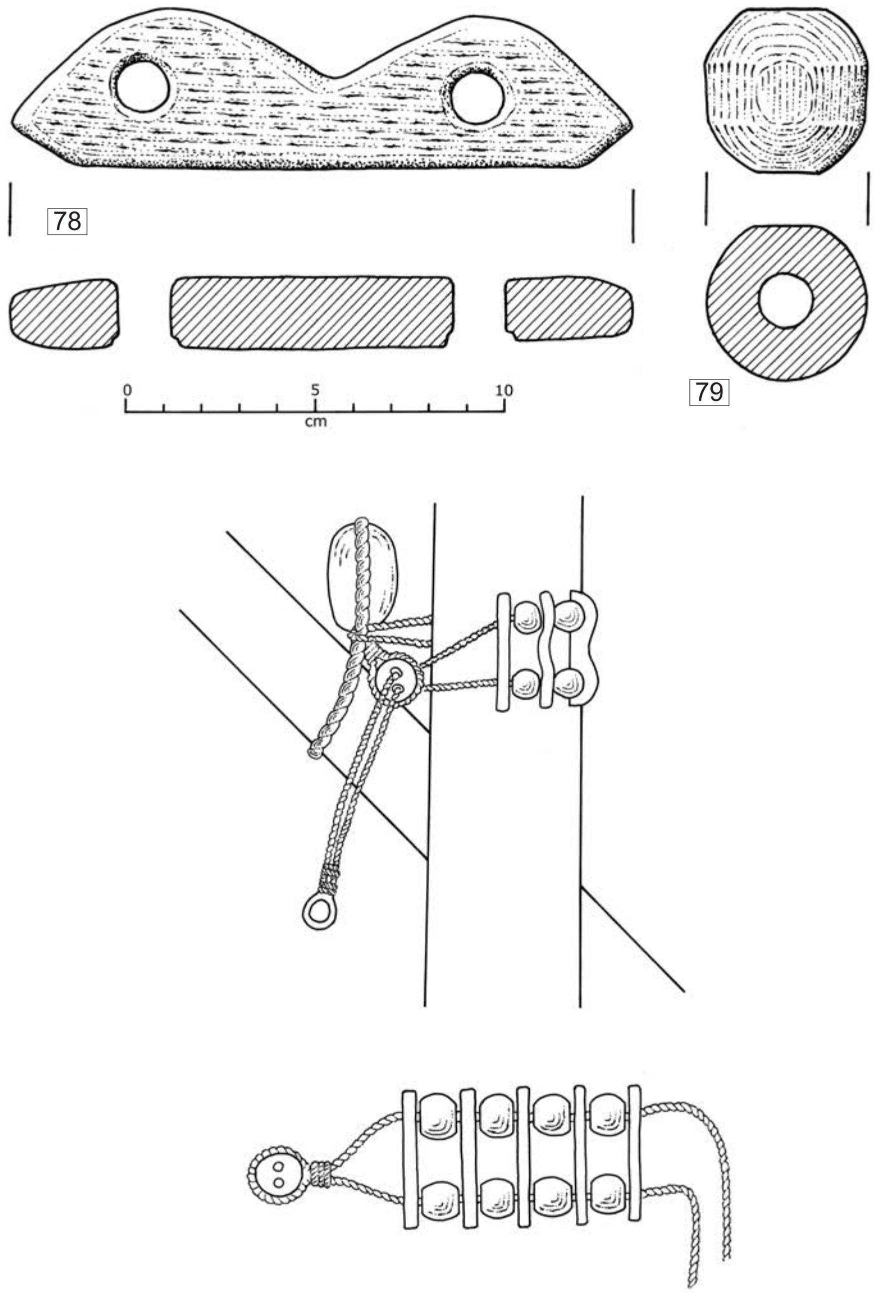


Illustration 192
Parrel-truck 79 and spacer 78, and diagram showing a parrel assembly

77 DP03/016, **113.086**, sheave, no outer edge surviving, diameter >90mm, thickness 17mm, hole diameter 23mm (Illus 191).

Wear on the two pins 70 and 71 is such as seriously to have affected the efficiency of the sheaves which rotated on them, causing them to rattle or even jam. They may of course have been from unserviceable blocks, or ones awaiting repair, but their presence may also reflect general standards of serviceability and maintenance aboard the ship.

Parrel trucks and ribs

Friction-reducing collars of rotating trucks threaded on a light rope secured the yards to the masts. The trucks were separated by spacers or 'ribs', straight on the edge which was in contact with the mast, and shaped to the roundness of the trucks on the other. Each rib had holes for the ropes, positioned so the trucks projected just beyond the flat edge. This projection brought the trucks into contact with the mast and allowed the collar to move up and down without undue friction. One example of each element from a two-row assembly was found. There could be two or more rows in a parrel assembly. A complete example from *Mary Rose* has five horizontal rows comprising in all 30 trucks and seven ribs (Endsor 2009: 258–60).

78 DP00/140, **111.082**, parrel rib 164mm × 42mm × 19mm (6½in × 1⅝in × ¾in) (Illus 192).

79 DP00/181, **109.088**, parrel truck 43mm in diameter, 43mm wide, central 14mm hole (1⅝in × 1⅝in × ½in) (Illus 192).

Wear on one side of the parrel truck 79 is extensive. An assembly of trucks thus affected would have slid rather than rolled against the surface of the mast, negating the purpose for which it was designed. Though the same cautions apply as for the remarks concerning the asymmetric block-pins, this may be another hint that the Duart Point ship was not in a fully serviceable condition. Much greater wear is apparent on a parrel truck recovered from the Newport ship (Erica McCarthy, Newport Museum and Heritage Service pers comm). The parrel assembly from the *Mary Rose* also showed evidence of wear: the ropes were frayed and there were indications of scorching on the flat edges of the ribs. It was found on the orlop deck and it has been suggested that it may have been in store awaiting repair (Endsor 2009: 258).

Cordage

Although modern commercial practice is to measure rope by its metric diameter, in the Royal Navy cordage is still described by its circumference in inches (*Admiralty Manual of Seamanship* vol 1 1972: 104). It is so described here.

Small fragments and individual fibres of hemp cordage were frequently observed in the archaeological deposits, particularly among detritus between the frames (see above, 6.4), but finds of structured rope were few. Short pieces of 25mm (1in) Z-laid hawser were preserved in a deadeye 64 and in a block 69, while a substantial cache of coherent cordage was recovered from the port bilge just aft of midships. These finds were delivered to the National Museum before the publication of Sanders's paper on methodologies for the study of cordage from shipwrecks (2010), and are currently in conservation, so the following descriptions should be regarded as provisional.

80 DP97/A015, **079.092**, the longest example, three-strand Z-laid hawser of 38mm diameter (1½in) 1.6m long, disposed in one-and-a-half coiled loops (Illus 193). At one point a single lie of spun-yarn worming is evident, though this has been lost from all other spaces between the hawser strands which have lost their servings. Along most of its length it is served with a continuous binding of 2.5mm spun yarn which increases the diameter to 43mm (1¾in). Pieces of its leather parcelling are shown on the left. This is part of a group of cordage found in Excavation Area 5, in a deposit largely filled with organic material. It consists of three main elements of probably conjoining hemp cordage and two associated leather items, and appears to derive from a single length of hemp hawser which has been wormed, served, and parcelled with leather. Such protective treatment, which rendered the rope at least partly waterproof, was generally reserved for standing rigging (Stopford 1953: 40–1. Procedures for dressing rope in this way are described in the *Admiralty Manual of Seamanship* vol 1 1972: 188–90).

Illustration 193
Rope 80, wormed, served and parcelled (DP 173271); top left: detail of rope showing the partial unwrapping of its outer worming and serving. Scale 10 centimetres (DP 174087)

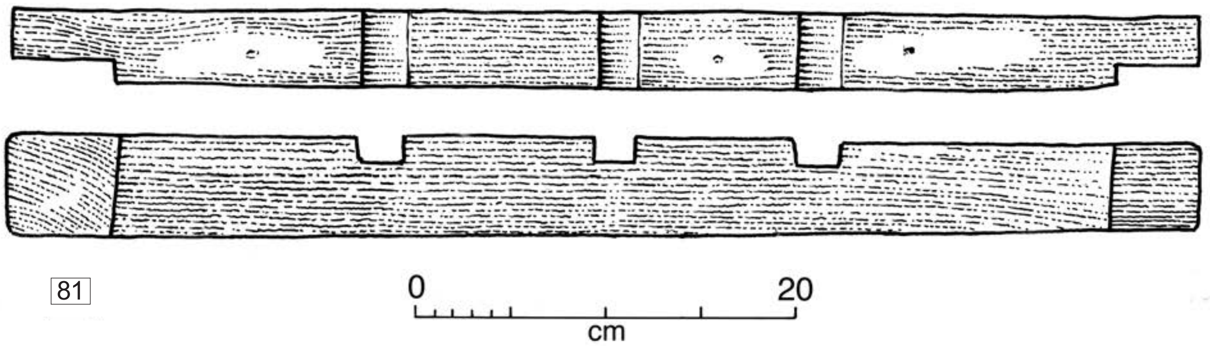


Illustration 194
Wooden grating-bar 81

Grating

81 DP00/200, **085.097**, rectangular-sectioned wooden bar 630mm × 50mm × 40mm (Illus 194). The ends of the wider face are lapped for halving joints while three housings for cross-halving joints are cut across the central part of the narrower face. There is no evidence of fastenings to indicate that any of the joints had previously been assembled, and the item may have been a spare.

It can be identified as part of a small grating or scuttle, the purpose of which is described by Smith (1627: 7):

> A scuttle-hatch is a little hatch doth cover a little square hole we call the scuttle, where but one man alone can go down into the ship, there are divers of the ship whereby men pass from deck to deck, and there is also small scuttles grated, to give light to them betwixt decks, and for the smoke of the ordnances to pass away by.

Mainwaring adds further detail, ‘there are small scuttles with gratings. They have all covers fitted for them lest men in the night should fall into them’ (Manwaring & Perrin 1922: 218).

Chapter 7

SHIP'S ARMAMENT

7.1 The guns

Eight cast-iron guns have been identified on the wreck-site (Illus 195–6). With the exception of Gun 8 they have been left in situ in their concreted state, though some have undergone minor intrusive investigation to determine their corrosion potential and other physical characteristics (MacLeod 1995) (Illus 197–8). Because of variable thicknesses of concretion the only reasonably reliable measurements which can be recorded are the overall length, and length from base-ring to muzzle. In obtaining these measurements allowance has been made for concretion thickness, while the estimated bores are based on the general proportions of the pieces. The data for the unrecovered pieces should therefore be regarded as approximate (Table 7.1). Only Gun 8 has been accurately measured following recovery, the removal of concretion, and conservation. No data are given for the partly buried Gun 5, or for Gun 7 because of its fragmentary state. Neither of these guns has yielded meaningful measurements.

Guns 1, 3, 4 and 6 appear to form a broadly homogenous group, and their estimated bores of 89mm (3½in) are appropriate to the three cast-iron roundshot recovered from the wreck (2 × 84mm and 1 × 85.5mm diameter). It should also be noted that the cartridge-box [84] and powder-scoop [85] (see section 7.5 below) would comfortably hold a filled cartridge of this diameter. These observations combine to suggest that

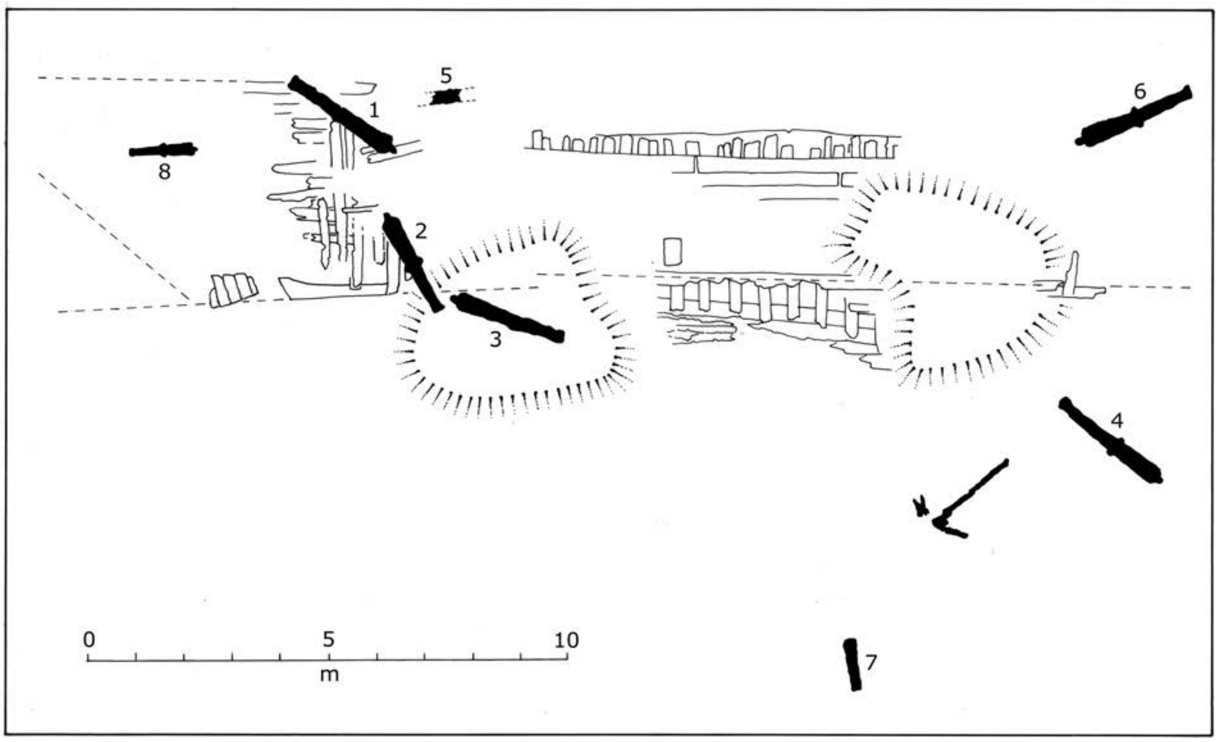


Illustration 195
Locations and identifying numbers of the guns (DP 174815)

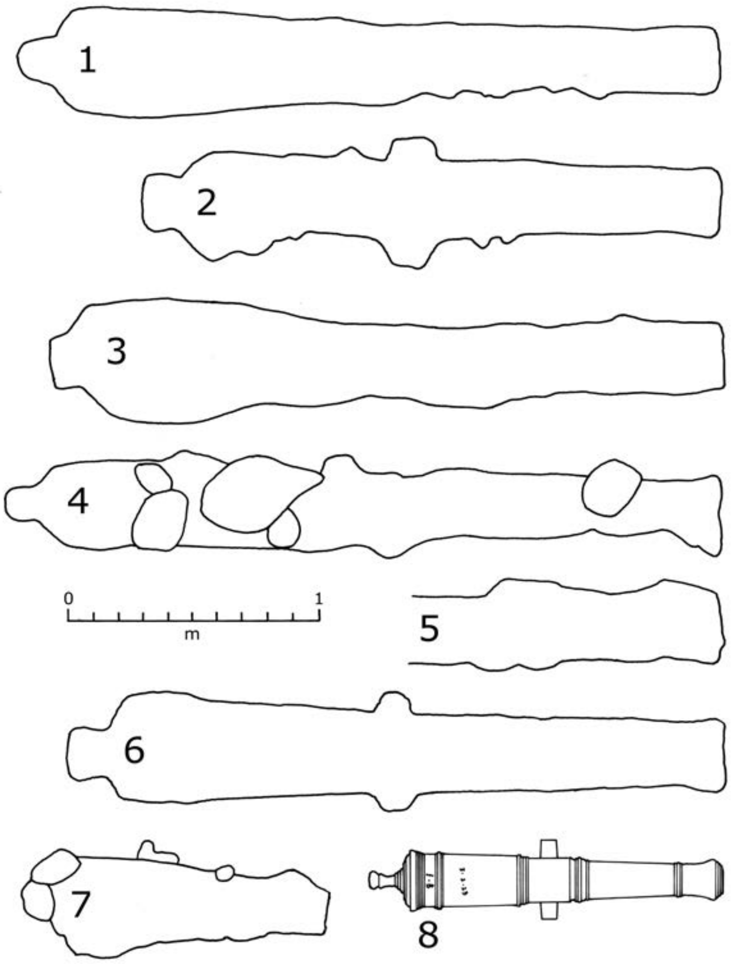


Illustration 196
Profiles of the cast-iron guns. Guns 1–7 are outlines of the still-concreted pieces which have been left in situ; Gun 8 82 has been de-concreted and conserved (DP 174818)

Illustration 198
Attaching a sacrificial anode to Gun 2 to assist in stabilising corrosion (DP 174699)

the pieces are 5-pounder sakers (Norton 1628: 53; Ward 1639: 109; Eldred 1646: 15). Norton specifies the length and weight of such a piece as 9ft (2.74m) and 1400lbs (635kg), while Ward and Eldred give figures of 9½ft/1900lbs and 9½ft/2500lbs respectively. The Duart group as a whole appears to consist of guns a little shorter and consequently lighter than these figures indicate.

Gun 2 is significantly shorter and slimmer than the main group, and is best identified as a minion, for which Norton,

Illustration 197
Using an air-drill to test the thickness of concretion and to take pH and e_{corr} readings from the surviving metal (DP 174016)

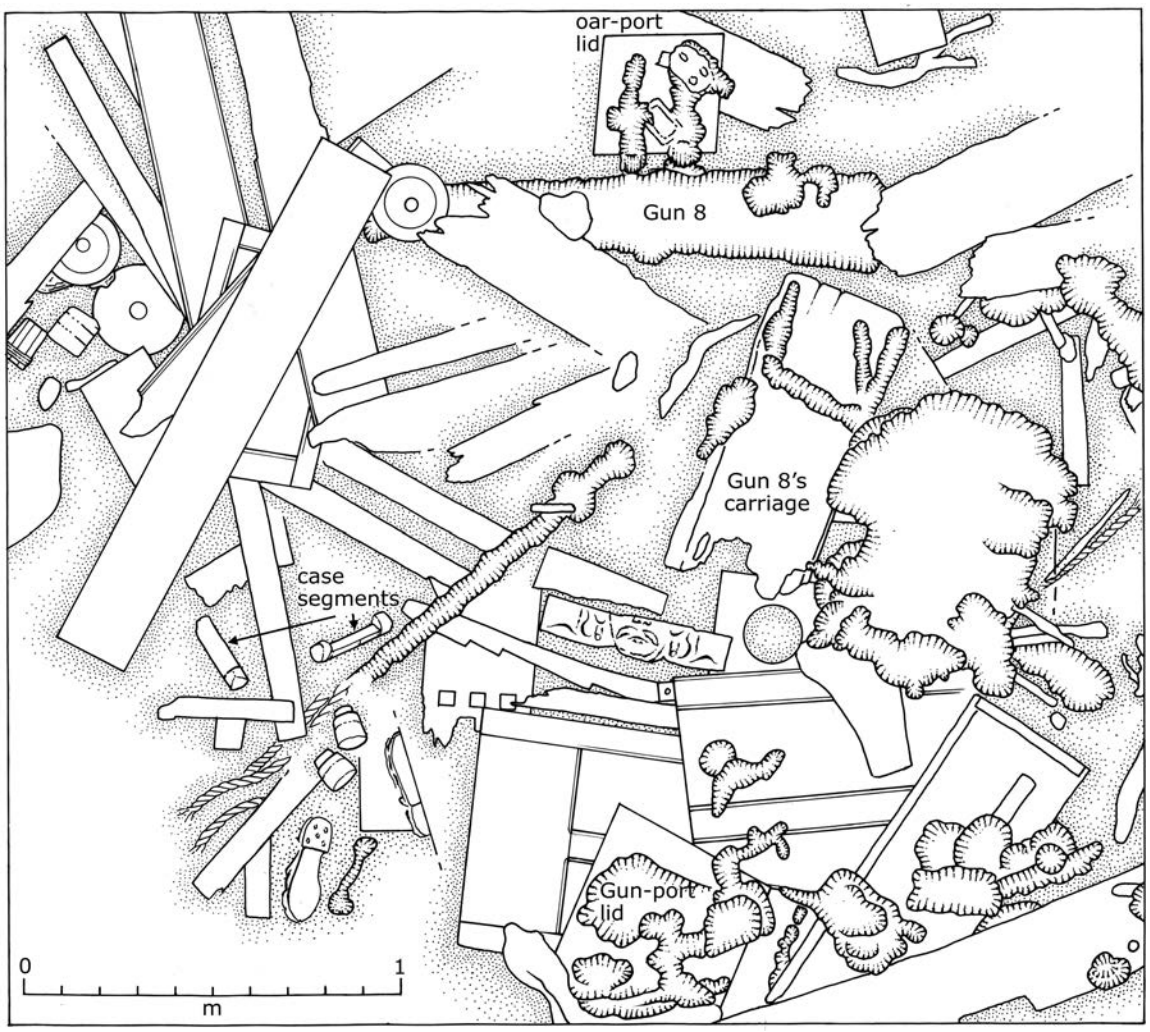


Illustration 199
The deposit associated with Gun 8, with key features labelled

Table 7.1
Specifications of the measured guns

Gun no	*L muzzle to base-ring (m)*	*L muzzle to base-ring (imperial)*	*L overall (m)*	*L overall (imperial)*	*Estimated bore (m)*	*Estimated bore (imperial)*	*Bore:length ratio*
1	2.45	8ft	2.65	8ft 8in	0.089	3½in	1:27.5
2	2.1	6ft 10in	2.3	7ft 7in	0.076	3in	1:27.6
3	2.45	8ft	2.6	8ft 6in	0.089	3½in	1:27.5
4	2.5	8ft 2in	2.7	8ft 10in	0.089	3½in	1:28.1
6	2.45	8ft	2.6	8ft 6in	0.089	3½in	1:27.5
8	1.24	4ft 1in	1.41	4ft 7½in	0.082	3¼in	1:15.1

Illustration 200
Gun 8 82, still in its concreted state, being prepared for transport to the conservation laboratory (Edward Martin, DP 174564)

Illustration 201
Gun 8 82 after conservation (DP 174285)

Illustration 202
Surface detail of Gun 8 82 at the breech, showing the initials of John Browne of Horsmonden and the weight in hundredweights, quarters, and pounds. These marks were cut with a chisel after casting. Note the marks which represent a final wiping of the clay surface of the mould pattern. Scale in centimetres (DP 174286)

Ward, and Eldred respectively give bores of 3¼, 3¼ and 3in; shot-weights of 3¾, 3¼ and 4lb; lengths of 7½, 8 and 8ft; and weights of 1200, 1100 and 1500lb (Norton 1628: 53; Ward 1639: 109; Eldred 1646: 15). Gun 5 is partly buried, so its full length could not be determined, but it appears to be of a girth appropriate either to a minion or a saker as described above. Gun 7 lies some distance from the main site, and may have been displaced and damaged during an abortive salvage attempt in 1979 (John Dadd pers comm). It does, however, appear to be of slight proportions, and is perhaps a companion to the stern-mounted minion drake, Gun 8, described below.

Cast-iron Gun 8

82 Gun 8, DP00/203, was found adjacent to its inverted carriage at **080.107/094.106** (Illus 199). It was completely buried when found, though its top surface was only a few centimetres below the present shingle level (Illus 79–80). The piece was raised and transported in its concreted state (Illus 49–50, 200) to the conservation laboratories of National Museums Scotland, where the concretion was removed prior to treatment (Illus 201). Its outer surfaces everywhere show no loss of material to abrasion or corrosion, and the wipe-marks of the final skim of clay on the mould-pattern are replicated crisply on the casting (Illus 202). The gun's overall length is 1.41m (4ft 7½in), and from muzzle to breech-ring it measures 1.24m (4ft 1in). Its bore is 82mm (3¼in) in diameter. This identifies the piece as a minion (Ward 1639: 109; Eldred 1646: 15), firing an iron ball *c* 76mm (3in) in diameter and weighing *c* 1.36kg (3½lb). The bore is 1.17m (3ft 10in) long, and the final 232mm (9in) of its breech end narrows from the full bore-diameter of 82mm to 55mm at the concave rear face of the chamber (Illus 203).

This characteristic identifies the gun as a tapered-chamber piece of the 'drake' family (Wilson 1988; Towes & McCree 1994). A mark '3–2–23' cut on the first reinforce after casting (Illus 202–3) indicates a certified weight of

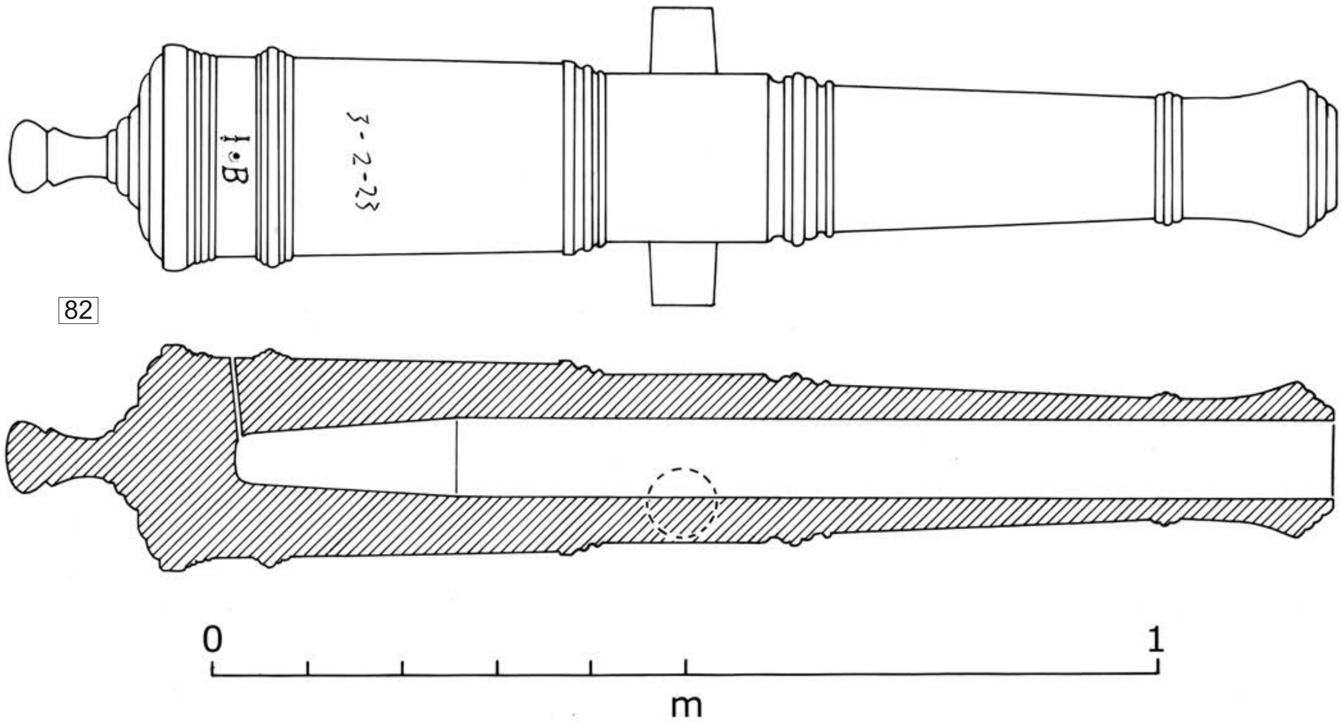


Illustration 203
Gun 8 82: top view and section (DP 174821)

3cwt (1 hundredweight = 112 English pounds of 454g), 2 quarters (each of 28lb), and 23 individual pounds, giving a total of 415lb (188kg). This figure, since the weighing of pieces was an officially controlled process, may be presumed to be accurate. The gun's present weight with the concretion removed is just under 185 kg, giving the metal an exceptionally low loss of weight to corrosion, during 348 years of immersion in seawater, of only 1.7% of its original mass.

John Browne, gunfounder

The letters 'I B' cut on either side of the touch-hole (Illus 202–3) identify the piece as having been cast by John Browne, gunfounder successively to James I, Charles I, and (after 1642), the Civil War Parliament. Browne was the foremost producer of drakes in England (Towes & McCree 1994). He was active in Kent and Surrey from at least 1613 until his death in 1652, operating mainly from furnaces at Brenchley and Horsmonden (Ffoulkes 1937: 118). The furnace-pond and adjacent wheel-pool, together with industrial debris from the foundry, can still be seen in woodland to the north-west of Horsmonden in Kent at NGR: TQ 694 412 (Illus 204) (personal visit, 15 December 2005). A similar gunfounding furnace and associated structures have been excavated at Pippingford in Sussex (TQ 450 316), 30 km west of Horsemonden (Crossley 1975). It is believed that the Duart Point gun is the only cast-iron drake by John Browne currently known, although four, perhaps five 'ordinary' castings carrying his initials have been identified. The best-known is now mounted on a replica

Illustration 204
Stratified industrial debris at the site of John Browne's foundry near Horsmonden, Kent

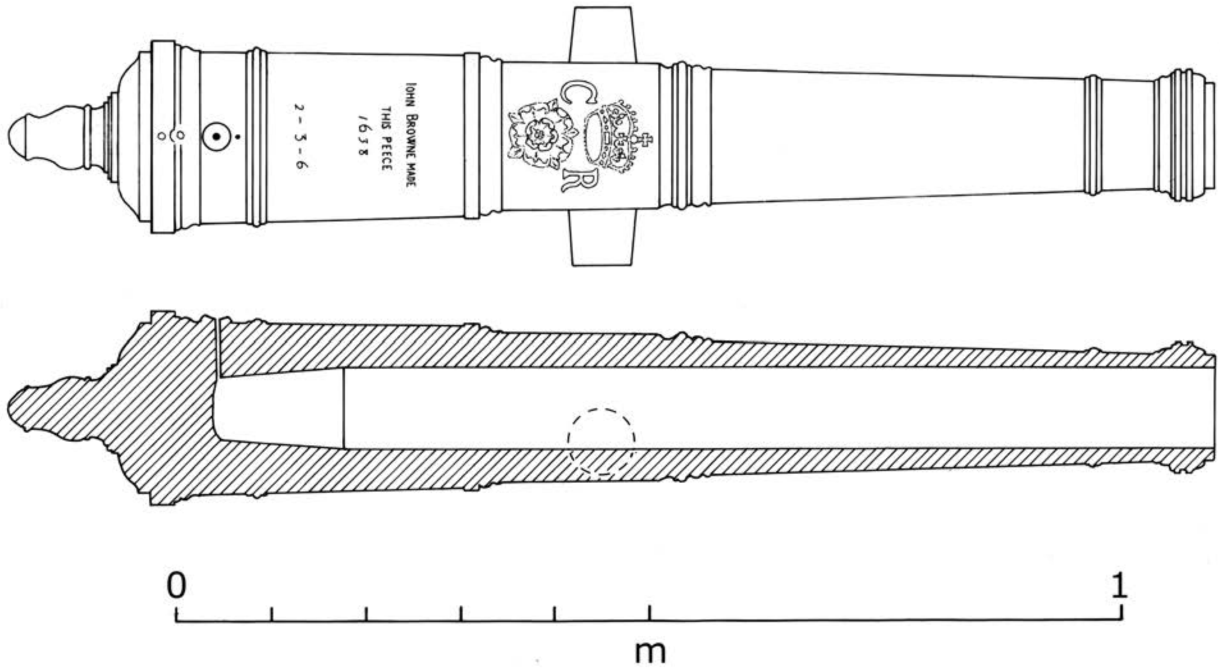


Illustration 205
The bronze minion drake now at Boston, Lincolnshire (after a drawing by R Roth 1994: 44) (DP 174822)

carriage on the walls of Derry/Londonderry in Northern Ireland (Scott et al 2008: 145–7). It is a demi-culverin, the proportions and weight of which (3,117lb or 1,414kg) make it clear that it is a full-weight parallel-chambered piece.

Other IB-marked pieces include one recovered from a wreck off Terschelling which bears a Dutch Admiralty mark and the date 1623 (Brinck 1996: 9); one associated with the Dutch West Indies Company (Brinck 1996: 43–5); and one from Mehrangarh Fort, Jodhpur, India (cat no 1780, Scott et al 2008: 49). There is another possible example at Mehrangarh (cat no 1732) but the mark is indistinct. None appears to be a drake. An iron demi-culverin bearing the 'C R' cipher of Charles I, and the Tudor rose-and-crown emblem, was recently discovered re-used as a bollard in the old Dockyard at Bermuda. Its marked weight of 1988lb (903kg) set against the 3248lb (1475kg) of an 'ordinary' demi-culverin (see below) suggests that it is probably a drake, although its ascription to John Browne on the basis of its proportions and mouldings is inconclusive (Horsmonden village website).

Four bronze drakes by John Browne are, however, known to survive. Two are in the Royal Armouries, Leeds. They are minions weighing 335lbs (142kg) and 305lbs (138.3kg) respectively (Blackmore 1976: 64–5, cat 38–9, pl 17). No 38 bears the remarkable inscription 'CAST IN PRESENCE OF HIS MAJTY OCTO THE FIFTH 1638. MOUNTJOY EARLE OF NEWPORT MR GENERALL OF THE ORDNANCE. IOHN BROWNE MADE THIS PEECE'. A bronze demi-culverin drake by Browne, also dated 1638, is preserved in the Royal Artillery Museum at Woolwich, London. It carries the English rose entwined with a fouled anchor, trident and sceptre, with the inscription 'CAROLVS EDGARI SCEPTRVM STABILVI AQUARVM' (Charles has established Edgar's sceptre on the waters). It was probably one of the drakes specially cast for *Sovereign of the Seas*, referring to the mythical King Edgar whose mounted effigy trampling seven kings formed her elaborate figurehead (Heywood 1637: 29–39). The final surviving Browne bronze drake is a minion in the Guildhall Museum at Boston, Lincolnshire, also dated 1638 (Illus 205). Like the two minion drakes in the Royal Armouries, this gun is shorter (1.127m from muzzle to base-ring) and lighter (314lbs marked weight, or 141.3kg) than the Duart Point piece, although it has a slightly larger bore (86mm or 3$\frac{2}{5}$in). The Woolwich and Boston guns are illustrated by Roth (Towes & McCree 1994: 44–5). A list of guns at Ayr in February 1653, recently brought there from Argyll, included two bronze drakes, each weighing 278lb, and 4ft long (Clarke MS 3/5 unfol).

Historical context of the minion drake

During the 1620s a new type of lightweight gun called the drake was introduced to England. Its origins are obscure, but the use of such guns on the continent is recorded in 1622 when Prince Maurice of Nassau, marching to relieve Bergen-op-Zoom, included in his train 'new devised pieces called Drakes' (Firth 1992: 46). Drakes had evidently reached England by

1625, when they were employed against Cadiz during the abortive Anglo-Dutch attack on the city. 'We discharged upon them some of our drakes or field pieces loaded with small shot' wrote John Glanville, who was there (Towes & McCree 1994: 39).

By 1626 John Browne, then Charles I's master-gunfounder, was conducting experiments to reduce the weight of cast-iron guns by 'refining' the metal, though the process involved is not explained. But in a report dated November 1627 Browne provides a set of equivalence figures for three guns cast in 'ordinary' and 'extraordinary' ('refined') metal (Towes & McCree 1994: 39–40, citing TNA SP16/95) (Table 7.2).

Six guns cast by Browne in refined metal (for which he charged double the normal price for cast iron) were tested under the supervision of Charles I's proof-master, John Reynolds, at Millhall in Kent in April 1627. All the pieces 'endured the King's double proof and yet are lighter than bronze', reported Reynolds, although he added the rider that because of the guns' lightness 'their reverse [recoil] is so much that I doubt they may hazard the breaking of their tacklings and ringbolts and so deliver their shot uncertainly'. Nonetheless, he went on, 'for shooting at eleven or twelve score [yards, or *c* 200m] which is considered by most seamen to be far enough at sea, these pieces have done such execution … as more is not required'. In conclusion, Reynolds considered, such pieces could most profitably be used on the upper decks of ships 'where heavier guns could not be brought to bear' (Towes & McCree 1994: 39, citing TNA SP16/25/79).

Hitherto most English warships had been equipped with expensive bronze guns, and the introduction of the lightweight drake design, combined with Browne's successful experiments in producing iron guns cast using 'refined' metal, clearly appealed to the Navy Commissioners as a means whereby the King's ships could be equipped with lighter and cheaper guns without reducing the weight or effective range of the projectile fired. During a meeting in March 1627 the Commissioners took into consideration,

> the great inconvenience which many of His Majesty's ships do suffer by overweight of ordnance … when the upper tier lies high their overbalance makes the ship walty and cranksided where she bears small sail; and is unwholesome at sea … when they strive to lay them lower, they are forced to lay the Lower Tier so near the water that they cannot carry them out in any reasonable weather, but are driven to shut up their ports and so they become useless cumber.

The Commissioners recommended that two steps should be taken to remedy these defects. The first was to make use of 'metal refined', a clear reference to the high-grade cast iron with which John Browne was experimenting. Their second recommendation spelled out the attributes by which they defined drakes. The new guns were to be 'foundered in new measures both shorter and lesser in Diametrical Magnitude or in forming the metal of the Chamber by diminishing the same towards the touch-hole according to the nature of the Drakes'. Such guns, the Commissioners concluded, 'were more nimble and proper for their uses, as well through bulkheads as from the upper places of deck, half-deck, or forecastles' (Towes & McCree 1994: 40–1, citing TNA SP16/56/45). Another description of the type is included in the *Travels of Sir William Bereton* (cited by Thompson 1977), in a diary entry dated 23 July 1635 at Wexford when he 'went aboard one of the king's ships, called the ninth *Whelp*. He found it to be armed exclusively with drakes, which he describes as 'taper bored in the chamber, and are tempered with extraordinary metal to carry that shot; these are narrower where the powder is put

Table 7.2
Examples of the difference between the weights of guns made with 'ordinary' and 'extraordinary' metal, compared with the actual weight of the Duart Point minion drake

Gun type	*Length*	*Bore*	*'Ordinary' weight*	*'Extraordinary' weight*
Whole culverin	8ft 6in	5¼in	40cwt	33cwt 3qr†
Demi-culverin	8ft	4½in	29cwt	23cwt†
Saker	8ft	3½in	22cwt	18cwt†
Duart minion	4ft 0¾in*	3¼in		3cwt 2qr 23lb

* Length from muzzle to base-ring. Browne's measurements were probably the same
† Towes & McCree 1994: 40

in, and wider where the shot is put in, and with this kind of ordnance his majesty is much affected'.

By these criteria Gun 8 is a classic minion drake. Analyses by Dr MacLeod and Professor Preβlinger confirm that it was cast of 'refined' metal of exceptional strength and resistance to corrosion, while its tapered chamber fits the specifications given above. It should be noted that the modified chamber was not intended to reduce the weight of the propellant charge, for its dimensions accommodate the same volume of powder as specified for a conventional piece. The volume of Gun 8's chamber, the length of which is defined unambiguously by its tapered end (as it is not in a straight-bored piece), is 750cc. The constituents of gunpowder have a solid specific gravity of just over 2, but when granulated or 'corned' the near-spherical grains pack into a face-centred cubic lattice which occupies about 75% of the available space, reducing the weight/volume equation commensurately (Hall 1997: 69). Applying these figures to the chamber of the Duart Point minion drake gives a powder capacity of 1.125kg or 2lb 8oz.

Drakes have long caused confusion among historians. Lewis (1961: 25 n1) thought that the term 'taper-bored' meant 'decreasing more or less uniformly in bore from muzzle to breech', an interpretation followed by Lavery (1987: 90–1), who added by way of explanation that drakes 'were intended mainly to fire grape-shot … and a taper bore would spread such shot.' But while drakes undoubtedly were used for canister-shot they routinely fired roundshot too, for which a bore flared along its full length would be ballistic nonsense. As surviving examples show, it is the chamber only that flares, an arrangement unequivocally confirmed by the Navy Commissioners in their report of March 1627 (TNA SP16/56/45), which notes 'forming the metal of the Chamber by diminishing the same towards the touch-hole according to the nature of the Drakes'. Beyond the tapered chamber the bore-diameter is constant, as confirmed by the Duart Point drake and the surviving bronze examples.

Another long-standing drake *canard* (to which the writer succumbed in an earlier paper, Martin 2004: 85–6) is that Browne alloyed the iron in some way to form a lighter mix. This too is scotched by a careful reading of the Navy Commissioners' March 1627 report, which states: 'order be taken with the founder to fortify his pieces rather by the virtue and strength of the metal refined … than by adding plurality of ordinary stuff which increases the weight' (Towes & McCree 1994: 41 citing TNA SP1/56/45). In other words the metal was not *lighter* but *stronger*, so less of it was needed to achieve the required strength. This is borne out by the unusual composition which analysis has shown to characterise the metallurgy of the Duart Point drake (see below).

The widely held belief that drakes bore a lighter charge than their 'ordinary' equivalents is also a misconception. As we have seen, the taper was confined to the chamber and its capacity was the same as that of a full-bored gun. What the tapering achieves is to maintain the wall thickness of the barrel around the chamber, where the pressure stress is greatest, while allowing the outer circumference of the breech (its 'diametrical magnitude', as the Navy Commissioners put it) to be significantly reduced. The high internal pressure developed at this point by the expanding combustion of gases following ignition is well illustrated by a photo-elastic model analysis of internal stresses around the chamber of a gun replicated in resin, carried out at Princeton University (Guilmartin 1974: 287–8, fig 17). Less metal around the circumference of a tapered chamber was needed to achieve the requisite strength. More weight was saved by shortening the piece. Ward's specification (1639: 109) for a conventional minion indicates a bore:length ratio of 1:29.7, almost double that of the Duart Point piece. By applying all three factors – stronger 'refined' metal, a tapered chamber which allowed a reduction of the circumference at the breech, and reduced length – such a gun's weight could be reduced by more than half when compared with its 'ordinary' equivalents (Table 7.3).

Most guns produced for the navy during Charles I's reign were drakes (Caruana 1994: 56–68). Among them were 36 demi-cannon drakes, 40 culverin drakes, and 40 demi-culverin drakes, all of iron and all cast by John Browne, issued in 1628 to ten new pinnaces, the *Lion's Whelps* (arguably the Royal Navy's first 'class' of warships) (Caruana 1994: 59). A decade later John Browne and Thomas Pitt cast 102 bronze

Table 7.3
The specifications of two ordinary minions from 17th-century sources, compared with the specifications of the Duart Point minion drake

Gun type	*Bore*	*Shot weight*	*Length*	*Weight*	*Source*
Minion	3¼in	4lb	–	1,000lb	Monson 1913: 41
Minion	3¼in	3lb 12oz	8ft	1,000lb	Seller 1691:137
Duart Point minion drake	3¼in	4lb	4ft 1in	415lb	

guns, almost all of them drakes, for the King's ornate and expensive nautical showpiece, *Sovereign of the Seas* (Caruana 1994: 63; Rodger 1997: 388–9). Originally conceived as a two-decker mounting 90 guns, Charles had defied expert advice (and the recent disastrous precedent of *Vasa*) by insisting on an additional gun-deck to make the ship the first true three-decker, and increasing her armament to over 100 muzzle-loading guns – another first. This number of large-calibre guns could certainly not have been achieved without exploiting the weight-saving characteristics of drakes.

The Duart piece's short length, tapered chamber, and refined metal combine to give it, in the evocative technical jargon of its time, the full descriptive nomenclature 'bastard [= shortened] minion [= bore] drake [= tapered chamber] extraordinary [= cast from refined metal]'. It is a unique relic of a short-lived and probably unsuccessful phase in the development of naval ordnance, and its exceptional condition (metallurgically as well as physically) has made possible the important analytical work by Dr Ian MacLeod and others, presented below.

7.2 The composition and properties of 'refined' iron: a metallurgical analysis of Gun 8

Ian MacLeod

The piece's weight loss, determined after the removal of concretion after 350 years of immersion in seawater, amounts to only 3.24kg (1.72 wt%), or only 5×10^{-3}wt% per year of immersion. Given the remarkable degree of preservation and the questions posed by its resistance to corrosion, permission was granted by National Museums Scotland to take a sample from the gun for metallographic analysis. A full report on the archaeometallurgy and microstructure of the gun is published elsewhere (Preßlinger et al 2012).

From the measurements and description of the gun it is possible to calculate the wetted surface area of the piece, assuming that the tampion was not in place so that seawater could penetrate the bore. There was no evidence of a tampion and, had one been fitted, the pressure differential would probably have forced it up the barrel when the gun sank, where it would almost certainly have been preserved. Tampions were recovered from guns on the Dutch East India Company (VOC) ships *Batavia* (1629) and *Zuytdorp* (1712) (Green 1989: 54; WA Museum artefact database). From these data it was possible to use the weight-loss information to calculate the corrosion rate, assuming a uniform distribution of decay across the gun. Corrosion rates expressed in mm.y^{-1} of metal loss are calculated according to the formula:

$$i_{corr} = 10 \times \{\delta / SA\rho t\}$$

where the 10-fold factor is to allow for conversion from cm of corrosion per year to mm.y^{-1}, the weight loss in grammes (δ), the surface area (*SA*) in cm^2, the density ρ is in $gm.cm^{-3}$ and the time of immersion (*t*) in years. The density used in the calculations was obtained from an un-corroded section of the solid metal which had been cut with a diamond-tipped metallographic instrument, which was approximately 20mm × 7.5mm × 7.5mm, and determined to be 7.17 $gm.cm^{-3}$, which is significantly higher than the initial bulk estimate value of 6.71 calculated from the displacement volume of the conserved gun (Martin 2004: 82). The metal sample has a density that is typical of a medium-carbon grey cast-iron (American Society for Metals 1983: 167, 172). A section of the gun that included an edge of corroded material had a density of 7 ± 0.02 $gm.cm^{-3}$, which shows that even a small amount of corrosion can significantly alter the apparent density. When attempting to determine the density of a large whole object such as a cast-iron gun special care needs to be exercised when taking readings on the corroded rough surfaces to ensure that all the areas have been thoroughly wetted, as entrained air can result in lower density readings.

From the conversion weight % loss to mm.y^{-1} of corrosion, the John Browne minion drake can be seen to have an estimated uniform corrosion rate of 1.15×10^{-3} mm.y^{-1} which amounts to a total depth of graphitisation of only 0.4mm after 350 years of immersion. A scanning electron micrograph of the leading edge of the sectioned gun is shown in Illus 206; the bar-scale is 1mm. The view of the metal was obtained using a backscattered secondary electron image which is atomic numbered contrast-sensitive so that light elements like carbon show up as black and heavier elements like iron are manifest by a light-grey to white tone. Corrosion has occurred in patches around the roseate-shaped graphitic clusters (dark-grey image areas). There is some solid metal to within 100μm of the seaward surface, which is in marked contrast to most iron

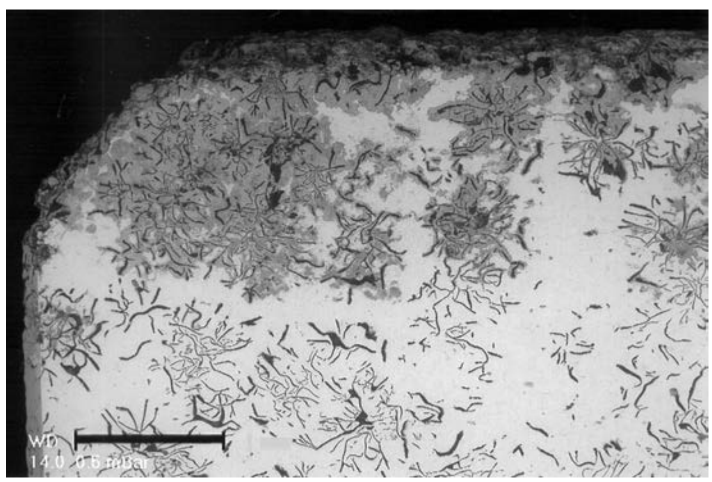


Illustration 206
Scanning electron micrograph of the leading edge of the sectioned Gun 8 [82]. The bar-scale is 1 millimetre

Table 7.4
Summary of the principal components of the alloy

ppm											
Element	Li/7	Be/9	B/10	Sc/45	Ti/48	51/V	Cr/52	Mn/55	Co/59	Ni/60	Cu/65
Canon	< 0.1	< 0.1	<0.1	0.9	86	75	57	6200	20.5	59.4	2100
Element	Zn/66	Ga/69	Ge/74	As/75	Se/82	Rb/85	Sr/88	Y/89	Zr/90	Nb/93	Mo/98
Canon	761	12	1.1	53	0.3	0.1	0.3	0.4	158	43.5	3.9
Element	Ru/101	Rh/103	Pd/105	Ag/107	Cd/111	In/115	Sn/120	Sb/121	Te/126	Cs/133	Ba/138
Canon	<0.1	<0.1	0.1	<0.1	0.5	<0.1	8.0	3.4	0.3	<0.1	1.3
Element	La/139	Ce/140	Pr/141	Nd/144	Sm/152	Eu/153	Gd/158	Tb/159	Dy/162	Ho/165	Er/166
Canon	0.1	0.4	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	0.1
Element	Tm/169	Yb/172	Lu/175	Hf/178	Ta/181	W/182	Tl/205	Pb/208	Bi/209	Th/232	U/238
Canon	<0.1	0.1	<0.1	4.7	2.4	6.1	<0.1	10.0	<0.1	0.3	<0.1

samples from marine contexts of similar age, where corrosion profiles are typically of the order of 35mm. Given that the gun appears to have been buried for most of the time since the vessel sank it is instructive to compare its corrosion rate with Gun 5 which had been partially buried at the foot of the cliff and had a corrosion rate of only 1.9×10^{-2} mm.y^{-1} which in itself is roughly five times less than the normal corrosion rate of iron in seawater of 0.1mm per year of immersion.

Thus Gun 8, which may be presumed to have been cast with John Browne's 'extraordinary' metal, has corroded at roughly one-sixteenth the rate of an apparently normal 17th-century cast-iron piece of ordnance. This level of corrosion rate is normally only obtained today by costly duplex stainless steels designed for performance in aggressive marine and chemical environments. For example the specialised steel SCS10 JIS duplex stainless steel containing 25% chromium, 7% nickel, 3% molybdenum, has a combined corrosion- and erosion-rate equivalent to 1.06×10^{-3}mm.y^{-1} (Yokota 2011), which is the same as that calculated for Gun 8, the product of a technology available nearly four centuries ago (the SCS codes relate to the Japanese Standards Association).

The incised markings on the surface of the gun showing its measured original weight recorded at the time of casting, 3cwt 2qr 23lb (415lb or 188.24kg), are seen against a surface detail which preserves the brush-marks from the mould used at the gun-foundry (Illus 202). The fine surface detail reveals even grains of sand, attesting to the remarkably small extent of corrosion since cast iron would normally lose this level of surface detail quite quickly. Metal swarf was obtained by penetrating the core sample with a drill-bit in the middle of the square-end cross-section after removing the surface 0.5mm of material and collecting metal shavings to a depth of 10mm. The metal was dissolved in nitric acid and analysed by inductively coupled plasma – mass spectrometry (ICP MS) at the University of Western Australia's micro-analytical service laboratory, and the carbon content was determined on duplicate solid samples in a Leco furnace. A summary of the principal components of the alloy is given in Table 7.4, and the full range of trace metals found in the alloy, which provides clues to the provenance of the ore body and the metallurgical processes used in the manufacture of the gun, are reported in detail in a separate publication (Preßlinger et al 2012).

The basic metallurgical composition of cast-iron objects is controlled by the phase diagram for iron and carbon. If the effective carbon content, or carbon equivalent, is on the low carbon side of the eutectic composition the alloy is referred to as being a hypo-eutectic grey cast iron, which is the appropriate description for Gun 8. One of the principal ways in which the presence of silicon and phosphorous is manifested is that they act as though they are carbon, in terms of modifying the melting-point and altering composition of the phase diagram. These factors in turn control the phases that are present in the solid materials when recovered from the marine environment. Using the formula

$$CE\% = \%C + 0.3*\%Si + \tfrac{1}{3}*\%P - 0.027*\%Mn + 0.4*\%S,$$

where CE is the carbon equivalent, and using the weight % composition of the silicon and phosphorous recorded (see Table 7.4) it is possible to calculate what the effective concentration of carbon is in the alloy (Campbell 2008: 454). Thus the 1.04% Si and 0.378% P increases the analytical concentration of carbon from 2.76% to 3.22%, which may seem trivial, but an inspection of the phase diagram shows that this 'equivalence' alters the melting-point of the iron alloy by 125°C, which naturally makes it much easier to manage and to achieve a fine casting with less porosity. The small amounts of chromium and vanadium, which promote the formation of the iron-carbide phase cementite, are unlikely to have had any measurable impact on the microstructure. Manganese increases the hardenability and retards the softening and tempering of the cast iron. Mechanical testing of the metallographic coupon showed a Brinell hardness of 175 which is the same value as an ASTM 25 standard grey cast iron (Illus 207).

The phosphorous impurities react to form the iron phosphide which combines with the ferrite phase to form the eutectic phase called steadite, and this composition assists the fluidity by lengthening the solidification process (Abbasi et al 2007). The relatively low amount of silicon will tend to inhibit the formation of iron-carbide cementite, Fe_3C, and promotes the growth of graphite phases which are present in the metal structure as flakes (Smallman & Bishop 1999: section 9.3).

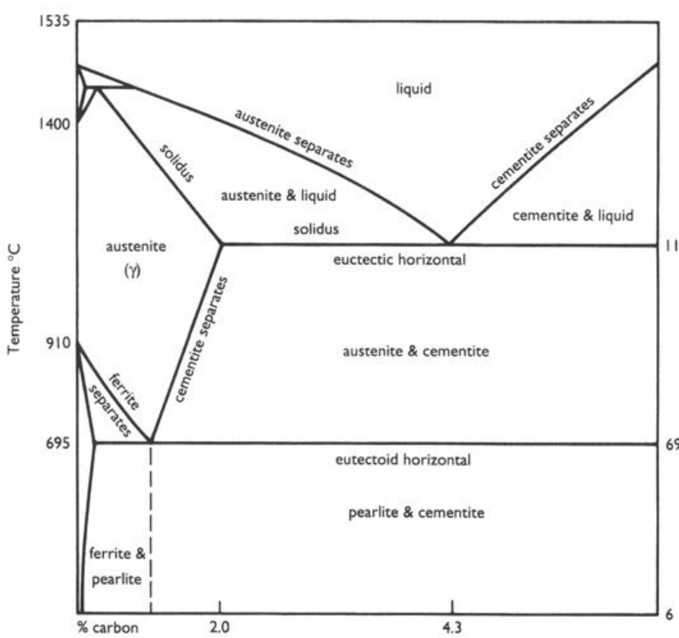


Illustration 207
The complete iron-carbon diagram for the sample from Gun 8 82

Corrosion of cast iron is strongly influenced by the level of impurities in the alloy and how they affect the microstructure, which in turn controls the corrosion mechanism. In most cast-iron guns and roundshot the principal phases are ferrite (pure iron), pearlite (a lamellar structure of ferrite with bands of iron-carbide cementite), cementite Fe_3C, and graphite. The electrochemical differences in reactivity of the phases ultimately result in the selective dissolution of ferrite in grey cast irons in the marine microenvironment. After the ferrite phase has been corroded the pearlite phases are next to go, which are followed by the cementite phases until only the graphite structure remains (Pearson 1972; Wu et al 1998).

Another source of localised corrosion for cast-iron objects is the presence of sulphur as an impurity, for in the molten state the sulphur reacts with iron to form iron sulphides like pyrite (FeS_2), which act as electrical conductors and have different chemical reactivity to the phases around them, and this in turn causes localised corrosion. Pyrite can also be present as inclusions from the parent ore body which was incompletely roasted to form an oxide mineral which could then be reduced to iron metal in the normal furnace operations. However the low level of sulphur ($<0.1\%$) present in cast iron attests to its quality.

Chemical analyses of the underlying metal from cast-iron guns recovered from shipwrecks dating from 1622 to 1875 conserved in the Western Australian Museum showed that there were two distinct groupings that had the same rate of decrease in sulphur content for each year of the casting date(s) but different intercept values. In other words, the graph of sulphur content versus the date of the wreck or its build date consisted of two parallel lines, and the rate of the decrease in sulphur content per year was approximately 0.0011 ± 0.0003 wt% per year as the technology of manufacturing guns improved and the awareness of the impact of impurities began to be better understood. Using these data and the relationships discussed above it can be seen that Gun 8 fits to the lower sulphur content with a predicted sulphur content of 0.09% for a gun made *c* 1640 which is what the analytical results bear out for the Browne gun. It is of interest to note that this lower level of sulphur in cast-iron guns was found in examples from three Dutch East India Company shipwrecks from Australian waters, the *Batavia* (1629), *Vergulde Draeck* (1656) and *Zuytdorp* (1712), as well in the Duart Point Gun 8. It is most likely that the iron source minerals were based on oxide ores of hematite, goethite, or magnetite.

If the proposed casting-date of *c* 1640 for Gun 8 is used to calculate sulphur content from the upper linear relationship, derived from guns from the *Trial* (1622), *Sirius* (1790), *Cumberland* (1830) and *Fairy Queen* (1875), the theoretical value was 0.25% which is substantially higher than the analytical value of $<0.1\%$. As previously discussed, the higher sulphur contents of these guns are probably due to contamination from pyritic ore bodies used in the production of cast iron. When pyrite FeS_2 is roasted sulphur dioxide is released and the iron product is based on Fe_2O_3 which can then undergo standard blast-furnace reduction (Carpenter & MacLeod 1993).

When the manganese and phosphorous contents of the Western Australian Museum cast-iron ordnance were examined it was found that for pieces from the *Batavia*, *Sirius*, *Rapid*, *Cumberland* and *Fairy Queen* there was a direct linkage between the amount of phosphorous present and the amount of manganese which had an R^2 of 0.975 for the linear regression, $\%P = 0.73 x Mn\% + 0.0899$, but this relationship does not correlate with the composition ratios found in the gun from the Duart Point wreck. It has been noted above that John Browne had used 'refined' iron (metal not directly smelted from the parent ore bodies) to make his special guns, and so this disjoint in composition ratios provides additional support for this supposition. At present a research programme looking at osmium isotope ratios in the gun and comparing them with slag residues from the foundry site in Kent is likely to be able to source the iron ore from which this unusual gun was made (Preßlinger et al 2012).

Other than the main impact on the melting-point, the presence of phosphorous is normally regarded as being deleterious in that the iron phosphide steadite phase, Fe_3P, makes the alloy increasingly brittle and subject to accidental damage during firing and reloading activities. Recently these effects have been superbly quantified in a study showing that increasing amounts of phosphorous make grey cast iron weaker through a combination of reduced tensile strength and reduced impact strength, while at the same time increasing the hardness and lowering the eutectic temperature (Abbasi et al 2007). The eutectic mixture of iron and iron phosphide is the last phase to solidify and so the impurities tend to be concentrated at the grain boundaries with concomitant negative effects on the corrosion and mechanical properties.

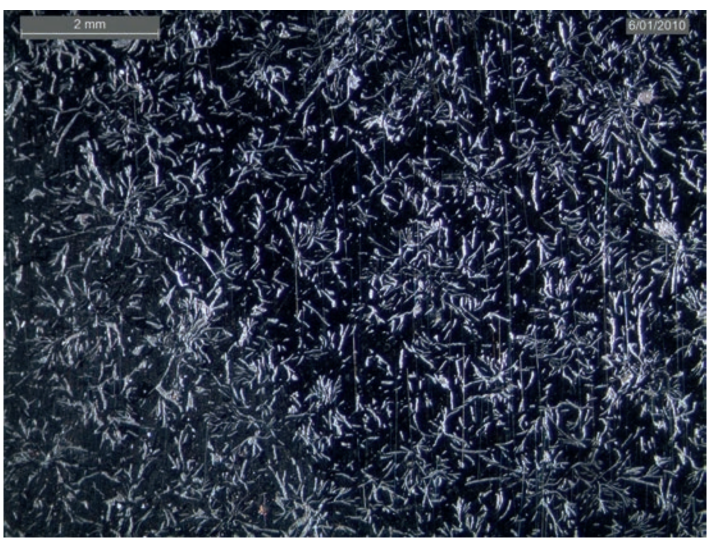


Illustration 208
The as-polished metal section of Gun 8 [82]

Analysis of the microstructure of the section of solid metal from Gun 8 showed that the cast iron has an unusual structure for 17th-century guns in that there is essentially no ferritic phase present. The un-etched surfaces showed up a characteristic roseate pattern of graphite which was visible to the naked eye. Part of the mystery for 'extraordinary' materials performance is explained by the major amounts of pearlite in the alloy, which will have greatly reduced the internal galvanic reaction between graphite, pure iron, and the surrounding seawater. Black malleable iron is made by annealing white iron in a neutral packing of iron-silicate slag when the cementite in the original white iron is changed into the rosette-shaped graphite nodules in a ferritic matrix (Campbell 2008) – see Illus 208 for the as-polished metal section of the gun. Especially to be noted is the remarkable way in which the lamellar structure of pearlite is formed in its different phases where the bands of iron carbide Fe_3C are laid down in a fashion that depends on the rate at which the molten metal cools (Campbell 2008). Closer bands of Fe_3C within the lamellae indicate cementite formation from graphite at a lower temperature such as 600° where the spacings are of the order of 0.1μm. Although iron carbide has low tensile strength it has great compressive strength and so the presence of the pearlite structure will explain in part why the guns were able to withstand the double proof-firing of contemporary testing (Towes & McCree 1994: 39, citing TNA SP16/25/79).

Another remarkable feature of Gun 8 is that the normally deleterious effects of sulphur have been eliminated through the formation of manganese sulphide inclusions which are electrochemically much less reactive than iron sulphides. The manganese sulphide inclusions appear as rounded grey particles at the dendrite boundaries of the alloy. Different surfaces of the alloy showed up structures that were indicative of interdendritic segregation with random orientation, while other areas showed up some preferential orientation of the phases. As previously mentioned the majority of the phosphorous present would react to form iron phosphide, Fe_3P, which solidifies out as the eutectic phase of ferrite and phosphide known as steadite which increases the hardness of grey cast iron, which is a beneficial effect for a piece of ordnance (Abbasi et al 2007).

In summary, the metallurgical structure of Gun 8 is most complex, as it consists of a quaternary phase system with graphite, manganese sulphide inclusions, the Fe_3P containing phase, as well as the pearlitic phases. Although the normal lamellae of pearlite I phase are present at about five times more abundant than the spheroidal form of pearlite II, it is believed that the complex and interacting structures of this alloy all contributed to its remarkable properties. John Browne appears to have been fully justified in charging double for his 'refined' metal (£26 13s 4d per ton instead of £13 6s 8d, Towes & McCree 1994: 39–40, citing BL Harleian MS429).

Acknowledgements

Ian MacLeod

The assistance of Dr Bernard Pilcher, Professor Alfred Vendl and Professor Hr Preßlinger of the Technical University of Vienna in enabling the metallographic analysis of the core sample is gratefully acknowledged. The encouragement and support of Drs Colin and Paula Martin who brought the gun to my attention is happily noted. Without financial assistance from a grant by the J Paul Getty Trust to enable the author to work at the Getty Conservation Institute in Los Angeles this work could not have been effected.

Additional note

Colin Martin

Since Dr MacLeod's analysis was carried out my attention has been drawn to research by Wertime (1962), who more than half-a-century ago reached much the same conclusion as Macleod & Preßlinger from oblique and intuitive study. He notes (1962: 168),

> though records and personal accounts reveal very little of the underlying chemical knowledge of the Sussex founders, it seems reasonable to believe … that masters of the Sussex tradition came to grasp in a limited practical way the majority of basic rules still applicable in iron-founding. These related to the positive role of certain phosphorus-bearing limonite ores; the negative role of sulphur; the central importance of gray iron; and the importance of proper pouring and moulding practice, including slow cooling without quenching. A superior gray cast iron resulted, as attested by metallographic results in firebacks cited by Schubert [1957: 246ff].

These pioneering conclusions by historians of technology are thus independently confirmed by MacLeod & Preßlinger's archaeologically based analyses, which were conducted without knowledge of the earlier work.

7.3 The drake carriage

83 DP00/013, **090.096/093.104** and fragment DP99/101 at **089.102**, a wooden carriage lay upside-down adjacent to Gun 8 (Illus 209–12). Mounted guns often invert themselves when they sink, because of the buoyancy of their carriages. Mechanical and biological degradation has severely damaged the exposed lower parts, and there is no sign of the forward trucks or axle, although the concreted

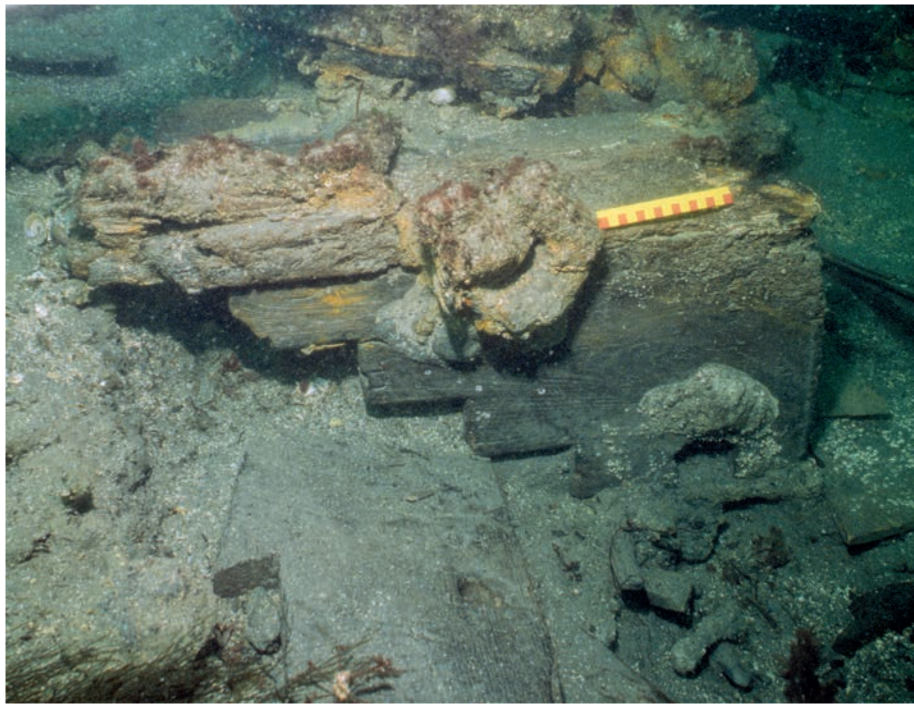


Illustration 209
The inverted drake carriage 83 at **091.101**. Scale 15 centimetres (DP 174310)

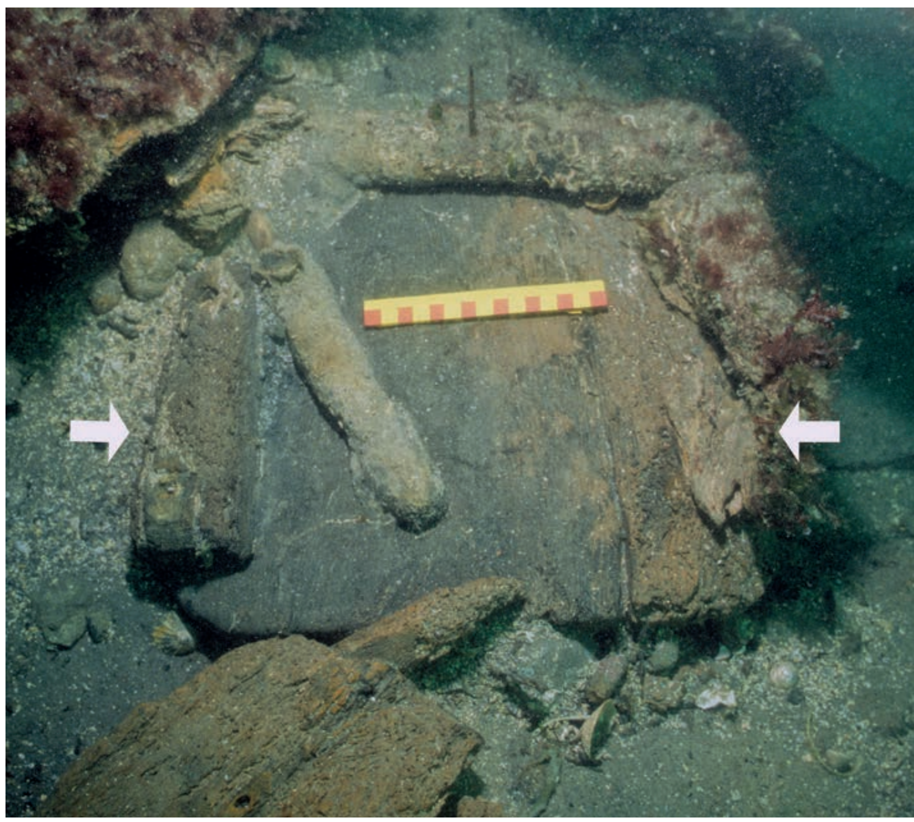


Illustration 210
The bottom rear part of the drake carriage-bed 83, showing the two abraded chocks (arrowed). The iron concretions are not part of the assembly. Scale 15 centimetres (DP 174317)

remains of iron fixing bolts for the front undercarriage are in place. At the rear end of the bed, however, there is no evidence of an axle or its fastenings. Instead the much-abraded remains of two pieces of wood, one fixed to each outer side, were noted. These can be identified as the vestiges of wooden chocks or skids (Illus 210).

The main body of the carriage consists of three components, a bed and two stepped cheeks, all of elm (*Ulmus* sp) (Illus 211). This conforms with contemporary practice: 'only elm doth make them', wrote Sir Henry Mainwaring of shipboard gun-carriages in the 1620s (Manwaring & Perrin 1922: 119). Elm is a resilient wood capable of withstanding shock. The bed is 60mm (2⅓in) thick and 0.9m (3ft) long, and tapers from a width of 0.388m (15¼in) at the rear to 0.324 m (12¾in) at the front. It is derived from the full width of the tree; that is, the central growth-ring of the parent log lies at the centre of the board, making it a tangential slice with balanced grain, and thus resistant to warping (McGrail 1987: 32–3). The cheeks are likewise of 60mm (2⅓in) elm board 0.66m (2ft 2in) long, falling from a level front portion 0.32m (12½in) high in four steps to the bed forward of its rear. The boards appear to be a handed pair derived from either side of the parent log's centreline, though they are placed in parallel without being reversed to mirror one another's grain, as might be expected. Just forward of the mid-point of the level foreparts of the cheeks, U-shaped recesses are cut to accommodate the full depth

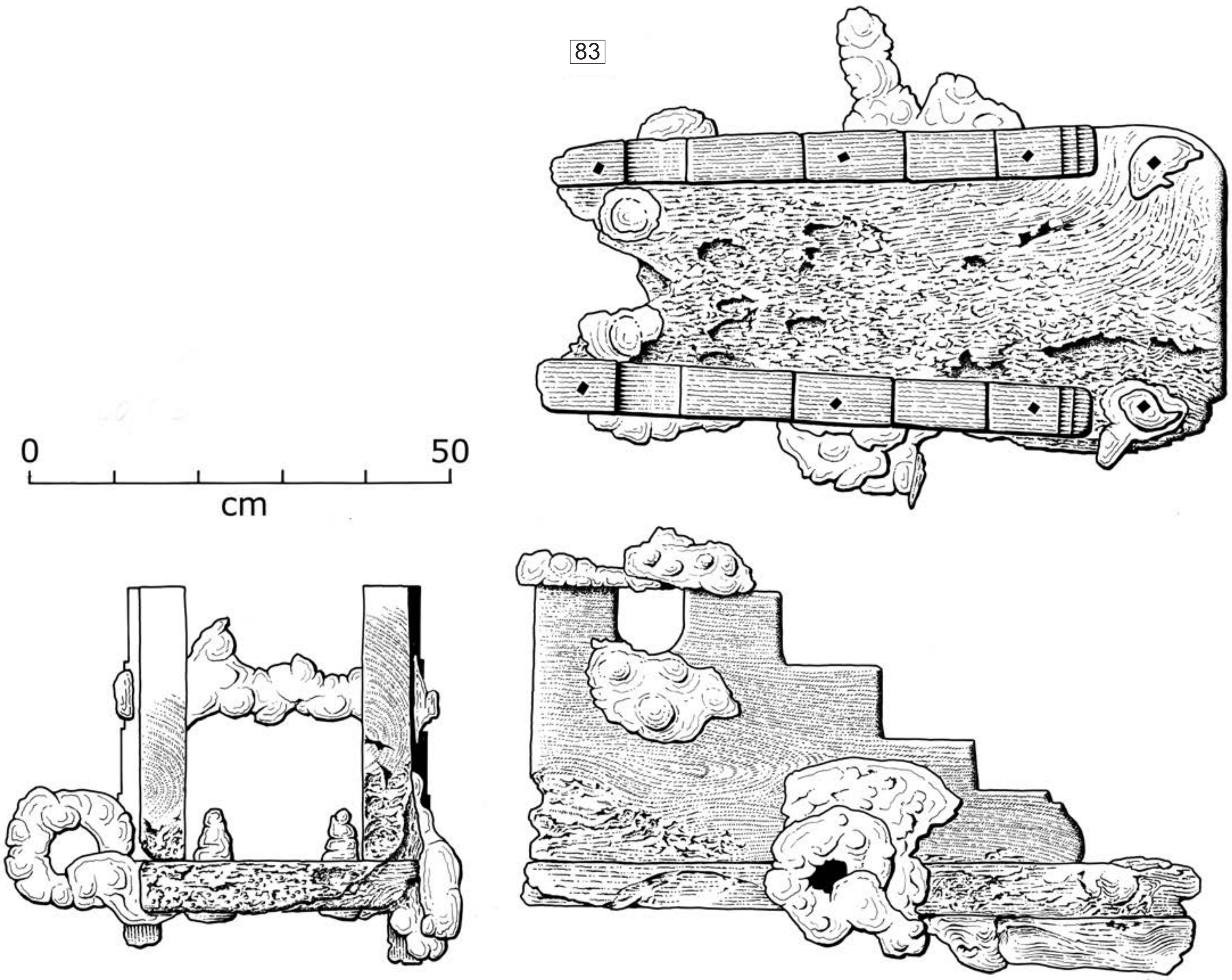


Illustration 211
Plan and front and side elevations of the drake carriage 83 (DP 174823)

of the minion drake's 72mm (2¾in) diameter trunnions. This is similar to the arrangement noted on truck carriages from *Mary Rose* (Hildred 2011: 99) but distinctively different from later practice, in which the recesses were generally semi-circular housings accommodating only the lower halves of the trunnions, with the capsquares arching over them, as on *Vasa*'s mounted guns (Padfield 1973: 66–9).

Flat iron capsquares hinged at the rear locked the trunnions to the carriage when the gun was bedded in place. The concreted left-hand capsquare remains in place but the one on the right has been thrown backwards, no doubt when the gun detached itself from the carriage during the wrecking process (Illus 212). Six through-bolts, three on each side, fix the cheeks to the bed, and were presumably secured at their lower ends by forelocks (slotted iron pins and locking wedges), though this detail was obscured by concretion. The front bolts also secure the capsquares, and it is presumed that iron spikes were provided to hold their rear ends in place. Two bolts at the forward end of the carriage indicate the position of the now-lost axle and fore-truck assembly. Close to the rounded rear corners of the bed two more bolts retain the rear chocks, which are secured at the front by the main bolts passing through the cheeks and bed. The rear bolts may also have been fitted with securing-rings.

The carriage was braced laterally by two transverse bolts. One joins the two cheeks just below the trunnion recess, and may have retained a wooden transom bracing the structure internally, although no evidence of this has survived. Another bolt, placed under the second cheek-step, runs through the full width of the bed to prevent it from splitting. At each end of this bolt breeching-rings 100mm (4in) in diameter are fastened.

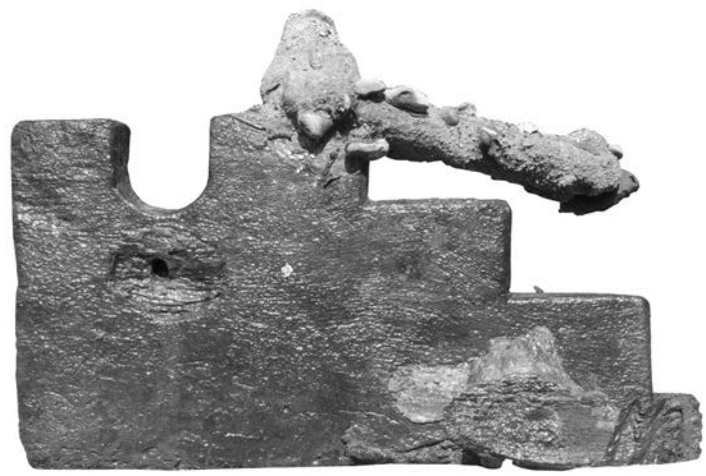


Illustration 212
Inside view of the right-hand cheek of the drake carriage 83 showing the rearwards throw of the concreted capsquare (DP 173431)

In most respects the design of this carriage is typical of 17th-century practice (Moody 1952: 303–4), except for the solid wooden rear chocks in place of the more familiar rotating trucks. Evidence is, however, growing that rear-chocked carriages may have been more common than has been supposed, and frequently appear in association with drakes. Caruana (1994: 181–2) cites a document dated 1 May 1639 which refers to 'ship carriages for his Majesty's ship the *Sovereign* [*of the Seas*]', all of which are described as having 'whole trucks and half trucks'. Caruana also refers (1994: 182) to documents in the Library of the Royal Artillery Institute (RAI) at Woolwich which, although not quite contemporary, show carriages of this type. One of these is by a Dane, Albert Borgard, who joined the British artillery service in 1692 and made drawings of 'historic' ordnance and related equipment he found lying at Woolwich. These include several rear-chocked carriages, one of which Caruana has re-drawn (1994: 115). The RAI also possesses the notebooks of a Lieutenant James, which contain a drawing of a rear-chock carriage. Caruana (1994: 181) has redrawn this, believing it (on unstated grounds) to be for one of the *Sovereign*'s drakes. That drake ship-carriages were a recognisable type is indicated by an entry in an inventory listing ordnance in the Tower of London dated 20 March 1634 which records six 'drake shipp Carriages' – two for demi-culverins, and four for sakers (TNA WO55/1690, transcribed by Blackmore 1976: 303).

Puype (1990: 15–16) illustrates and describes two rather different rear-chock carriages. One is from a manuscript of *c* 1660 in the Netherlands Scheepvaart Museum. The other is a 1675 sketch by van de Velde the Younger which depicts a rear-chock carriage designed for a yacht (Robinson 1958: 370). In the 19th century carriages of similar design are sometimes encountered, particularly in association with lightweight heavily shotted pieces (for example Moody 1952: 309; Padfield 1973: 153, 155). At least two rear-chock carriages, evidently of 17th-century date, have survived on land. One is at Windsor Castle (Smith 2001), the other in Barbados (Charles Trollope pers comm).

Finally, mention should be made of the carriages associated with ten model guns presented to the future Charles II in 1638 and 1639, when he was Prince of Wales (Blackmore 1976: 65–6, pls 74–5). The five cast in 1638 were by John Browne, and the remaining five, cast a year later, by Thomas Pitt. All were mounted on wooden carriages which were destroyed in a fire at the Tower of London in 1841, although the guns survived. The new carriages made to replace them are so similar in design to the Duart drake's rear-chock carriage as to suggest that they are close replicas of the originals, which themselves must have been faithful representations of the real thing (Illus 213). The rear chocks are particularly clear, being semi-circular pieces of

Illustration 213
Model bronze gun and carriage. English, 1638. Cast by John Browne (XIX.24, © Royal Armouries)

wood with flattened bottoms and short rearward extensions. Since these models are static the flattened bottoms must have been intentional, and not the result of wear.

Drakes and rear-chock carriages

The replacement of the more usual rotating rear trucks with fixed semi-circular chocks with flattened bottoms on drake sea-carriages was clearly intended to increase friction on the deck and so contribute to the absorption of recoil. That modified carriages were needed for these light but heavily shotted guns is evident from Nathaniel Butler's *Dialogues* of *c* 1634 (Perrin 1929: 260–1) in which he presents an imaginary conversation between an admiral and a captain, with specific reference to drakes:

> ADMIRAL: What say you of those light kind of guns newly invented, called drakes?
>
> CAPTAIN: For these also, howsoever in regard of lightness and smallness, they may seem desirable, yet in respect of their violent reverse, occasioned by their over-lightness; so they are not to be used on ship-board, unless the trucks of their carriages be so framed, as by their straitness upon the axle-trees, their reverse may be regulated; and that, being thus straitened, they become as hard to be traversed as most of the heavier pieces; and besides that by reason of the thinness of their metal they are so soon overheated, as not to be made use of in any long fight. In these respects (I say) it is mine opinion of these drakes likewise, that they are not to be held in any great account for service at sea.

Butler's modern editor, W G Perrin, considered that 'straitness' should be rendered in modern English as 'tightness': in other words the trucks being tight on their axles would fail to rotate on recoil and so dampen the 'violent reverse' (1929: 260 n3). It seems more likely, however, that Butler's 'strait' trucks were none other than the fixed rear chocks with flattened bottoms now seen to be characteristic of drake carriages. Such an arrangement would help to mitigate the recoil problem. Since the gun's trunnions are set below the axis of the bore, recoil would push the breech downwards, so increasing the friction of the flat-bottomed chocks against the deck. This explains what Butler meant by the 'straitness' which regulated the 'reverse'. By the same token, such a carriage would be harder to traverse (to move its rear sideways).

Little is known of Butler's life and sea-experience, although in the abortive Cadiz expedition of 1625 (in which, as we have noted, drakes were first recorded in English sea-service) he was, apparently at Charles I's behest, commander of the *Jonathan*, a 371-ton hired merchantman in the Admiral's squadron. In 1627 he commanded the *Patient Adventure*, another auxiliary merchantman of 360 tons, in the Ile de Ré campaign. A year later he became captain of one of the King's ships, *Nonsuch* (600 tons, 40 guns), and took part in the relief of Rochelle (Perrin 1929: xiii; Rodger 1997: 347–63). Though these campaigns were far from successful (a consequence of Charles I's abysmal naval administration and his dreadful Lord Admiral, the Duke of Buckingham) they took place at just the time drakes were beginning to enter naval service, so

Butler's low opinion of them was probably rooted in first-hand and perhaps hard-won experience.

It seems likely that the drake, while no doubt excellent for use in the field (for which, apparently, it was originally designed), where its lightness would have been a virtue and its boisterous recoil much easier to manage, was from the outset problematic at sea. Contemporary land carriages, with their pairs of large-diameter spoked wheels and long downward-angled trails, were designed to operate without any form of tethered restraint. On recoil the heel of the trail tended to dig in, causing the coupling effect of the recoil axis along the barrel to lift the gun and its attached carriage bodily off the ground. This progressively and smoothly absorbed the recoil forces. Such a procedure would have been impossible to follow at sea, as discussed below. Yet no doubt the ingenious technology which lay behind the drake as a successful light field-piece, pushed by the vigorous entrepreneurship of English gunfounders led by John Browne, brought it to the attention of naval administrators (who would value the economy of such pieces) and of Charles I (who, because of the lighter weight of such guns, could cram more aboard his ships and so enhance his prestige). No one in a position of power and influence, apparently, thought to assess their actual shipboard performance or to consult the sea-gunners who would have to operate them. If so, it would not be the first or last time that political expediency and wishful thinking on the part of state authorities and bureaucrats has driven armament policies in ill-judged directions.

Nonetheless drakes continued to be manufactured into the second half of the 17th century, as shown by the recent recovery of a Commonwealth cast-iron culverin drake from the sea off Holland (Wilson 1988; it is now in the Royal Armouries). Probably a casualty of the battle of Schveningen between the English and Dutch fleets in 1653, the gun may have been cast in 1652 by George Browne, John's son and successor. As the century progressed, however, the term 'drake' became ever more vague, and the guns so described are increasingly heavy and lengthy, while their tapered chambers give way to 'home bores' (parallel-sided ones). It is beyond the scope of this report to examine the convoluted and rather mysterious demise of the drake over the second half of the century, although the subject has usefully been investigated by Towes & McCree (1994).

7.4 Disposition of armament

As argued in Chapter 4 the ship appears to have broken up in a relatively coherent and predictable manner, and most items have not moved far from where they were originally deposited. This will have been particularly so in respect of heavy objects such as guns, so their relative positions on the sea-bed today probably broadly reflect their original locations within the ship. A systematic metal-detector survey in 1997 recorded no hits which could be interpreted as buried guns, so the eight now identified probably represent the ship's full complement. *Swan* had five guns when she was purchased for the state in June 1653, but armament levels were frequently adjusted and we know that the Ayr-based contingent of Cobbett's fleet, which included *Swan*, had called at Knapdale to collect some pieces of artillery (Chapter 1.2). So we may therefore conclude that *Swan* mounted eight guns on her main deck, probably disposed as suggested in Illus 214.

Guns 4 and 6, provisionally identified as sakers, lie close to the port and starboard quarters of the forward ballast-mound, and were probably mounted well forward in the bow. Even allowing for a bluff shape to the bow, as argued in Chapter

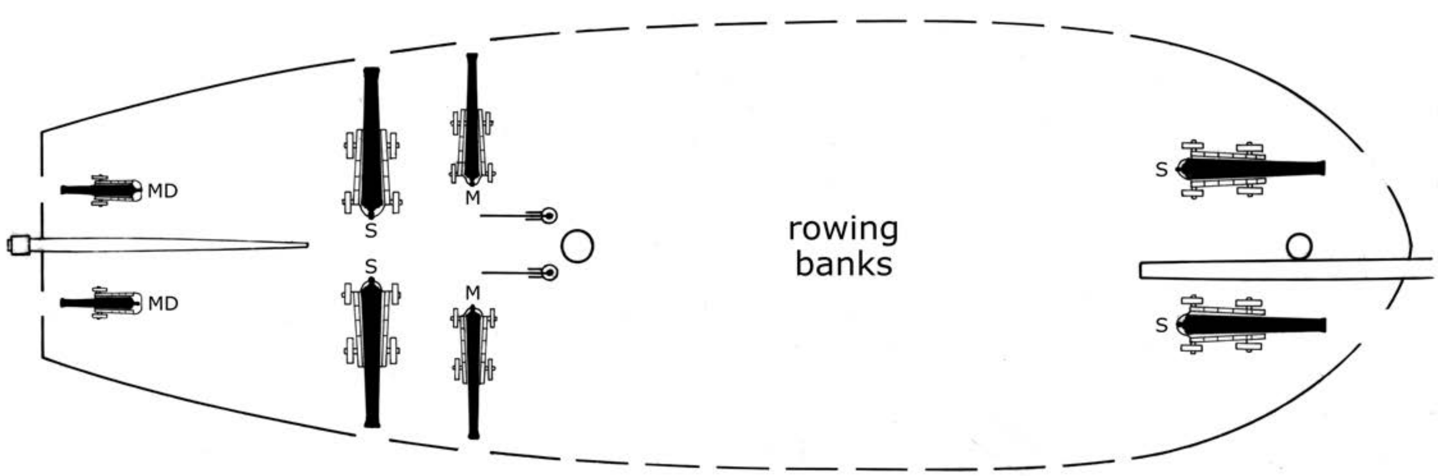


Illustration 214
Suggested arrangement of guns on the main deck. M = minion; S = saker; MD = minion drake (DP 174816)

5.1, there would scarcely have been room on the narrowing deck to operate long guns of this kind opposite one another on the broadside, which in any case would have been encumbered by the foremast, bowsprit, and galley structure. A more likely disposition would be in parallel, pointing forward through the bow on the port and starboard sides.

There are no guns in the midships part of the wreck, which suggests that none had been mounted there. This is best explained by the fact that the ship is known to have possessed auxiliary oar-power. Although some oar-assisted sailing ships combined sweeps and guns amidships, either by arranging them in tiers or by alternating oar-ports with gun-ports along the same deck, such solutions were not always practicable. Alternating guns and oars on a single deck would have raised problems of space, particularly in a small ship.

Four guns (Guns 1, 2, 3 and 5), however, cluster in the after part of the ship, on and around the aft ballast-mound. They presumably fell there from the collapsed upper deck. Two appear to be sakers, one a minion, while the fourth is of indeterminate type, though it is probably either a saker or minion too. We can reasonably suppose that these were mounted in pairs on the main-deck broadside, two to port and two to starboard, aft of the mainmast. The gun-port lid at **088.087** no doubt belongs to one of them. The identification of a cartridge-box [84] and powder-scoop [85] appropriate to guns of saker calibre with parallel-sided chambers strongly suggests that the four putative pieces of this type (Guns 1, 3, 4 and 6), and probably the pair of putative minions as well (Guns 2 and 5), were not drakes but 'home bored' guns – that is, they have untapered chambers of the same diameter as the bore.

Gun 8 [82] is the small minion drake, complete with its carriage, which lay at the upper end of the transom complex. As argued above, its position and associations suggest that it was mounted at the aft end of the main deck, pointing through the stern on the port side as suggested in the general arrangement reconstruction of the ship (Illus 159). If this interpretation is correct there would probably be a matching piece on the starboard side, for which a candidate may be Gun 7, the small broken piece some way distant from the main site which appears to have been displaced in 1979.

7.5 Working the guns

There has been much debate about the working of guns at sea during the 16th and 17th centuries (Laughton 1928; Rodger 1996; Martin & Parker 1999). In particular it is unclear when loading on the recoil – that is, allowing a gun to travel inboard using the rearwards momentum generated by firing, restrained only by its mass and the friction of its breeching tackles and truck wheels – was first introduced. This brought the gun back into the loading position without effort from its crew, and led to the high rates of fire achieved by sailing navies of later eras (Rodger 2004: 539–42). Before this procedure was introduced guns were generally secured to the side of the ship by breeching-ropes before firing, a much less efficient process which not only placed considerable stress on the vessel's structure but also required the guns to be unhitched and manhandled inboard for reloading. Alternatively pieces could be left secured in the run-out position, and loaded outboard by a crew member perched precariously astride the muzzle (Konstam 1988: 19–20).

It is generally agreed that loading on the recoil through running tackles was introduced during the first half of the 17th century, but it was adopted gradually and, on smaller ships in particular, the older system continued until the end of the century and perhaps beyond. Laughton (1928: 340) cites an encounter between an English merchantman and five small pirate ships off the Cape Verde Islands in 1686 in which the former drove off the latter by picking the gunners off with musket fire as they attempted, somewhat unadvisedly, to load outboard.

It is unlikely that Gun 8, the minion drake, with its 'boisterous reverse' and strong upwards kick, could have been allowed a free recoil to carry the assembly inboard for reloading. It must therefore have been secured to the ship's structure during firing to restrain its upwards and backwards movement. Not all the strain would have been taken directly by the hull-timbers. It is likely that the breeching-rope was allowed some slack so that cushioning friction would be generated by the initial slide over the deck, as experimental firing tests on replicas of guns and carriages from the *Mary Rose* have demonstrated (Hildred 2011: 127–9). The elasticity of the breeching-rope after pulling taut would also absorb some of the recoil, as would the additional friction provided by the rear chocks. The low set of the trunnions, moreover, would create a downwards couple at the breech during recoil, which would increase the pressure of the chocks against the deck (I am indebted to Fred Hocker for this observation). We must suppose that such guns were manageable under battle conditions or they would surely have been discarded, though Butler's forthright Captain was probably right when he said they were tricky to handle, and 'are not to be held in any great account for service at sea' (Perrin 1929: 260–1).

We can be less sure of the operating procedures used for the ship's larger guns, but the restricted space available would have made it difficult to employ the recoil method. The two pairs of broadside guns aft of the mainmast, if mounted on truck carriages, would have extended at least 1.6m (5ft 3in) inboard when fully run-out, so between them they would occupy 3.2m (10ft 6in) athwartships, considerably more than half the gun-deck breadth available at this point. Brought fully inboard, whether by recoil or manhandling, they would have run foul of each other. If only one broadside was engaged at a time, recoil firing might have been possible, but the fixed-tackle option was probably a safer alternative. The same is likely to have been true of the forward-firing guns in the bow.

Gun-port lid

During the investigation of the collapsed after-castle a composite wooden object with concreted iron fittings was located at **088.087** (Illus 215). It was approximately square, 60mm (2⅓in) thick, with sides 0.51m (20in) long. A slightly smaller square piece of similar thickness was fixed to its underside to leave a flange of *c* 25mm around the outside. The grain of the two elements ran at right-angles to one another, and what appeared to be two wrought-iron straps were fixed to the outer face. The object was clearly a gun-port lid and the intention was to raise it for conservation and study, but unfortunately operational considerations at the close of the season precluded this. It was left protected by sandbags so that it could be located and recovered the following season, but the sandbagging became consolidated with fresh silting during the winter to such an extent that it was felt that the disturbance involved to retrieve it would not be justified. However the object had been photographed in situ and its primary measurements obtained, and this information is presented in Illus 216.

Mainwaring, writing in the 1620s (Manwaring & Perrin 1922: 200), prescribes a 30-inch port for a 9-pounder demi-culverin, so a 20-inch port would be for a significantly smaller piece. As argued above, the Duart Point ship's armament probably included full-bored 5-pounder sakers and 3½-pounder minions, and perhaps a pair of the smaller and lighter 3½-pounder minion drakes. One of the drakes seems the most appropriate candidate for the 20-inch port lid, a supposition reinforced by the fact that Gun 8 is the piece closest to the lid, which lies only 2m from it. The next nearest (Guns 1 and 2) are 4.5m away.

Illustration 215
Gun-port lid at **088.087** lying on top of the framed-and-panelled door [17].
Scale 15 centimetres (DP 173891)

Cartridge-box

[84] DP97/A009, **077.095**, a segment of a hollow cylindrical object with a solid base, turned from poplar (*Populus tremula*) (Illus 217–18). Its external diameter is estimated as 120mm and its internal diameter 94mm. The base is 78mm thick and its surviving overall height is 378mm, although the extreme top is missing. An external collar of semi-circular section surrounds the exterior 275mm from the foot, and four narrow beads are spaced at roughly equal intervals from the base upwards. The object is shown restored to its estimated diameter in Illus 218.

A substantial number of almost identical objects, most of them complete and with associated lids, have been recovered from the wreck of *Invincible* (1758) (Bingeman 2010: 107–10). These have been identified as the boxes in which gunpowder-filled cartridges of paper, parchment, or cloth were carried from the powder-room to the gun-decks during action. The *Invincible* boxes are in three sizes, appropriate to 9-, 24- and 32-pounder guns. Their flanged lids plug into the tops of

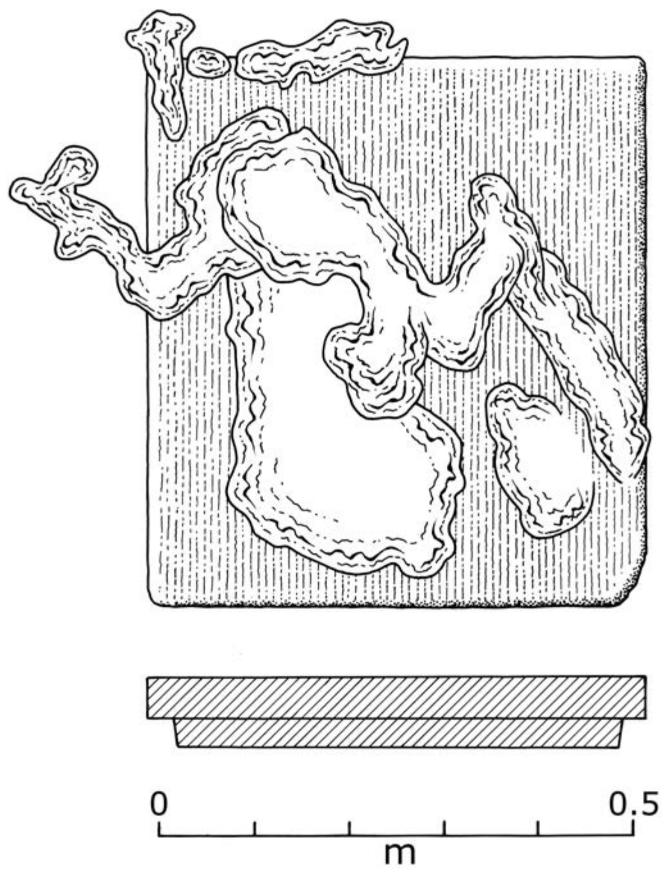


Illustration 216
Gun-port lid with concretion associated with its hinges. Drawn in situ and from photographs. Its dimensions are reliable but its geometry may not be precise.

Illustration 217
Segment of a wooden powder-cartridge box 84 in situ. Scale in centimetres (Steve Liscoe, DP 173946)

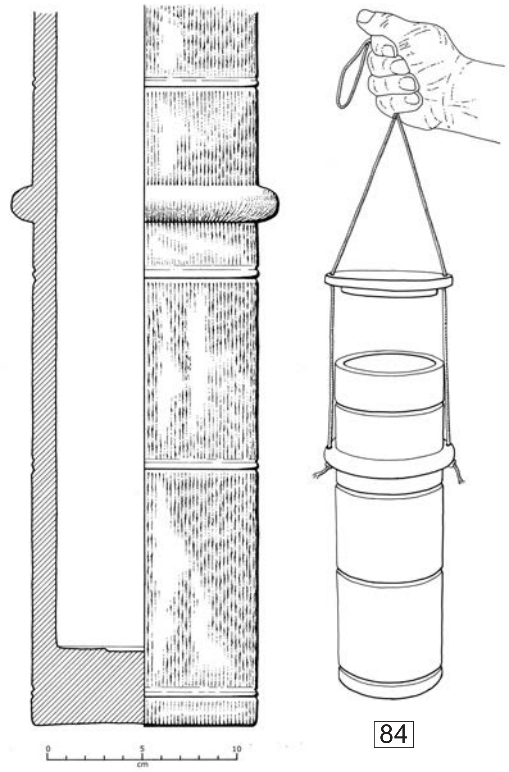


Illustration 218
Drawing and reconstruction of the wooden powder-cartridge box 84 (DP 174824)

the boxes. Looped lanyards anchored by terminal knots in holes drilled through the collars pass through holes in the flanges of the lids. Thus when a box was slung its lid was held secure, but when the lanyard was released the lid could quickly be opened and the cartridge extracted, although the lid would remain secured to the lanyard. A diagrammatic reconstruction of the system is shown in Illus 218. This simple procedure, well suited to the stresses and confusion of battle, is similar to that followed by musketeers with their bandolier-slung powder boxes.

The efficacy of this simple design is emphasised by the century that separates the *Invincible* and Duart Point wrecks, during which it remained essentially unchanged. It apparently continued in service until the end of the smooth-bore muzzle-loading era, as evidenced by a detail showing a wounded powder-monkey holding a lanyard-slung collared powder-box in Denis Dighton's well-known painting *The Fall of Nelson at Trafalgar*, painted in 1825 and now in the National Maritime Museum (BHC0552).

As far as I am aware the Duart Point find is the earliest recorded example of the collared type of cartridge-box, but earlier forms are known. Turned wooden cases without collars are known from *Vasa* (Cederlund 2006: 351), and while these have tentatively been identified as case-shot canisters I am informed that their exterior diameters are too great for the calibres of the ship's largest guns so they cannot have served this purpose. Their interior diameters do, however, match the guns' calibres, so they are more plausibly identified as powder-boxes (Fred Hocker pers comm). Sheet-copper powder-boxes with lids have been found on the *Batavia* wreck (1629). A loaded iron gun of culverin calibre (125mm) from *Batavia* contained a tampion, wadding, a 110mm roundshot, and a linen powder-cartridge (Green 1989: 54, 64–5, 67)

A 1665 inventory of ordnance stores in the Tower of London notes 2608 'Cases of wood for Cartouches' representing all calibres from 3-pounders to 'Cannon of 8 [inches calibre]' (TNA WO55/1699, transcribed by Blackmore 1976: 309). There are earlier indications of cartridge containers, though their forms are not specified. In 1558 William Wynter instructed that 'if he [the master-gunner] shall need to lade his brass or cast pieces, to do it by cartridge covered in mantles [a word meaning, in this context, some kind of protective container], or some other thing out of hazard of fire' (Corbett 1905: 367). Lord Wimbledon's Fleet Instructions of 1625 state that in every ship there should be men 'of good understanding and diligence … forthwith appointed to fill carthouses [cartridges] of powder, and to carry them in cases or barrels covered to the places assigned' (Corbett 1905: Lord Wimbledon 1625/3/19).

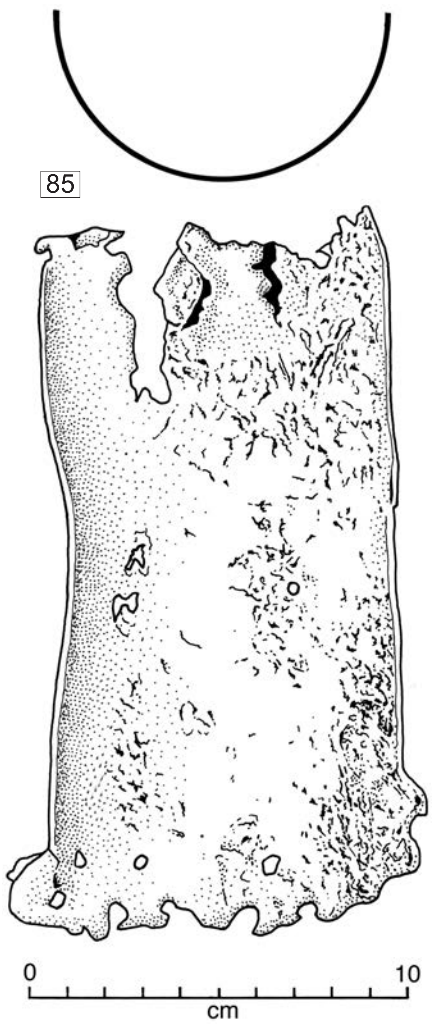
Sir Henry Mainwaring, writing in the 1620s, has much of relevance to say on these matters, and is here quoted in full:

> A cartridge is a bag made of canvas which is reasonable good, being made upon a former, the diameter whereof must be somewhat smaller than the cylinder of the piece, and of such a length or depth as that it shall contain just so much powder as is in the charge of the piece. This is wondrous necessary for our great ordnance in fight both for speedy lading our ordnance and also for saving the powder, which is in danger to be fired if in fight we should use a ladle and carry a budge barrel [an open powder-barrel] about the ship. These cartridges are many times made of paper, parchment, or the like, but are not so good as the other. There are also other cartridges, or more properly are to be called cases for cartridges, which are made of latten [brass], in which we put these other cartridges to bring alongst the ship so much the safer from fire, till we put them into the piece's mouth; which is a care that in fight there cannot be too much diligence and order used (Manwaring & Perrin 1922: 119–20).

Towards the end of the 17th century Thomas Binning (1676: 109) recommended that sea-gunners should have 'to every piece 24 cartridges at least, ready made, to wit 12 filled and 12 empty in sort', and keep them in marked chests or barrels.

The appearance of an item which suggests the application of such procedures on a small vessel of limited importance on a remote Scottish station in 1653 has wider implications. Ships largely constructed of wood, fibre, and tar were naturally combustible, and when gunpowder, the use of fire in battle, and the malign intentions of an enemy eager to exploit every weakness are added to the mix the dangers become real and immediate. The carefully designed powder-box from the Duart Point wreck hints at well-established procedures of risk-management, with secure gunpowder stowage, spark-resistant handling arrangements, and safe delivery to the guns when required in spark-proof containers which were easy to carry and operate. The sophisticated powder-handling routines of Nelson's era may have had earlier roots than has previously been supposed.

85 DP00/171, **106.079**, damaged semi-circular copper-alloy powder-scoop, 190mm × 88mm (Illus 219). Evidence of nail-holes for attaching to a wooden former along the rear edge. Appropriate to a bore of saker calibre (3½ins, firing a ball of *c* 5lb).



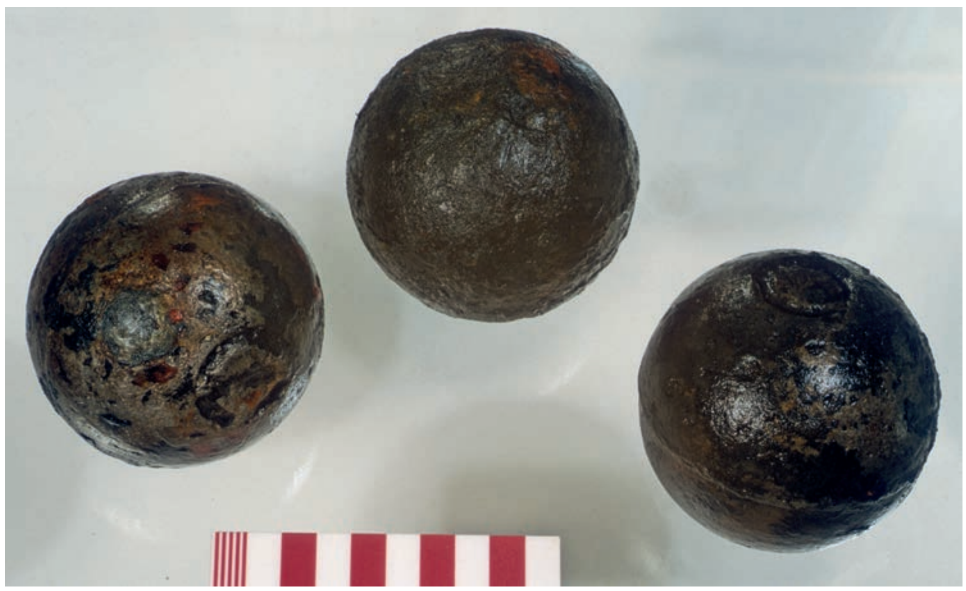


Illustration 220
Three cast-iron roundshot 86 of saker calibre (*c* 5-pounder). The piece on the right shows the flash of a two-part mould around its middle, and on the top the cut-off sprue scar. Scale in centimetres

Illustration 219
Copper-alloy powder-scoop 85

Illustration 221
Outside and inside views of two conjoining segments of a wooden shot-case 87
(DP 174293, DP 174294). Note the grooves for cord bindings

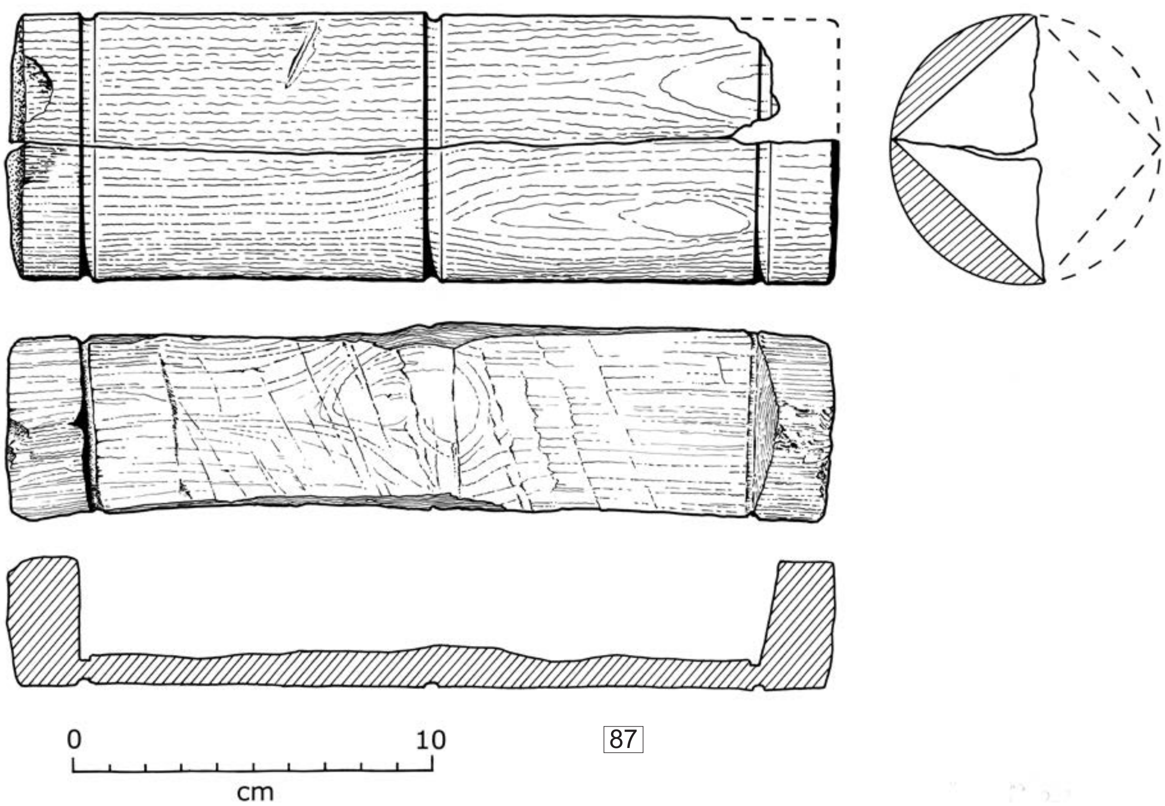


Illustration 222
The shot-case segments 87

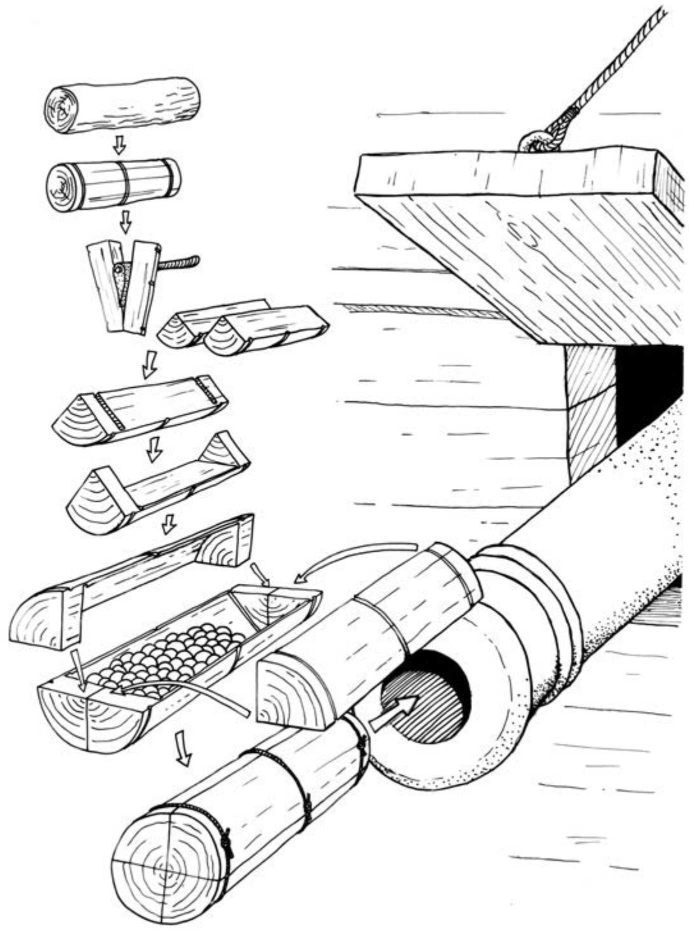


Illustration 223
Reconstruction of the processes involved in the manufacture and operation of case-shot (Graham Scott DP 174819)

7.6 Projectiles

Iron roundshot

86 DP99/122, inside wooden chest 110, **095.088**, three cast-iron roundshot (Illus 220). They were accurately cast in two-part moulds, leaving distinct mould-lines around their circumferences and scars where the sprue had been chiselled off. Their diameters are 84mm (3.3in) (two examples) and 85.5mm (3.4in). Their original weights, assuming a specific gravity of 7gm/cm^3, would be 4.8 and 5.05lb respectively (2.18kg and 2.29kg), straddling the 5lb saker median.

Wooden case and burr-shot

87 DP99/032, **075.094** and DP99/076, **079.096**, two conjoining segments of a four-piece cylindrical wooden container were found close to Gun 8 (Illus 221–2). The container had been turned from a small-diameter piece of alder roundwood (*Alnus* sp) (a round billet, probably from a straight branch), with growth-rings radiating from its centre. Such work would be well suited to a simple pole-lathe. Three grooves had been turned around the cylinder, one towards each end and one in the middle. The billet had then been quartered along the grain with an axe (the radial grain-structure facilitating this operation) and saw-cuts made close to the ends of each piece, allowing the central waste to be removed. Tool-marks suggest that the latter operation was carried out with a draw-knife, perhaps used in conjunction with a shaving-horse. These basic but effective processes are typical of a traditional woodland craftsman, probably working in the forest using green wood (Abbott 1989). Because the quarters had been split rather than sawn none of the wood would be lost to kerfs (the width of saw-cuts), and the pieces would reassemble as a true cylinder held together with cords around the grooves. The case would hold the projectiles secure in the barrel, but disintegrate during firing. Once clear of the barrel its load of lead balls would spread in an expanding cone of fire (Illus 223). Similar wooden cases of four conjoining pieces were found on the *Batavia* wreck (1629) (Green 1989: 60).

The reconstructed container is 76mm (3in) in diameter and 230mm (9in) long with an internal box, formed by the cut-out segments, 50mm (2in) wide and 180mm (7in) long, with a capacity of *c* 450cc. This would be sufficient to contain about 48 lead balls of 19mm (¾in) diameter, which is the 12-bore (12 to the pound) calibre of many of the musket balls found on the site. The diameter of the container, and its capacity for 48 balls with a total weight of 4lbs (1.81kg), match the projectile specifications of a minion drake.

Several musket-calibre lead balls recovered from the site have had their surfaces systematically gouged with a sharp implement (see Chapter 8). These were probably intended as dum-dum rounds to be fired from muskets (Foard 2012: 104) – captured royalists were executed at Colchester when found in possession of such bullets (Carlton 1992: 322–3). They might also have been intended for use in wooden cases like the one described above. An ordnance inventory of 1634/5 (TNA WO55/1690, cited by Blackmore 1976: 287–306) contains several references to wooden cases filled with burr shot, and while there is no positive indication that the projectiles were of lead, the term 'burr' might imply roughening or gouging in the manner noted on the Duart Point examples. However, recent experiments have shown that acceleration forces on a load of cased lead balls fired from a cannon barrel smoothed and distorted them (Foard 2012: 104; see Chapter 8). Contemporaries may not of course have been aware of this effect, so the question remains open. John Smith (1627:

86) describes cases made of 'two pieces of hollow wood joined together … fit to be put in the bore of a Piece', and filled with 'any kind of small Bullets, Nails, old iron or the like'. Two-part wooden cases filled with fractured flint have been recovered from the wreck of *Mary Rose* (Hildred 2009: 320).

Contemporary sources identify such projectiles as being particularly suited to drakes. The Navy Commissioners' detailed consideration of drakes during their meeting in March 1627 noted the difficulties encountered with the breech-loading guns previously used in an anti-personnel role, observing that they are 'subject to tumble out of their cases and to offend the Gunner that gives fire through the vent of their chambers which are worn or can seldom be fitted as they ought'. Closed-breech drakes, on the other hand, 'are more nimble and proper for their uses, as well through bulkheads as from the upper places of deck, half-deck, or forecastles' (Towes & McCree 1994: 41). The Duart ship's presumed rearward-firing minion drakes would have been well placed to fulfil such a role. It seems that the drake, for all its inadequacies as part of a ship's main armament, at least represented a significant if short-lived improvement in her close-quarter capability.

Chapter 8

OTHER FINDS AND RELATED ACTIVITIES 1

8.1 Navigation

It is unlikely that the Duart Point ship, which appears to have operated mainly if not exclusively off western Scotland and around the Irish Sea, would have been equipped for long-distance open-water voyaging or global position-fixing (Taylor 1956; Waters 1958). No evidence has been found on the wreck of instruments such as the cross-staff or astrolabe, used for measuring the altitude of the sun to determine latitude. Nor is there any equipment to suggest the practice of dead reckoning, which involved running out a line pulled by a wooden drogue, or log-ship, in the vessel's wake over a timed period (usually half a minute) to calculate speed through the water (Taylor 1956: 201; Bingeman 2010: 98–103). This, together with routinely recorded compass headings and regular observations to determine latitude, allowed the ship's progress to be estimated and its positions plotted sequentially. Had such procedures been routine aboard the Duart Point ship it is probable that traces of the distinctive equipment required – instruments for measuring altitude, logs and lines, tabulated slates for recording observations (or traverse boards, which served a similar purpose), and sand-glasses for timing – would have survived among the collapsed interior of the stern, where a substantial cache of more basic navigational equipment suitable for coastal voyaging has been found.

These include the remains of a binnacle, parts of three mariner's compasses (one substantially intact), three compass-box lids, and two pairs of dividers. In 1991 or 1992, before the site was designated, a sounding-lead was found on the wreck by a casual visitor, though exactly where is not known. These items suggest that traditional pilotage techniques were practised on board, as would be appropriate for a ship in regular visual contact with the distinctive inshore sea-marks which characterise the confined waters of Britain's western seaboard. Detailed local knowledge of landforms, havens, anchorages, tides, and currents would have been a navigator's primary assets in such an environment. To find his way around this juxtaposition of sea and land he would have needed to know only where he was with reference to known sea-marks, his ship's heading, the depth of water under the keel, and the character of the sea-bed. This information could readily have been be obtained with compass and lead-line alone (Hutchinson 1997: 164–9), and both have been found on the Duart Point wreck.

The binnacle

88 DP96/004, **002.015/011.014**, the remains of a wooden box-binnacle lay just below a semi-mobile surface layer within an isolated deposit some 10m north-east of the aft part of the main wreckage (Illus 63). The rear part of a box-like structure of pine now measuring 930mm × 430mm × 122mm (Illus 224), it is fastened with square-sectioned oak pegs 14mm long and 4mm square at the top, tapering to a point, which suggests that they were hammered in like nails. Seven components (or parts of them) survive. Two rear planks 14mm thick are edge-joined with an overlapping rebate, and held together by side pieces 3mm thick. One of these remains in place, while peg-holes on the opposite side indicate a similar arrangement. The rear planks are tangentially derived, and tool-marks indicate that they were trimmed to a constant thickness with an edge which has left a slightly concave signature. A 30mm plank spans the side pieces, and can be identified as the top of the box from the burn-marks discussed below.

Slots cut into the top plank house the remnants of two internal panels, 10mm thick, dividing the box into three compartments. The two outside compartments are *c* 0.3m wide, suggesting that the intended measurement had been one English foot (0.305m), while the central compartment is 0.2m (8in) wide. A 0.1m-diameter aperture is cut through the rear of the left-hand compartment. The purpose of this hole is unclear, though it may have provided draught-free ventilation for a light in the adjacent central compartment. In the upper right-hand corner of the left compartment lay the lead-ballasted wooden base and brass pin of a mariner's compass 78. That the assembly had extended below the second transverse rear plank is evident from a rebate cut along its lower edge to receive a third plank. Unlike the rebate in the

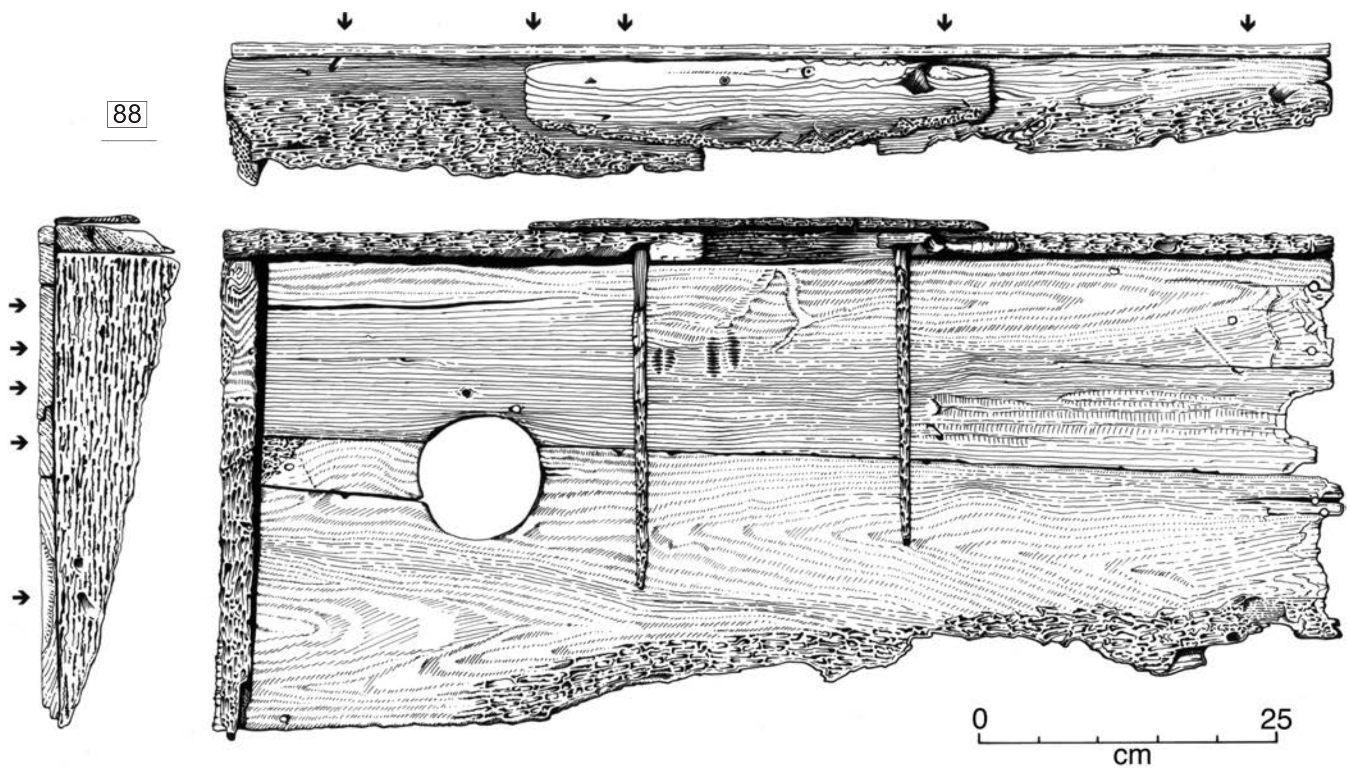


Illustration 224
The remains of the binnacle 88, showing the relationship of its components. Arrows indicate the locations of the oak pins (Peter Martin, DP 174865)

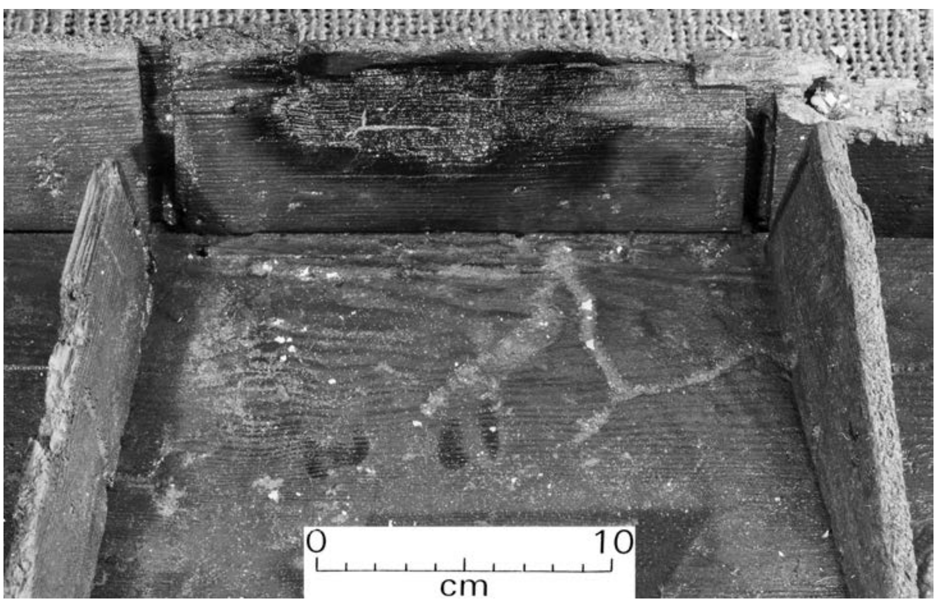


Illustration 225
Detail of the binnacle's central compartment, showing the burnt hole in the top plank and the repair patch. Four small scorch-marks can be seen within the compartment (DP 173211)

top plank, which is lapped externally to throw water from the joint, the second was lapped internally, which would have rendered it prone to water ingress from the outside and consequent rot. This was probably a mistake, perhaps reflecting inexperience on the part of the maker.

These structural characteristics, together with the associated compass-base, unambiguously identify the object as the rear part of a binnacle, or bittacle, of the type described by Sir Henry Mainwaring in his *Seaman's Dictionary* of *c* 1620–3 (Manwaring & Perrin 1922: 98–9):

> A Bittacle is a close cupboard placed in the steerage before the whip or tiller, wherein the compass doth stand, which is not fastened with iron nails, but wooden pins, because that iron would draw the compass so that it would never stand true. These

> are to be so contrived, that they may carry a candle or lamp in them to give light to the compass, so as they dispense no light, nor yet any be seen about the ship.

John Smith (1627: 11), confirms these arrangements: 'before him [the steersman] is a square box nailed together with wooden pins, called a bittacle, because the iron nails would attract the compass. This is built so close, that the lamp or candle only showeth light to the steerage'. The etymology of the word has been discussed by Waters (1955: 198–9), who notes a shift in usage from 'bittacle' to 'binnacle' during the 18th century. While the latter term is therefore technically an anachronism when applied to the Duart Point find, it is used here for clarity.

Traces of burning on the back of the central compartment confirm that it had housed a flame, presumably from a candle or lantern (Illus 225). Four small scorch-marks are evident on the back of the compartment, while a slightly irregular hole with burnt edges some 0.12m across penetrates the top plank. The direction of burn indicates that this plank had faced upwards when the mishap occurred, confirming the orientation of the binnacle as interpreted above. It may be supposed that an inattentive steersman had allowed the illuminating flame of the candle or lantern inside to burn through its top. The damage was roughly repaired with a wooden patch secured with iron nails. The use of such nails is contrary to the strictures of Mainwaring and Smith, who rightly identify iron fastenings in a binnacle as a cause of magnetic deviation, and specify the use of wooden pins throughout. It is noteworthy, however, that both authorities failed to recognise the greater errors inherent in placing two magnetic needles so close to each other. The provision of a compass at either end of the binnacle was intended to give the steersman at the whipstaff clear sight of one from whichever side of the deck he happened to be standing (Lavery 1987: 26). This arrangement must have caused significant inaccuracies because of the mutual attraction of the needles.

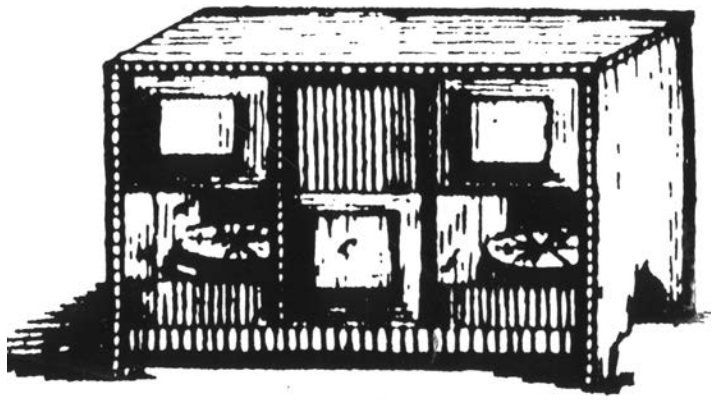
This type of three-compartment binnacle is illustrated by Falconer (1780: pl I, no 4) (Illus 226 top), who describes the object as

> a wooden case or box, which contains the compass, log glasses, watch glasses, and lights to shew the compass at night … The Binacle is furnished with three compartments, with sliding shutters: the two side ones always have a compass in each, to direct the ship's way, while the middle division has a lamp or candle, with a pane of glass in either side.

This arrangement is shown in a watercolour of a view from the poop of the warship *Deal Castle*, painted in 1756 (reproduced in Lavery 1987: 26). Falconer notes that two binnacles were provided on warships, one for the steersman and the other for the officer of the watch. However a small vessel such as the Duart Point ship probably contained only one, positioned immediately forward of the whipstaff.

Early binnacles from archaeological contexts are rare. An upright box-binnacle was found in a wreck believed to be that of the Basque whaling ship *San Juan*, lost in Red Bay, Labrador, in 1565 (Grenier et al 2007: 147–9). It too had burn-marks inside, and iron nails had been used in its construction. One of the compass-boxes found on *Mary Rose* (1545) was also fastened with iron (Stimson 2005: 269–70). The undesirability of iron in the proximity of compasses was evidently not appreciated in the 16th century.

It appears that three-compartment binnacles came into use around the beginning of the 17th century (Lavery 1987:



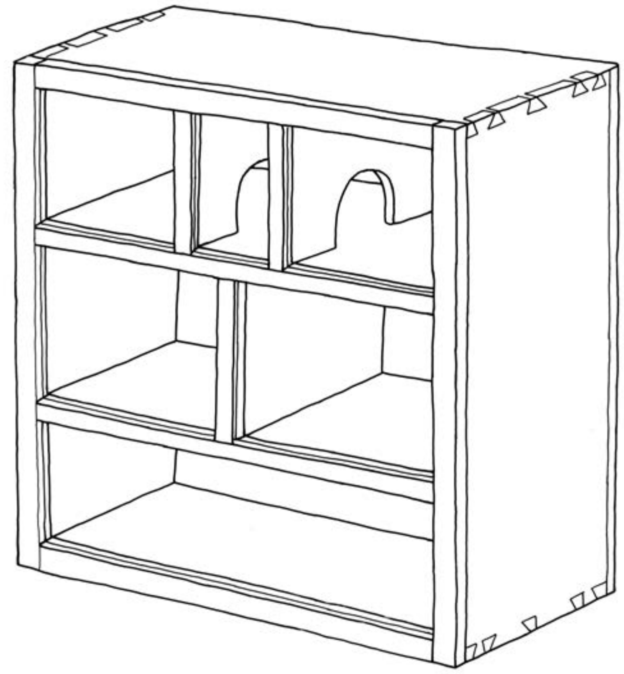


Illustration 226
Top: an 18th-century binnacle from Falconer's *Universal Dictionary of the Marine* (1780). Bottom: a reconstruction of the Stinesminde binnacle of *c* 1640 (after Gøthche 1994: 184, fig 7)

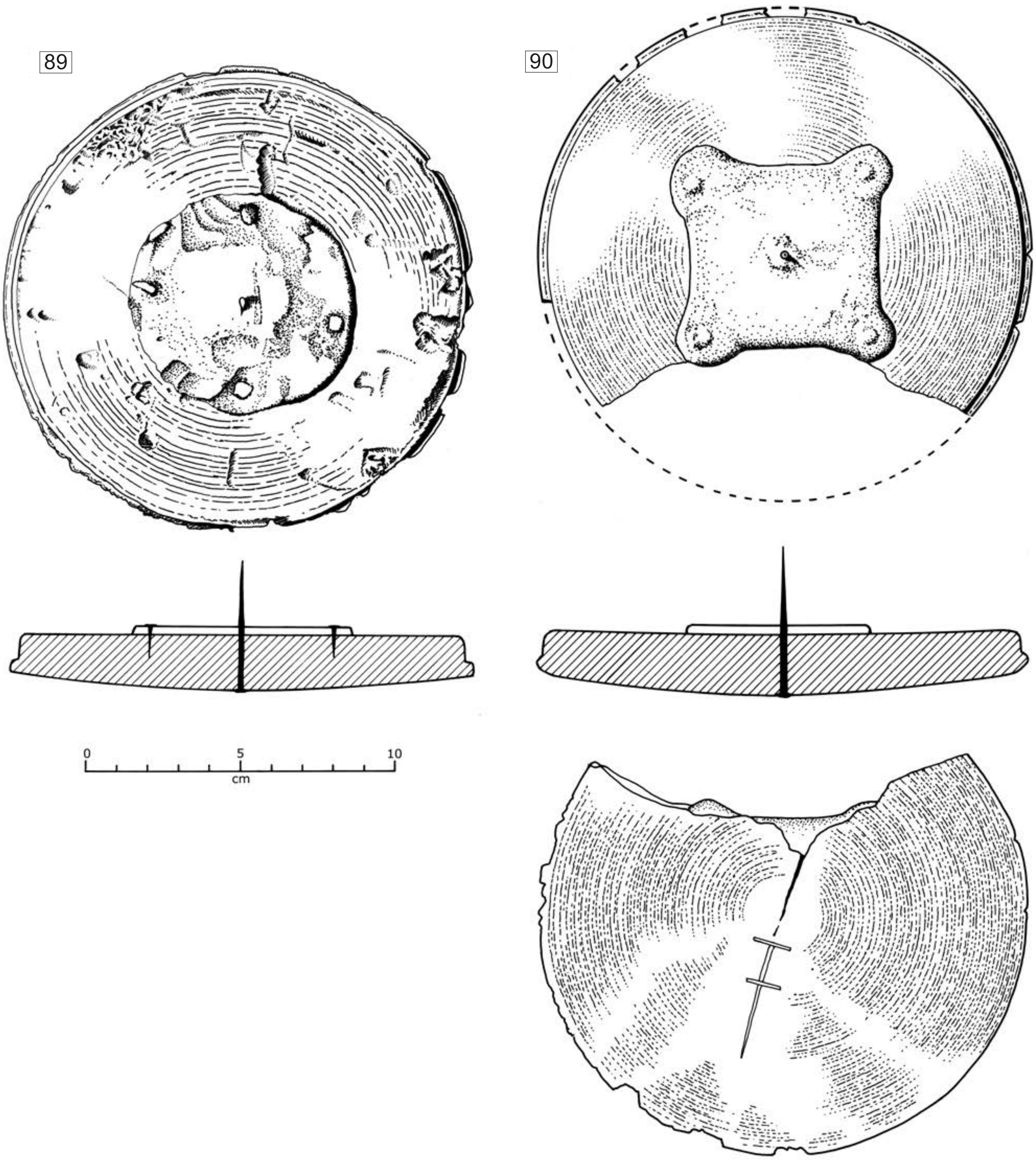


Illustration 227
Left: compass-base 89, found inside the binnacle. Right: compass-base 90, showing a crack in the base repaired by the insertion of two copper-alloy dogs

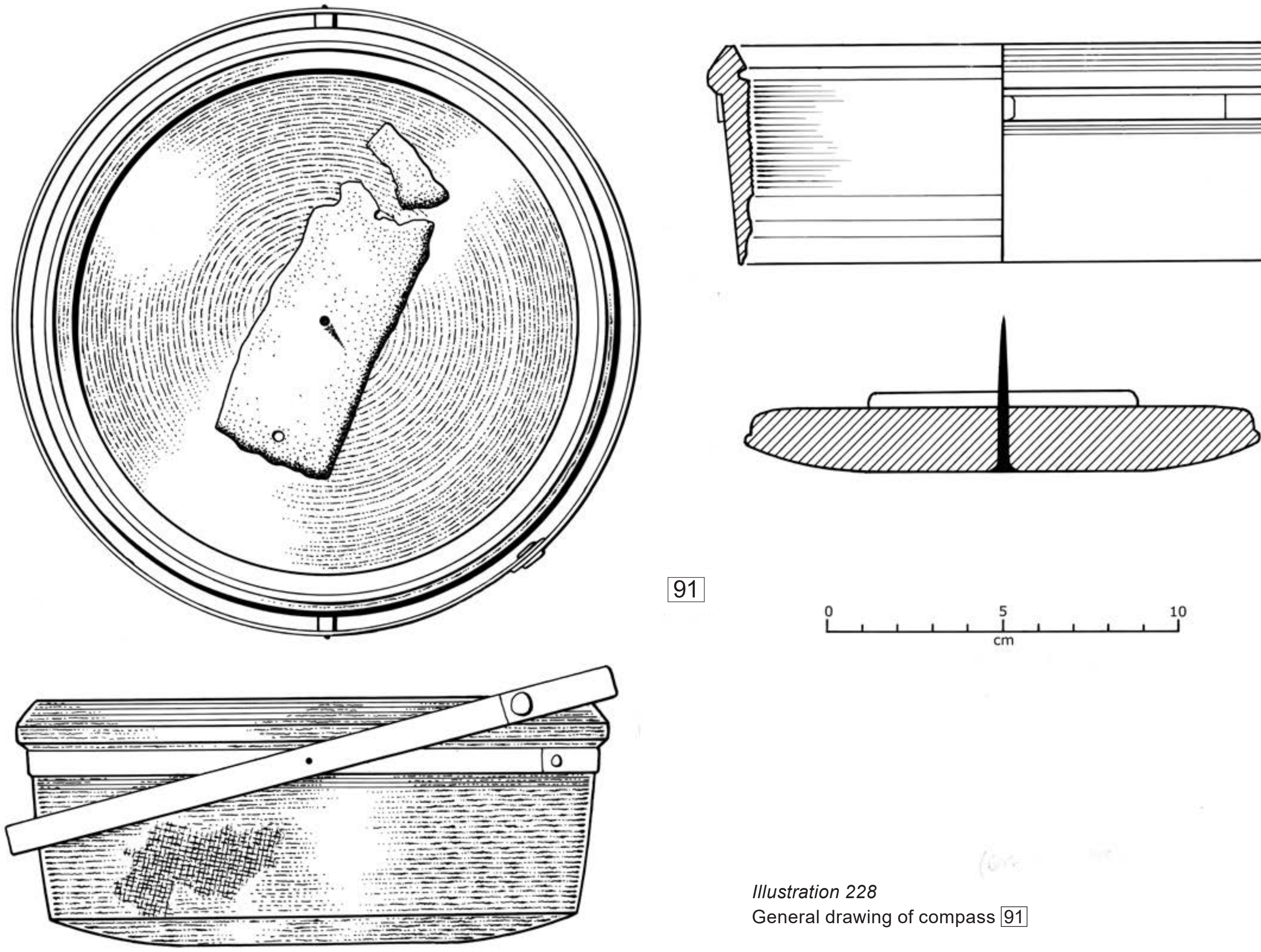


Illustration 228
General drawing of compass [91]

26). The supposition is supported by the present find, and by the identification of a similar and more intact binnacle on the Stinesminde wreck off north Jutland, which has been dated to *c* 1640 (Gøthche 1994: 184, fig 7). The Stinesminde binnacle is of pine, and consists of an open-fronted box with a base and two shelves (Illus 226 bottom). Its top shelf is divided into three compartments of which the central is the narrowest and the outer ones are equal, as on the Duart Point example. Two semi-circular cuts in the partitions allow light to pass from the central compartment onto the compass faces. It is likely that the lower shelves provided stowage for charts and associated navigational equipment. The incomplete Duart Point binnacle was probably of similar form.

Mariner's compasses

Waters (1958: 26–9) has described the construction of the mariner's common sea-compass of early modern times, based on Richard Eden's 1561 translation of Martin Cortes's *Arte de Navigar* (1551). The description accords closely with the Duart Point instruments, the characteristics of which are discussed below.

[89] DP96/003, **009.013**, compass-base, 150mm (6in) in diameter (Illus 227). The turned base of a mariner's compass in poplar was found inside the left-hand compartment of the binnacle [88]. The bottom is slightly rounded, and its lower rim is finished with a semi-circular bead. A 70mm-diameter lead ballasting-disk has been nailed to the middle of the base with four broad-headed copper-alloy nails, to dampen the instrument's movement from the horizontal as it swung on its gimbals. The pin on which the needle rotated is also of copper alloy, driven through the centre of the base to protrude 24mm above its upper surface.

[90] DP00/016, **093.106**, a partly broken compass-base was found beneath Gun 8 [82] (Illus 227). Like compasses [89] and [91] it was turned from poplar, with a diameter of

Illustration 229
The bowl, gimbal-ring, and base of compass 91. Note the patch of fabric adhering to the bowl near the bottom left (DP 173338, DP 173339)

160mm, and was the largest of the group. It is of similar design, with a beaded lower rim and rounded bottom. A square lead ballast-weight has been hammered at the corners to create rounded tabs by which it is fixed to the base with four copper-alloy nails. The central copper-alloy pin passes through the base and extends 30mm above it. A serious crack in the base has been repaired (or possibly a manufacturing imperfection concealed) by the insertion of two almost-invisible copper-alloy joiner's dogs.

91 DP97/A050 (base) (DP97/A051) (glass) and DP97/A035, **060.095**, excavation some 10m inshore from the binnacle complex revealed another mariner's compass (Illus 228–30). The 170mm-diameter compass-bowl is turned from poplar, as is the 150mm-diameter base. Its height of 65mm is about half the presumed diameter of the missing card or 'fly', the proportion ascribed by Waters (1958: 26–9) in his description of the European mariner's sea-compass from the 16th century onwards. Its thickened rim, of flattened triangular section, is grooved on the inside to accommodate the glass face, which was sealed with resin,

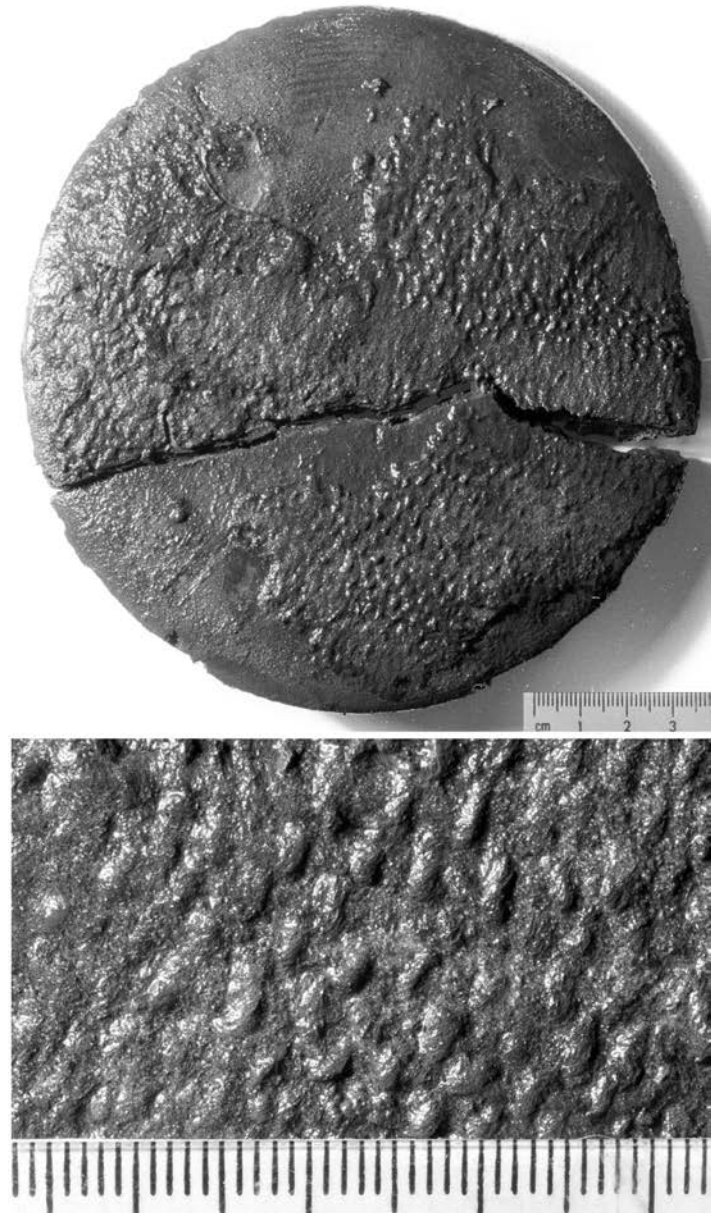


Illustration 230
Top: the underside of the base of compass 91, showing the remains of the fabric sleeve. Scale in centimetres (DP 173336). Bottom: detail of the fabric weave. Scale in millimetres (DP 173340)

traces of which survive. A copper-alloy strip 8mm deep and 0.15mm thick encircles the rim immediately below its shoulder, its overlapped joint fixed with a flat rivet. This would have strengthened the compass-bowl, locked the glass face, and provided opposing pivot-pins for the copper-alloy gimbal-ring. The gimbal-ring itself, 180mm in diameter, remains in place. It too is joined with a rivet. Two 3mm holes set 90° from each of the gimbal pivots are provided for mounting the ring on pins inside a missing outer compass-box.

The separate base is similar to that of 89 and has the same diameter. Fixed to it is a rectangular ballasting-piece of lead, much degraded by electrolysis, no doubt stimulated by the proximity of the copper-alloy fittings. A copper-alloy pin thrusts through the base, extending 28mm above it. The method by which the base was secured to the compass-bowl is of particular interest. As on 89's base, its lower edge is finished with a bead of semi-circular section. This is designed to fit snugly into a slightly tapered seating at the bottom of the compass-bowl, with the bead forming what is in effect an 'O-ring' seal. There are no other fastenings. The base, together with its compass-card and attached iron needle, could thus easily be removed. This would have been necessary at intervals to reactivate the needle by stroking the iron with a lodestone or, as contemporaries engagingly put it, 'feeding' the compass (Waters 1958: 27–8).

The tapered seating arrangement would have prevented the base, once inserted, from moving upwards into the bowl. It would not, however, have stopped it from dropping out. This was evidently prevented by encasing the bottom and sides of the compass-bowl in a tightly fitted cloth sheath, parts of which still adhere to its base and sides (Illus 229–30). Although this method of securing the base might seem unnecessarily elaborate, it reveals considerable sophistication of design. The compass, secured at the top with a face of resin-sealed glass and at the bottom with a ring-seal held in place by a fabric sheath, would have been absolutely watertight. Just how effective this arrangement was is indicated by the fact that when the compass sank to the equivalent of one extra atmosphere above ambient pressure it was the wooden base, and not the seals, which ultimately failed to withstand the differential.

The account-book of James Forrester, a skipper from Prestonpans near Edinburgh, contains four undated entries between 1687 and 1690 for 'dressing the compasses and glasses' (Hustwick 2000: 100–23). It may be presumed that this involved checking the compasses and sand-glasses, and reactivating the magnetic needles. The number of entries over a four-year period suggests that this was an annual operation, while the fact that the transactions were listed in the expenditure accounts suggests that these specialist tasks were not undertaken by the crew but required the services of an outside contractor. The same document records the purchase of 'a new bittikell' for £4 Scots, while a further 16s was paid for horns 'for the same' (Hustwick 2000: 111). The latter were probably translucent panels for the lighting compartment.

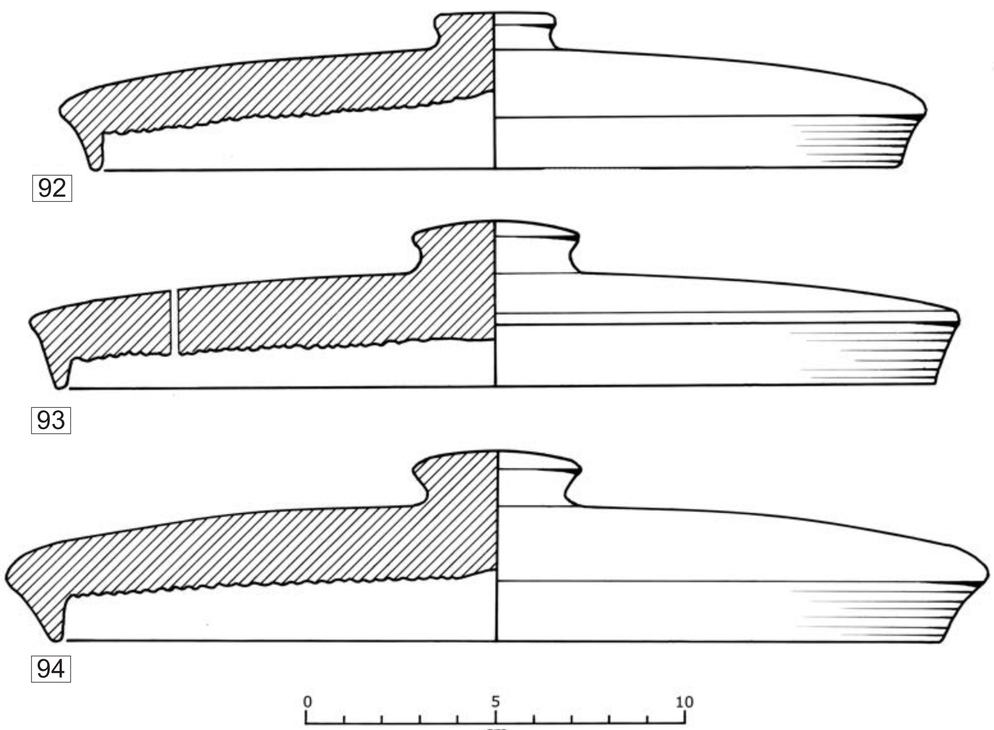


Illustration 231
The compass-box lids 92–4 (DP 174867)

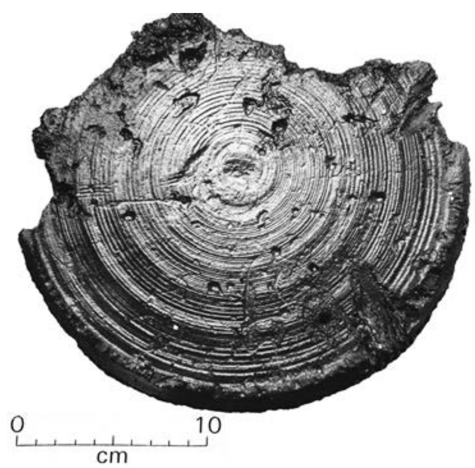


Illustration 232
The underside of compass-box lid 92 showing evidence of turning with a coarse gouge and the rough removal of the central spigot (DP 173401)

Note on the fabric

Janet Shelley

This report is offered in the light of a visual examination conducted in advance of conservation, and without the opportunity of identifying the fibre or disassembling a sample of fabric to confirm the structure of the weave. It should therefore be regarded as a provisional statement, suggesting various possibilities which may be elucidated as the conservation procedures progress.

The remains of a double or single textile structure are clearly visible on the base and sides of the compass-bowl. The diagonal pattern of the material suggests the possibility of a twill fabric (Illus 230). However, as only one element of the structure is prominent (it could be either the warp or the weft), it is probably an unbalanced twill of warp- or weft-faced type.

Both twill and loosely woven plain-weave structures would have had sufficient elasticity to cover the base and sides of the compass without creating awkward bulk, rather in the manner of a jampot cover or 'clootie dumpling'. The bias distortion of the weave created by stretching would also enhance the diagonal appearance of the cloth. Greasing the fabric might have been employed to improve the fit. How it was held in place around the compass-bowl is not clear. The brass band around the upper part might have been used to secure it, but this seems unlikely since the band appears to have been permanently riveted in place, and in any case no fabric appears to have been trapped behind it. As far as can be seen from the sample, the yarn appears to be rounded and loosely spun, and is possibly linen 'tow' of a kind widely used throughout Europe. The finest quality linen (line) was only used for household linen and apparel.

Compass-box lids

92 DP96/005, **009.109**, immediately adjacent to the binnacle, and at the interface between the mobile surface shingle and stabilised substratum, was a turned wooden lid with an upstanding central knob and an inwards-tapered rim, 250mm in diameter (Illus 231). It is made of poplar. The top surface is smoothly finished but its underside, which would not normally have been visible, has been roughly turned with a deep gouge and no attempt made to conceal the spigot-scar at the centre (Illus 232). A hole has been drilled towards one side in the manner of a bread-crock, perhaps to avoid an air-lock. It may be surmised that the lid belonged to a turned box of matching diameter, into which the compass bowl would have been secured by the holes in its gimbal-ring. The diameter suggests that its purpose was to contain one of the compasses associated with the binnacle, into which the assembly would have comfortably fitted. Turned compass-boxes with similar lids have been found on the wreck-sites of *Mary Rose* (1545) (Stimson 2005: 267–71) and *Kronan* (1676) (Johansson 1985: 129, 215).

93 DP99/045, **074.104**, compass-box lid, 260mm diameter (Illus 231).

94 DP99/074, **082.102**, compass-box lid, 230mm diameter (Illus 231).

Deep-sea sounding-lead

95 DPnd/001, location unknown, sounding-lead, weight 6.94kg (15.3lb), length 372mm, width at base 60mm (Illus

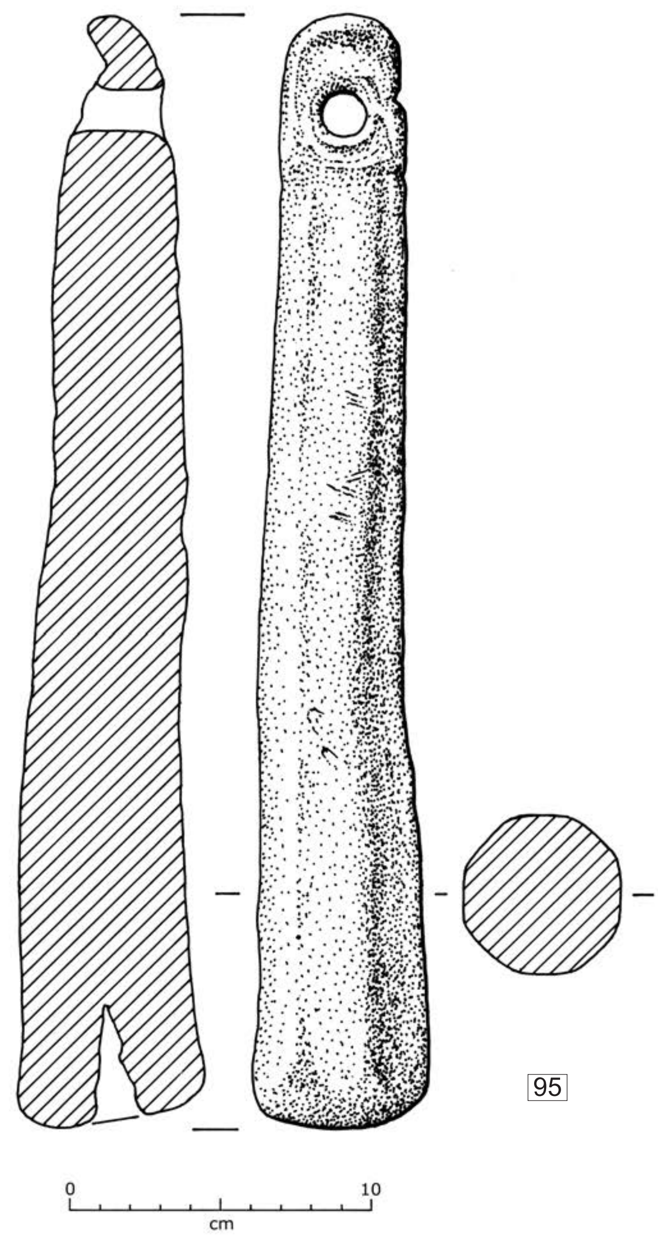


Illustration 233
Deep-sea sounding-lead 95 (DP 174869)

233). A deep-sea sounding-lead, reported as having been recovered from the site in 1991 or 1992, was anonymously returned to Historic Scotland in 2011, and passed to National Museums Scotland for accession in the Duart Point collection. Without knowledge of its context there is no absolute certainty that it is associated with the wreck, but its form and condition, together with the circumstances of its discovery, leave little doubt of its provenance. It is of octagonal cross-section with a lug at the top and a 15mm diameter suspension-hole. An irregular arming recess 15mm in diameter on the surface penetrates 35mm into the base, where it ends in a point. Various cut-marks on its surface do not appear to represent numerals, and may well be accidental.

Such objects are common on post-medieval shipwrecks, and a close parallel comes from what is probably the wreck of *Ann Francis*, lost in 1583 on Margam Sands, Swansea Bay, South Wales (Redknap & Besly 1997: 200–1). The Margam example is inscribed with the Roman numeral XIII, and weighs 6.1kg (13lb 4½oz). It is 358mm long and 58mm diameter at the base. Mainwaring *c* 1623 specifies 14lbs as the common weight of a deep-sea lead. It was used with a 100- or 200-fathom line with the first mark at 20 fathoms and at 10-fathom increments thereafter (Manwaring & Perrin 1922: 229). A 7lb lead on a heavier 20-fathom line marked at more frequent intervals was used for sounding in shoal waters. Both types were provided with a hollow which could be 'armed' with tallow to obtain a sample of the sea-bed encountered by each cast. In most cases this is a shallow depression in the base, the narrow conical recess in the head of the Duart Point lead being unusual. It is suggested that a mushroom-shaped piece of tallow was used, its stalk thrust into the arming-hole so that the bulbous head would squash on impact, picking up a good sample of the ground.

Navigator's dividers

96 DP00/132, **106.083**, copper-alloy navigator's dividers, 158mm long, 60mm across the bow (Illus 234).

97 DP00/177, **101.083**, copper-alloy navigator's dividers, 164mm long, 60mm across the bow (Illus 234).

Found among the remains of the collapsed stern, they are both of the so-called 'single handed' type; that is, the upper parts of the two legs form interlocking double bows below the hinge so they can be adjusted between the palm and fingers of one hand. They are of similar but not identical design, and suggest the use of charts on board.

8.2 Hand-weapons and related finds

Powder-boxes

Four powder-boxes or -flasks were recovered from the collapsed stern area (Illus 235–6). These cylindrical wooden

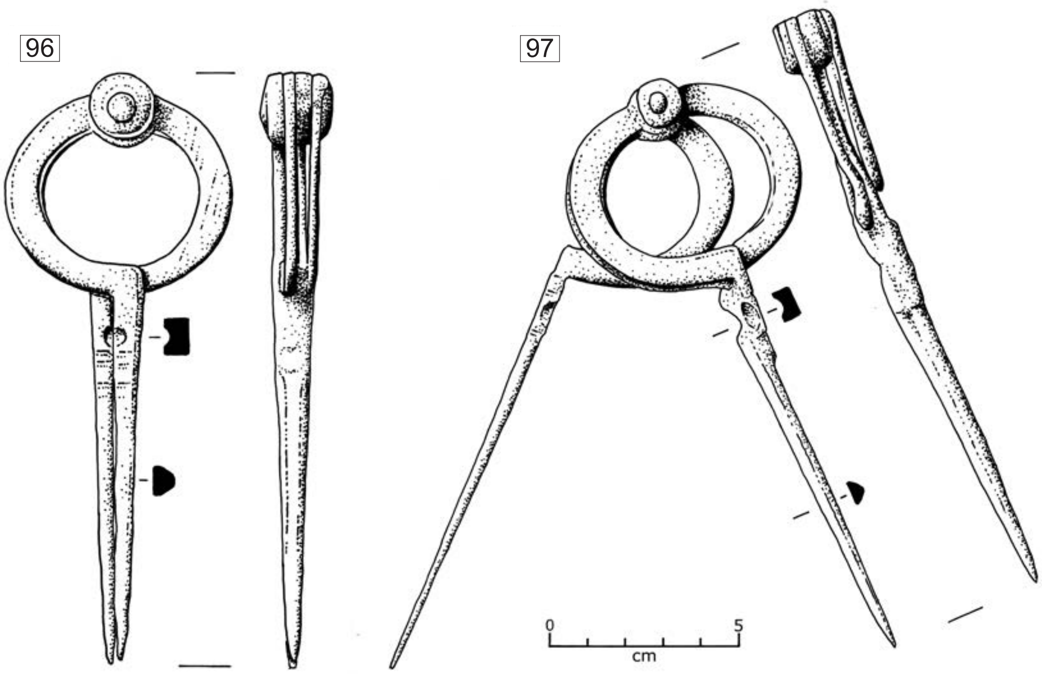


Illustration 234
Copper-alloy navigator's dividers 96–7 (DP 174870)

Illustration 235
Examples of turned wooden powder-boxes (DP 174349).
Scale in centimetres

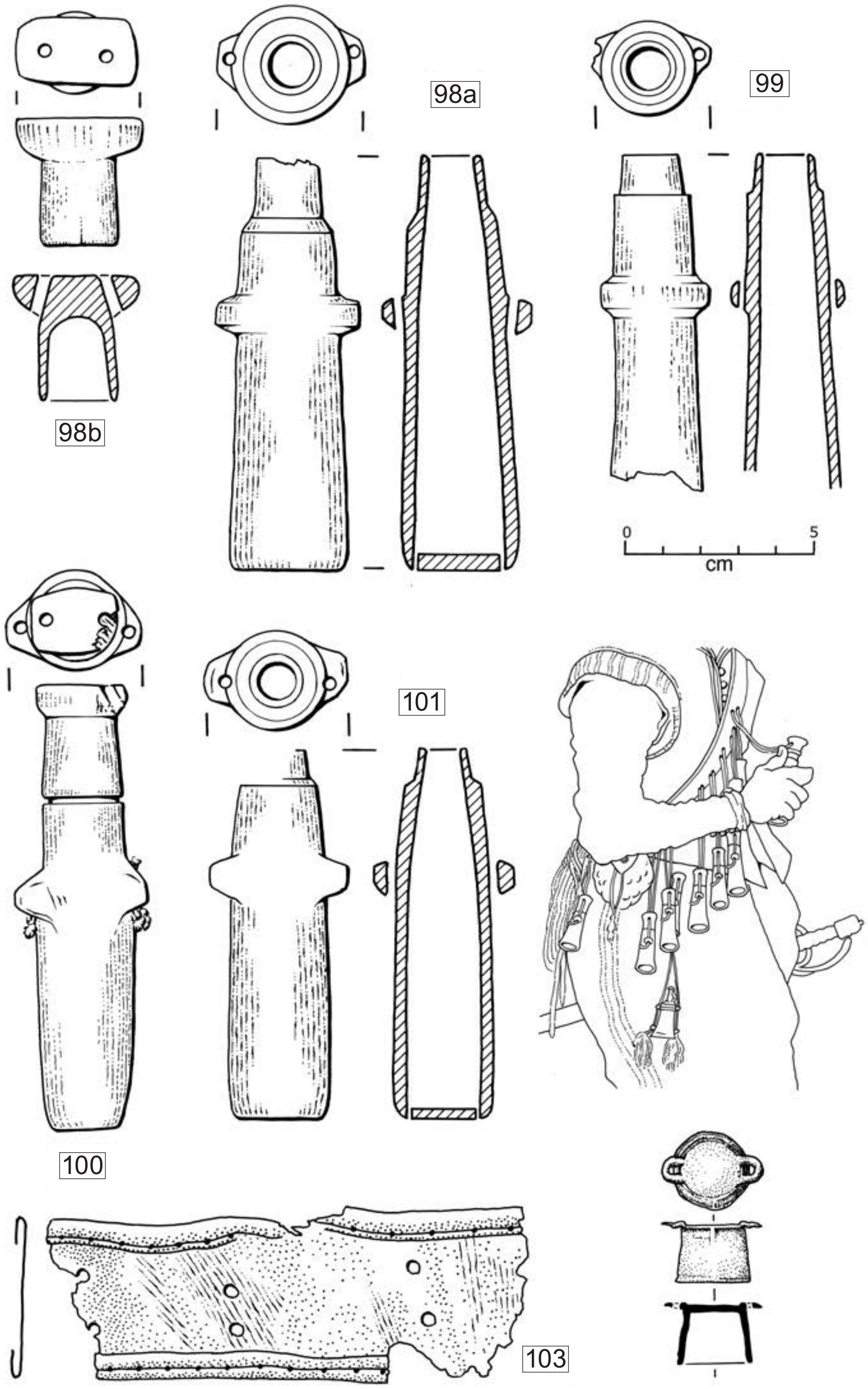


Illustration 236
Drawing of turned wooden powder-boxes 98–101 (DP 174833). Bottom left: leather fragment with hemmed edges and paired holes 103, identified as part of a musketeer's bandolier. Centre right: detail of a musketeer's bandolier and powder-boxes (after de Gheyn 1608: engraving 23). Bottom right: lead powder-box cap from Tantallon Castle (after Caldwell 1991: illus 5 no 40)

Illustration 237
Seventeenth-century musketeer's equipment demonstrated by a re-enactor (DP 174351)

containers would have hung from a musketeer's bandolier or crossbelt (Illus 236–7), and were designed to hold a single pre-prepared charge of gunpowder which was tipped into the upturned muzzle during the loading sequence. A set of 12 was normally carried.

98a DP00/166, **111.085**, intact turned sub-conical powder-box, its main body 109mm high extending to 120mm with the lid in place (Illus 235–6). It has a 31mm-diameter base blocked with a plug 4mm thick. The sides are a fairly constant thickness of between 3 and 4mm, rising to a shoulder 90mm above the base where the thickness reduces to 2mm forming a tapering spout 15mm deep and 18mm in diameter. The interior volume of the box is 25cm^3, which allowing a weight/volume figure for packed gunpowder of 1.5g/cm^3 gives a charged capacity, if filled to the top, of 37g (1⅓oz).

98b DP00/079, **111.075**, powder-box cap (Illus 235–6) fits the above.

This suggests that box 98 was designed for the larger category of lead bullets identified in the Duart Point sample, the 12-bore calibre at *c* 19mm diameter, which weighs *c* 43g (1½oz) (see Foard below). This powder/shot proportion is considerably greater than that prescribed by Sir James Turner in his *Pallas Armata* of 1683, that 'a musket requires the half weight of her ball in fine powder and two thirds of common powder' (Firth 1992: 81). This may suggest that powder-boxes of this size were intended for 12-bore muskets, that the powder was of 'common' grade, and that they were not filled to the brim. The space at the top might have held a twist of wadding, where it would have been conveniently to hand when required.

The spout would fit comfortably into a musket-calibre muzzle, making it easy to insert, empty, and withdraw. The cap is topped with a flat T-piece to facilitate grip, through which two 2mm-diameter holes for cords slant outwards. The body of the box has two matching lugs below the shoulder, formed by leaving a ring on the carcass during turning on a lathe and subsequently trimming off the excess. These lugs are also drilled with 2mm-diameter cord holes.

The method of hanging the boxes on a bandolier is shown in a number of contemporary illustrations, notably the set of engravings by Jakob de Gheyn published in 1608, showing in sequence the full drill for loading and firing a musket (Illus 236). The boxes are suspended on a double cord looped through the bottom lugs and brought through the holes on either side of the cap before rising to the bandolier, where both ends are made fast. At this point in the sequence the musketeer is gripping the box while thumbing off the cap and pushing it out of the way up the cords. The slanting holes lock the cord so the cap will not slide back, allowing the spout to be inserted into the musket-barrel and the full charge tipped in. Below the musketeer's elbow is a pouch for bullets (and perhaps wadding), while the small triangular flask hanging below the bandolier is for priming powder. Looped at his back is a hank of spare match.

99 DP00/170, **107.079**, powder-box missing its base and bottom part and lacking a cap. Its proportions and surviving dimensions are similar to those of box 98 (Illus 235–6).

100 DP01/015, **170.093**, powder-box with cap, which at the time of writing had not yet been removed by the conservators. It has a bottom diameter of 25mm and a height from base to shoulder of 87mm, similar in form and dimensions to box 98. The cap is similar to that of box 98 though more truncated (Illus 235–6). The end of the suspension cord survives in each of the box's lower lugs, with locking knots underneath to resist a downwards pull. This suggests that the box was hung either from two separate cords, with each upper end tied to the bandolier, or on a single running cord fixed at each lower end and looped through the bandolier. A different arrangement is shown in the de Gheyn engraving.

101 DP00/149, **106.083**, powder-box, lacking its cap, 97.5mm high from base to spout rim, and 89mm from base to shoulder, significantly smaller than box 98. Its lower diameter is 27mm and the spout is 13.5mm wide (Illus 236). The shape is more rounded than box 98 and the lower part shows a distinct inwards curve. Its sides are 3–4mm thick, encasing a volume of *c* 20cm^3, indicating a powder-weight of some 30g (1.06oz). It is thus presumably intended for use with smaller shot than that associated with box 98 and the other main group from the bullet sample – 14-bore, with a median diameter of *c* 18mm and a weight of *c* 38g (1¼oz) – is the most likely candidate.

102 DP00/205, **109.081**, powder-box cap (not illustrated).

It is noteworthy that the Duart Point powder-boxes all have bases formed by a separate wooden plug, contrary to specifications in contract books for the New Model Army, which state that the boxes should 'be of wood with whole bottoms, to be turned within and not bored, the heads [caps] to be of wood' (Roberts 1989: 58). The Duart boxes are indeed 'turned within' and not bored, as their tapering profiles demonstrate, but the technically difficult process of hollowing out so deep a recess flaring downwards from a narrow top to leave an integral base at the foot evidently defeated the contract woodturners, who have adopted the simpler, but just as effective, solution of working upwards from the wider base and stopping the hole with a plug. It is still a remarkably adept piece of precision woodturning.

No trace of leather was noted on any of the Duart Point powder boxes. They may however have been oiled or painted to render them waterproof. State Papers of April 1649 record

£100 paid for '1000 collars of bandoleers, blue-painted in oil', and £75 for another 1000 painted black (Asquith 1981: 36). Another source specifies oiled bandoliers 'coloured blue with blue and white strings with strong thread twist with good belts, at twenty pence a piece' (Roberts 1989: 58).

Discussion

Examples of similar powder-boxes have been found on contemporary shipwrecks and, less commonly, from terrestrial contexts. The closest parallels are from Newcastle-upon-Tyne, from the excavation of a Civil War bastion (Ellison & Harbottle 1983). Among the finds were three powder-boxes of beech (*Fagus* sp) all of which showed evidence of having been covered with leather (Goodhand 1983: 206 and fig 17). The objects appear somewhat damaged and shrunk, perhaps from drying, and so their dimensions, especially lateral ones, may be distorted. Nonetheless no 123, which measures 110mm overall (without cap), 92mm to the shoulder, and has an 18mm-diameter spout and a bottom width of 24mm, is very similar to box 98 from Duart, while Newcastle nos 122 and 124 broadly match Duart boxes 99 and 100.

This seems to confirm the hypothesis that the two types of boxes match the two sizes of musket generally agreed to have been in service during the Civil War period, 12- and 14-bore, but the samples from both sites are very small and the suggestion must remain tentative. Box-caps were sometimes made of lead or pewter, numbers of which have been discovered on the battlefields of Edgehill and Naseby (Foard 2012: 170). Lead caps are known from Tantallon Castle in East Lothian, which saw action during the First Bishops' War in 1639 and again during Cromwell's invasion of Scotland in 1651 (Caldwell 1991: 342 illus 5), while two lead examples were recovered from an early 18th-century context during excavations at Landguard Fort, Harwich (Meredith et al 2008: 258–9).

Another closely contemporary find comes from the wreck of the Dutch East Indiaman *Vergulde Draeck*, lost on the coast of Western Australia in 1656 (Green 1977: 234–5). Seven wooden powder-boxes were recovered, five of which showed evidence of leather coverings. The best-preserved example (GT 1036) is complete with its wooden cap and measures 112mm from base to spout, 136mm overall, 36mm wide at the base, spout diameter 17mm. These dimensions are similar to those of Duart Point box 98 and Newcastle no 123. Wooden powder-boxes with a more bulbous profile have been recovered from the wreck of *La Belle* (1686). At 100mm × 36mm they have a similar capacity to the larger Duart Point boxes (Bruseth 2014: 76).

It is proposed to categorise the larger boxes (12-bore?) as Type I and the smaller ones (14-bore?) as Type II, tentatively linking them to the pattern identified in the Duart Point shot sample. This seems to reflect the statement of Lord Orrey, Cromwell's commander in Ireland, that muskets should be 'at one bore, or at most two sorts of certain bore, the bigger for the stronger, the smaller for lesser bodies … for want of this I have seen much hazard undergone' (Asquith 1981: 32). The old heavy 12-bore musket had a barrel 48in (1.22m) long while the lighter 14-bore replacement, used without a rest, was 6in (0.15m) shorter (Roberts 1989: 19–20). Both the bullets and the powder-boxes from the Duart Point wreck indicate that the two types were still in service as late as 1653.

Metal powder-boxes are also known. Twenty-four have been recovered from a late Elizabethan wreck off Alderney (Bound 1998: 75). They were made of copper-alloy sheet with seams closed with lead-tin solder. Heights (with caps) ranged from 99mm to 106mm and maximum body diameters from 27mm to 31mm, indicating capacities broadly similar to the Type I wooden examples described above.

Bandolier

103 DP01/045, **105.074**, piece of leather strap 125mm × 40mm with rolled and stitched edges and three pairs of 4mm holes, set obliquely across the strap (Illus 236). This can confidently be identified as part of the distinctive type of bandolier used by musketeers to hang their powder-boxes from cord lanyards as described above. The oblique set of the holes would have given the boxes a vertical hang when the bandolier was slung across the chest, and the 45mm spacing between pairs would allow for 12 boxes, the usual number carried (Asquith 1981: 14) (Illus 236–7).

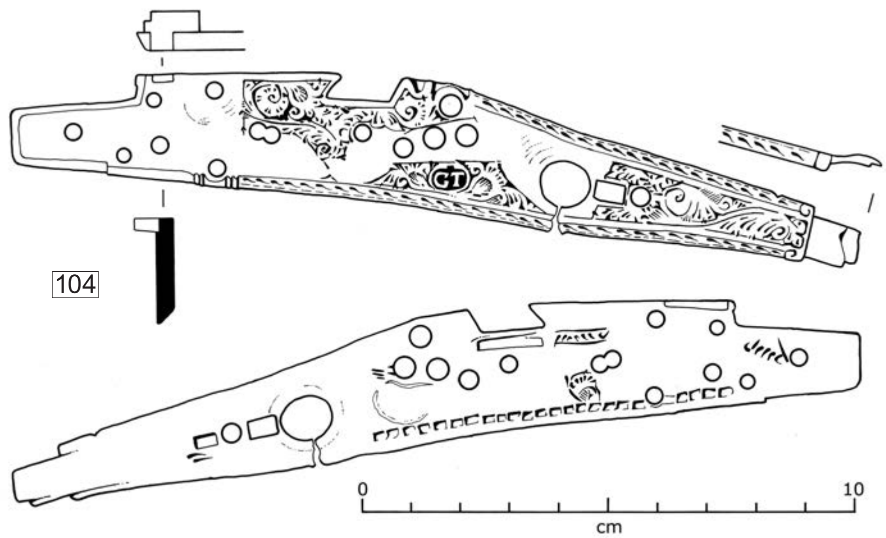


Illustration 238
Pistol lock-plate 104 (DP174831)

Illustration 239
Detail showing the maker's initials 'GT' on the pistol lock-plate 104.
Scale in millimetres (DP 174346)

Gun furniture

104 DP92/DG11, findspot not known, brass lock-plate 175mm long with holes and recesses appropriate to a snaphaunce lock (Illus 238). That it is fashioned for a left-handed mechanism suggests it is from the left member of a handed pair of pistols. The lack of a screw-hole in the tongue at the butt end suggests that it was intended to be gripped here by a pommel, further indication that it belongs to a pistol and not a musket. The piece is chased with foliar decoration and carries the letters G T in a circle flanked by thistles (Illus 239).

These initials can be identified as those of George Turner, a dagmaker (gunsmith) in Edinburgh's Canongate whose apprentice-piece ('sey') was accepted on 21 May 1639, being described as 'a pistolet with an iron ratchet sufficiently made and stocked in timber'. He was admitted freeman on 28 June 1639, and on 10 June 1650 was appointed King's Armourer 'anent the making and mending of his highness's hagbuts, pistolets, acre [arrow] and pellet bows and all iron weapons'. Turner's royal appointment suggests that he was by then a craftsman of the highest reputation. He was alive on 4 January 1660 when he acted as a seymaster (member of an apprentice assessment board) for Hugh Somervell, but by 28 August 1662, when his son William (also a gunsmith) was admitted burgess, he is described as 'deceased' (Whitelaw 1977: 209).

The weapon is of distinctively Scottish type, and the tongue at the rear of the lock-plate would suit the reception of a lemon-shaped butt terminal (Boothroyd 1981: 327–8). A pair of lemon-butted pistols with the unidentified initials AG and the date 1634, now in the Marischal College Museum, Aberdeen, have lock-plates of similar form (Kelvin 1996: 112 fig 27) (Illus 240).

Gunflints

105 DP00/142, **106.075**, deep wedge-shaped gunflint with front edge damaged (Illus 241).

DP01/092, **215.085**, shallow gunflint with curved front edge, and rear part broken off (Illus 241).

Edged weapons

107 DP92/178, findspot unknown, a concretion 380mm long was X-rayed to reveal the ornate wire-wound hilt,

Illustration 240
Top: the left-handed example from a pair of Scottish lemon-butted snaphaunce pistols, marked 'A G 1634', probably made in Edinburgh (© University of Aberdeen. Licensor www.scran.ac.uk). Below: at a slightly larger scale, the lock-plate 104 from the Duart Point wreck

spherical pommel, guard and quillons of an English or Dutch rapier of the first half of the 17th century (Dufty 1974: 19–20 and pl 28) (Illus 242). The 25mm-wide blade, of which the top part survives as a void in the concretion, is encased in the remains of a leather scabbard. The well-preserved hilt was subsequently extracted from concretion by Dr Theo Skinner of National Museums Scotland to reveal that it is covered in sharkskin and wound with gold and silver wire (Illus 243–5). The top and bottom ends of the hilt are encircled with woven gold-wire collars. Negative impressions within the concretion preserve details of vanished ferrous and organic materials including the gilded cherubic faces in relief which had adorned the guard and quillons, and surface gilding around the sharkskin hilt. What appears to have been a steel square-sectioned pin penetrates the blade close to its top, and is perhaps associated with a

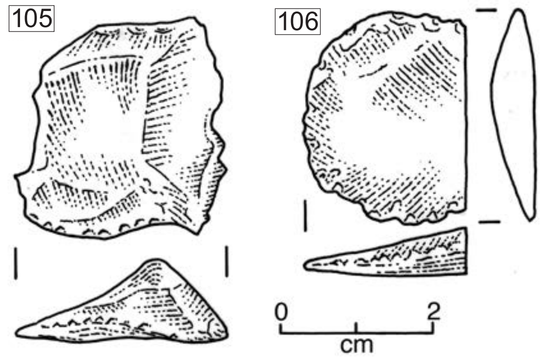


Illustration 241
Gunflints 105–6

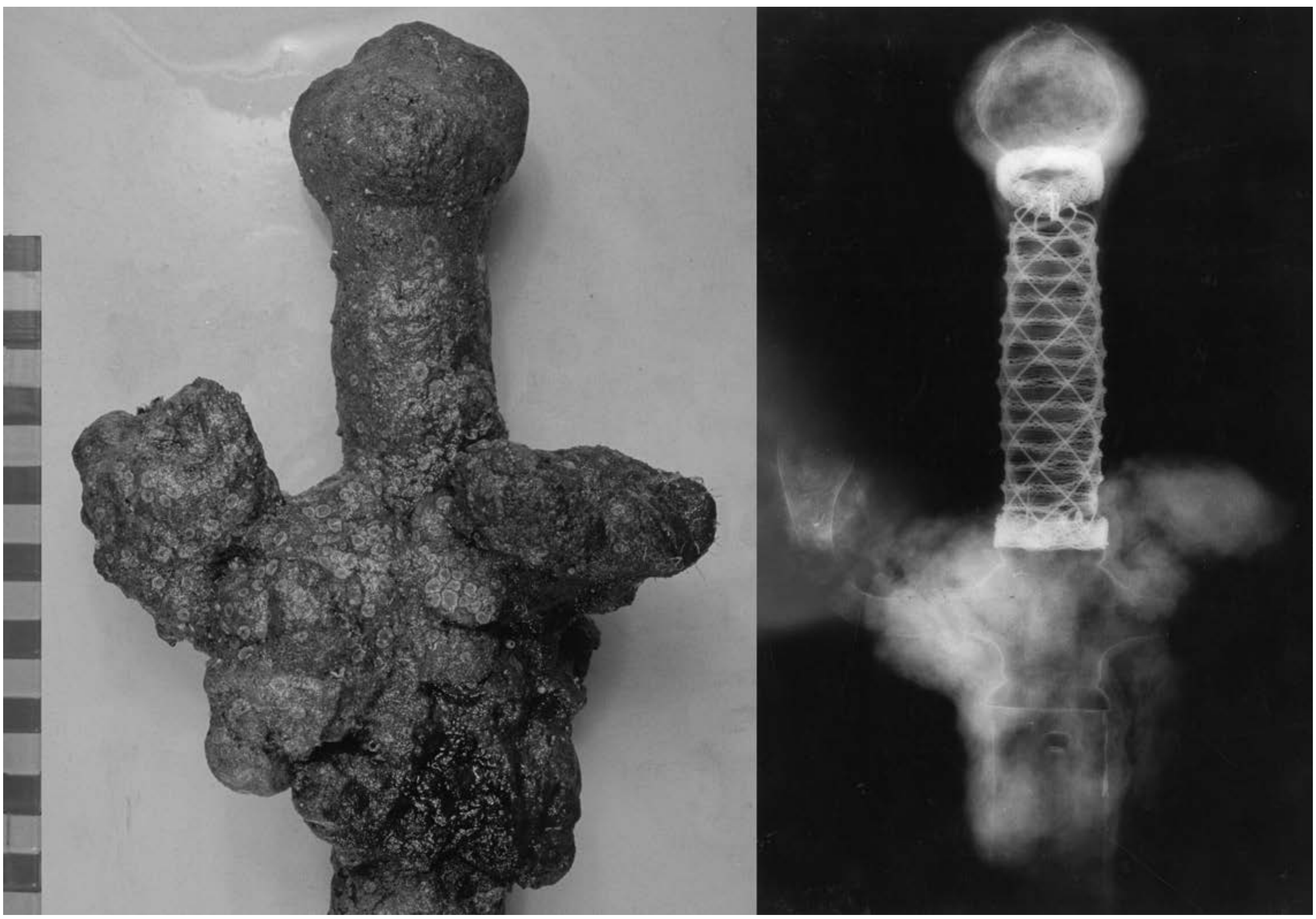


Illustration 242
Concreted sword-hilt 107 (DP 174339), and radiograph (SC 1127030) (Image © National Museums Scotland)

Illustration 243
Sword-hilt 107 wound with gold and silver wire, after removal from concretion and conservation. Scale in millimetres (DP 174340)

Illustration 244
Fragment of the sword-hilt 107, showing sharkskin overlaid with gold-leaf. Scale in millimetres (DP 174343)

Illustration 245
Negative image from the concretion surrounding the sword-hilt 107, showing a human face in relief (DP 173232)

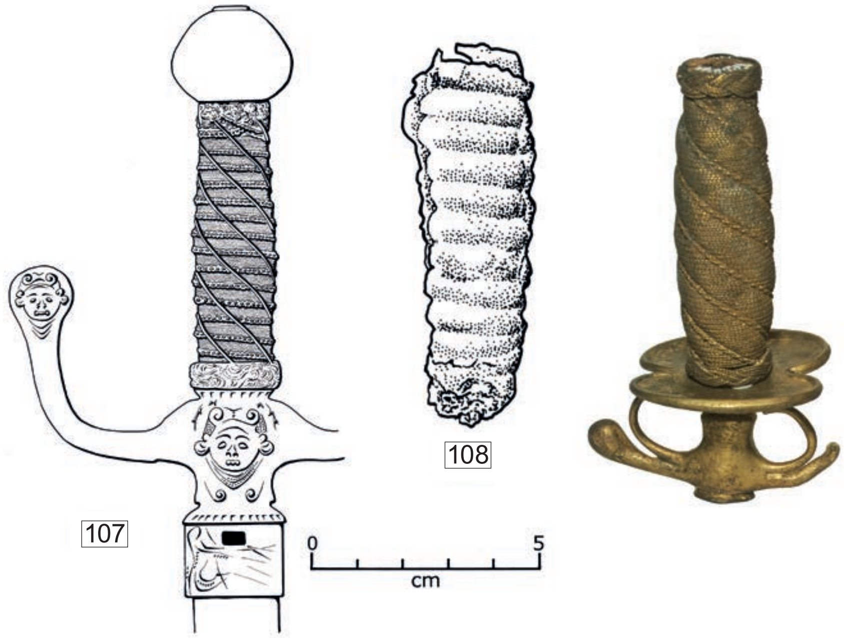


Illustration 246
Left: sword-hilt 107 reconstructed. Centre: concretion of another probable hilt 108. Right: hilt from the wreck of *De Liefde* (1711)

missing hand-guard, no doubt of richly decorated silver to complement the opulence of the overall design.

This is an exceptionally high-status weapon which may well have belonged to the ship's captain, Edward Tarleton. Close parallels are hard to find, but rather later and more commonplace sword-hilt furniture with some similarities has been recovered from the wreck of the Dutch East Indiaman *de Liefde*, wrecked on the Out Skerries of Shetland in 1711 (Illus 246) (Bax & Martin, 1974: 87)

108 DP99/058, surface findspot unknown, a concretion 85mm long with some apparent similarities to 107. Not radiographed or examined internally at the time of writing (Illus 246).

109 DP99/068, **079.094/087.100**, concretion of what appears to be a complete sword 1.07m long. Not radiographed or examined internally at the time of writing (Illus 247).

Note: At the time of the wreck's discovery in 1979 concreted remains identified as a musket, a pistol, and a sword-hilt were observed, probably in the vicinity of Guns 2 and 3. Their present location is unknown (John Dadd pers comm).

8.3 Lead bullets

Glenn Foard

Large assemblages of lead bullets from 17th-century wrecks are a hitherto poorly explored archaeological resource, the

Illustration 247
A complete sword 109, still in concretion (DP 174165)

analysis of which can contribute to the interpretation of contemporary battle archaeology. Because bullets from wrecks are normally unfired they suffer none of the distortion or weight-loss which result from firing and impact-damage seen in battlefield assemblages. As a result the groupings revealed in the calibre graphs are more discrete and, when windage is taken into account, are likely closely to represent the weapons in use in the relevant nation or army. In addition, the absence of attributes resulting from use means they provide a valuable baseline data-set for manufacturing attributes against which to compare battlefield bullets. Analysis is further enhanced where, as on the *Vasa* and *La Belle* wrecks, intact barrels full of bullets are recovered, as these provide confirmation that the contents of each represent a single intended calibre. The tightness of calibre groupings, as seen in the graph (Illus 248), may even offer an opportunity to study the evolving efficiency of munitions manufacture from the late Medieval period through to the early 19th century, when the full impact of the Industrial Revolution on manufacturing consistency had been felt. Assemblages from magazines do exist on land, as for example the late 17th-century material from the Jacobite garrison at Ballymore in Ireland (Foard 2012: 58–61), but they are rare, while fragmentary collections might also be found on sites of the destruction of artillery-trains during battles. However these groups will normally lack the completeness, clarity and close dating of the closed assemblage from a wreck.

A total of 102 spherical lead bullets recovered from the Duart Point wreck was provided for analysis (Illus 248). No slugs or other non-spherical forms were present. All appear to be of 'pure' lead, with no evidence of exceptional corrosion which might suggest a mix of tin or other metal. This is a small assemblage compared to those from some other 17th-century wrecks, such as *Vasa* with more than 8000 bullets, *Batavia* for which 1794 were reported on, and *La Belle* which produced more than 300,000 (Green 1989: 70–1; Bruseth & Turner 2005: 95–6; Cederlund 2006: 368). The paucity of numbers may simply be because the excavation at Duart Point was only partial, but it is also possible that this assemblage does not represent a large and intact munitions delivery stored in barrels, since historical sources imply that at the time of the wrecking most of the troops and military stores had come ashore. Such distinctions are relevant to the interpretation of bullet assemblages from wreck-sites, as there may be significant differences between the munitions already issued for the use of troops on the vessels themselves, as opposed to consignments carried to supply field-armies or for other specialised use. On *Vasa* most of the bullets were intended to be fired as case-shot (that is, enclosed within a wooden case). This is one type of 'hail-shot' or composite anti-personnel munition used in the mid 17th century in which large numbers of bullets or other projectiles were fired from an artillery-piece. Although fragments of one wooden case were found on the Duart Point wreck, there is no evidence to suggest that the bullets recovered were intended for use in case-shot as opposed to small-arms.

During excavation the bullets were documented in groups rather than individually, although all came from the vicinity of the collapsed stern, which suggests that they had been contained within the cabin interior, so are unlikely to have been part of a general stores consignment. In the absence of exact locational information for each bullet it has not been possible to seek significant patterning in the assemblage, which might

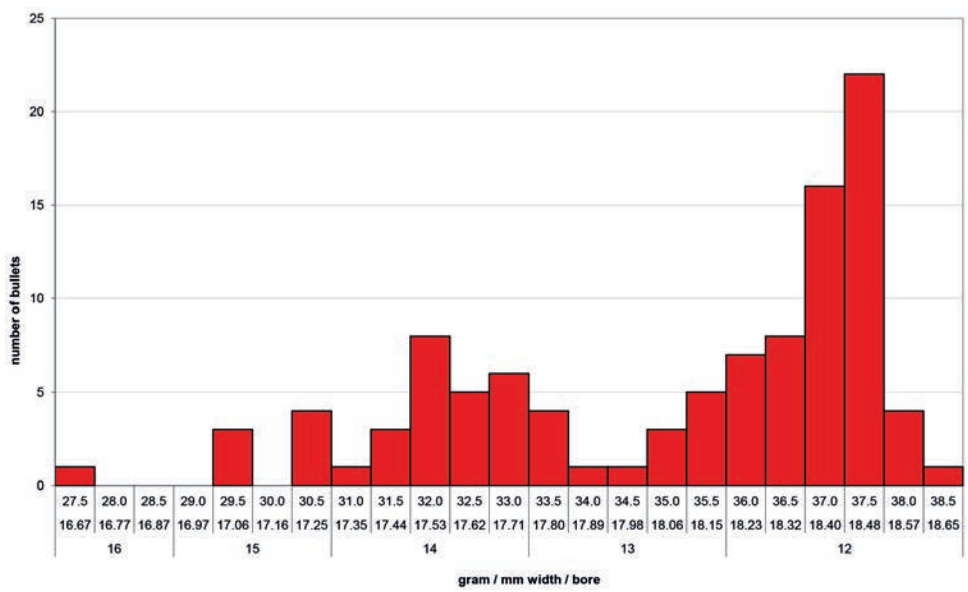


Illustration 248
Left: Sample group of lead bullets (DP 174347). Right: the gramme/bore graph of the bullets from the wreck (Glen Foard)

indicate that different calibres came from different locations. The bullets were examined as part of a programme of research into unfired-bullet collections, to provide a reference-point for the study of 17th-century battlefield assemblages, and were analysed according to procedures defined for the wider study (Foard 2012). Each bullet was weighed, which for spherical lead bullets is not only the quickest but also the most consistent method of classification, as long as the bullets do not have a significant admixture of other metals such as tin, and yielding the clearest identification of discrete calibre groupings, especially true for battlefield survey where distortion through firing and impact can make measurement of diameter impractical for a large percentage of the assemblage.

A sample of 36 bullets was then also measured for width and depth, in order to correlate mass in relation to diameter, and their attributes fully described. The width of a bullet is defined as the diameter close to the mould seam, where the two halves of the bullet mould came together, and it is this that provides the most accurate linear measurement of the intended calibre. The depth of the bullet is taken at 90° to this and can vary substantially from the intended calibre if, for example, the mould faces have been reworked or if lead or other debris has collected on these faces during casting, which is a common occurrence. The comparison of width with the diameter calculated from weight shows that with the Duart Point wreck assemblage the latter almost always underestimates diameter by an average 0.4mm. The variation was between −0.2mm and +0.8mm, though the latter had significant concretion while a further six of the sample could not be measured due to extreme concretion. This suggests that in exceptional cases, like the Duart Point wreck, where accurate width measurements can be taken, because most bullets are not altered by significant corrosion or distorted by firing and impact, this is a more accurate indication of calibre. However, experimental data are required to test such conclusions, as the 0.4mm average represents only 0.2mm

Illustration 249

Characteristic features of lead bullets: (a) concretion masking surface features; (b) extreme example of a flash along the mould seam, which has subsequently been smoothed, presumably by contact with other bullets during transport; (c) snipped sprue and mould-line; (d) distinct parallel lines, reflecting grooves in the mould; (e) bullet showing impact damage, presumably from being fired; (f–h) possible burr-shot, with numerous small gouge-marks (DP 174044–174051) on either side of the bullet and it is possible that corrosion or concretion effects frequently result in this degree of increase in bullet diameter while having minimal effect on weight.

Because lead is typically very stable in seawater, as it is in many conditions on land, the majority of the bullets show minimal corrosion, and most surface attributes are therefore clearly visible. A small percentage of the assemblage shows a high degree of concretion, presumed to be calcium carbonate blackened with lead sulphide, which normally obscures detail rather than represents destruction of the original lead surface (Illus 249a) (Cronyn 1990: 202–5). This concretion rendered full analysis of these bullets impossible and also precluded accurate linear measurement, making weight the only indicator of calibre. It is unclear whether the weight was significantly distorted by such concretion, though the data suggest a slight reduction rather than an increase.

The gramme/bore graph (Illus 248) indicates two distinct calibres present in the Duart Point assemblage, both intended for use in muskets: one of 14-bore, centred on 17.6mm diameter, and the other of 12-bore, centred on 18.5mm. At this period the bore was the standard term for the classification of bullets and of the guns for which they were intended. It represented the number of bullets per pound of lead, the musket barrel itself being *c* 1.5mm greater in internal diameter than the bullet, representing the windage which allowed the bullet to be introduced into the gun-barrel. There are just eight bullets (*c* 8%) of other calibres in the sample. Fourteen- and 12-bore were the two standard calibres still in use for muskets in the 1660s, after the Restoration.

The bullets from Duart Point tend to suggest that by 1653 this standard may already have been enforced in the New Model Army, which was the national army formed by Parliament in April 1645 and disbanded at the Restoration in 1660 (Kishlansky 1979). More and larger assemblages from the period, however, need to be examined to confirm such standardisation and, if so, the relative importance of the two calibres. In contrast, a sample of unfired bullets from the battle of Edgehill (Foard nd: fig 3) suggests that in 1642 various smaller bores were also still in use. The slight bias of *c* 0.5g in the Duart Point bullets towards the lower end of the 12-bore range, visible in the graphs, cannot be explained at present. The dominance of 12-bore is clear in both assemblages, and also in the surviving Civil War muskets in the Littlecote collection in the Royal Armouries, though this is not repeated on all sites (Foard 2012: 71–4).

The Duart Point bullets show typical surface features indicative of manufacturing techniques. These include the snipped sprue, where the lead that filled the pour-hole into the mould has been removed with nippers, leaving distinctive half-moon surfaces with a central bar (Illus 249c). This example also shows the faint mould-line where a tiny amount of lead has seeped into the join between the mould halves to create a slight ridge around the bullet. Occasionally a large offset between the halves, resulting from poor registration of the closed mould, gives a misshapen bullet. On another Duart wreck bullet the faces of the mould did not seat properly and a substantial amount of lead seeped out to create a flash several millimetres wide (Illus 249b). In this example both are seen, with the flash subsequently swaged over, probably by bumping against other bullets during storage and transport. Seven bullets clearly show what appear to be grooves and ridges encircling the shot in regular lines centred on the axis of the sprue (Illus 249d). These latitudinal lines reflect tooling on the inner surface of the mould-chamber, which was presumably machined with a router or similar instrument (Foard 2012: 95). The regular pattern of lines is far more fine and consistent than the coarser ridges which can be caused when a bullet is cast in a cold mould and the lead solidifies in stages as the mould is filled.

Bullets often have these manufacturing attributes obscured as a result of prolonged bumping against other bullets. It has been suggested that this was the result of transport in barrels (Sivlich 1996). The presence among the Duart Point assemblage of 14 bullets where such fine surface detail survives may indicate that this is not the case. As yet the effects of bumping have only been demonstrated experimentally through prolonged carriage in a re-enactment musketeer's bullet-pouch. Alternatively it may be that carriage by sea is far more gentle than carriage on land by cart, and therefore bumping does not occur to the same degree.

A few of the Duart Point bullets carry evidence of intentional modification, through various types of gouging to create a rough surface (Illus 249f–h). Microscope imaging shows clear evidence of tool-marks in the form of striations along the length of each gouge (Illus 250). These bullets

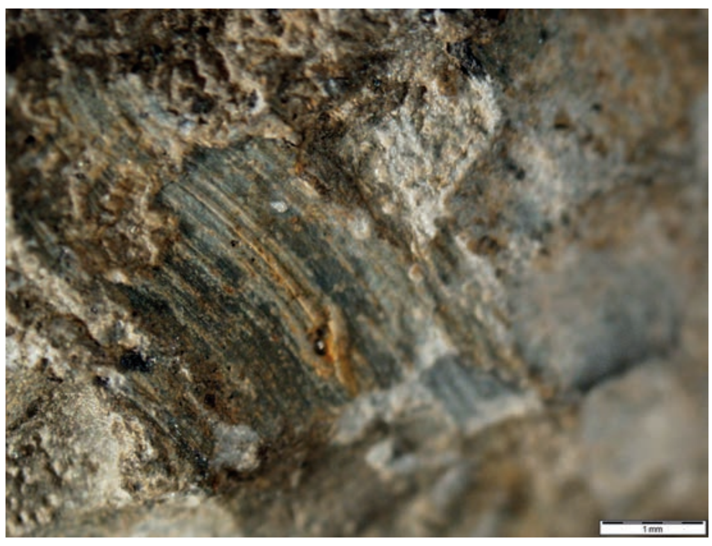


Illustration 250
Microscope image showing striations along the length of each gouge. Scale 1 millimetre (Image © National Museums Scotland)

comprise 6.7% of the assemblage. Similar evidence is also present on assemblages from contemporary battlefields, representing for example 2.5% of the Edgehill musket-calibre bullets. Such bullets have tentatively been described as 'burred', but there is conflicting evidence as to what is meant by this term in contemporary sources.

There are references in military manuals and supply records to both burr shot and 'rough-hewn' musket balls. However a source of *c* 1600 describes burr shot as 'fragments of iron rough and ragged', and in 1595 it is specified as 'burres alias haileshot'. There is thus some confusion over the exact meaning of the term, which may even change over time, for a burr could also be a sprue (OED, quoting a 1611 military source). It is normally assumed that the burring was carried out by individual musketeers after bullet issue rather than being an attribute created during normal manufacture, and therefore indicating that these bullets, at least, had already been issued for use. The sharp edges of the Duart Point burring, compared to the rounding of the edges seen when an experimentally burred bullet has been experimentally fired, indicate that although the burred bullets in this assemblage had been modified for use, they were never fired (Foard 2012: 103).

All the burred examples from Duart Point are of 12-bore, a musket calibre. If this was intended to be fired as 'hail-shot' it would have been packed into wooden cases, canvas bags, canisters of tinned iron or loose in the barrel of an artillery piece for firing in an anti-personnel role, as, for example, the 'case of wood for burr shot' noted in an ordnance inventory of 1635 (TNA WO55/1690, cited in Blackmore 1976: 294). However, the experimental firing of hail-shot in both cases and canvas bags has shown that the whole surface of the vast majority of bullets is completely re-formed during firing, and thus burring would not survive the internal ballistic forces of an artillery piece. As this will presumably have been known to contemporaries it is difficult to understand why the time-consuming modification by gouging would have been undertaken (Allsop & Foard 2008). The alternative is that they were for use in muskets. Experimental firing has shown that roughened bullets can be fired from a musket, and that the surface suffers only slight smoothing. At least two burred bullets showing evidence of firing from a musket were recovered in the Edgehill survey, while the distribution-pattern on that battlefield shows no association between these bullets and hail-shot groups from the site (Foard 2012: ch 5). Thus there is at present no secure explanation for this type of bullet, and even the contemporary name remains uncertain.

Unexpectedly, one bullet from the wreck collection shows very clear impact damage, suggesting that it had been fired (Illus 249e), but as no reference collection of experimental bullets showing types of impact damage has yet been established it has not been possible to confirm this or to suggest the type of impact or the material impacted. However, one might expect that ships which had been engaged at close quarters would have bullets embedded in their timbers. If so, then the accurate plotting of the distribution of impacted and unimpacted bullets, where present in significant numbers on well-preserved wreck-sites, might yield significant patterning.

8.4 Chest, chest-fittings and box-lid

110 DP99/069, **093.087/098.094**, immediately above the run of panelling 21 the remains of a wooden chest (see Chapter 4.2 for the significance of its stratigraphy). The substantially intact single baseboard measures 1.044m × 0.36m and is 20mm thick (3ft 5in × 1ft 4in × ¾in) (Illus 251–2). The south-east side and south-west end are largely intact, but the tops of both elements are eroded so their full height cannot be determined, though it was not less than 0.27m (10½in) including the baseboard. A small fragment of the north-east end survives close to its joint with the south-east side but the rest has gone, along with the whole north-west side. Side and end boards are 20mm (¾in) thick. The corners were secured with lap-joints 9mm deep, and the carcass was held together with iron nails, the positions of which are indicated by holes in the surviving timbers, their locations shown diagrammatically in Illus 252. It may be noted that the spacing and symmetry of the three nails securing the surviving corner joint suggests that the highest point of the chest's surviving edge is close to its original top. A rectangular slot 12mm wide × 9mm deep (½ × ⅜in) has been cut vertically from top to bottom on the interior of the side plank, presumably to house a divider for an end compartment 0.30m (1ft) deep. The minimum capacity of the chest is 0.077 m^3 or 2.68 ft^3.

111 DP99/106, **098.092**, a cleat with a squared central slot 20mm wide and 12mm deep, positioned vertically and secured to the south-west end of the chest 110 with four short nails set in pairs 0.18m (7in) above the base (Illus 253). Holes for the vanished nails penetrate the end of the box where their points were presumably bent over to fix them. The cleat no doubt housed a pin for securing a rope becket, the traditional form of end-handle on a sea-chest.

This chest invites comparison with the large collection recovered from *Mary Rose* (Richards with Every 2005). It fulfils some of the criteria for their Types 1 and 2, both of which are categorised by the 'base resting directly on the deck' (ie with flush bottom) but sub-divided by the absence of hinges and a lock (Type 1) or their presence (Type 2). This cannot be determined with certainty for the Duart Point chest, although the end compartment, presumably intended for small valuables, would seem superfluous if the main lid could not be closed and locked. The chest does however fit into the category of sub-type 2, which is 'nailed, boards affixed through "fitting"

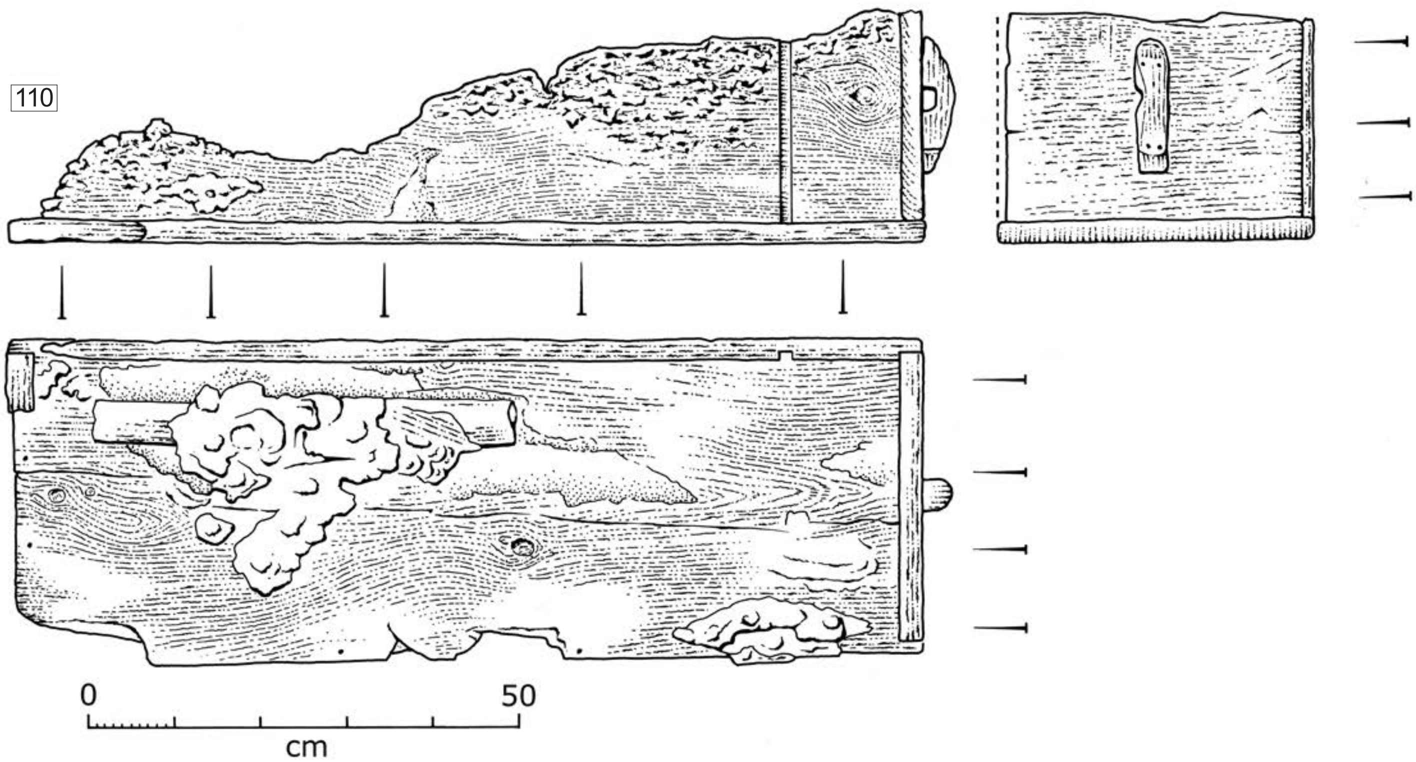


Illustration 251
Surviving elements of a wooden chest 110 (DP 174841)

rebates up to 5mm deep cut along the edges of some carcass elements' (Richards with Every 2005: 387). Though largely devoid of artefacts when excavated (it contained only three pieces of iron roundshot and four musket bullets, and some indeterminate scraps of wood) it seems likely that this was an ordinary seaman's chest, to keep his personal possessions tidy and secure.

112 DP99/108, **101.090**, fragmentary cleat 118mm × 54mm × 25mm with most of the central slot surviving. Estimated original length 216mm; slot *c* 25mm wide by 15mm deep. Square 6mm nail hole on the surviving side (Illus 253).

113 DP03/020, **109.097**, cleat missing part of one end, present dimensions 240mm × 33mm × 38mm; original length *c*.300mm. Slot 45mm wide by 20mm deep. Three square 6mm nail-holes along the central axis. A fourth at the missing end is presumed (Illus 253).

114 DP03/022, **109.090**, complete cleat with one end shorter than the other, 305mm × 55mm × 60mm, slot 47mm wide by 32mm deep. Four square 6mm nail-holes along the central axis, two on either side of the slot (Illus 253).

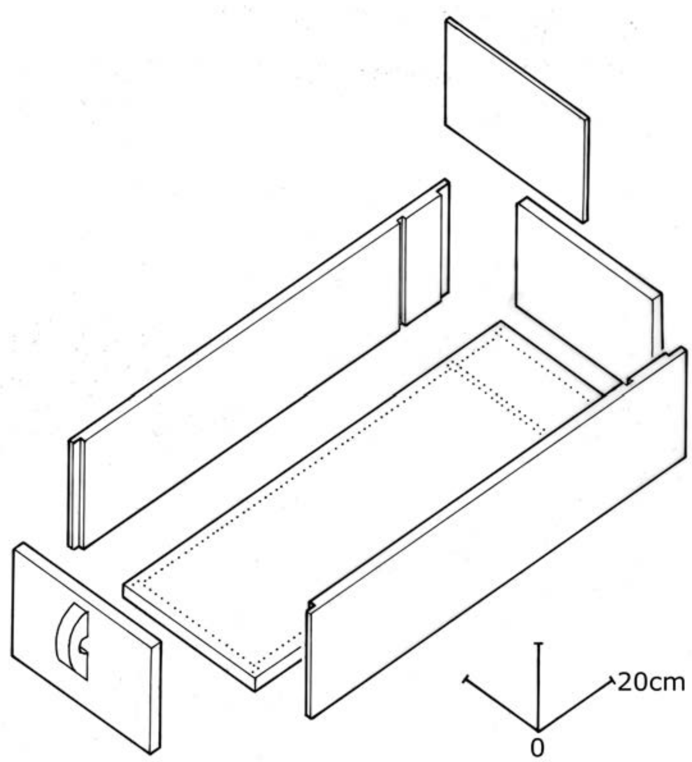


Illustration 252
Isometric reconstruction of the wooden chest 110 (DP 174842)

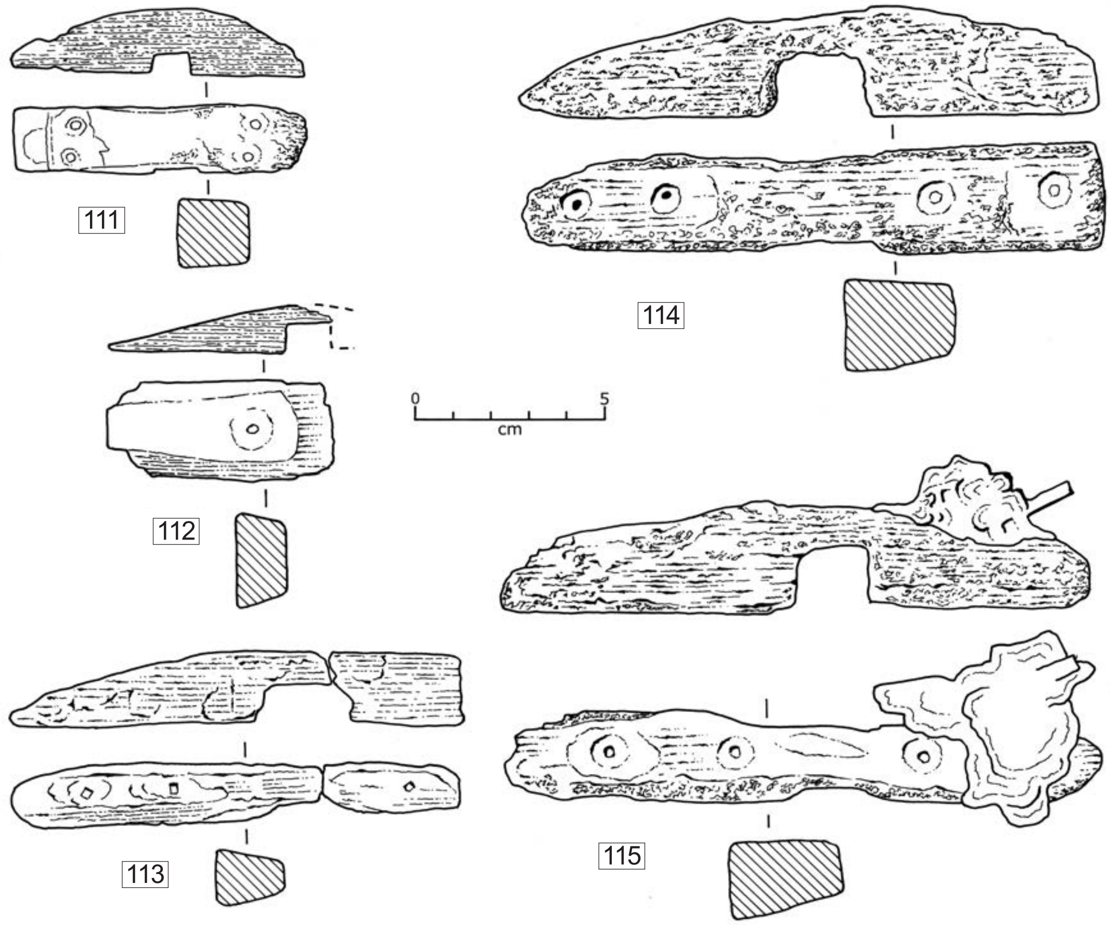


Illustration 253
Wooden chest cleats 111–15; 111 is from chest 110 (DP 174843)

115 DP03/025, **110.085**, cleat similar to 114, also with one shortened end, 310mm × 49mm × 55mm, slot 38mm wide by 30mm deep. Two holes for 6mm-square nail shanks on each side, along the horizontal axis (Illus 253).

There is no doubt that the cleat on the surviving short end of the chest 110 was set vertically, for it was found in that configuration, still held by the corroded remains of four nails. All the wooden cleats identified on the *Mary Rose* chests were set in the same way (Richards with Every 2005: 388), and traditional sea-chests are still made with rope becket-handles slung on vertical cleats (frayedknotarts.com/beckets). A short pin of wood or metal would have passed through the hole in the cleat, and the eyes of a short rope becket seized to both ends. The *Mary Rose* produced a large number of chests and chest components, from which a minimum of 49 individual examples can be identified (Richards with Every 2005: 387). They clearly served a number of functions including the stowage of personal kit, for which the smaller and sometimes more elaborately constructed chests were employed, as an analysis of their contents shows. The Duart Point chest appears to fit this category, very much at the lower end of the status scale.

116 DP99/039, **066.105**, handle made of 40mm-circumference three-strand hemp rope, right-hand Z-twist lay, with a crown-and-wall knot at each end which locks the strands into the lay (*Admiralty Manual of Seamanship* vol 1 1972: 177–8; see note on cordage measurement in Chapter 6) (Illus 254). This knot is commonly used to finish off the ends of seizings to prevent them from unreeving. Handles such as this are known from *Mary Rose* (Richards with Every 2005: 388–9), where they pass through two holes drilled horizontally in the box-end and are secured with knots. It can be surmised that after the first knot was tied the free end was passed from the inside through the

116

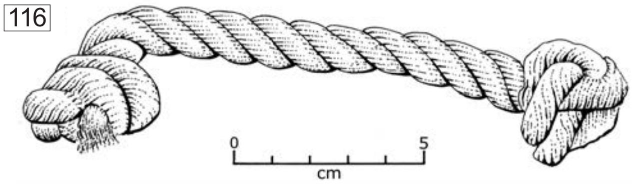


Illustration 254
Rope handle 116 from a chest or box (DP 174844)

first hole and then returned through the second, where the three strands were worked into an anchoring knot.

Bigger chests were used for the tidy organisation of specialist gear, such as carpenter's tools or apothecary's equipment, and their presence on the Duart Point ship can be inferred from the larger cleats in the assemblage. They were also used for the storage of weapons and munitions, and several chests full of longbows and arrows were found on *Mary Rose*. These had horizontally set rope handles on their ends, and it may be that this was a characteristic of munitions boxes. Becket handles would have served well enough aboard ship for slinging or handling over short distances, but for carrying (for example) a crate of muskets on shore the wider, more easily grasped, rope-loop handles would have been more suitable (Richards with Every 2005: 388).

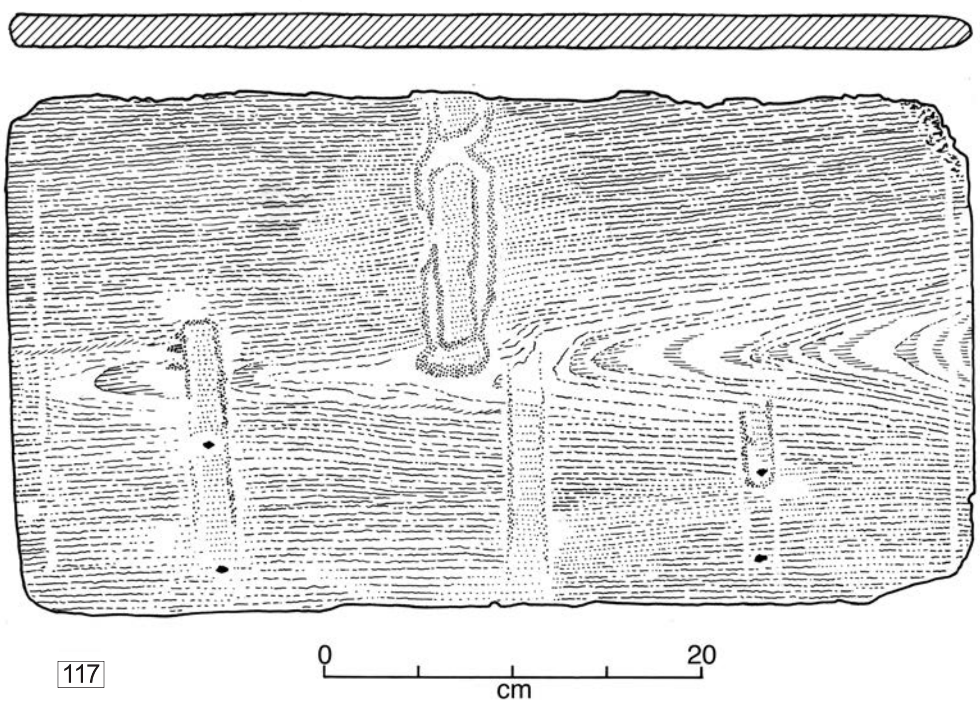
117 DP92/172, findspot unknown, oblong pine board, 508mm × 272mm × 18m, cut through centre grain, with four nail-holes and the impressions of three straps or hinges extending to the centre of one side, and a single central strap-mark on the other (Illus 255). Probably a hinged box-lid with a locking latch.

8.5 The pocket-watch

Lore Troalen, Darren Cox, Theo Skinner, Andrew Ramsey & David Bate

(this report is based on a publication by these authors in 2010 in the *International Journal of Nautical Archaeology*)

118 DP92/252, found loose on the sea-bed at **091.088**. It appeared to have been recently displaced by the erosion of adjacent deposits. Though covered by concretion, it was tentatively identified as a pocket-watch. X-ray radiography at National Museums Scotland in 1994 confirmed this identification and close scrutiny suggested that within the concretion much of the internal mechanism survived (Illus 256–8). Conventional radiography, however, is very limited in its ability to investigate so small and complex an artefact, and at this stage the conservation process was unable to reveal the



117

Illustration 255
Rectangular plank 117 with evidence of hinges, probably the lid of a chest or box

mechanism more closely without intrusive procedures which would irreversibly change the object.

Early modern pocket-watches are rare archaeological finds, but several have recently come to light, especially from submerged contexts or in the inter-tidal zone. The best-known was recovered from the sunken remains of Port Royal, Jamaica, its stopped hands supposedly recording the exact time of the disastrous earthquake on 7 June 1692 (Link 1960: 173). Also of note is the 17th-century watch in a case made from a large emerald, part of the Cheapside hoard found close to the Thames (Forsyth 2013). Another 17th-century pocket-watch, made by 'Johannes Cooke Londini' was found in the Thames between Tower Bridge and London Bridge. This watch was in good condition with the inner case very well preserved, to the extent that the maker and place of manufacture could be read on the back-plate (Meehan et al 1996).

In 1983 an 18th-century pocket-watch was found on the wreck of HMS *Pandora*, lost on the Great Barrier Reef in 1791 (Carpenter et al 1985). This watch, conserved by the Department of Materials Conservation at the Western Australian Maritime Museum, was found encased in concretion, but the interior was in good enough condition for Hugh Whitwell, the antique-watch restorer engaged to reassemble it, to advise that it could be restored to working order. The watchmakers' names, 'J & J Jackson, London', the number '9866', and a 1788 hallmark were identified on the case. Individual parts of pocket-watches are sometimes found on shipwrecks as, for example, the cock from a verge fusee watch from the wreck of *Adelaar*, a Dutch East Indiaman wrecked off Barra, Outer Hebrides, in 1728 (Martin 2005: fig 30.11).

Microfocus 3D X-ray computed tomography

Following the recent development of a high-precision microfocus X-ray computed tomography system by X-Tec Systems Ltd and its application to the study of an ancient astronomical calendar recovered from a 1st century BC Greek shipwreck in the Mediterranean, the so-called 'Antikythera Mechanism' (Freeth et al 2006; Ramsey 2007), it was decided to apply this technique to the Duart Point watch. In the Antikythera investigation the Three-Dimensional Computed Tomography (3D-CT) had revealed very fine inscriptions on the mechanism which enabled its function to be understood. 3D-CT images are created from a set of high-resolution two-dimensional (2D) X-radiographs collected during a single rotation of the object with high accuracy in the positional alignment. The Computed Tomography (CT) dataset, and the associated image-management software, allow the researcher to visualise the object in three dimensions, to strip away components, and to slice it in any arbitrary direction to see interior detail.

The watch was mounted in a polythene box, held securely with Plastazote foam, and fixed on a stand for investigation. The main limitation of such analysis is generally the depth to which X-rays will penetrate. This depends on the X-ray energy and the material density – for brass at 225 kV the maximum depth will typically be *c* 40mm – while the

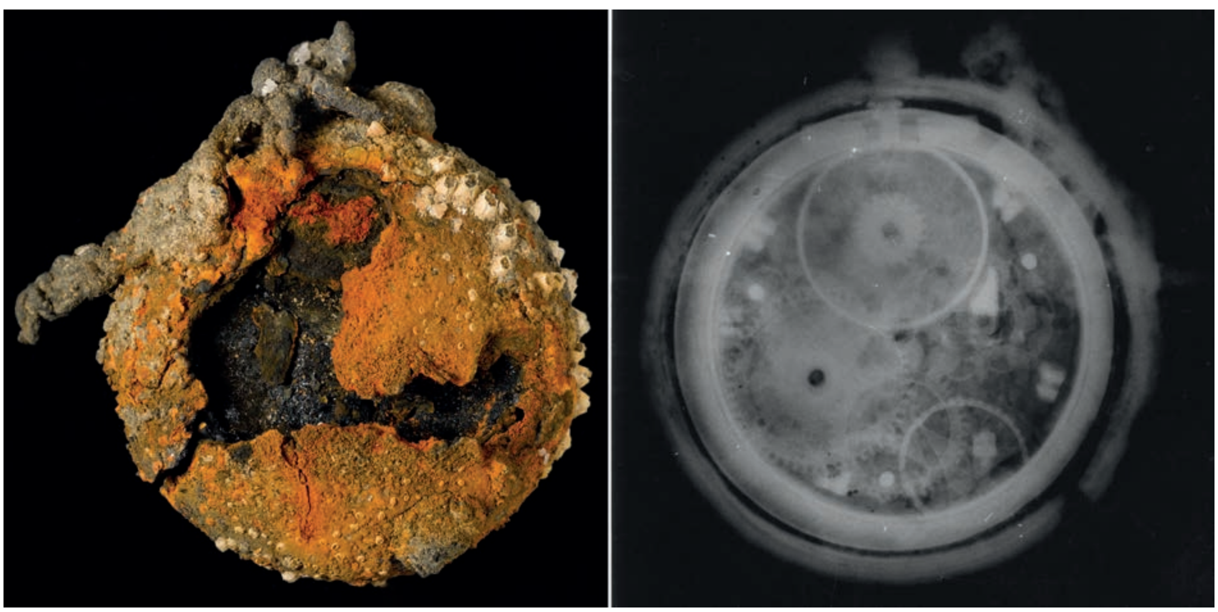


Illustration 256
Left: the watch 118 as found. Right: conventional radiograph of the watch (both images © National Museums Scotland)

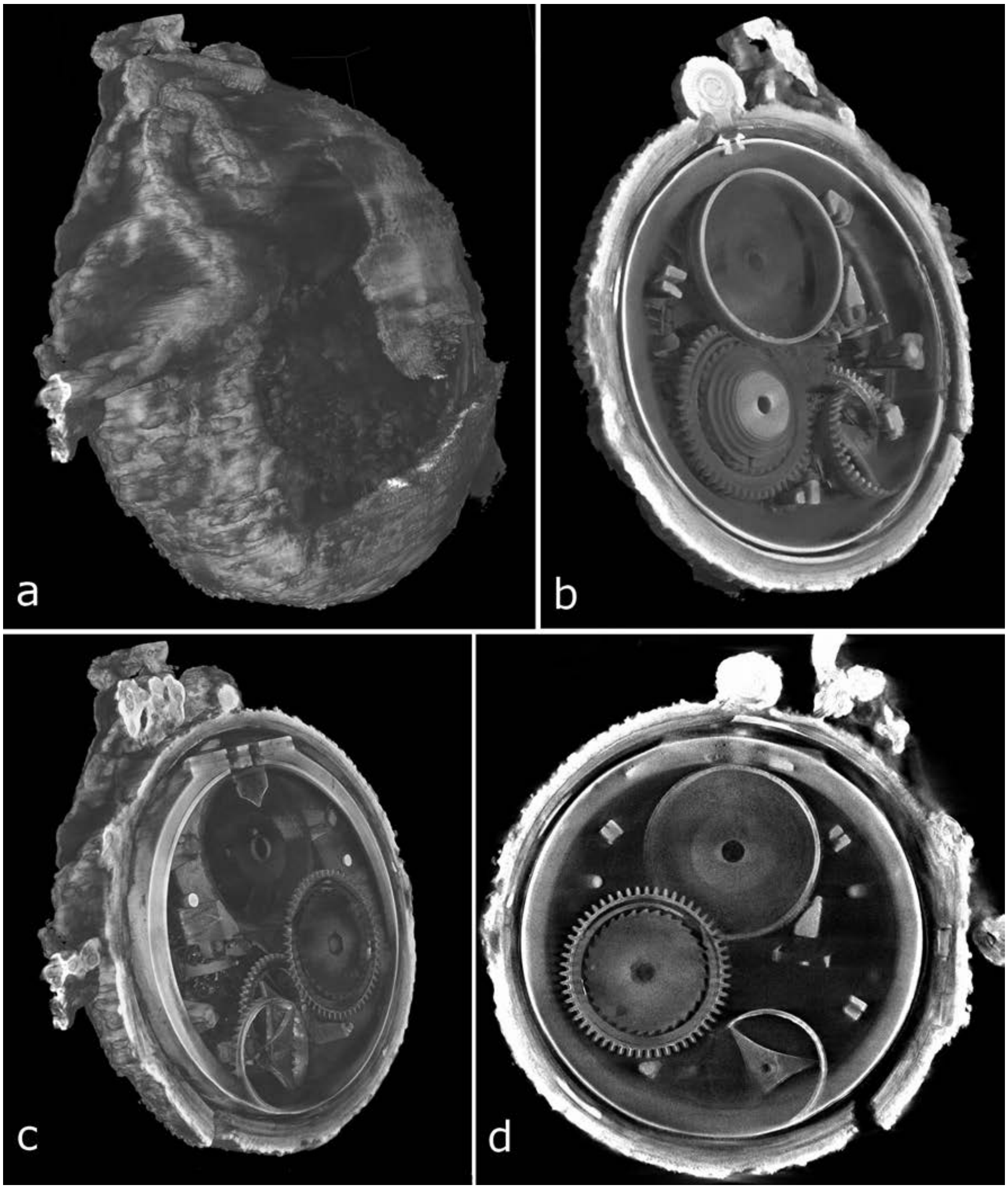


Illustration 257
3D-CT images, showing: (a) reconstruction of the volume of the watch; (b) 2D slice through the 3D-CT volume (or '2D-CT slice') after image processing, showing the inner mechanism, including traces of the watch-spring in the barrel and four Egyptian pillars; (c) the inner mechanism; (d) 2D-CT slice, after image processing, showing the fusee click teeth (all images © National Museums Scotland)

limited space in the CT system makes the technique suitable only for small, relatively light objects. These conditions limit the investigation of dense materials such as heavy metals. The mounting requires the object to be centred and completely stable during scanning to allow accurate registration of each X-ray image. The manipulator is accurate to about 2μm and rotates with a precision of less than 70 milli-radians.

The object was investigated using an X-Tek HMXST-CT system from Metris UK, using a 5μm spot-size 225kV tube

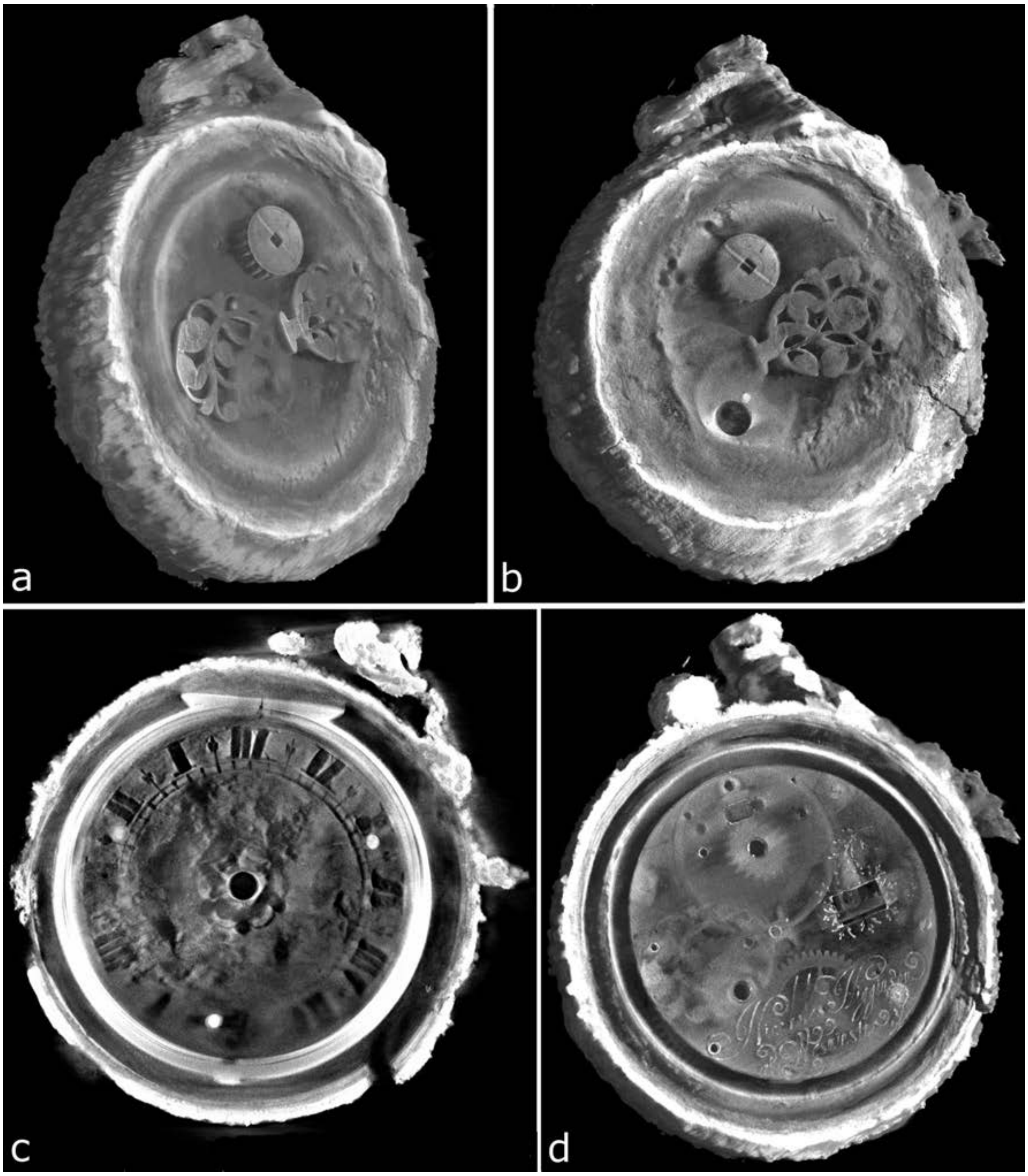


Illustration 258
(a) detail of 3D-CT image showing the regulation dial and the remain of its brass pin; (b) 2D slice through the 3D-CT volume, showing the engraving on balance back cock; (c) 2D-CT slice, showing the dial with rose engravings; (d) 2D-CT slice showing a floral engraving and the engraved signature: 'Niccholas Higginson Westminster' (all images © National Museums Scotland)

with an amorphous silicon flat-panel detector. The resolution obtained on the CT scan is voxel size of 63µm. The data were then reconstructed using X-Tec's CT-Pro Computed Tomography software and visualised using VolumeGraphics software. An Audiovisual Interleave animation (AVI) has been produced, showing a three-dimensional reconstruction of the watch and allowing a viewer to pass through the object from one side to the other and back again. This has important implications for the display and explanation of such objects.

The results of the investigation exceeded all expectations. The three-dimensional character of the scans, and the very high resolution, allow fine details to be seen. Images this fine might be resolved by conventional radiography, but they would be exceedingly difficult to interpret. The 3-D visualisation makes possible a virtual reconstruction of the mechanism, which confirms the date and origin of the watch (Troalen et al 2010) (Illus 257–8). The CT scans reveal that all the steel pieces appear to have decayed through corrosion, whereas the brasswork remains in fine condition. As a result it has not been possible to define ferrous pieces such as arbors, pinions, pallets or balance-wheels, which are traditionally made of steel. However, since the brass components remain fixed within the matrix of concretion, their original configurations are preserved, while corrosion-products of the steel and (to a lesser extent) the brass appear to fill the voids inside the movement. Using image-processing/-enhancing software it has been possible to observe a cloudy feature which could represent either this corrosion or some scattered X-rays. Within this some traces of the original ferrous metalwork can be observed. For example, parts of the iron spring-coils appear in the barrel, showing a typical corrosive angular pattern (Illus 257b).

Description

Around 1630 England produced a plain-looking watch now classified as the 'puritan' type, a style relatively free of decoration (Harris 1977: 36). The scans of the Duart Point watch suggest that the inner case is simple and undecorated. This need not, however, imply austere treatment, for by the second quarter of the century greater emphasis of decoration was often placed on the outer case, leaving the inner one plain. Because of corrosion and concretion the character of the Duart Point watch's outer case cannot be ascertained, although surface X-Ray Fluorescence analysis revealed the presence of silver in the chain and the watch's case suggesting that these were made of silver, or possibly silver-plated copper alloy (Wilthew 1994). This is an extremely high-status artefact for its period, and its presence (along with the snaphaunce pistol and gold-wound sword-hilt) implies an owner of considerable wealth and high social standing. The most likely candidate is the ship's captain, Edward Tarleton.

The watch has a single train movement with verge escapement typical of the period. Until the invention of the Virgule Escapement in 1660 the verge and crown-wheel was the only escapement used in watches (Britten 1904: 529). The wheels are so clearly visible that the teeth can be counted (Illus 257d). It was not uncommon at the time of manufacture for all the brass pieces to be gilded, which could possibly explain the relatively good preservation of most of the non-ferrous parts. It is not possible, however, to determine whether or not gilding is present, as the thickness of the gold layer would be much less than the resolution achievable with the CT scan.

On the top plate there is evidence of a worm-and-wheel set-up, a system for regulating the time via the spring. What remains of this is an engraved dial numbered 1 to 8 in Arabic numerals and the regulation wheel beneath it. The steel square, attached to the centre of the spring and linked to the regulation wheel, which would have been used to adjust spring tension, appears to be missing, but the 'ghost' of the brass pin used to secure the dial remains as a void in the corrosion products (Illus 258a). The regulation dial indicates the amount of tension on the spring, which would adjust the rate (time-keeping) of the watch. Around 1610 the worm-and-wheel replaced the ratchet as the regulator of a watch (Baillie 1929: 87), so the presence of this feature suggests that this watch was made after this date. The top and bottom plates are held together by square-sectioned Egyptian tapered pillars (Illus 257b), a style introduced *c* 1640, which brings the typological dating closer to the middle of the century (Britten 1904: 529).

Contemporary watches commonly have floral engraving in areas such as the dial and top-plate. By rotating the virtual reconstruction of the watch and looking at specific two-dimensional projections it has been possible to record detailed images of engraved parts, even though these are no more than fractions of a millimetre deep. There are floral engravings around the aperture for the verge pallets/crown wheel. Some floral engravings which define the pierced balance-cock can be seen (Illus 258b). These types of engraving are common in this period as watch decoration. The dial has a 12-hour chapter-ring in Roman numerals, with quarter-hour graduations and half-hour decorative symbols, which may be fleurs-de-lys, though this cannot be judged with certainty from the image (Illus 258c). An English rose surrounds the central hole. There would have been only one hand on a watch of this date, and this hand has unfortunately completely corroded away.

Engraved on the top-plate in copperplate script are the words 'Niccholas Higginson of Westminster' (Illus 258d). Loomes (1981: 300) notes that a Nicholas Higginson of London was granted the freedom of the Clockmakers' Company in 1646. He rebelled against them in 1656 and was working in Chancery Lane (in Westminster not the City of London) by 1662. He paid a search fee in 1671. Freedom of the Clockmakers' Company was required in order to trade in the City of London, and was only granted after serving an apprenticeship. Rebelling against the Clockmakers implies that Higginson had refused to pay his membership dues in 1656. This did not evidently free him from all his former responsibilities, however, for the fee paid in 1671 was a fine for deficient work found during one of their 'searches' or periodic inspections. The Duart Point pocket-watch is the only known surviving example of this maker's work.

Chapter 9

OTHER FINDS AND RELATED ACTIVITIES 2

9.1 Pewter: the Scots tappit hens

Peter Spencer Davies, George Dalgleish & David Lamb (this is an abridged and modified version of a paper published by these authors in the *Proceedings of the Society of Antiquaries of Scotland*, which places the Duart Point finds into the wider context of Scottish pewter studies. See also Davies 2014: 171–4)

Three lidded pewter vessels were found during the excavation of the collapsed stern. This form of measure, known as the 'tappit hen', is peculiar to Scotland. The name is applied to measures comprising a small straight-sided top section, a larger straight-sided bottom section and a curved section joining them. Typically, the measure has a domed lid raised by means of an erect thumbpiece located on a hinge at the top of the handle. The largest is a Scots pint, the second a half-pint or chopin, and the third one-eighth of a pint, commonly referred to as a half-mutchkin.

119 DP00/204, **110.081**, pewter tappit hen, height to rim 250mm, top diameter 92mm, base diameter 120mm (Illus 259–60).

120 DP03/063, **132.099**, pewter tappit hen, height to rim 210mm, top diameter 73mm, base diameter 98mm (Illus 259–60).

121 DP01/131, **173.090**, pewter tappit hen, height to rim 102mm, top diameter 46mm, base diameter 55mm (Illus 259–60).

Examples of the Scots pint capacity (which approximates to three of today's imperial pints) dating from the late 18th century, are not hard to come by. However, very little Scottish pewter has survived from the 17th century, when the craft of the pewterer was at its peak. This is largely because pewter is a relatively soft metal and easily damaged, and the damaged pewter was sold back to the pewterer for recycling, much in the same way that silver was melted down (Dalgleish & Fotheringham 2008: 29–31). As a consequence, our knowledge of the early forms of the tappit-hen measure has until now been based on a single excavated example (Ingleby Wood 1904: pl 22), dating to some time after 1669, when the maker became a master-pewterer. It had never been subjected to detailed examination and several interesting features had been overlooked. However, the discovery of three tappit hens from the Duart Point wreck, together with the recognition of four very early 18th-century examples previously overlooked in private collections (Davies et al 2012), enables us for the first time to piece together the early evolution of this distinctive Scottish measure.

Throughout the 16th and 17th centuries the generic term for a vessel was a 'stoup' (*Dictionary of the Scots Language*). A stoup could be made from wood, silver or other metals, but it is probable that most were made of pewter. After the Reformation stoups are recorded as being used for carrying wine to the communion table and for water at baptism. Those used as measures were referred to by their capacities. Thus there were pint stoups, based upon the Scottish Stirling pint (1696ml or 103.35in^3, compared to the English pint of 591ml) (Connor et al 2004: 279–83, item 108), and its sub-divisions of chopin (848ml or 51.67in^3), mutchkin (424ml or 25.84in^3), half-mutchkin (212ml or 12.92in^3) and gill (106ml or 6.46in^3). In commerce they were used in the sale of liquids, from wine and ale to buttermilk and vinegar, and were to be found in the kitchens of larger houses. There were two distinct forms of these stoups. In the north-east of Scotland a pot-bellied type was made by the pewterers of Aberdeen and Inverness, and was clearly derived from similar vessels in use in the Low Countries (cf 122 below). They continued to be made well into the 18th century. There is no evidence that they were ever made in Edinburgh, which instead adopted the tappit-hen form. It is important to recognise that this name was not used until the early 18th century, and prior to that they were simply referred to as pint stoups, chopin stoups, and so on. For clarity, however, we will use the term 'tappit hen' here.

At the time of discovery the three measures on the Duart Point wreck were covered in a heavy calcareous accretion. This was painstakingly removed by Dr Theo Skinner of National Museums Scotland, exposing their previously unknown early features. The amount of information they contain is remarkable, and they have massively extended our knowledge of this vessel-type.

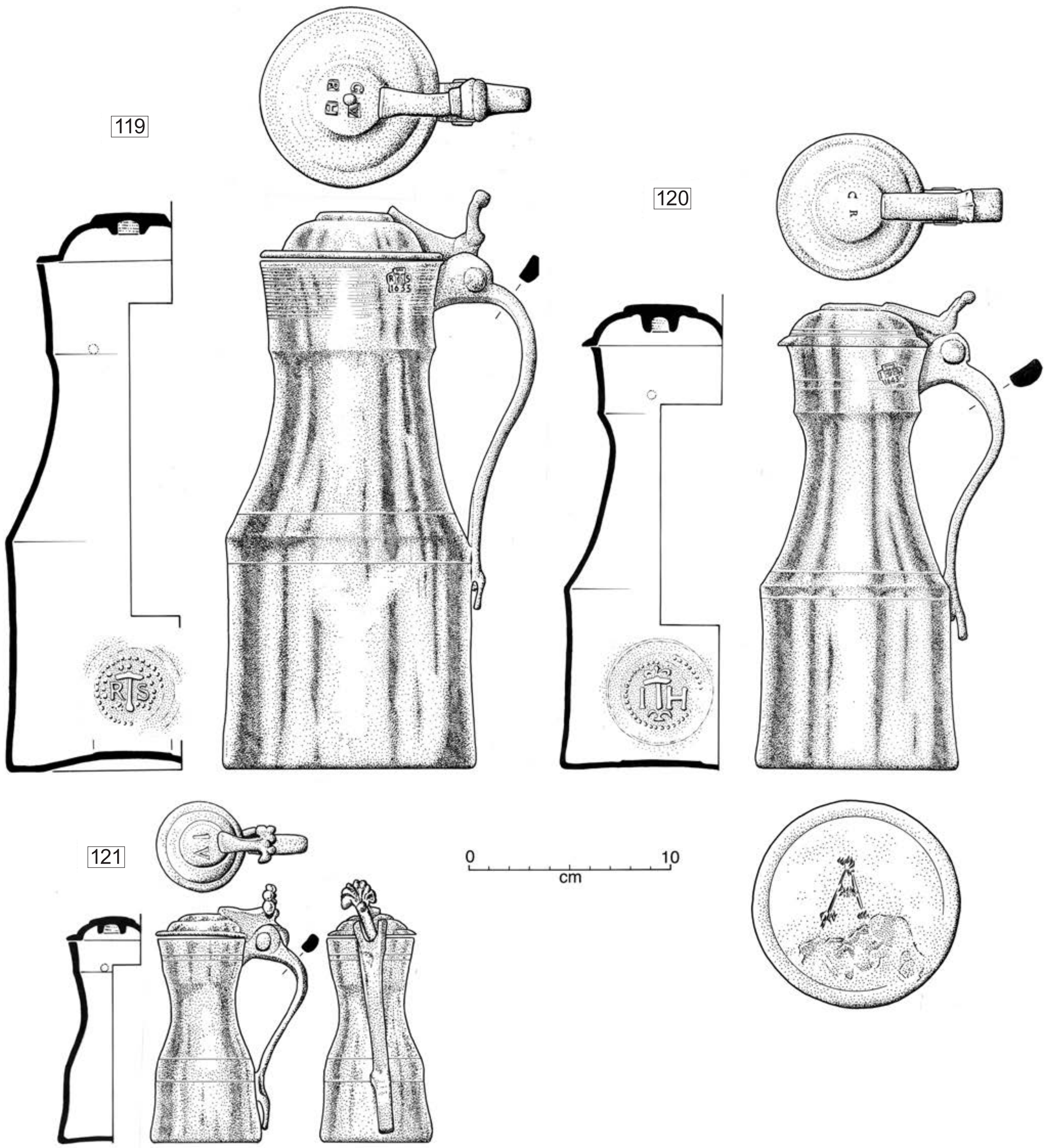


Illustration 259

Pewter tappit hens: 119 by Robert Somervell of Edinburgh, one Scots pint capacity; 120 by John Harvie of Edinburgh, one chopin capacity; 121 maker unknown, half-mutchkin capacity (DP 174070)

Illustration 260
The three tappit hens 119–21 showing their 'plouks' or certified volume marks (DP 174070)

Compared with the familiar 18th-century forms they are more heavily cast, with thicker walls. The most interesting feature is their method of construction. The bodies of 18th-century tappit hens were cast in three parts, circular in section, which were then joined together along horizontal seams running around the circumference. However, the Duart Point tappit hens, and other early examples examined during the course of their study, demonstrate a distinctively different manufacturing technique, apparently confined to this period. The body was cast in bronze moulds as two vertical halves of semi-circular section. Only four moulds would have been required – for the half-bodies, the lid, the thumbpiece, and the handle. The two halves of the body were then joined using pewter as the solder. The two vertical seams were left unfinished on the inside, where they can be seen clearly (Illus 261), but on the outside the body was finished by turning, followed by burnishing to give it a high surface polish.

In order to hold the vessel on the lathe it would have been centred on a fixed iron headstock and tailstock. The base was an integral part of the casting, and each of the two base halves had a semi-circular cut-out in the centre. When joined a circular hole was left. Wooden plugs would have been inserted at the base and top openings to centre the vessel against the headstock and tailstock. When the surface treatment was complete the base-hole was filled with a plug of pewter. Excess metal on the outside was removed using a hand-scraper tool. On the inside the pewterer used a punch to strike a circular mark onto the top of the plug. The mark was in the form of a beaded circle surrounding a hammer flanked by the maker's initials. Traces of the plug can be seen on close examination of the bases (Illus 262). The internal marks are clearly seen on the pint and chopin measures. Because of difficulties of access, the calcareous

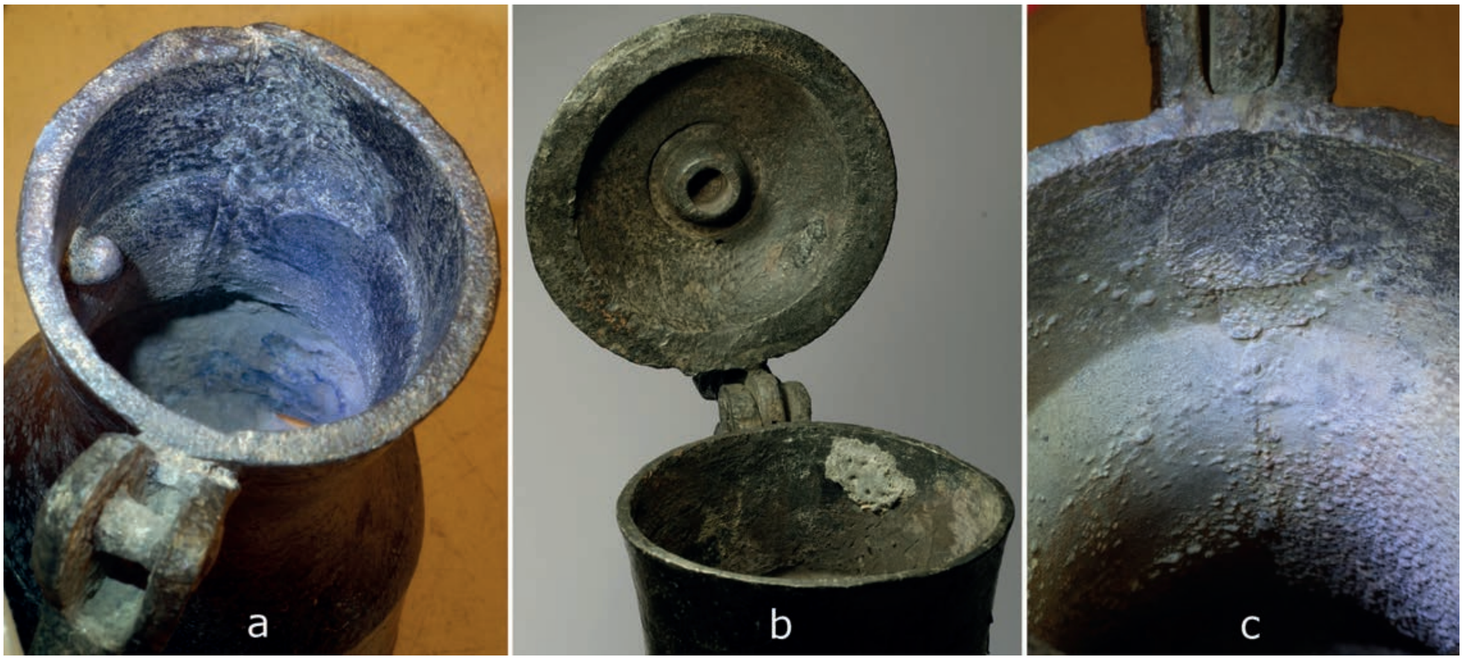


Illustration 261

(a) Internal view of the half-mutchkin measure 121, showing the plouk and vertical seam-joint; (b) open lid of the pint measure 119 showing detail of the hinge and the screw-threaded projection at the centre of the lid interior; (c) detail of the half-mutchkin interior, showing the 'cloth mark' that was left when the handle was joined to the body. Below it the soldered vertical seam joining the body's two halves is clearly visible

accretion covering the base of the half-mutchkin measure has not yet been removed, so we do not know whether it also bears a mark.

Lathes of the period were turned by hand, rotation being provided by a large iron flywheel. The woodcut (Illus 263) shows a German pewterer of 1568 finishing a flagon, while his journeyman or apprentice turns the wheel. The wooden plug in the hole in the base, which was used to hold it against the tailstock of the lathe, is clearly shown. At some time during the mid 18th century this method of manufacture ceased, and

Illustration 262

Left: base of the pint measure 119 (120mm diameter) showing evidence of the plug which filled the hole in the base where the vessel was held on the lathe during the finishing process. Right: enlarged photograph of the inner face of the plug showing the stamped hammer and initials mark of Robert Somervell the body was subsequently cast in horizontal sections. This allowed the base to be made in one piece, doing away with the need for a hole.

On the insides of the necks of all the measures, to the left of the handle and below the rim, is a blob of pewter referred to as the 'tapoun' or, more commonly, the 'plouk' (a Scots word for pimple) (Illus 260–1). This indicates the level to which the measure was to be filled to hold its certified capacity. The requirement of a tapoun was first mentioned in legislation passed by Edinburgh Town Council on 31 January 1543 (ECA SL1/1/2). A further statute of 16 February 1555 (ECA SL1/1/2) is explicit:

> Compeared John Rynd John Weir John Watsoun and James Cranstoun pewterers and obliged themselves in time coming to make their stoups pints and chopins … of the just measure of the manner following viz. that each measure have a tapoun an inch beneath the lip and the stoup to be just measure to the tapoun.

Tappit hens continued to be made with the tapoun or plouk throughout the 18th century, and the makers of pot-bellied measures in the north-east of Scotland were also required to adopt this method of showing certified capacity.

The dome-shaped lids are very heavily cast and bear in their centres a slightly raised disc, as on all later tappit hens. In the centre on the inside they have a short tubular projection, with coarse-cut threads on the inner surface (Illus 261). It is suggested that this was used to screw the lid to a threaded iron rod in the chuck of the lathe to hold it in position for surface finishing. This feature is not seen in 18th-century examples. The thumbpieces and their attachments to the lids are all very heavily cast. These were attached with solder after the lid had been turned (Illus 259–60). On the pint and chopin measures the thumbpiece is of the erect type also seen on pot-bellied measures and 18th-century tappit hens. The half-mutchkin measure, however, has a double-sided palmette thumbpiece with six lobes. In all three measures the lid attachment is an almost horizontal trapezoidal or wedge-shaped bar reaching to the central disc of the lid. The hinge at the top of the handle is also massive and heavily cast, and is in three parts, linked by a pin, the centre section being a part of the lid (Illus 259–61). The handles of the pint and half-mutchkin measures are

Illustration 263
A 16th-century woodcut showing a pewterer finishing a flagon on a wheel-driven lathe. Note the cylindrical chuck inserted into a hole in the base (after Amman & Sachs 1973)

rectangular in cross-section, while the chopin has more of the D-section handle familiar on later forms.

The makers

The half-mutchkin measure has no maker's mark on the neck, and we are so far unable to tell whether there is a mark on the plug inside the base. The other two measures have remarkably clear maker's touchmarks, located to the left of the hinge and directly behind the position of the plouk. The positioning of the mark dates from 1554, when the statute of Edinburgh Town Council referred to above also called for 'on the outer side of the tapoun that the town's mark be thereon and maker's mark beside it' (ECA SL1/1/2).

The pint measure has the mark of Robert Somervell (Illus 262), comprising a castle with the initials RS and the date 1633. We know that Robert Somervell was the son of James Somervell, pewterer (Watson 1929) and became a burgess in 1633, becoming a freeman of the Incorporation of Hammermen of Edinburgh in the same year (ECA ED008/1/3). This was the date at which he opened his workshop as a master-pewterer, and would have struck a record of his mark, or 'touch', on the touchplate of the Incorporation of Hammermen. The set of two touchplates, each a 5mm-thick slab of pewter measuring 315mm × 110mm, now belongs to National Museums Scotland.

Of particular interest is the mark struck on the base-plug. It depicts a hammer with Robert Somervell's initials on either side. This mark, together with similar ones inside the Duart Point chopin measure and the John Abernethie chopin already in the Museum's collection, are the earliest recorded examples of this type. However, similar marks were struck on the bases of vertical-seam flagons in France and Germany in the 15th and 16th centuries. The use of a hammer in all three marks is appropriate, since a crowned hammer forms the centrepiece of the insignia of the Edinburgh Incorporation of Hammermen. Careful examination of the marks shows that the hammer, in this case, does not have a crown above it.

The chopin tappit hen has the touchmark of a castle, the initials I H, and the date 1643 (Illus 259), while the mark on the base comprises a hammer with the same initials and some scrollwork above, possibly representing a crown. The maker can be identified as John Harvie, the first of two Edinburgh pewterers of that name. He became a burgess in 1642 (Watson 1929) and a freeman pewterer in 1643. He died in 1658 (Davies 2014: 66).

Owners' initials

Pewter utensils usually bore the owner's initials, either punched or engraved. The pint measure has the punched initials G W above R H on the lid, while the chopin is stamped C R and the half mutchkin has the initials I V (or possibly I K). The pint tappit hen presumably carries the initials of a husband and wife, and that all three vessels have different groups of initials indicate that they are not parts of a set.

The Mackenzie crest

A sharply incised mark has subsequently been cut on the base of the chopin measure, presumably by an owner (Illus 264). It is recognisable as 'a mountain inflamed proper', the crest of the Mackenzie clan (McIan & Logan 1983: 128). The crest symbolises the network of beacons in the highland landscape which linked a maritime clan's castles with its galley fleets. Prior to its arrival at Duart the 1653 Cromwellian expedition

Illustration 264
Mark cut on the base of the chopin measure 120 showing the 'mountain inflamed' crest of the Mackenzie clan

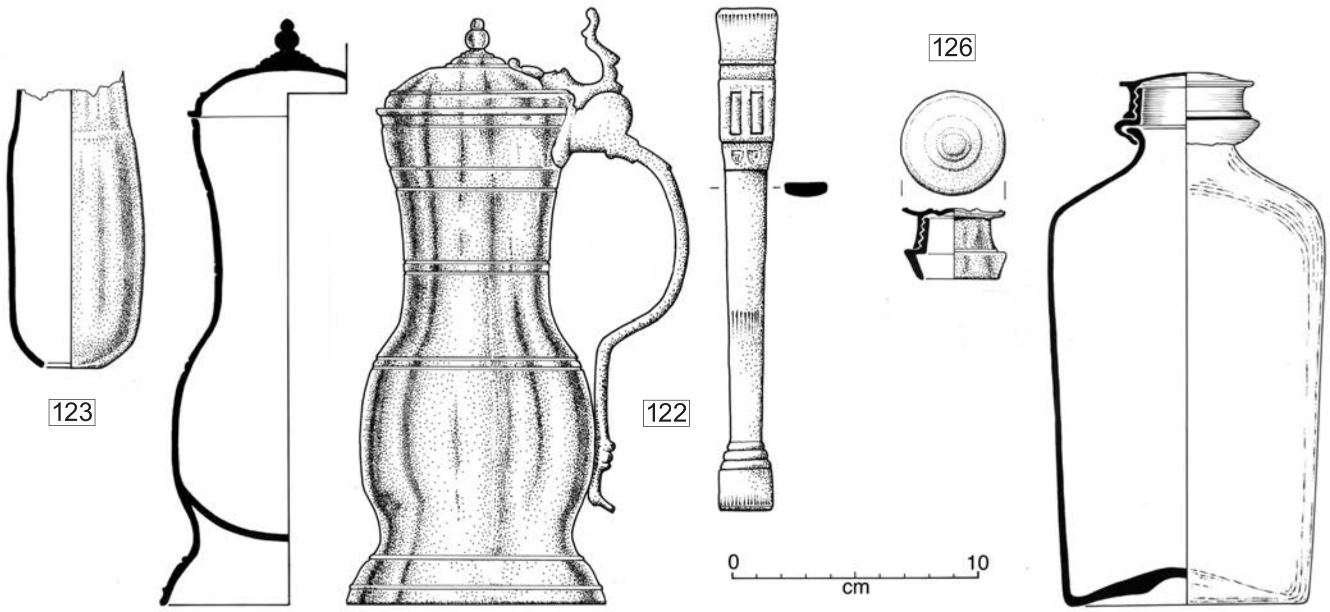


Illustration 265
Left: bulbous flagon 122, partially reconstructed. It was found in association with the tubular pewter object 123 to its left (DP 174837). Right: crimped pewter bottle-top and threaded cap 126. Far right: similar bottle-top and cap and square case-bottle (partly reconstructed) from the wreck of the Dutch East Indiaman *Kennemerland* (1664)

had seized the Mackenzie strongholds at Stornoway and Eilean Donan, and it is likely that this item was plunder from one or other of these castles, as the other two tappit hens may also have been. The historical significance of this evidence is considered in Chapter 11.

9.2 Other pewter finds

122 DP79/001a, findspot uncertain, pewter flagon, height to rim 202mm, top diameter 82mm, base diameter 105mm, recovered by John Dadd in 1979. It was crushed and damaged, and Illus 265 shows it in its conserved and restored state. The flagon is pear-shaped with a bulbous body, a wide flared base, a long neck which flares as it rises, and a domed lid with double-beaded finial. The lid is raised by an erect thumbpiece located on a hinge at the top of the handle. The heavy handle bears two incuse shields set side-by-side which are not decipherable but which are presumably maker's marks. A continental origin, perhaps Flemish, is likely.

123 DP79/001b, found inside DP79/001a, tubular pewter vessel, lacking its top, and with a hole at its base, surviving height 113mm, maximum width 54mm. Function unknown (Illus 265).

124 DP02/020, **283.083**, large pewter dish with wide rim, diameter *c* 340mm (Illus 113, 266).

125 DP99/026, **066.103**, large pewter dish with a narrower rim, diameter *c* 300mm (Illus 267). These two pewter dishes were found at opposite ends of the wreck. At the time of writing they were in conservation and not available for measured drawing.

126 DP01/132, **173.090**, pewter top for a glass case-bottle (Illus 265). The lower element was crimped to grip the rim of a glass bottle (of which no part had survived), and carried a threaded collar above it. A mating threaded lid with a flat top was still screwed in place. Such items are common on shipwrecks of this period, particularly Dutch East Indiamen. Examples have been recorded on *Batavia* (1629) (Green 1989: 173), *Lastdrager* (1653) (Sténuit 1974: 241), *Vergulde Draeck* (1656) (Green 1977: 215–17), *Kennemerland* (1664) (Price & Muckelroy 1977: 205–6), *Santo Christo de Castello* (1667) (Larn et al 1974: 77), and *de Liefde* (1711) (Bax & Martin 1974: 85). An example from *Kennemerland* is illustrated (Illus 265 right), together with the partly restored glass case-bottle to which it was attached. Square bottles thus capped, some containing traces of spirits, have been found on the *Kronan* wreck in the compartmented wooden cases which have given them their name (Johansson 1985: 81). They perhaps represent an early example of recyclable packaging, which may explain their almost complete absence from terrestrial assemblages.

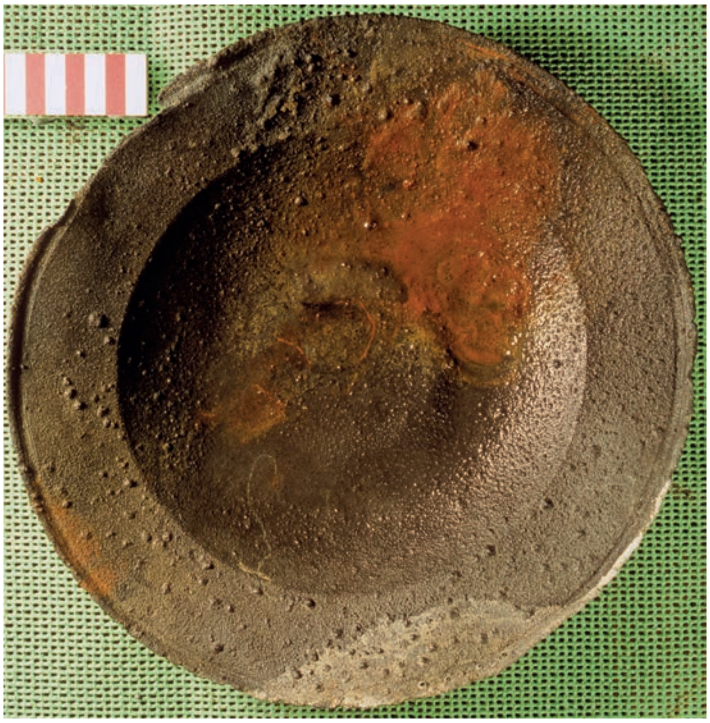


Illustration 266
Wide-rimmed pewter dish 124, diameter *c* 340mm. Scale in centimetres (DP 174178)

Illustration 267
Narrow-rimmed pewter dish 125 in situ, diameter *c* 300mm. Scale 15 centimetres (DP 173147)

9.3 Pottery

A relatively small quantity of pottery was found on the wreck. Other finds show that many domestic utensils aboard the ship were of wood, either turned or stave-built, or of pewter. But the paucity of ceramics may also reflect the fact that the ship had largely been emptied before she sank, a probability reinforced by the general dearth of other portable artefacts encountered during the excavation.

The pottery falls into two groups. The first appears to have been directly associated with the ship, and constitutes a closed and closely dated assemblage. It comprises four intact Rhenish stoneware bottles; several pieces of glazed red earthenware (GRE) including a butter-crock, a pipkin, and a chamber-pot; tin-glazed drug-pots, one of which is decorated; an unusual fluted slipware bowl which may perhaps be associated with smoking; and a hand-built Hebridean *crogan*. As is often the case with shipwreck-derived ceramics, many of the pieces are complete or nearly so, and relatively few small sherds were found. A second group of 11 sherds, none of them conjoining, was found among the gravel ballast, and the association with the ship is probably fortuitous (see Chapter 4.1).

Frechen salt-glazed stoneware

Four complete bottles of mottled salt-glazed stoneware characteristic of the Frechen potteries near Cologne (Gaimster 1997: 208–23), with their distinctive *bartmann* masks and escutcheons, were found in the after part of the wreck. Three were in or close to the area of the collapsed stern interior; the fourth, which was recovered in 1979, is believed to have been found in the same locality (John Dadd pers comm). No sherds of this fabric were noted elsewhere on the site during the excavation, although in 2007 a large body sherd was observed loose on the sea-bed by a diver participating in the historic-wreck visitor scheme operating on the site (Mark Lawrence pers comm). It was not recovered, and could not subsequently be located. Wall-thicknesses and corking space have been estimated in calculating the capacities of the bottles.

127 DP00/049, **102.087**, between collapsed timbers and adjacent to 132, stoneware bottle with external light-grey glaze with brown mottle, height 220mm, diameter 141mm (Illus 268–70). Bearded face-mask with elongated ‘hour-glass’ mouth. Oval escutcheon with eight petals each enclosing a stamen and a central eight-armed star within a circle. Cork in place and evidence of liquid inside. Capacity 0.995 litres.

128 DP79/003, private collection, *c* **10.11**, stoneware bottle with external dark-brown mottle against a lighter field, height 210mm, diameter 130mm, capacity 0.74 litres (Illus 268). Bearded face-mask with ‘ladder’ mouth.

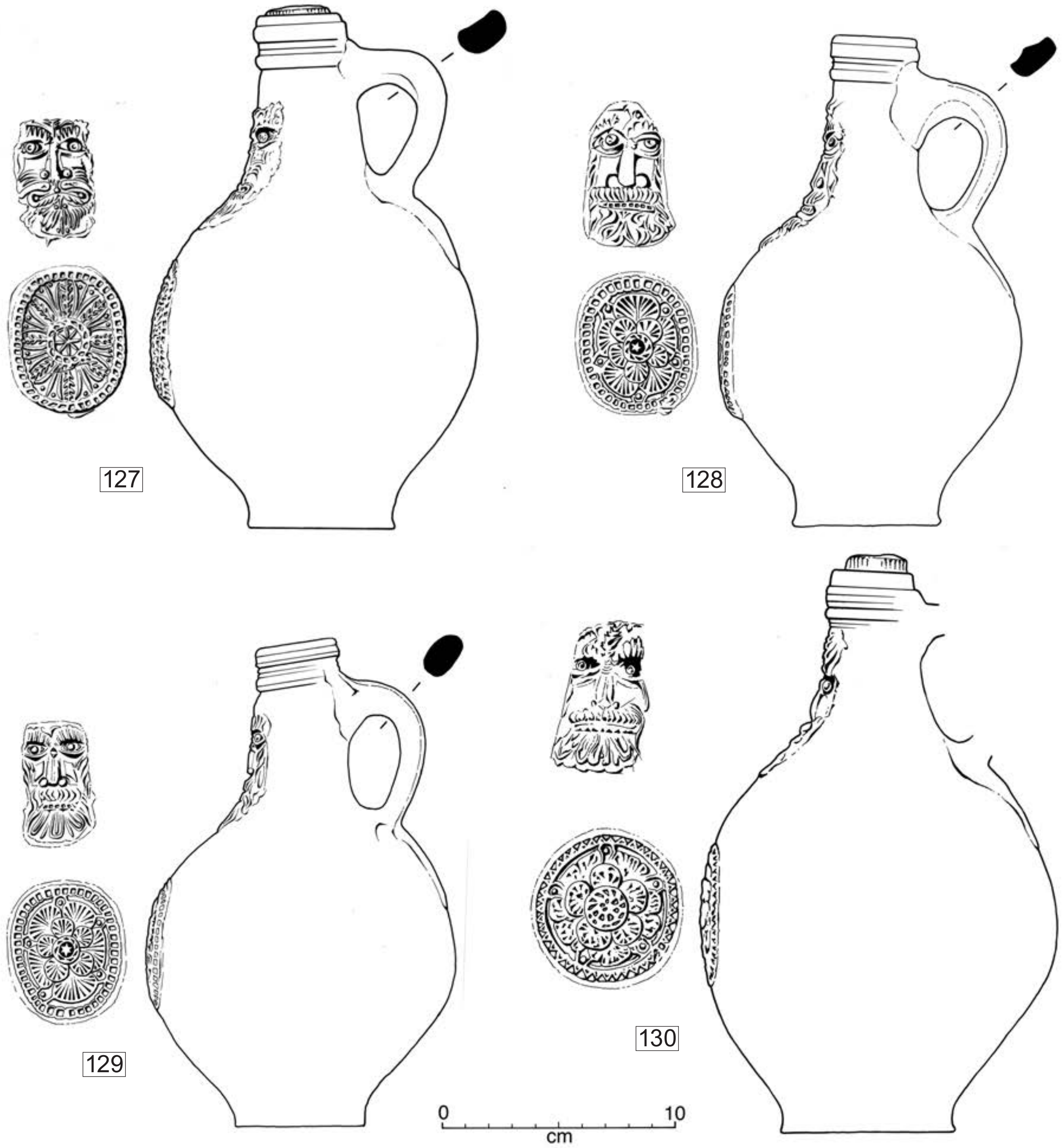


Illustration 268
Frechen salt-glazed stoneware jars 127–30 (DP 174203)

Oval rosette escutcheon with two superimposed five-petalled flowers and a central five-pointed star within a circle.

129 DP01/117, **174.095**, in bilge deposit next to 130, stoneware bottle with even, light-brown glaze with slight mottle, height 210mm, diameter 132mm, capacity 0.89 litres (Illus 98, 268, 270). Marked forward skew of rim and neck. Bearded face-mask with 'ladder' mouth. The escutcheon is similar to 128 but oriented in the opposite direction.

130 DP01/120 and 121, **174.095**, in bilge deposit next to 129, stoneware bottle broken in two conjoining pieces, and missing the handle, height 240mm, diameter 152mm, capacity 1.38 litres (Illus 98, 268, 270). Cork still in place. Finely mottled light-brown glaze on a lighter ground. There is a pronounced depression on the shoulder, perhaps due to pressure from an adjacent vessel in the kiln. Bearded face-mask with narrow serrated mouth. Circular rosette escutcheon with eight-petalled outer flower and five-petalled inner, and central boss of

Illustration 269
Intact Frechen stoneware jar 127 in situ during excavation. Scale 15 centimetres. In front of the scale is a rim-sherd 132 from a glazed red earthenware jar (DP 174211)

Illustration 270
Three of the Frechen salt-glazed stoneware jars 130, 127, 129

indeterminate design. The escutcheon is much less crisp than the other examples, and was probably formed in a worn mould.

These bottles are characteristic of the major production centre at Frechen, a small town some 10km south-west of Cologne where nearly 50 kilns and associated waster-dumps have been identified (Gaimster 1997: 208). They were evidently mass-produced as containers for a variety of products, and are widely distributed throughout north-west Europe. A nearly intact example was found on the 17th-century wreck off Mingary Castle, Ardnamurchan (Phil Richards pers comm). Several important groups have been found on Dutch East-India Company shipwrecks, notably *Batavia* (1627) (Green 1989), *Lastdrager* (1652) (Sténuit 1974), *Vergulde Draeck* (1656) (Green 1977), and *Kennemerland* (1664) (Foster & Higgs 1973: 297; author's unpublished archive). Although the wreck-groups have firm *termini post quem* fixed by the dates of loss, many of the various forms and decorative moulds show little change from *c* 1625 to *c* 1675. Such bottles were clearly re-used for as long as they remained unbroken and many may have been of considerable age when lost.

The apparently random variation in capacities shown by this small sample gives no indication of what measures, if any, may have been intended, and this difficulty appears to extend to larger collections (Steane 1987). The closest chronological parallel to the Duart Point group is the large collection recovered from the Dutch East Indiaman *Vergulde Draeck*, lost off Western Australia in 1656 (Green 1977: 110–41). However the two groups are distinctively different in character. The *Vergulde Draeck* bottles, though they too show a random variation of size, are significantly larger than the Duart Point group, the 16 examples tested for volume ranging from 1.24 to 3.25 litres, with eight larger than 2.1 litres, in contrast to the Duart group's range of 0.74 to 1.38 litres.

Perhaps more surprising is the much squatter proportions of the *Vergulde Draeck* bottles compared with the Duart Point ones. It has been suggested that this is a dating attribute (Thwaite 1973; Hurst et al 1986: 220–1; Hildyard 1989), the squat form being earlier than the elongated one, but in view of the contemporaneity of these two groups the dating relevance of this criterion may be questioned. Moreover the *Kennemerland* group of 1664 includes both types (Foster & Higgs 1973: 297, figs 6–8). The difference in shape is perhaps due more to function and usage than to date, and it may be suggested that the larger and more stable squat form, with its broad base and low centre of gravity, was a specialised type intended for shipboard use. Though the squat form is not unknown in terrestrial contexts it is far less common, as

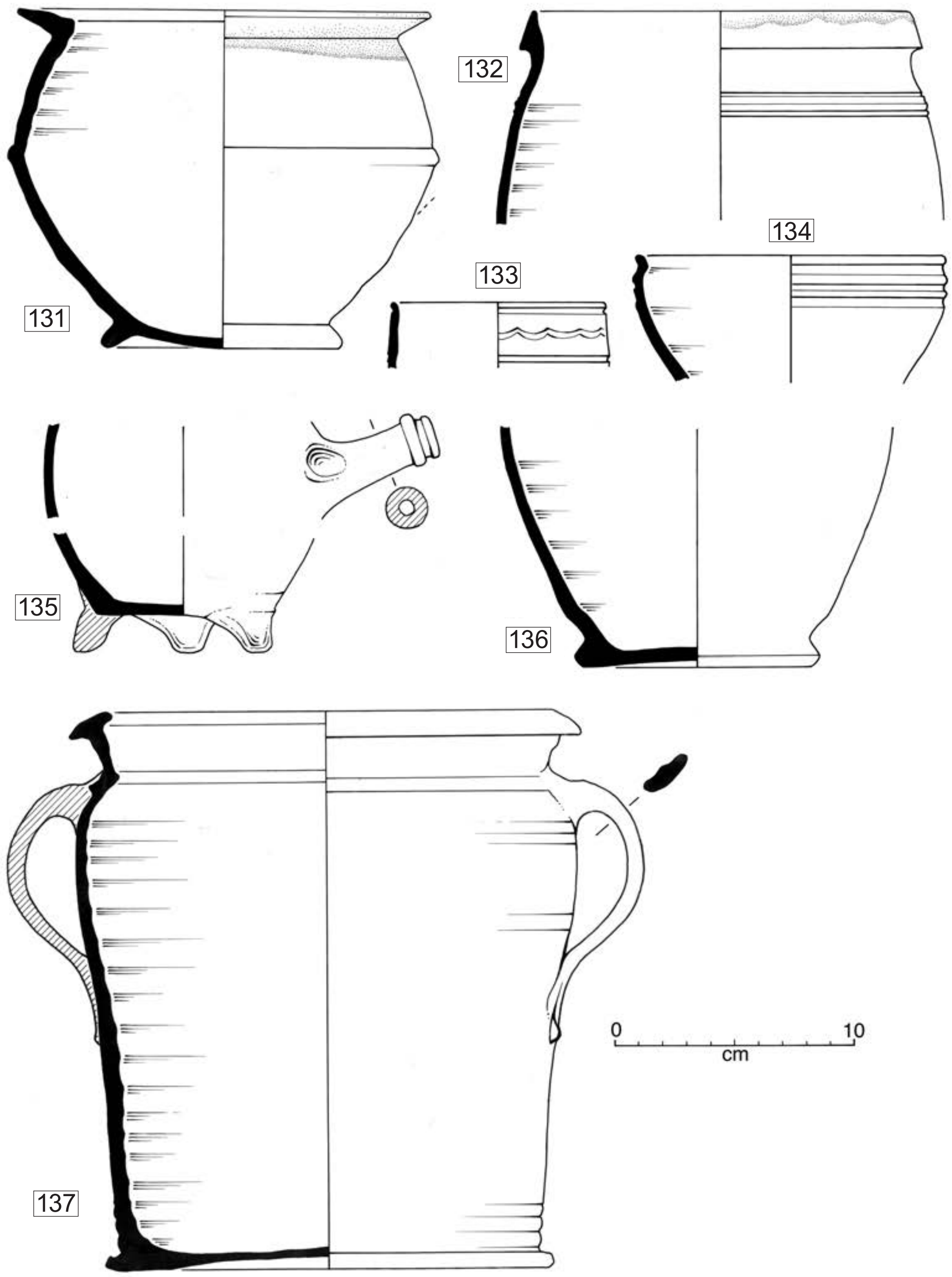


Illustration 271
Glazed red earthenwares (GRE) 131–7 (DP174863)

shown for example by the large groups from Basing House, Hampshire (Moorhouse 1970: 78–80) and Norwich (Jennings 1981: 119–23). That the Duart Point bottles are all of the elongated 'landlubberly' shape need occasion no surprise, since the Cromwellian supply bases at Newcastle and Leith were geared primarily to the requirements of land forces operating in Scotland.

Glazed red earthenware (GRE)

This red sandy earthenware, with small white and off-white gritty inclusions and a clear glaze which accentuates the deep hue of the fabric beneath, is of a generic type produced in many northern Europe centres from the 16th to 18th centuries, and there is little prospect of determining the precise origins of

Illustration 272
A selection of glazed red earthenware forms. Scale 10 centimetres (DP 174208)

the examples found at Duart Point. Important collections of similar ware have been identified at Norwich (Jennings 1981: 157–85), where it dominates the assemblage, and at Beeston in Cheshire (Harrington 2004: 116). The latter, which derives from a Civil War context, contains forms with parallels in the Duart group. A rather later group (late 17th/early 18th centuries), also with military associations, was recovered during excavations at Tilbury Fort, Essex (Meddens 2000).

Illustration 273
Rim fragment of a green-glazed vessel which has broken and fused in the kiln with the rim of the chamber-pot 131

131 DP02/021, **104.087**, in the collapsed stern deposit, GRE chamber-pot, reconstructed from several sherds, with scar from a single handle, height 141mm, max diameter 173mm, capacity 1.9 litres (Illus 271–3). Glazed internally and around the rim. Adhering to the inner edge of the chamber-pot is a broken rim-sherd from a green-glazed vessel in off-white fabric, which had evidently been stacked upside-down and above it in the kiln. The latter piece presumably broke during firing and the molten glazes on both vessels had fused.

Several GRE chamber-pots are recorded in Norwich (Jennings 1981: 175–6). The small diameter of this example would make it unsuitable for seated use, and it probably served mainly as a urinal. A parallel for the form is provided by a Westerwald stoneware chamber-pot from Cologne (Hurst et al 1986: 224 no 339) which is dated 1632 on its applied escutcheon. That this form continued through the century is indicated by an example from Hull dated 1672 (Bartlett 1970: 21, fig 29). A group of redware chamber-pots was found in a pit-deposit containing material from *c* 1650 to *c* 1714 at Guildford, Surrey, and these provide good parallels for the Duart Point example (Fryer & Shelley 1997: 168, figs 24–5 nos 108–11). Others have been identified at Tilbury, with diameters of between 170mm and 220mm (Meddens 2000: 45–7, fig. 34 nos 15, 17), placing the Duart Point specimen at the lower end of this range.

132 DP00/048, **105.087**, found in conjunction with Frechen bottle 127 within collapsed aft structure, rim sherd of GRE jar, reconstructed rim diameter 168mm (Illus 271). Glazed internally and splashed over rim. Similar in form to examples from Norwich (Jennings 1981: 174).

133 DP00/088, **114.077**, rim sherd of a small GRE straight-sided jar with incised wavy decoration, reconstructed diameter 90mm (Illus 271).

134 DP00/006, **099.094**, in sand beside starboard mid-ships structure, GRE bowl sherd, pronounced ribbing around rim. Reconstructed rim diameter 130mm (Illus 271).

135 DP00/117 (lug), 145 (base with 2 feet), 169 (handle) **105.084**, and 178 (foot), **103.084**, in the collapsed aft deposit, GRE pipkin (Illus 271–2). Basal sherd with tripod legs, and matching but not conjoining sherd with

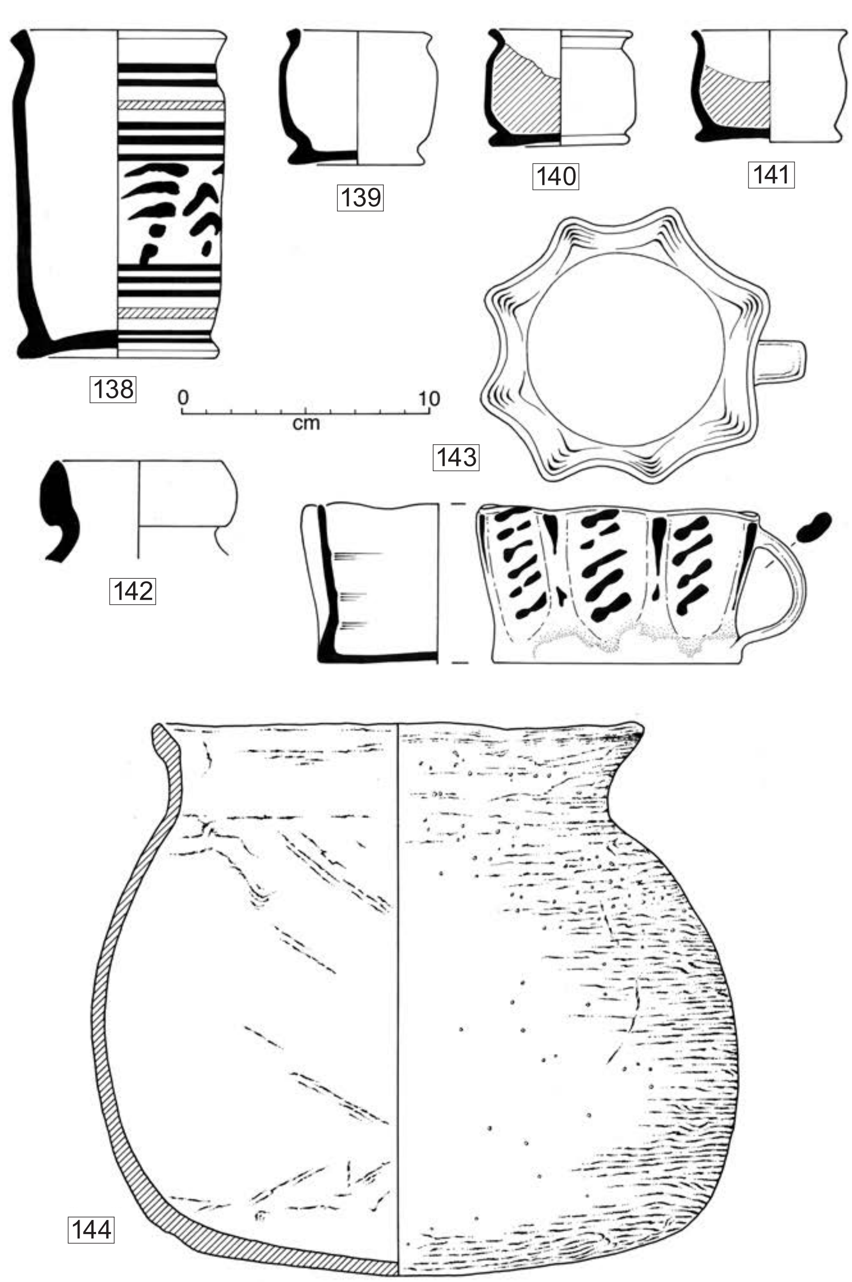


Illustration 274
Miscellaneous wares 138–44 (DP 174860)

Illustration 275
Albarello 140 showing grease-based contents, with its last user's finger scoop-mark in the top (DP 174214)

hollow thrown handle thumbed onto the body on either side. Internal glaze with external splashes.

136 DP00/127, **106.083**, GRE basal sherd of a flat-bottomed flared jar, glazed internally, base diameter 105mm (Illus 271). The form is paralleled at Norwich (Jennings 1981: 177, esp no 1277), and at Tilbury (Meddens 2000: 44–5).

137 DP03/007 and 013, **282.103**, from among collapsed galley debris in the port bow quarter, GRE butter-crock, glazed internally and externally, height 233mm, rim diameter 214mm, base diameter 188mm (Illus 271–2). This largely intact flat-bottomed two-handled vessel with near-vertical sides contained the remains of a yellowish fatty substance which appears to have been butter. The flanged rim would allow a cloth cover to be secured with cord. The estimated capacity if filled to the brim is 5.18 litres. Allowing butter a specific mass of 0.91 this would constitute a weight of 4.72kg, or 10.4lbs avoidupois (of 454g). This does not appear to be a standard unit of butter measurement. Similar jars occur in 17th/18th century contexts at Tilbury (Meddens 2000: 44–6).

Other wares

Tin-glazed albarelli, or ointment-pots, are ubiquitous at this period and come mainly from England or Holland, though the form derives from Italian, French, and Iberian prototypes.

138 DP00/128, **108.084**, Anglo-Dutch albarello in fawn fabric with heavily crazed ground glaze now stained greyish-blue but probably originally white. Light-purple and blue decoration. Height 133mm, rim diameter 87mm, capacity 0.44 litres (Illus 274). Its form and decoration are paralleled by a find in Norwich from a context of *c* 1625–50 (Jennings 1981: 206–7 no1474).

139 DP00/103, **091.096**, among collapsed panelling and close to the minion drake gun-carriage 83, tin-glazed albarello in light-buff fabric, height 56mm, rim diameter 59mm, capacity 0.09 litres (Illus 274).

140 DP00/185, **110.080**, concreted to timber near lower stern structure, plain tin-glazed albarello in light-buff fabric, height 47mm, rim diameter 57mm, capacity 0.08 litres (Illus 274–5). Partly filled with grease-based compound showing the mark of a finger-scoop on its surface.

141 DP99/096, **089.098**, plain tin-glazed albarello in light-buff fabric, height 46mm, rim diameter 63mm (Illus 274, 276).

Illustration 276
Albarello 141 in situ at **089.098**. Scale 15 centimetres (DP 174205)

142 DP01/017a and b, **174.095**, DP01/095, **218.085**, among gravel filling trench in the clay lining of the lower hull, rim and two body-sherds of Sevillian olive-jar in pinkish-buff fabric with gritty inclusions and a creamy external slip, rim diameter 80mm (Illus 166, 274). The rim-profile and fabric identify it as an olive jar or *botija*, a form made in industrial quantities in and around Seville between the 16th and 19th centuries. It was primarily used as a shipboard container for olive products and wine for trans-Atlantic trade, but was common throughout Atlantic Europe and beyond (Marken 1991: 68–193; Martin 1979). This sherd derives from the ballast gravel and is probably not associated with on-board use (see Chapter 6.1).

143 DP02/013, **102.074**, among organic deposits adjacent to the lower stern structure, complete flat-bottomed slipware cup in whitish fabric with eight lobes and a single strap handle, covered inside and out (but not on the bottom) with a light brownish-yellow ground glaze upon which short dashes of dark-brown slip have been trailed. The cup when found was in four pieces, cracked but not displaced, indicating that it had been intact when deposited but subsequently fractured by pressure or shock (Illus 274, 277 and 282).

Illustration 277
Slipware lobed cup 143 in situ during excavation. Scale in centimetres (DP 174204)

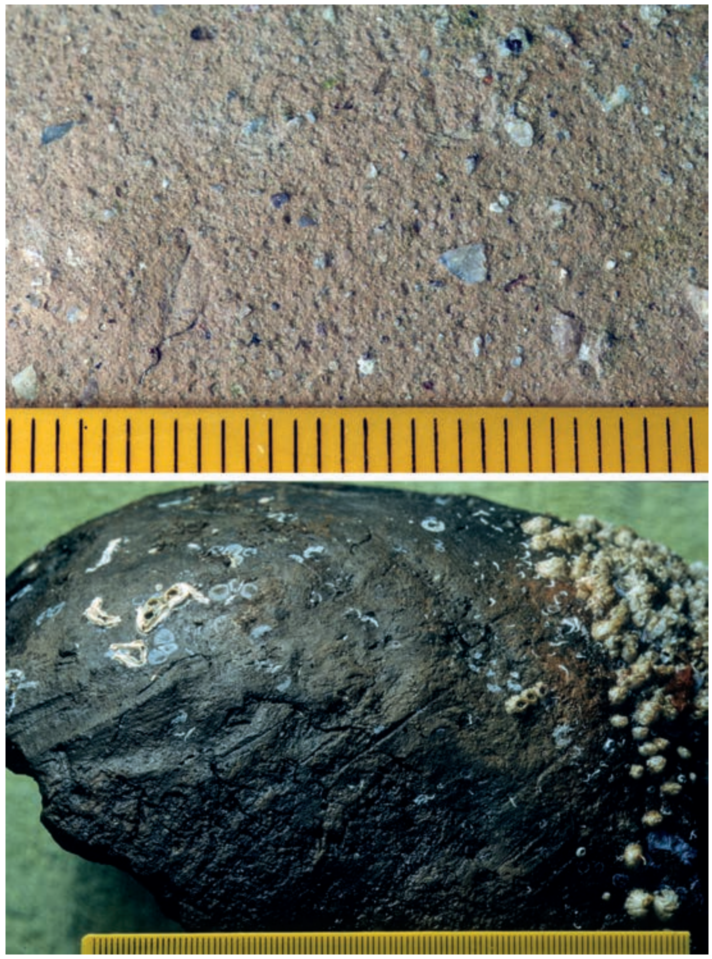


Illustration 278
Top: exterior fabric of *crogan* 144 showing characteristic micaceous inclusions (DP 174219). Bottom: detail of *crogan* base showing grass-impressions (DP 174218). The blackened surface indicates heating on an open fire. Scales in millimetres.

Though Staffordshire became synonymous with slipware in the later 17th century, the earliest production-centres were in the south of England, kiln-sites having been found at Harlow in Essex (Newton 1960: 358–62), mainly serving the London market from *c* 1615, though it was exported to East Anglia and even North America (Jennings 1981: 97). The technology had been developed in Holland during the later 16th century (Hurst et al 1986: 154). The slipware bowl found at Duart is typically English in fabric and glaze, though of unusual form. Such a vessel would be inappropriate for food and difficult to drink from, and its close proximity to two intact clay pipes suggest that it may have been a smoking accessory (Illus 282). A rather similar vessel was found in a context of *c* 1630–60 in Portsmouth (Fox & Barton 1986: 117 fig 52 no 3).

144 DP93/004, hand-built *crogan* with bag-shaped belly and everted rim. About half the vessel has survived, broken longitudinally so that its full profile is preserved, height 226mm, rim-diameter 200mm (Illus 127, 274 and 278). The fabric is a buff-coloured clay with numerous gritty inclusions. It was discovered *c* 15m south-east (down-tide) of the main grid, whither it had been dragged by an attached piece of kelp. An assumption has been made that it is associated with the wreck, and that it had become dislocated from the main wreck formation during the exposure episode of 1991–2.

Crogain derive from a vernacular tradition with roots in the Hebridean Iron Age, which continued well into the 20th century (Cheape 1988). They are hand-built vessels baked over an open fire and Martin Martin, writing *c* 1695, noted that they were always made by women (Withers & Munro 1999: 13). Dr John Walker, who visited the Hebrides in 1764, describes their manufacture in some detail (McKay 1980: 171). The Duart example may perhaps have been acquired as a container for local produce, probably butter.

Marks on the exterior and base indicate that it had been placed on straw or grass while still in a plastic state (Illus 278). The blackened interior surface is probably due to the vessel being filled with milk before firing, a traditional technique used to render the vessel impervious to liquids (McKay 1980: 171). Its capacity to the brim (assuming symmetry of the left-hand side, as drawn) works out at 7 litres, which by applying a specific-mass factor of 0.91 for butter indicates that it would hold about 14lbs avoidupois (1 stone, the normal unit in which butter was accounted). As suggested for the GRE butter-crock 137, the *crogan* would probably have been sealed with a cloth cover tied below its everted rim.

9.4 Clay pipes

By 1653 smoking was widespread throughout Britain, and nowhere more than among soldiers and sailors on active service. Thomas Sherman, the government storekeeper on Lewis, reported that he had lost 'beer, tobacco, pipes, strong water [whisky] and sugar' in the Duart wreckings, and it may have been concern for the troops' flagging morale as much as for private gain that motivated his urgent request for £10-worth of tobacco and pipes from the central stores at Leith (HMC Leyborne-Popham, 107–8).

Two complete pipes, 12 bowls, and two stems incorporating marks have been recovered from the wreck (Illus 280–81). Fifty-nine stem fragments without diagnostic features were also recorded. The group as a whole is remarkably cohesive. Five bowls bear heel-marks displaying the initials NW within a heart (Illus 279–81). The name of this maker is unknown but finds of his products have been, with the exceptions discussed below, confined to the Newcastle area, and it is clear that this is where he was based. Edwards (1988: 3) has argued convincingly that pipemaking on Tyneside began in the 1630s, a conclusion based on his own documentary research and on the investigation of a large group of pipes recovered from an excavation at Blackgate in Newcastle (Edwards 1986). This dating is two decades earlier than that proposed by Parsons for the origins of the industry in the north-east of England in his preliminary typology for the area (1964: 234).

The available material has been synthesised by Edwards (1988: 9–20) to create a revised typology for Tyneside pipes, the reliability of which is strongly endorsed by an analysis of the Duart Point material. Most of the pipes from the Duart Point wreck fall comfortably into Edwards's typology, though it should be stressed that some of the unmarked forms, particularly the earlier ones, can be matched elsewhere and may be from sources other than Newcastle. None appears to come from Scotland.

Parts of clay pipes were found throughout the vessel, but mainly in the area of the collapsed stern.

145 DP00/147, complete pipe with flat heel bearing within a heart NW in large letters above a simple fleur-de-lys, length 25cm (Illus 279, 280). Tyneside bowl-form 3a, NW stamp-type A2.

146 DP02/007, complete pipe similar to 145 (Illus 279, 280). Tyneside bowl-form 3a, NW stamp-type A2.

147 DP01/071b, bowl similar to 145 and 146 (Illus 279, 280). Tyneside bowl-form 3a, NW stamp-type A2.

148 DP01/059, bowl similar to three above, NW stamp with 2 dots above, 4 below (Illus 279, 280). Tyneside bowl-form 3a; NW stamp-type A4.

149 DP99/115, 105mm length of stem incorporating an NW-marked flat heel (Illus 279, 280). NW stamp-type A2.

150 DP00/072, bowl with clear but indeterminate heel-mark, perhaps a harp (Illus 279, 280). Tyneside bowl-form 2a.

151 DP01/060a, 40mm length of stem incorporating a flat unmarked heel with monogrammed initials on one side, perhaps RL (Illus 279, 280). No identified parallels.

152 DP01/037, bowl with unmarked flat heel (Illus 281). Tyneside bowl-form 3a.

153 DP01/046, bowl with unmarked flat heel (Illus 281). Tyneside bowl-form 3a.

154 DP93/001a, bowl with part of stem, 115mm long, unmarked flat heel (Illus 281). Tyneside bowl-form 3a.

155 DP93/001b. Spurred bowl with unmarked flat heel and 130mm of stem (Illus 281). Tyneside bowl-form 5.

156 DP00/116a, bowl with unmarked flat heel (Illus 281). Tyneside bowl-form 3a.

157 DP92/281, bowl with unmarked flat heel (Illus 281). Tyneside bowl-form 2a.

158 DP03/009, bowl with unmarked flat heel (Illus 281). Tyneside bowl-form 3b.

159 DP01/096, bowl with unmarked flat heel and 70mm of stem (Illus 281). Tyneside bowl-form 3a.

160 DP00/148, bowl with unmarked flat heel and 60mm of stem (Illus 281). Tyneside bowl-form 2a.

Illustration 279
Top: NW heel-marks: type 3a with pellets; type 3b with fleur-de-lys. Bottom: two other marked pipes. Left: harp; right: unidentified mark on side of heel (DP 173203, DP 173204, DP 173205, DP 173428)

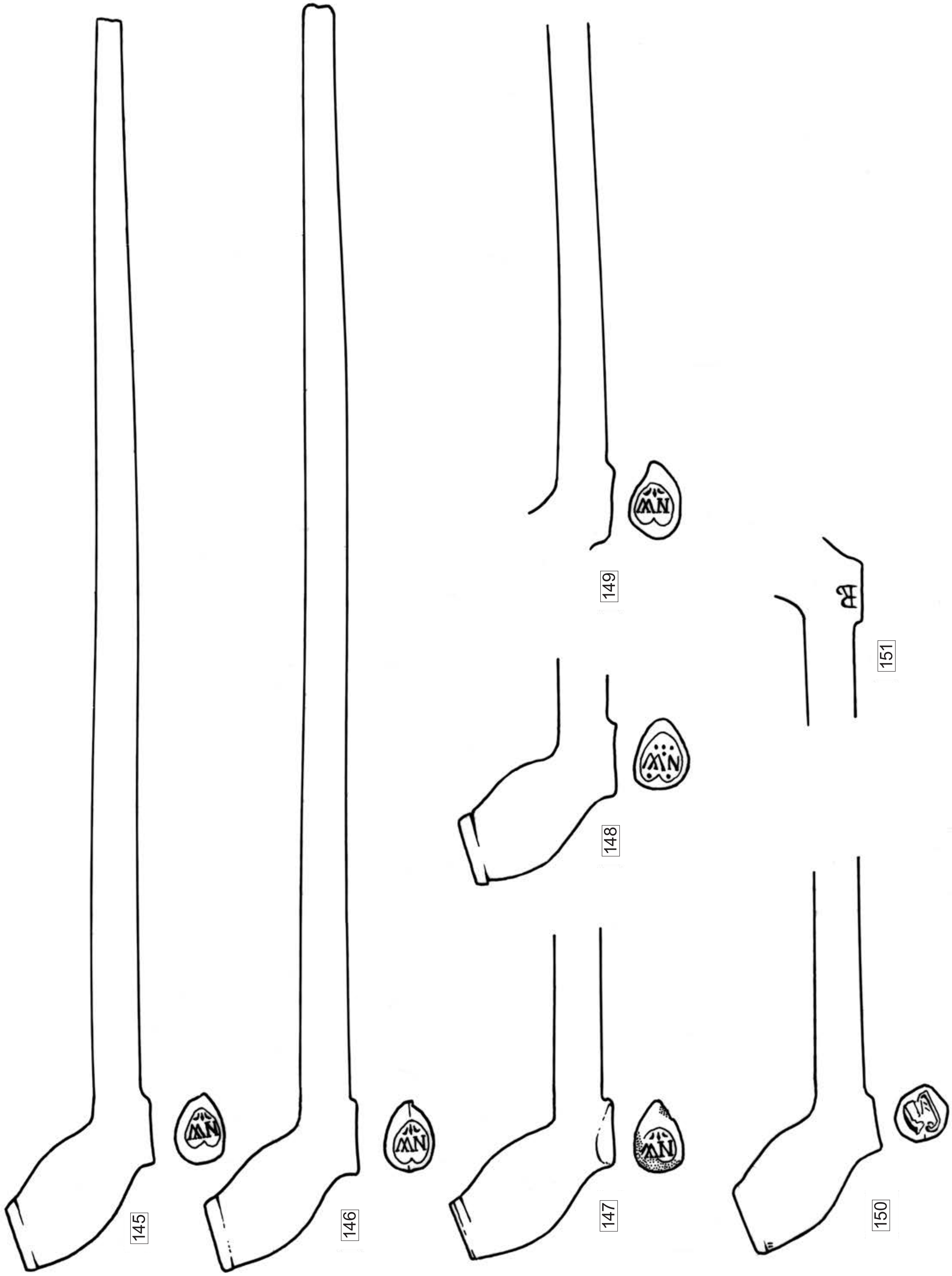


Illustration 280
Marked clay pipes 145–51. Scale 1:1

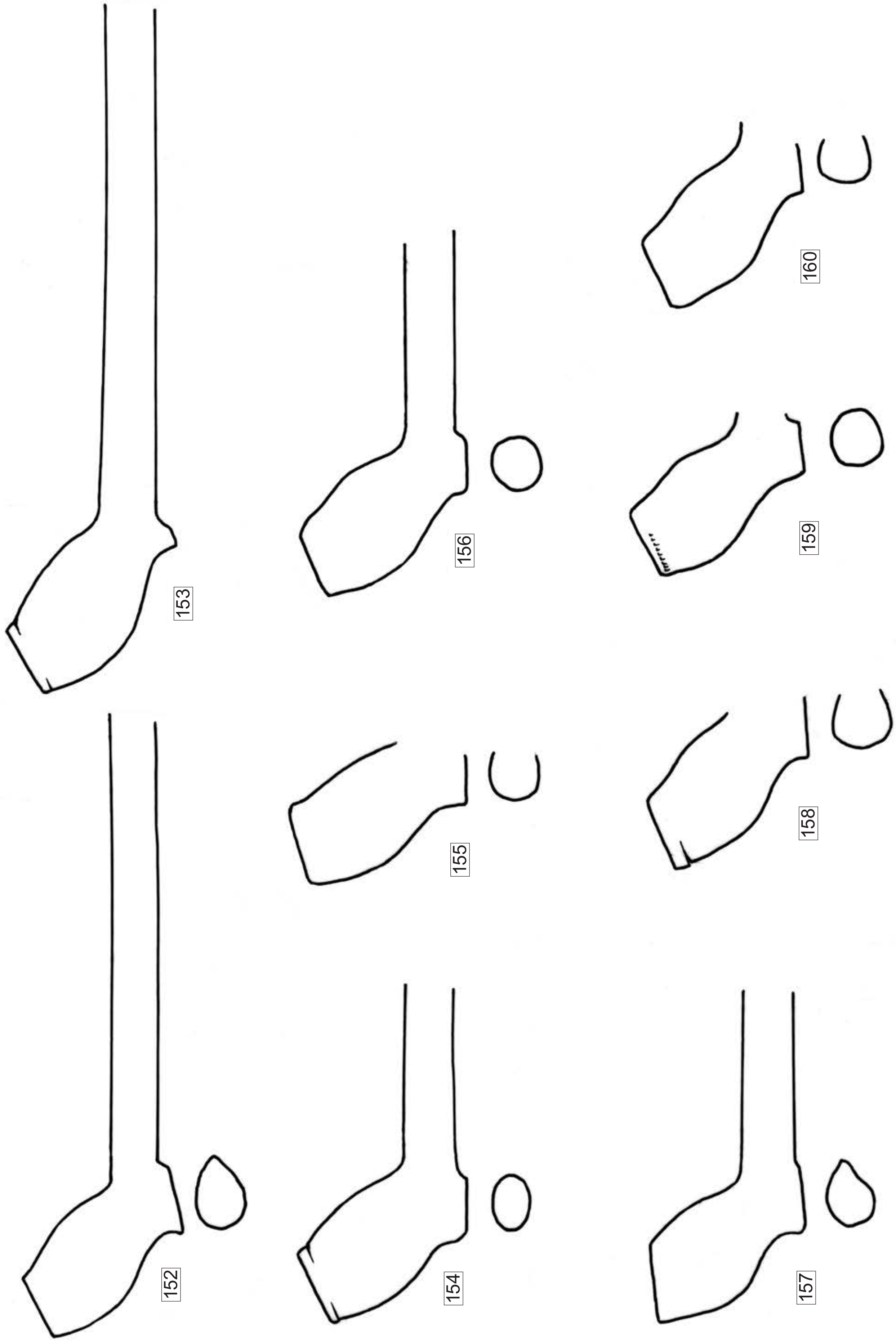


Illustration 281
Unmarked clay pipes 152–60. Scale 1:1

Typological dates

By comparing these bowl-forms with Edwards's Tyneside typology the following date-brackets are obtained:

2a,	150 157 160	*c* 1645–60
3a	145–8 152–4 156 159	*c* 1650–75
3b	158	*c* 1650–75
5	155	*c* 1630–45

This pattern is compatible with the pipe group's archaeologically secure *terminus ante quem* of 1653. The only bowl-form which does not straddle this date on typological criteria is the single Type 5, an early Tyneside form which accounts for only 7% of the sample and might therefore be explained as old stock. Type 2a falls neatly across the median date of 1653 and, with three bowls, represents 21.5% of the sample. It is the later date bracket, however, of the 3a and 3b forms that dominates the collection with 9 bowls, or 71.5%. Though the argument is in part circular, this concordance helps to confirm the validity of the Tyneside typology (at least for the period under discussion), and provides independent evidence for dating the wreck. That the 3a/3b forms appear to have been recent introductions in 1653 is significant, since Newcastle was the main Cromwellian base for operations in Scotland during the early 1650s, and it is reasonable to suppose that the city's pipemakers stepped up production to meet increasing demand, perhaps introducing new forms in the process. The absence of Scottish pipes in the group is notable, for there was a vigorous industry centred on Edinburgh by the mid 17th century (Gallagher 1987) and Leith was a supply base for Cromwellian operations in the north and west. We may suppose that pipes held by the commissariat stores at Leith had been shipped from Newcastle which, it seems, held a monopoly to supply Cromwell's forces with their smoking requirements while on active service in the North.

Such a mechanism explains the rare appearance of NW-marked pipes in contexts outwith the Newcastle area. One is known from St Andrews (Davey 1997: 95–7) while another has been recorded at Kirkwall in Orkney (Oswald 1975: 44–5). Both places were occupied by English forces during the invasion of Scotland in the early 1650s (Dow 1979: 14, 236) and, together with the five examples now recovered from the Duart Point wreck, it is not unreasonable to see these pipes as markers of Cromwellian troop-movements at the time. Peter Davey (pers comm) has informed me of another occurrence of the mark in Belfast.

Illustration 282
Pipes in fluted slipware bowl 143 (DP 174228)

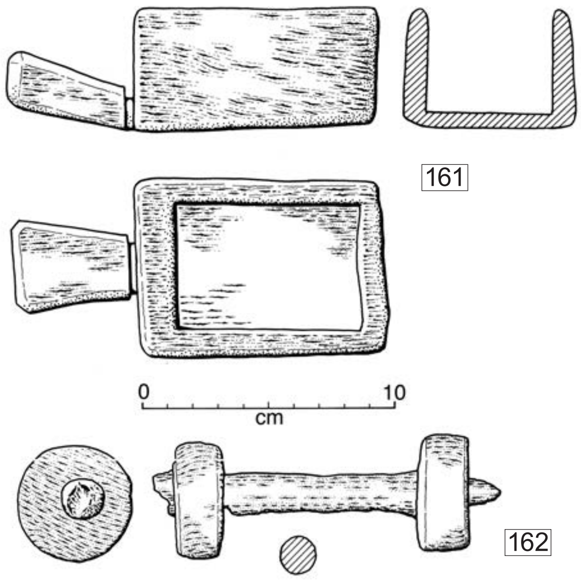


Illustration 283
Wooden oil-box 161 and bobbin 162 (DP 174807)

The two intact NW-marked pipes were found near the stern, in close association with a lobed slipware cup 143. The latter seems inappropriate as a utensil for eating or drinking, and its possible function as a smoking accessory is suggested in Illus 282.

This small collection of pipes demonstrates the capacity of a dated shipwreck assemblage to test and refine typological sequences from a wholly objective standpoint and, from the other end of the spectrum, to provide evidence relevant to determining the date and associations of the ship in which it was contained. As argued elsewhere (Chapter 2.2) there is no doubt that the Duart Point ship was a victim of the well-documented Cromwellian episode in 1653, so its date is absolutely secure. The association is further pointed up archaeologically by the five marked pipes from Cromwell's supply base at Newcastle. This conjunction may in future inform the interpretation of sites with similar associations of purpose and date, especially in Scotland and Ireland.

9.5 Tools and utensils

Miscellaneous implements and fittings

161 DP01/119, **176.093**, monozylous rectangular wooden box with integral flared handle (Illus 283). Its internal measurement of 70mm × 50mm × 40mm give it a capacity of 0.14litres. The saw-kerf isolating the handle has been cut too deep on three sides, an error which would have rendered it prone to breakage. It may be identified as a caulker's oil-box, described by Horsley (1978: fig 9; 126) as 'a simple oil box, cut from solid wood, and kept topped up with linseed oil. The caulking-irons were dipped in the oil to prevent them sticking in the seams. Linseed and pitch are compatible, and the oil does not prevent the pitch sticking'.

162 DP00/182, **107.082**, part of a multiple-collared wooden bobbin with two 45mm-diameter collars set 76mm apart on a 14mm-diameter shaft (Illus 283). A continuation of the shaft at either end suggests that at least two further shaft/collar elements had been present. The arrangement is similar to the four bobbins recorded on *Mary Rose* (Every 2005: 327–8), although the stoppered cavity through the centre of the shaft for holding pins or needles, noted on the *Mary Rose* examples, was not present in the Duart Point bobbin. It is likely that this object held thread or twine associated with rigging and sail-maintenance.

163 DP00/172, **107.077**, dowel or shaft 28mm in diameter and 265mm long, broken at both ends, whipped along 225mm of its length with 44 turns of 5mm-diameter hemp cord (Illus 284). Marks show that whipping had continued in both directions.

164 DP92/DG02, findspot uncertain, block hand-brush of oak (*Quercus* sp), 205mm × 22mm × 18mm with 60 8mm bristle-holes arranged in five rows of 12 (Illus 284). The centre hole of the top row had been drilled through, presumably for hanging the brush. No traces of bristles survive. Similar brushes have been recovered from the *Mary Rose* and *Invincible* wrecks (McKewan 2005: 354–5; Bingeman 2010: 166–8).

165 DP03/064, **124.092**, wooden turnbutton with central hole, 180mm × 55mm × 11mm (Illus 284).

166 DP99/030, **075.096**, wooden peg, 125mm × 35mm, with octagonal head and tapering square-sectioned shaft terminating in a shallow point (Illus 284).

167 DP03/061, **093.083**, wooden peg, 120mm × 20mm, rounded section, pointed at bottom and notched towards the top (Illus 284).

168 DP92/???, findspot uncertain, wooden peg, 120mm × 30mm × 10mm, notched at top and broken at lower end, sub-rectangular cross-section (Illus 284).

169 DP03/041, **098.073**, wooden peg, 75mm × 24mm diameter (Illus 284).

170 DP00/087, **121.069**, wooden wedge, 130mm × 35mm × 29mm with chamfered top edges and central 8mm hole (Illus 284) (cf wedge from *Mary Rose*, McKewan 2005: 350).

171 DP00/198, **098.098**, wooden object of uncertain function, 480mm long (Illus 285).

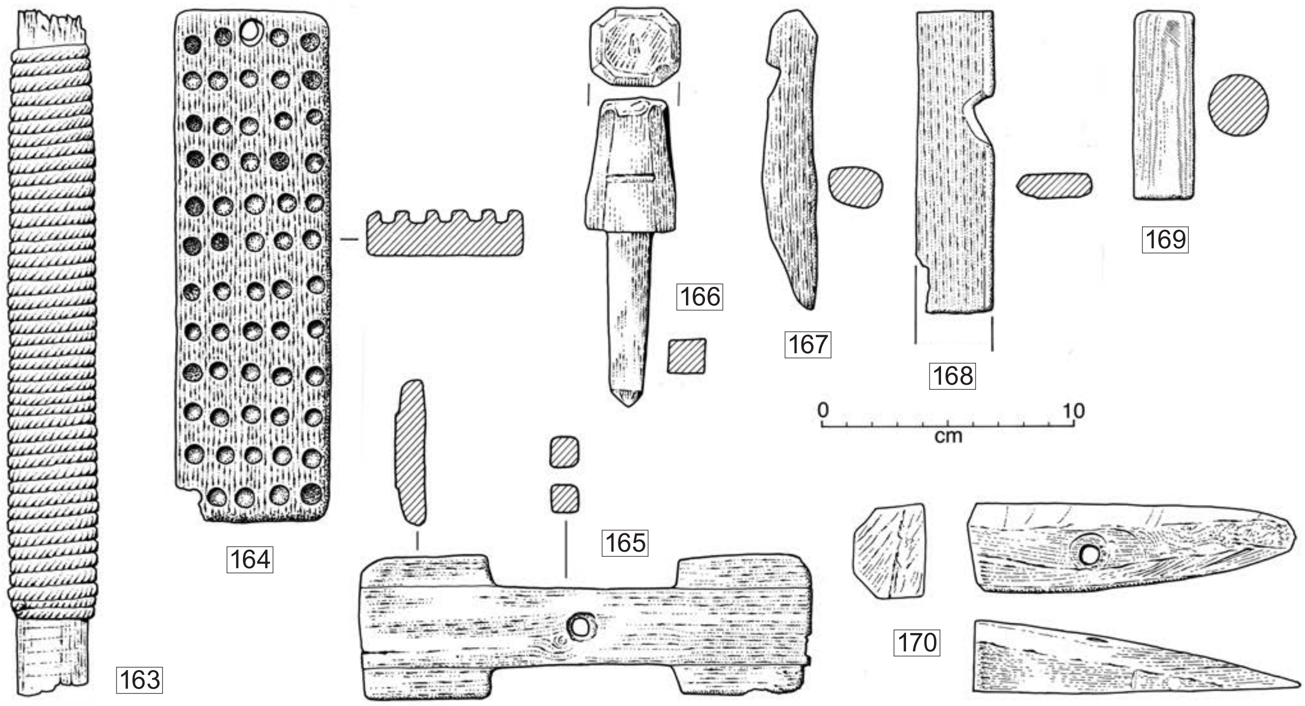


Illustration 284
Assorted wooden implements and fittings 163–70

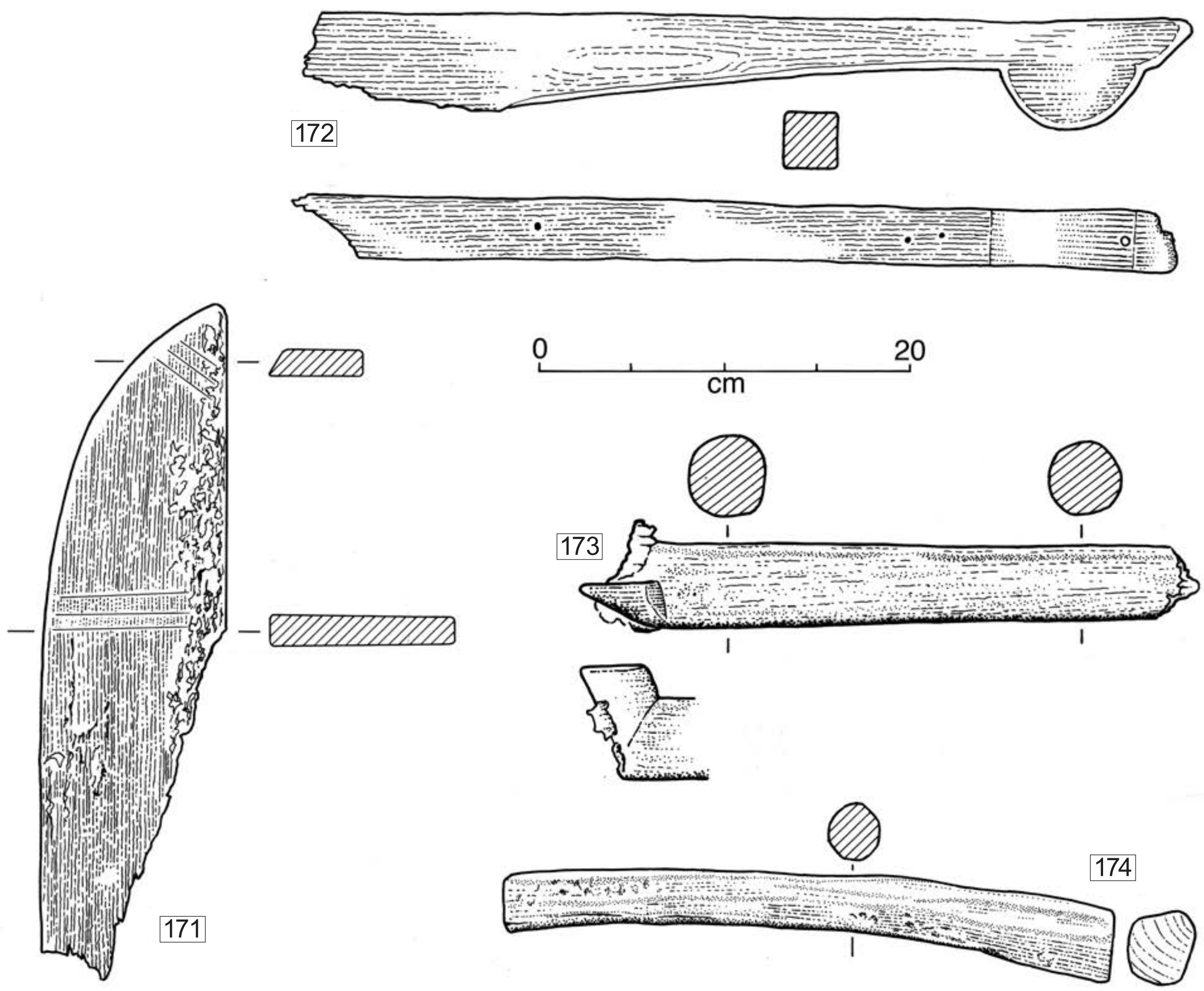


Illustration 285
Left, top and centre right: three unidentified objects 171–3. Bottom right: probable hatchet handle 174

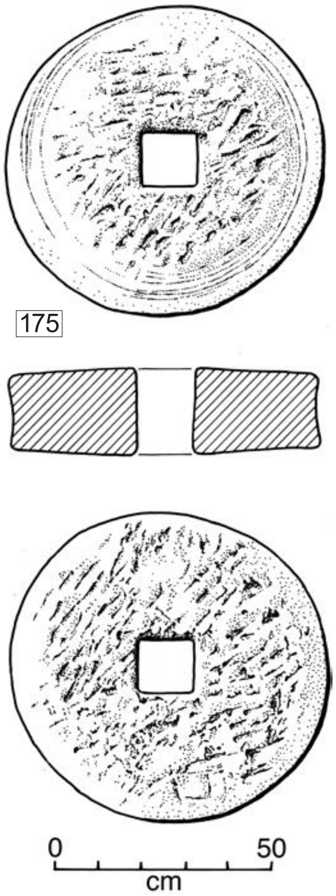


Illustration 286
Rotary grindstone 175 (DP 174847)

Illustration 287
Probable touchstone 176 (DP 174848)

172 DP92/032, findspot uncertain, carefully dressed timber 370mm × 100mm × 19mm with one edge curved and chamfered towards the point, the other edge straight and vertical (Illus 285). Incised lines on the surface. Function unknown.

173 DP92/???, findspot uncertain, wooden object of uncertain function, 330mm long (Illus 285). It consists of the broken-off end of a round-sectioned haft 40mm diameter at the break, expanding to 46mm. The much-damaged end shows indications of additional features including a well-fashioned flange extending forwards and to one side.

174 DP99/038, **064.103**, curved piece of ash, sub-circular in section, 0.23m long, probably an unused chopping-axe handle (Illus 285).

175 DP92/DG13, findspot uncertain, rotary grindstone of coarse sandstone, slightly ovoid, with a diameter varying from 690 to 730mm (Illus 286). The spindle-hole is 120mm square. The stone is 200mm thick at the centre reducing to 185mm at the rim. It shows evidence of use not only on its outer face but also on its sides close to the rim. The stone would have been turned by a handle and mounted upright on a bracket with its lower part in a trough of water to lubricate and cool the grinding surface and the metal edge. Such a grindstone appears in a political cartoon showing the Covenanting Scots putting Charles II's nose to it, mocking his coronation as puppet king of Scotland in 1651 (Illus 12). A rotary grindstone complete with its trough and wooden side-supports was found on *Mary Rose* (Gardiner 2005: 340–1).

176 DP92/DG04, findspot uncertain, a dark, hard-grained stone of roughly octagonal shape, 30mm × 35mm × 17mm (Illus 287). Scratch-marks on both faces show evidence of careful but occasional use, suggesting that it may have been a touchstone for assaying gold or silver. Known in Classical times (Singer et al 1956: 45), by the 16th century the technique had been replaced by more accurate scientific methods, though because of its simplicity it continued to be used when approximations would serve (Singer et al 1957: 65–6). A campaign which, like Cobbett's 1653 expedition, was charged, among other things, with recouping unpaid fines or taxes, might well have used such an item for assessing the values of confiscated precious metals.

9.6 Domestic treen

177 DP92/DG07, findspot uncertain, complete turned bowl, max diameter 130mm, height 60mm, shallow foot-ring (Illus 288).

178 DP92/066, **074.092**, complete turned pedestal cup of maple (*Acer* sp), its sides decorated with four grooves, diameter 102mm, height 62mm (Illus 288).

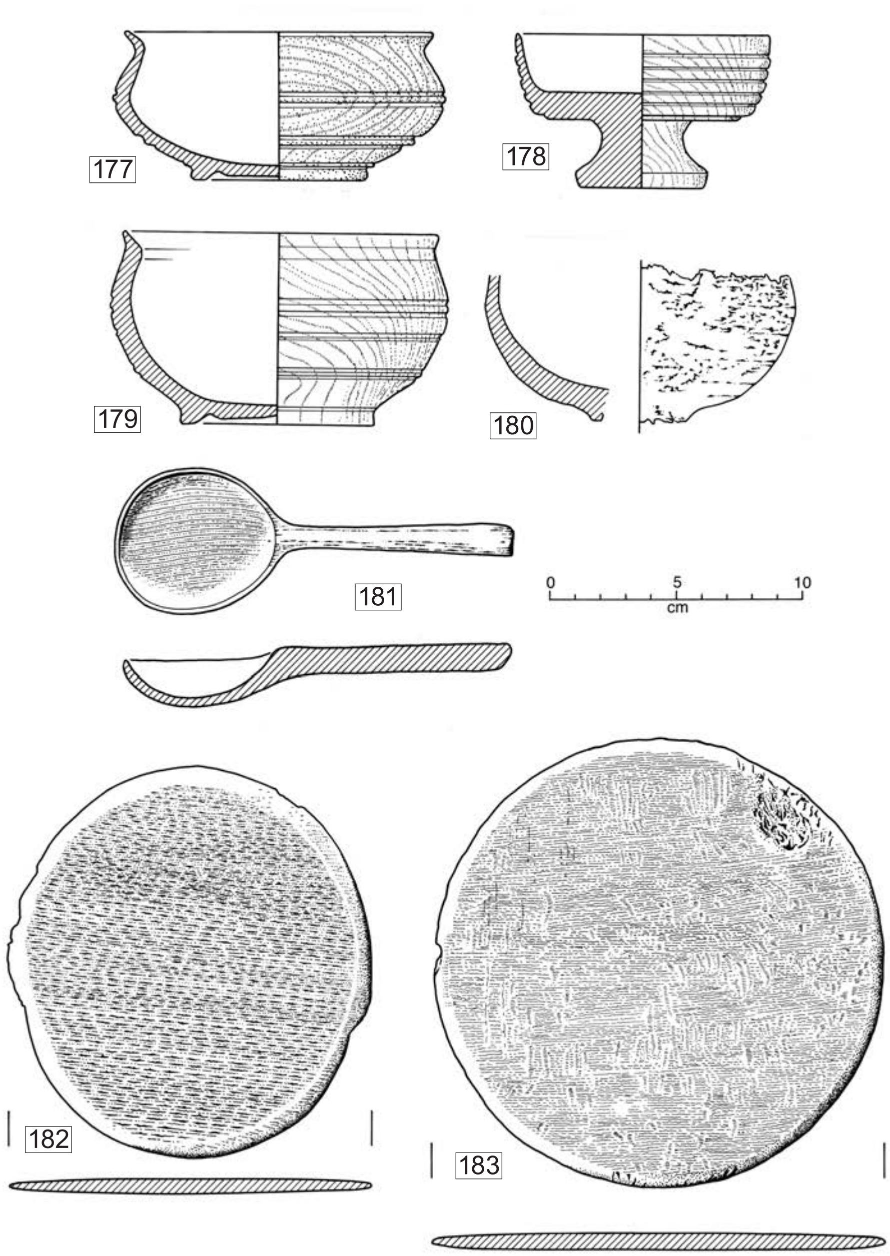


Illustration 288
Top: wooden bowls and spoon 177–81. Bottom: two wooden platters 182–3

179 DP93/006, **055.087**, largely complete turned bowl of maple (*Acer* sp), part of the rim and upper body lost to erosion and biological attack, max diameter 135mm, height 79mm (Illus 124, 288). Shallow foot-ring. The turning and finish is of high quality, with side mouldings and a finely tapered lip.

180 DP00/036, **108.083**, turned wooden bowl much damaged by erosion and missing the lip., max surviving diameter 123mm, height 64mm (Illus 288). Though what may be part of a vestigial foot-ring is evident, a ragged-edged hole penetrates the base, and it is uncertain whether or not this was an original feature.

181 DP97/A026, **089.097**, wooden spoon of maple (*Acer* sp), 158mm long and 57mm across the bowl (Illus 288). Shape similar to an example from *Mary Rose* (Weinstein 2005: 449 no 81A1578).

182 DP00/159, **104.086**, slightly ovoid disc of a fine-grained wood, diameter varying between 155mm and 145mm, 6mm thick at the centre, tapering towards the edges, which are rounded (Illus 288). The surface and edges are

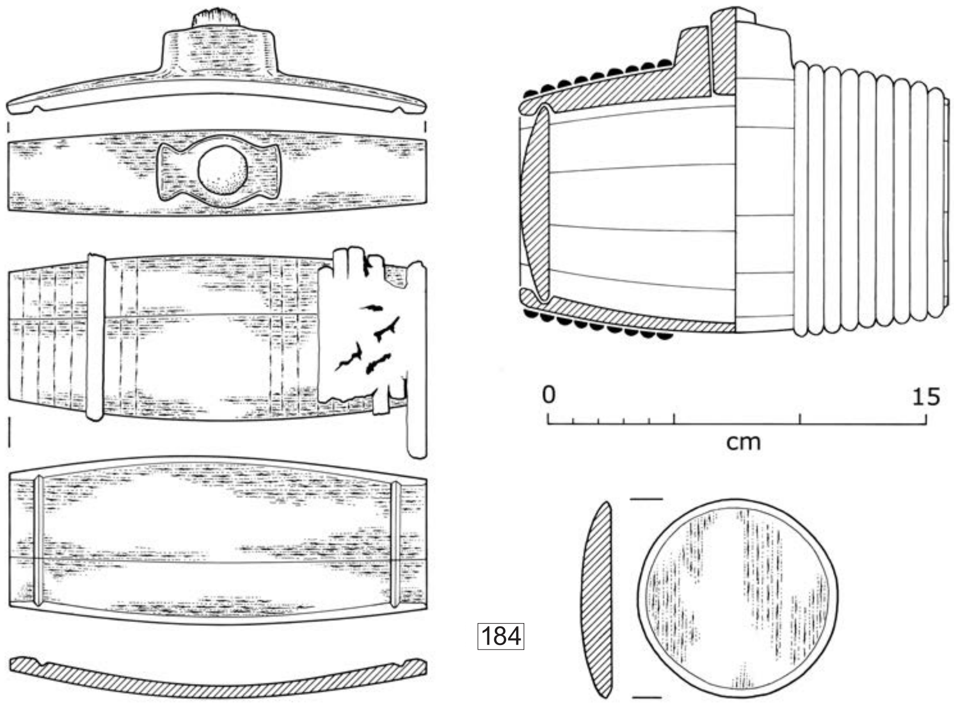


Illustration 289
Staved barrel costrel 184 (DP 174885)

abraded. It lacks the chamfered edge characteristic of keg-end and is perhaps best identified as a 6-inch platter.

183 DP99/053, **068.107**, circular disk of a fine-grained wood, diameter 177mm. 7mm thick at the centre with a sectional profile similar to 182 above (Illus 288). Probably a 7-inch platter.

184 DP92/063, **084.102**, barrel-costrel of oak (*Quercus* sp*)* with split-willow hoops (*Salix* sp), length 165mm, max diameter 110mm, capacity *c* 850ml (1½pt) (Illus 289). This vessel was found adjacent to the cherub carving during the ADU's 1992 rescue operation (Illus 118), and had suffered recent damage through exposure. Seven staves and one end survived in articulated form, as had parts (or the impressions) of 18 split-willow hoops. The staves are of varying width, the surviving ones ranging between 21 and 40mm. Three or perhaps four appear to be missing, having become dislocated and dispersed as the once-buried vessel became progressively exposed.

A feature of its construction is the stave that incorporates the neck. This is monoxylous; that is, it is fashioned from the solid with the required curve carved rigidly from the parent wood. The piece would not otherwise have bent sweetly because of its thickness and the intrusive neck. It thus forms a control-stave to which its straight-cut and thinner fellows were drawn into place by the pull of the hoops. The form is akin to 19th century 'bever' barrels used by farm-workers (Kilby 1977: 7). Barrel-costrels sometimes occur as ceramic skeuomorphs (for example Webster 1969: 9 and 29).

185 DP92/DG08, findspot uncertain, and DP97/A027, **084.095**, three staves of juniper (*Juniperus* sp) from a small flared wooden tub or bucket 130mm high, with a restored diameter of 165mm at the mouth and 125mm at the base (Illus 290). Capacity *c* 1460ml (2½pt). The piece shows impressions of the withy hoops which had bound it, a pair at the top and another pair at the base, the latter gripping the internal slot which housed the now-missing bottom disc. A diamond pattern has been executed on its exterior surface with a small round-headed punch.

186 DP99/020, **065.101**, basal disc from a staved vessel, diameter 125mm, thickness 7mm constant to the bevelled edge (Illus 290). Traces of what is probably a letter 'H' within a circle cut or branded on the base.

187 DP99/010, **072.103**, staved tankard found intact with all its components in place except the lid, and with some of its withy bindings. Because of its fragile condition it was disassembled for recovery. There are five staves, a basal disc and a handle with a hole for attaching the missing hinged lid. The tankard's re-assembled height is 155mm, its base diameter 82mm, its rim diameter 55mm and its

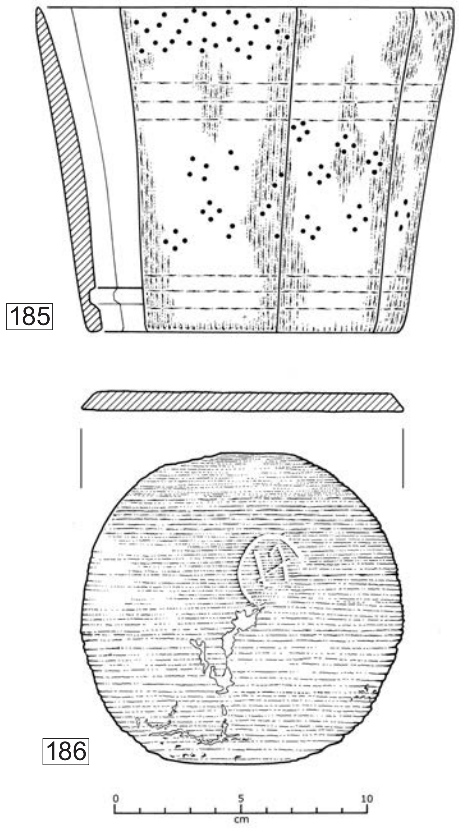


Illustration 290
Staves from a decorated flared bucket 185, and a base 186

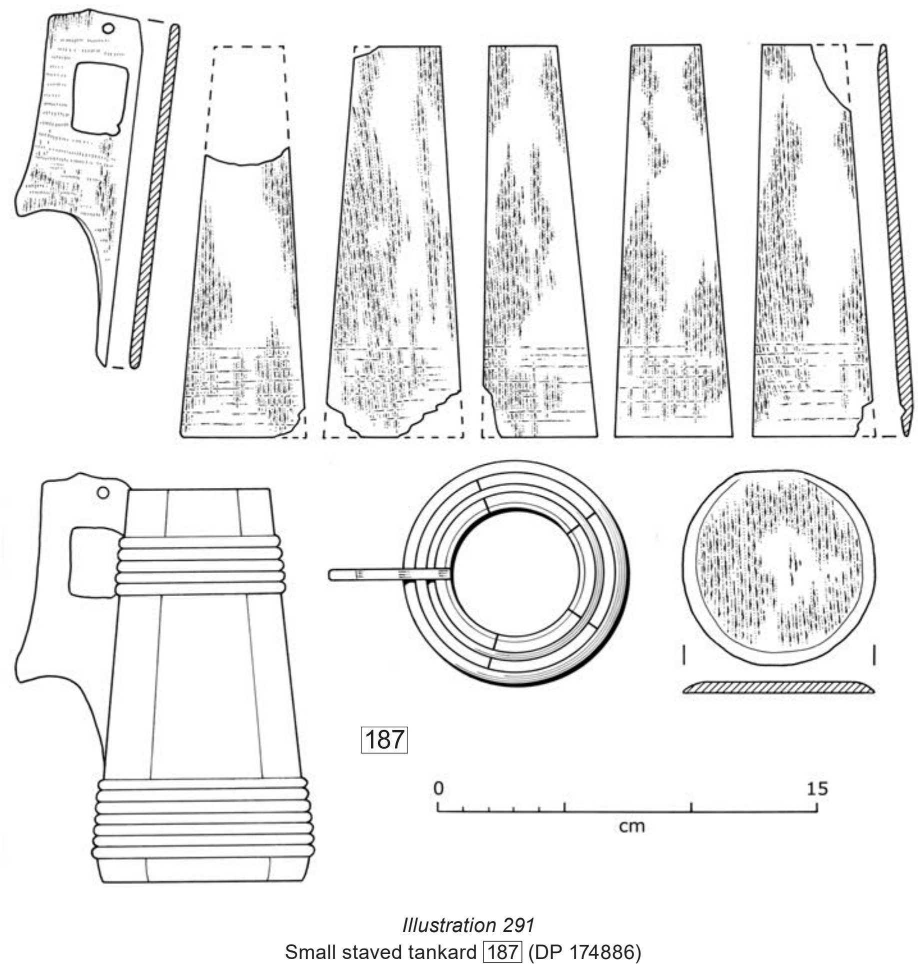


Illustration 291
Small staved tankard 187 (DP 174886)

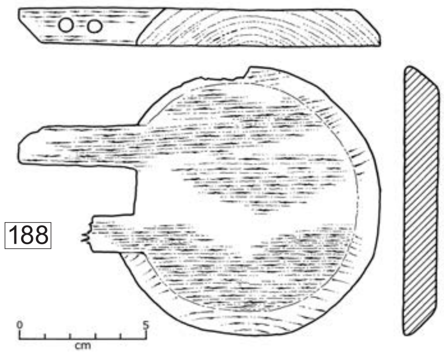


Illustration 292
Hinged lid from a larger staved tankard 188

capacity *c* 380ml (⅔pt) (Illus 291). The five staves are of slightly unequal widths and were bound, along with the handle piece, with seven hoops around the bottom and five towards the top, the latter passing through the inner cut-out of the handle. The tail of the handle does not extend all the way to the base, which would have left a slot between the adjacent staves which must have been filled in some way, though no evidence survives. The vessel is considerably smaller and more elongated than any of the 27 comparable examples from the *Mary Rose* (Weinstein 2005: 45–52).

188 DP97/A024, **061.094**, wooden lid for a staved tankard much larger than 187 108mm in diameter and 14mm thick. Two arms, one now broken, are set 18mm apart and extend 45mm beyond the rim to act as a hinge for the handle. Two holes are drilled in the intact arm (Illus 292). The associated vessel was probably a measure for liquids, and comparison with examples from *Mary Rose* suggests that it may have had a capacity of around half a gallon or a 'pottle' (1.8 litres) (Weinstein 2005: 435–9).

189 DP03/047, **113.072**, locking wooden lid from a staved tub, a 170mm-diameter disc, now broken into two unequal pieces, 11mm thick at the centre and tapering to 6mm at the edges. Its top side is cut by a central square-sectioned groove running from side to side across the grain, 10mm wide by 5mm deep on one side, tapering to 5mm × 5mm on the other (Illus 91, 293). A check some 5mm deep has been cut from the lid's circumference at both groove ends, extending about 50mm on either side of them (these dimensions are approximate because of the abraded condition of the edges). Seated in the groove is a snugly fitting tapered wooden pin, flat on the bottom but with a 50mm recess 5mm deep cut in the centre of its top so that this part of the pin would be level with the lid's top. This suggests that a strip or band was wrapped over the lid across the pin for additional security. The strip might have been sealed if the tub contained a rationed commodity such as butter. The narrow end of the pin is finished with a slightly upturned wedge-shaped point. There is an inwards bevel around the edge of the lid.

Staved tubs with locking lids of this kind are known from the Oseberg Viking ship-burial (Almgren 1975: 182–3, fig 3) and *Vasa* (Matz nd: 37). The *Vasa* example contained butter. Its lid is similar to the Duart Point find, though the pin in the groove is flush with the lid surface

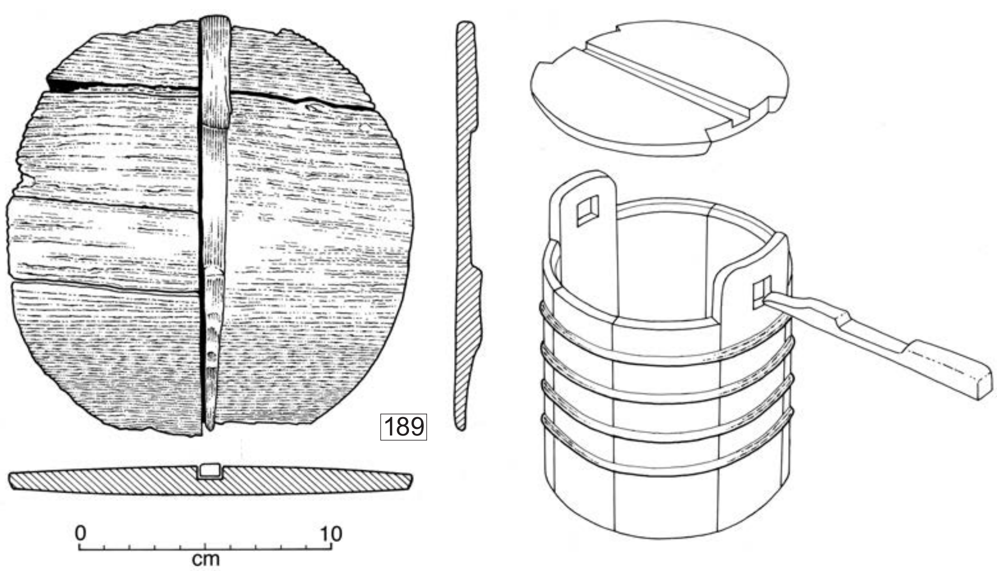


Illustration 293
Left: wooden lid of a butter-keg 189. Centre: section of locking-pin. Right: reconstruction of a staved butter-keg

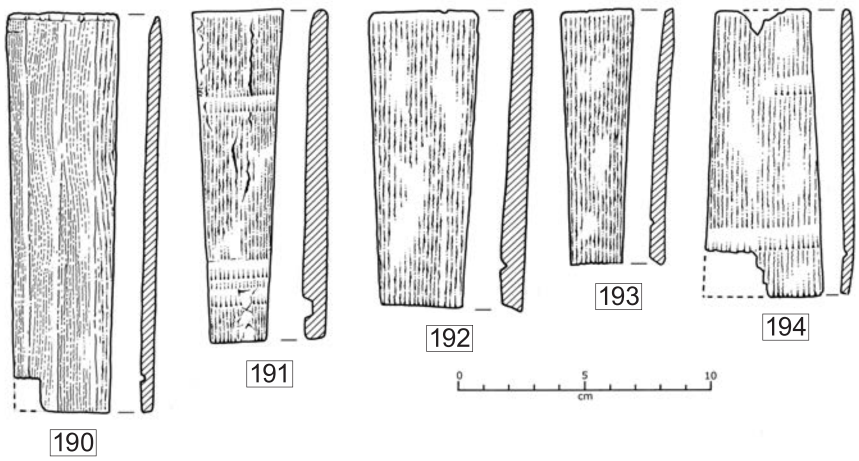


Illustration 294
Assorted staves 190–4

rather than raised at each end. A reconstruction of the Duart lid, and its missing staved tub, is presented in Illus 293. The lid and pin are as found. Two longer staves set opposite one another in the postulated tub form lugs above the rim, the latter being chamfered to fit the bevel of the lid. Square holes are cut in these lugs to accept the locking-pin. The remainder of the tub is stave-built in the normal manner, and bound with withy hoops.

An early reference to such a lidded tub is in Adomnán's *Life of Columba*, which records a miracle performed by the 6th-century saint concerning milk spilt from a vessel when the 'fastening peg of the lid was thrust back through its two holes and the lid fell to the ground' (bk 2, ch 16, Anderson & Anderson 1961: 167). Similar pinned lids have been noted on prehistoric/early historic butter-filled kegs from Scottish bogs, though these vessels are not staved but carved out of the solid, with separate bases and attached lugs for the locking-pins (Earwood 1991).

The five single staves (Illus 294) have suffered flattening distortion so no reliable estimates of the diameters of the original vessels can be made.

190 DP99/027, **085.099**, single stave from an outward-flaring vessel, 158mm tall, thickness at median point 5mm (Illus 294).

191 DP00/073, **098.096**, single stave from an outward-flaring vessel, 117mm tall, thickness at median point 8mm. Single withy impression towards top; double impressions near base (Illus 294).

192 DP92/033, findspot uncertain, single stave from an outward-flaring vessel, 115mm tall, thickness at median point 8mm (Illus 294).

193 DP03/072, **104.072**, single stave from an outward-flaring vessel, 100mm tall, thickness at median point 5mm (Illus 294).

194 DP03/059, **071.108**, single stave from an inward-flaring vessel 113mm tall, thickness at median point 4mm. Single withy impressions near top and around base (Illus 294).

195 DP00/160, **105.084**, much abraded circular wooden disk or plug 97mm in diameter (Illus 295). Slightly concave top, depth at centre 13mm increasing to 16mm near edge. Chamfered downwards around edges.

196 DP01/108, **094.093**, flat circular disc 65mm diameter and 7mm thick, vertical edge trimmed with a flat chisel, with little attempt to ease the angles (Illus 295).

197 DP99/017, **066.101**, finely turned object of unknown function, 79mm across the base and 59mm high (Illus 296). The mark of a central lathe-pin at the top end indicates that the object is complete, though two opposing edges on the top disc have broken off along the grain.

198 DP00/107, **071.102**, small turned decorative finial 35mm × 16mm (Illus 296).

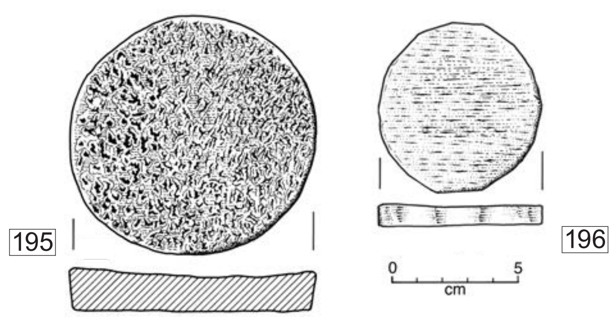


Illustration 295
Two wooden bungs 195–6

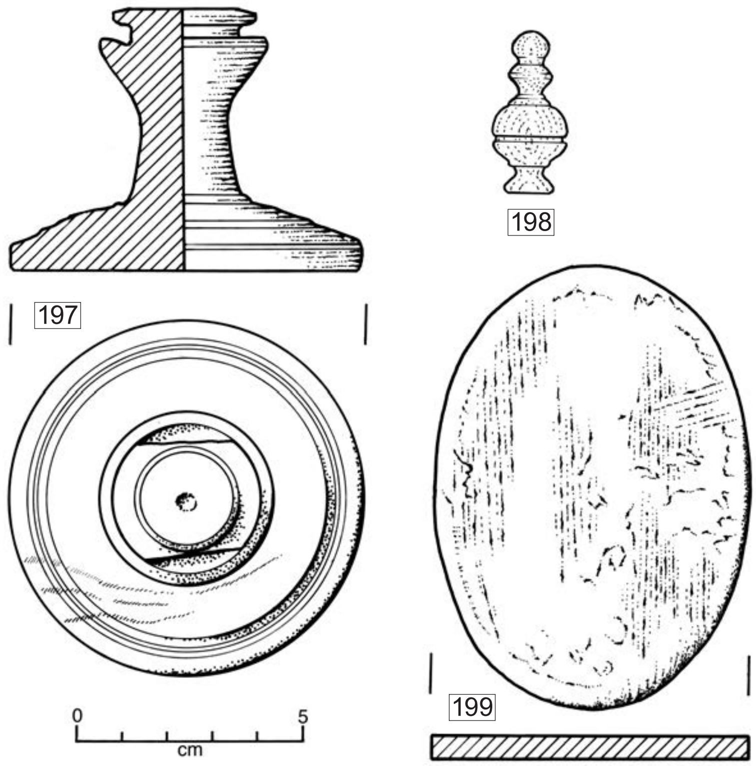


Illustration 296
Left: turned wooden object of uncertain function 197. Top right: wooden finial 198. Bottom right: flat oval piece 199, perhaps backing for a mirror or small picture (DP 174799)

199 DP01/011, **072.102**, well-finished oval piece of wood, 98mm × 69mm × 5mm thick, with carefully squared edges (Illus 296). Perhaps the bottom of a small box, or the backing of a mirror or miniature.

9.7 Lanterns

The remains of three, possibly four, wooden lanterns were found. They consist of two complete top pieces, one segment from which the profile and diameter of another top-piece can be reconstructed, and an upright.

200 DP99/002, **081.107**, turned dome-shaped lantern-top of poplar, 220mm (8¾in) in diameter, height 50mm (2in) (Illus 297). There is a 42mm (1⅝in) diameter opening at the top, and beyond it on either side is a 3mm (⅛in) hole, presumably for fixing a cowl or carrying-handle. Flat rim 27mm (1⅛in) wide with five roughly evenly spaced 10mm (⅜in) holes for uprights, positioned towards the outer edge of the rim; a broken-off tenon and locking-wedge survives in one of them.

201 DP99/008, **072.106**, turned lantern-top of poplar, similar to 200 200mm (8in) in diameter, 63mm (2½in) high, with a 43mm (1¾in) top opening and 5mm holes on either side (Illus 82, 297). Flat rim 20mm (¾in) wide with five evenly spaced 8mm × 10mm elliptical holes. Unlike 200, these holes are positioned at the inner edge of the rim, and partly cut into the side of the central dome.

202 DP00/109, **107.086**, segment comprising *c* 25% of the full circumference of a third turned lantern-top of poplar, 220m (8¾in) in diameter and 64mm (2½in) high (Illus 297). Two round 10mm (⅜in) holes are centrally placed on the 24mm (1in) rim, at a distance that suggests that this lantern too had five evenly spaced uprights. The top opening is 35mm (1⅜in) wide and there is a 5mm hole to the side, presumably one of a pair as on the other two examples.

203 DP99/093, **084.113**, upright of poplar 301mm (12in) long and 42mm (1⅝in) wide, with tenons protruding 12mm (½in) at either end (Illus 297). The stave is flat on one side and ridged on the other, giving a thickness at the centre of 10mm (⅜in). The 5mm sides are cut by V-sectioned slots which extend 5mm into the wood. Narrow horizontal grooves run 75mm from either end of the stave.

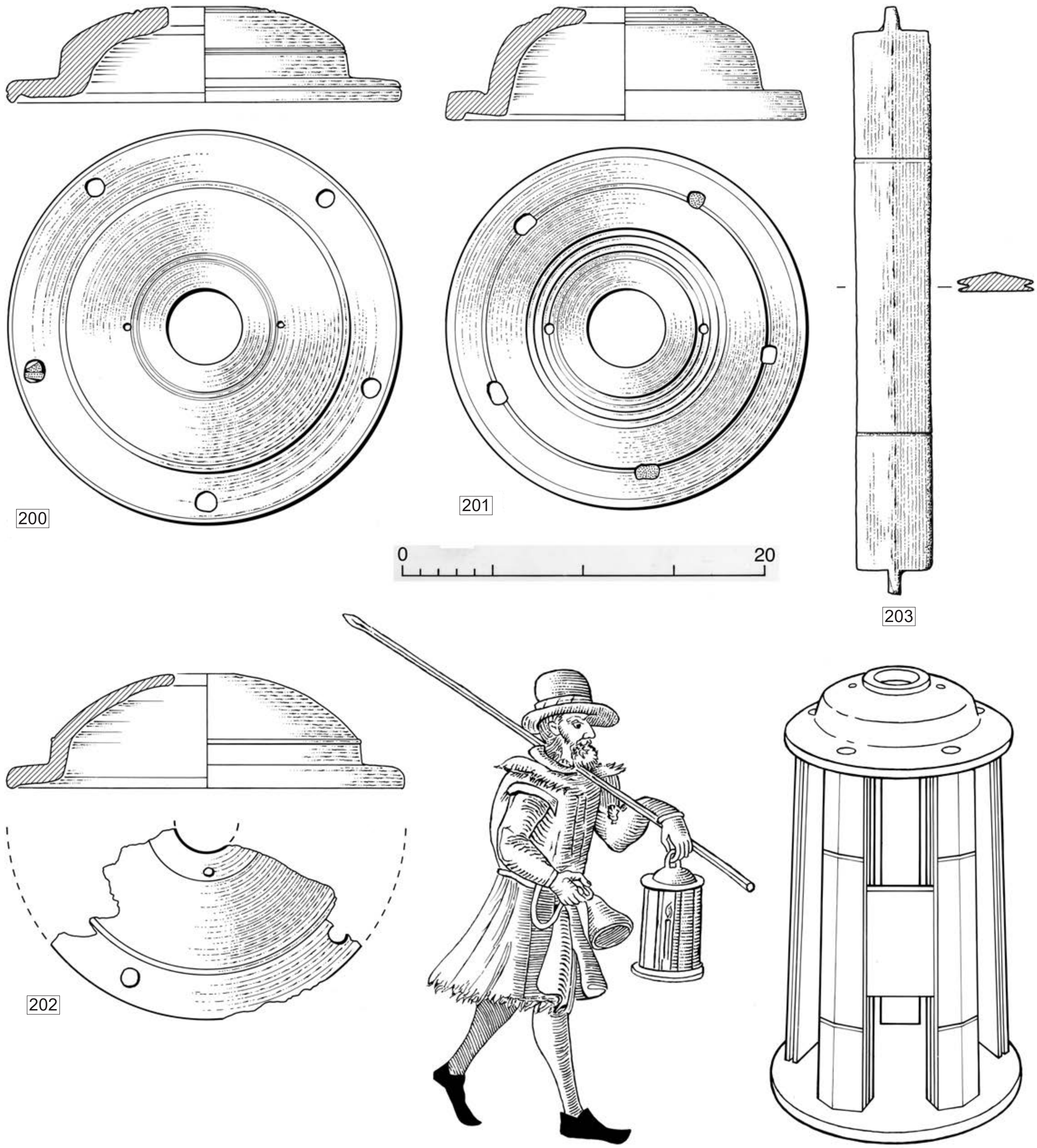


Illustration 297

Top: wooden lantern-tops 200–2 and upright 203. Bottom right: reconstruction of a Duart Point lantern (*Mary Rose* type 2). Bottom centre: night-watchman with bell and lantern from Thomas Dekker 1608, *The Belman of London*

These lantern parts are paralleled by finds from the 15th-century Aber Wrac'h wreck (L'Hour & Veyrat 1989: 293–96), *Mary Rose* (1545) (Richards 2005: 342–6), *La Trinidad Valencera* (1588) (Martin 1997: 9–10), and the 16th-century Yarmouth Roads wreck (Hampshire & Wight Trust 2010: 10). The *Mary Rose* group comprises parts of 17 lanterns, characterised as Type 1 (seven examples) and Type 2 (ten examples). Both types have uprights with slots cut into the edges, like that at Duart Point, and these grooves were intended to house thin translucent sheets of horn, of which fragments were found on the *Mary Rose* examples. *Mary Rose* Type 1 is distinguished by having two uprights close to one another, and this has been interpreted as an arrangement to accommodate a hinged door. *Mary Rose* Type 2 has five equally spaced uprights, like the Duart Point examples, and some of the uprights associated with this type – unlike Type 1 – have a double groove on one side. Such an arrangement would have provided a slot for a sliding door in front of the horn panel, as shown in the reconstruction (Illus 297). It can be assumed that the horn panel behind the door would not quite reach the base of the lantern, allowing access for igniting or extinguishing the light. With the door closed the gap between the outer and inner grooves would allow a sufficient intake of air to sustain the flame while excluding draughts. Loops of string tightened around the grooves in the uprights would have held the assembly secure. A Type 1 lantern was recovered from *La Trinidad Valencera*, and although no physical evidence of the lights remains the lading documents of the same ship make it clear that they were '*lumbradas de cuerno*' (lights of horn).

No example was found on the Duart Point wreck of an upright with one double-slotted and one single side, of which there would have been two in every Type 2 lantern, but since only one upright was found this is not significant. Nor was any bottom part found, though analogies from *Mary Rose* and *Trinidad Valencera* suggest that this would have been a circular wooden disc with holes for uprights matching those in the top piece. The remains of candle-stubs were found in two of the *Mary Rose* lanterns, and some of the bases bore tack-holes at the centre for fastening a cup or pricket for the candles. Two short pewter candle-holders were found close to one of the *Trinidad Valencera* lantern assemblages, though whether they were associated with it, and, if so, how they were fixed to the base, is not clear. That the *Mary Rose* Type 2 lanterns are in most respects identical to the Duart Point ones, though chronologically separated by more than a century, emphasises the innate conservatism of a successful simple design. The only additional features evident in later lanterns are horizontal grooves in the upright, no doubt for a strengthening binding of cord or wire.

Lantern housings for candles fulfilled two important criteria. The first is that they protected the flame from draughts, and could therefore be used outside. The second is that they isolated the flame from flammable surroundings. These precautions were essential in both domestic and nautical contexts where combustible materials were commonplace, but particularly in ships which suffered the added dangers of overcrowding and the presence of gunpowder.

It is noteworthy that these unremarkable objects have had a poor record of preservation in the terrestrial archaeological record or as surviving heirlooms. Hitherto they had been known only in rare pictorial representations such as Pieter Breugel the Elder's *Gloomy Day* (1559) in the Kunsthistorisches Museum, Vienna, or Thomas Decker's *The Belman of London* (1608) (Illus 297). The unique characteristics of a shipwreck, in terms both of the presence of such items and their capacity, in the right environmental circumstances, to survive, combine to bring to our attention this once essential but now largely forgotten aspect of past material culture.

9.8 Leather

Shoes

Seven shoes, six heels and ten soles or other parts of shoes were recorded. At the time of writing they are in wet storage awaiting conservation and detailed study, and the following brief descriptions of examples of the two main types identified should be regarded as provisional.

Latchet shoe

The latchet was a simple but effective design of shoe frequently associated with military footwear in the 17th century (Illus 298). Its upper consisted of three pieces sewn together edge-to-edge. One incorporated the instep, toes, and elongated tongue, while the two side pieces were joined at the back to form the heel and extended forwards into strap or latchet fastenings which were tied over the tongue in a bow with a single lace or ribbon. The uppers were stitched to the sole, and by the 17th century multi-layered heels were normally provided. The toe could be round or square, and the shoes were symmetrical and not made as inward-facing pairs. Until shaped by wear there was no left or right.

204 DP99/046, **076.105**, the most complete latchet shoe is square-toed and has a strong three-ply sole (Illus 298, two views). The heel has not survived but may be assumed.

205 DP99/024, **068.103**, another latchet shoe of which more of the side pieces have survived (Illus 128 bottom). Detail in this photograph is obscured by extraneous archaeological debris, including two human vertebrae and a clay-pipe stem.

A complete latchet shoe has been recovered from the wreck of *London*, an English warship lost in the Thames Estuary

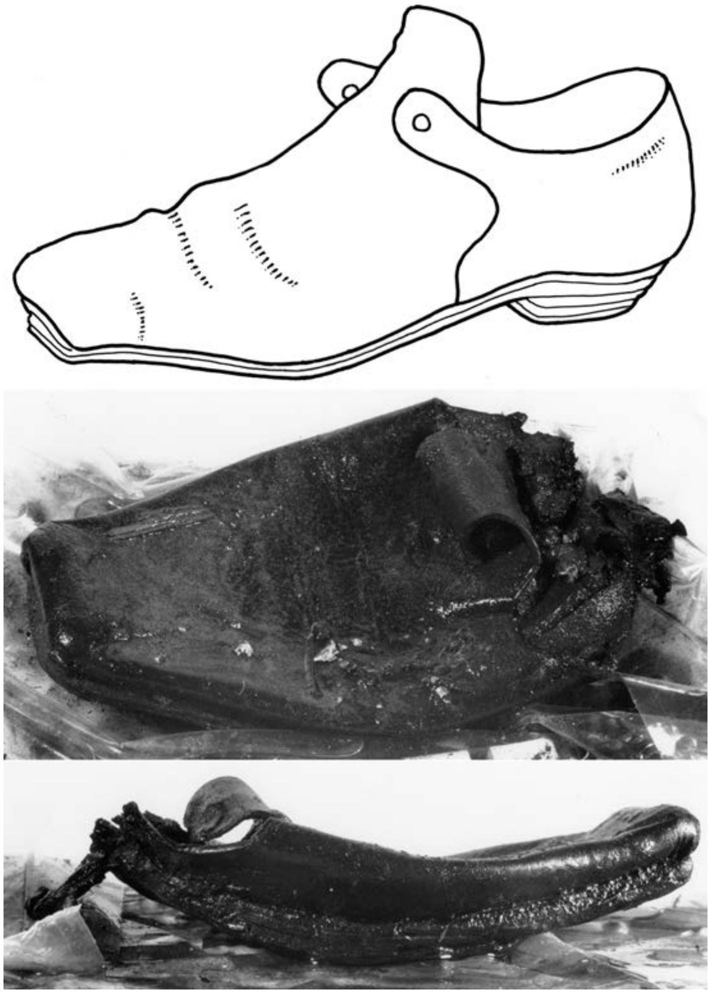


Illustration 298
Top: drawing of a latchet shoe. Centre and bottom: latchet shoe 204

in 1665 (*The Guardian*, 16 May 2014). The type is frequently depicted in contemporary portraits.

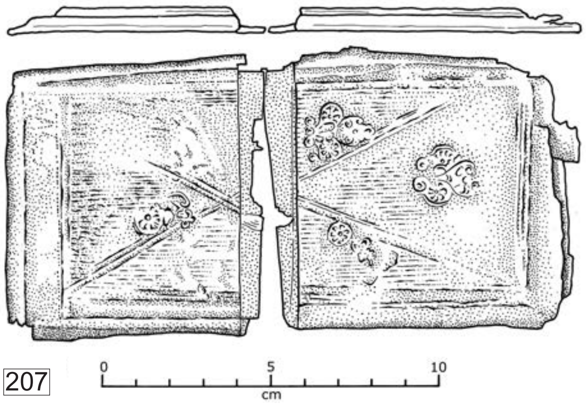
Heavy shoe or boot

206 DP99/025, **069.104**, other shoes in the Duart Point assemblage are of a rounded-toe configuration, with substantial soles and heels (Illus 299). Though none is complete they can probably be identified as heavy boots or shoes, and a parallel which may have a contemporary Civil War association was excavated at Basing House, the scene of a siege which terminated in October 1645 (Moorhouse 1971: 61–2, fig 26). A well-preserved example, again probably with military associations, was recovered from the bottom of a well in Jamestown, Virginia, with an associated date of 1626–50 (Cotter 1958: 193 pl 91).

Leather box- or book-cover

207 DP03/078, **109.073**, a folding wallet-type leather cover measuring 165mm × 82mm × 7mm (unfolded), with punched and incised decoration (Illus 300). It is closely paralleled by two box-covers from *Mary Rose*, one encasing two oblong wooden blocks with circular cut-outs containing a still-intact portable sundial, the other similarly arranged and recessed for a set of coin-scales and weights (Gardiner & Cowham 2005: 168–9; Crawforth-Hitchins 2005a). Small book-covers of similar construction were also recovered from this wreck (Richards & Gardiner 2005: 130–1). No evidence of the original contents of the cover was noted in the Duart Point example.

Illustration 299
Round-toed shoe or boot 206 (DP 173318)



207

Illustration 300
Small leather case 207 (DP 174814)

9.9 Weights

Steelyard poise

208 DP97/A006, **087.069**, just beyond the after end of the wreck, a bulbous lead weight with looped top, 75mm high, 55mm max diameter, and weighing 1040g (Illus 301). It can be identified as a steelyard poise, used in conjunction with an asymmetric beam balance with a short and long arm suspended from a fulcrum. The item to be weighed was hung on the short arm, and its weight determined by moving the much-lighter poise along the long arm until a point of balance was reached. The scale on the long arm was calibrated to express, by a simple computation of balancing moments, the weight of the load on the other side of the fulcrum. It was not necessary for the poise to have a specific weight-value, since the graduations were normally calibrated by placing a series of known loads at the short end and balancing the much lighter poise by moving it along the longer arm, but generally the weight-ratio was *c* 50:1 (Crawforth-Hitchins 2005b: 330), suggesting that the steelyard associated with this poise was intended to weigh loads of up to 52kg, which equates closely with the avoirdupois hundredweight of 112lbs (50.8 kg).

Balance-pan weights

Three circular lead weights of different sizes were found within 1m of one another in the area of the collapsed stern, centred on **100.084**. All have slightly domed tops and concavities *c* 1.5mm deep across the bases, probably caused by post-casting shrinkage, the blanks having been formed upside-down in an open mould. The edges are slightly

208

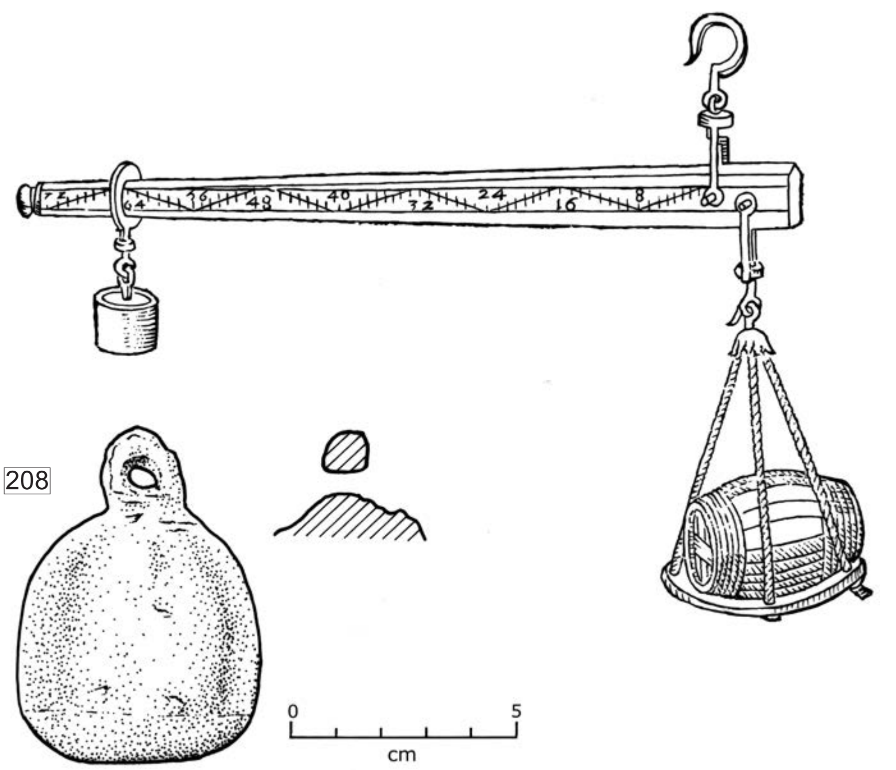


Illustration 301
Steelyard with poise (after Cyprian Lucar 1588). Lower: lead steelyard poise 208

bevelled, an operation evidently carried out after casting with a coarse file or similar tool (Illus 302–3). It may be supposed that this process allowed the weight-values to be precisely adjusted. All carry the same stamped markings consisting of a crowned 'C', representing the authority of the crown under Charles I, a short cruciform object which is the sword of St Paul, representing the City of London's Guildhall, and a winged figure holding a large set of scales, in an oval with a beaded border. This is the Archangel Michael weighing souls in the balance, the mark used since the reign of James I by the Worshipful Company of Plumbers to guarantee the value of weights they issued (Biggs & Withers 2000: 58–9). The three weights may be compared in Table 9.1.

209 DP97/A021, **088.090**, was in pristine condition, and showed no evidence of degradation by corrosion or mechanical abrasion (Illus 302). It was therefore presumed that its mass remains the same as the authenticated value, which was checked by weighing under scientifically controlled conditions through the good offices of Dr Barry Kaye of the Chemistry Department at St Andrews University. The result reveals that it is, to an extremely high degree of accuracy, a weight of 4lb avoirdupois (1.81kg).

210 DP00/033, **092.092**, weight 1lb (0.45kg) (Illus 302).

211 DP00/001, **099.098**, weight 8oz (227g) (Illus 302).

Table 9.1
The three balance-pan weights compared

No	*Dimensions in mm (diameter × height)*	*Weight in grammes*	*Avoirdupois equivalent*
DP97/A021	104 × 22.5	1814.37	3.99994lb (4lb)
DP00/033	69.5 × 13.5	450	0.991lb (1lb)
DP00/001	53.5 × 10.5	223	0.492lb (½lb)

These last two are in less good condition, and since they appear to have suffered some loss of mass to degradation, were weighed less precisely. Nevertheless their weights, despite a predicted small loss, are close enough to 1lb and ½lb values to make it clear that these were the standards intended. It may be presumed that the three are parts of a larger set.

These weights were presumably connected with the disbursement of rations aboard the ship, a strictly controlled procedure watched as closely by the recipients as by the issuing authorities. In 1651 a near-mutiny occurred in Dundee when an attempt was made to deny Cromwellian troops the right to witness the weighing of their rations. '"What", shouted one of the disgruntled soldiery, "shall we not see our biscuit and cheese weighed, I hope to see such officers as you disbanded

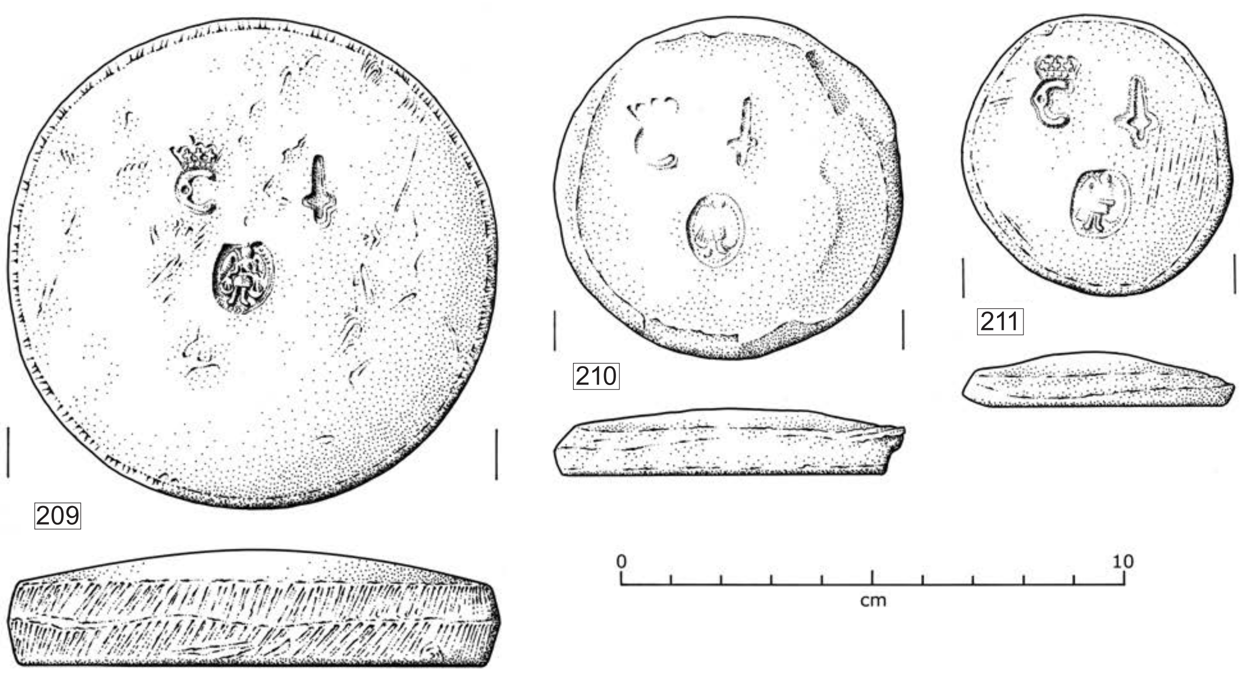


Illustration 302
Lead balance-pan weights of, left to right, 4lbs 209, 1lb 210, and 8oz 211 (DP 174828)

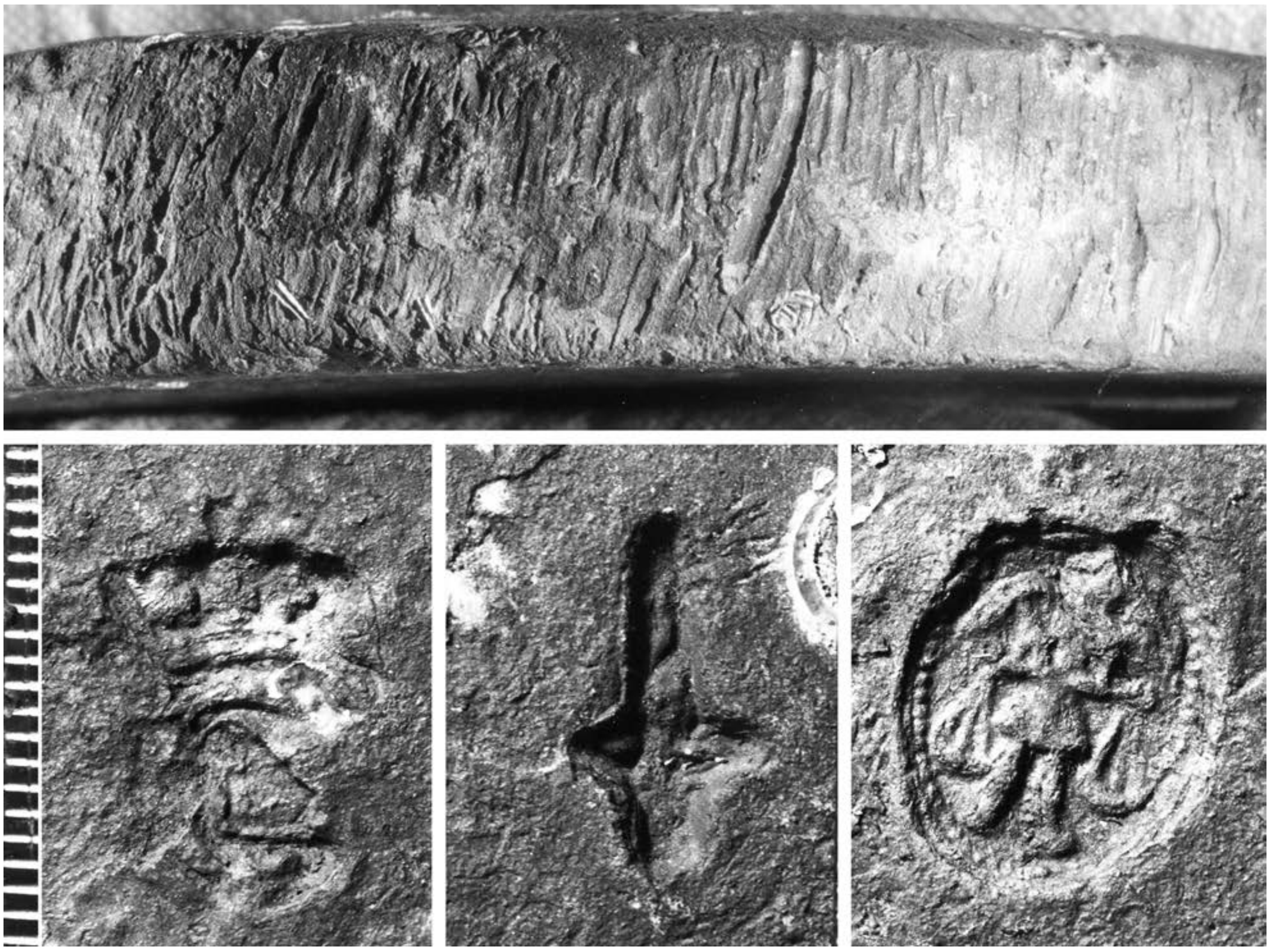


Illustration 303

Top: file-marks on the edge of the 4lb weight 209. This was presumably done to adjust the casting to the precise weight, which has proved extremely accurate. Bottom: control-marks common to all the balance-pan weights. From left, the crowned monogram of Charles I; the sword of St Paul representing the London Guildhall; and the Archangel Michael holding scales, the mark of the Worshipful Company of Plumbers. Scale in millimetres (DP 173359, DP 173352, DP 173351, DP 173350)

before long"' (Firth 1992: 224). The identification of the weight-standard used for ration-issue aboard a ship is one of the most telling indicators of its nationality and, as argued elsewhere, these avoirdupois weights make it virtually certain that the Duart Point ship was under English control when she sank.

9.10 Small objects

Copper-alloy

212 DP92/282, findspot uncertain, heart-shaped strap-terminal with clip at rear (Illus 304), paralleled by an example from *Batavia* (1629) (Green 1989: 175, BAT350).

213 DP92/062, **069.092**, plain rectangular buckle with prong (Illus 304).

214 DP92/257, **26.08**, 'spectacle'-type buckle missing the prong (Illus 304).

215 DP92/256, **26.08**, 'spectacle'-type buckle with prong (Illus 304). This form is common from *c* 1550 to *c* 1650 (Platt & Coleman-Smith 1975: 265 no 1858, fig 244).

216 DP92/DG14, findspot uncertain, fitting of uncertain use, possibly gun furniture (Illus 304).

217 DP00/115, **073.104**, hinge fitting, probably from a folding rule (Illus 304).

218 DP00/010, **097.103**, wire loop with twisted join and a short section of fine wire whipping (Illus 304).

219 DP00/047, **103.084**, sheet-brass mount of trapezoidal shape with four small corner holes and a larger raised central hole. The latter is edged with beaded decoration and what appears to be a crown (Illus 304). Function uncertain but paralleled by a find from Tantallon Castle (Caldwell 1991: 337 and illus 3.6). Tantallon was besieged by Cromwellian forces in 1651.

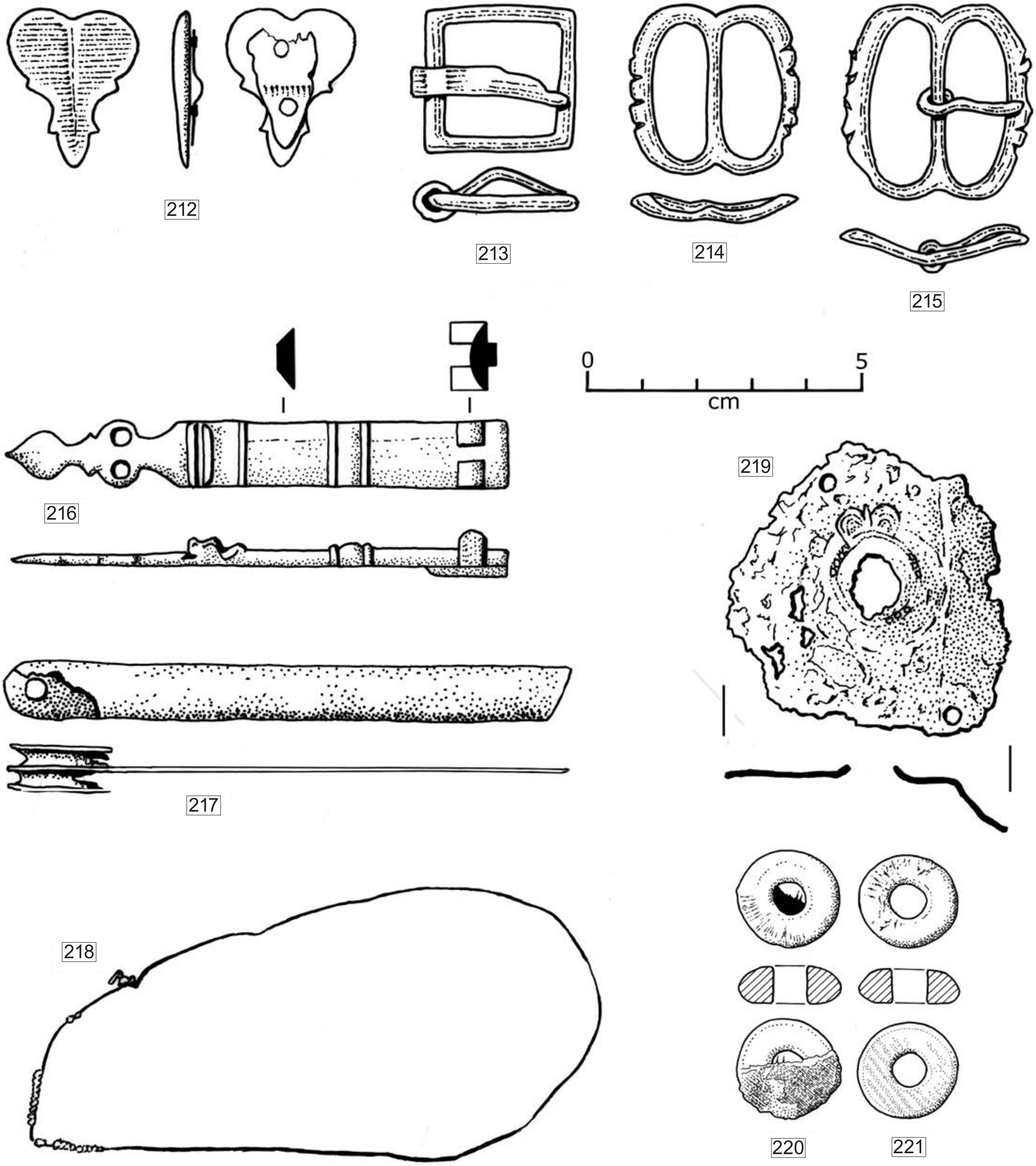


Illustration 304
Small copper-alloy and wooden finds 212–21

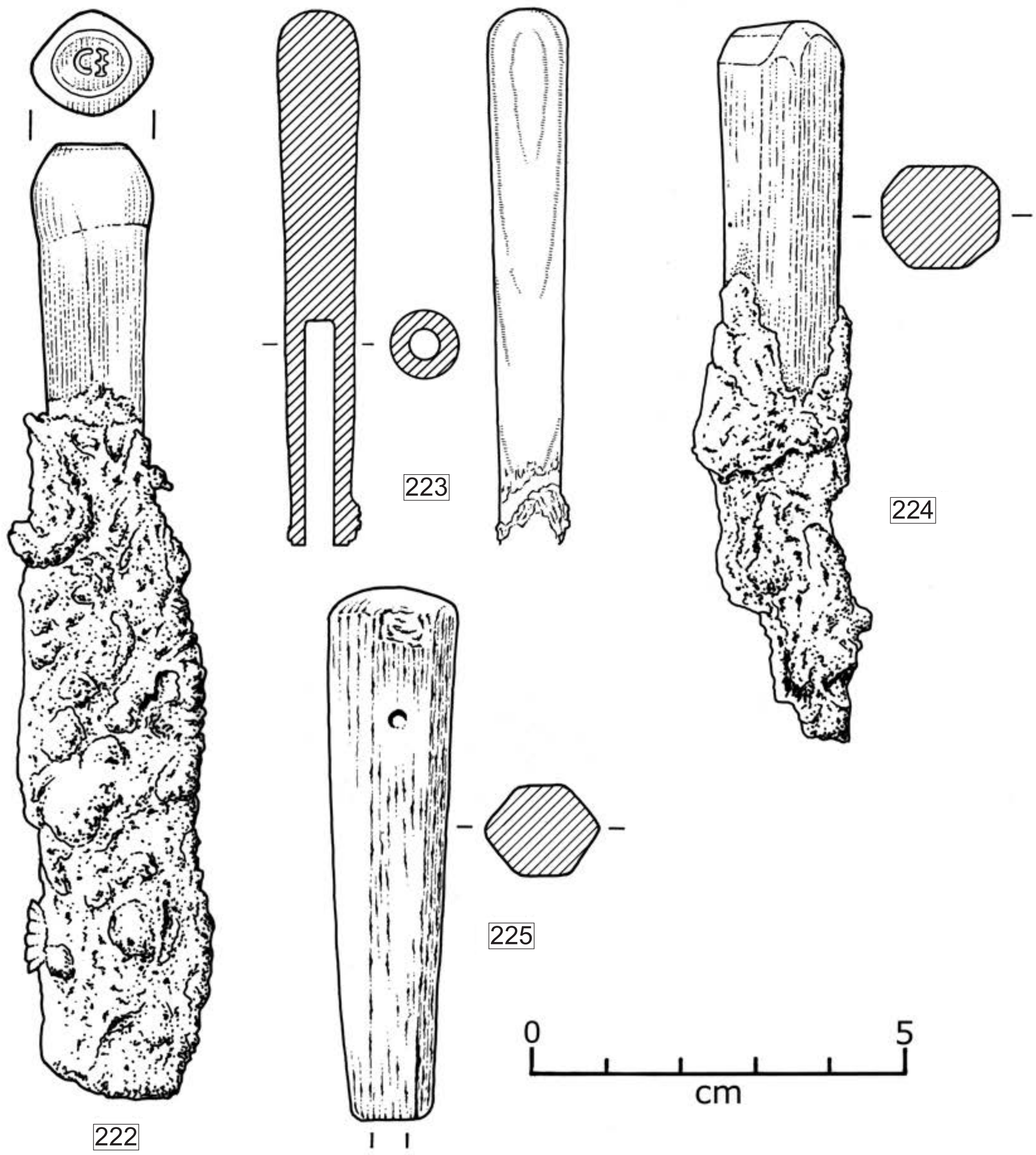


Illustration 305
Knife-handles 222–5 (DP 174864)

Wood

220 DP92/258, findspot uncertain, wooden button with remains of fabric covering (Illus 304). Small cloth-covered buttons of this type are shown on Edward Tarleton's waistcoat (Illus 14).

221 DP92/260, findspot uncertain, wooden button (Illus 304).

Knife-handles

222 DP00/019, **126.115**, bone knife-handle with rounded trapezoidal section and remains of the concreted iron blade (Illus 305). Initials 'C I' cut on the flat top of the handle.

223 DP99/094, **088.100**, bone knife-handle with circular section and circular tang-hole (Illus 305).

224 DP99/087, **081.102**, wooden knife-handle with octagonal section and remains of the concreted iron blade (Illus 305).

225 DP00/003, **129.102**, wooden knife-handle with hexagonal section and slightly rounded corners (Illus 305).

Illustration 306
Largest lump of coins 226 (DP 174160)

Illustration 307
Smaller lumps of coins 227–8 (DP 174161, DP 174158)

9.11 Coins

Several groups of silver coins were found by the Dumfries and Galloway Club in 1992 at approximately **08.07**. They were concreted into solid clumps covered with a grey to dark-brown corrosion residue, which in places shows the impressions of the cloth bags which once contained them.

226 The largest, DP92/DG03 (Illus 306), was estimated to contain *c* 300 pieces.

227 Clump of *c* 25 coins (Illus 307).

228 Clump of *c* eight coins (Illus 307). In this example the cloth impression is particularly clear, while two of the coins have lost their concretion to partially reveal their faces, of 28mm and 25mm diameter. Two 24mm diameter single coins which have lost their concretion on one side display the obverse sides of Elizabethan hammered sixpences, dated 1572 and 1578 respectively (Grueber 1970: 98 and pl 20; no 513).

Illustration 308
Individual coins, showing the range of sizes (DP 173224)

Illustration 309
The obverse and reverse of the Charles I crown 229 (DP 173226, DP 173227)

Three loose silver coins, all obscured by concretion, were recovered by the ADU in 1992 at **090.085** (Steve Liscoe pers comm). Forty more individual silver coins, in similar condition, were recovered during the excavation of Area 5 in grid square 17.09. The coins can be grouped into diameters of 20mm, 25mm, 30mm, and 36mm, of which a sample is shown in Illus 308. These sizes equate with those of English sixpences, shillings, half-crowns, and crowns. For display purposes the clumps have been kept intact, while at the time of writing the concreted single coins have not yet been cleaned and conserved. The silver is corroded and fragile, and the conservation implications are considerable, especially for the multiple-coin clumps. It is to be hoped that in due course this important hoard of Cromwellian military coinage can be conserved, identified, and fully studied.

229 DP99/054, **068.107**, one coin is preserved in good, though worn, condition (Illus 309). It is a silver half-crown of Charles I (Grueber 1970: 115; 618 and pl 25) which may be described thus: Obverse: X CARO[LVS]: D: G: MAG: BRIT: FRA: ET HIB: REX King riding to left holding an upright sword or baton, seated on a trotting horse, his sash tied in a bow behind, the whole within a dotted inner circle. Rose mark of Truro or Exeter mint. Reverse: [CHRISTO]:AUSPICE:REGNO Crowned oval garnished shield within a dotted inner circle.

This coin is typical of undated issues from the Royalist strongholds at Truro and Exeter in the early 1640s, the central mint in the Tower of London being under Parliamentary control. Cornwall was largely loyal to the King, and on 14 November 1642 Charles commissioned Sir Richard Vyvyan of Trelowarren to set up one or more mints in the county to produce coinage to established standards of purity and weight from whatever bullion could be obtained (Besly 1992: 102). The first of the new mints, at Truro, appears to have been short-lived, and its production limited. Exeter had been secured for Parliament at the beginning of the Civil War but in September 1643 the city surrendered to an army under Prince Maurice and remained in Royalist hands until it was recaptured by Sir Thomas Fairfax in April 1646. During this period the large-scale production of Royalist silver crowns and half-crowns was conducted on an *ad hoc* basis, from a bewildering variety of dies. All carry a rose mark denoting the Truro or Exeter mints. Exeter coins of 1644 and 1645 were dated, which suggests that the Duart Point crown is either a Truro minting or an early Exeter coin. In either case a date in the early part of the 1640s is assured, thus providing the Duart Point with a *terminus post quem* within this bracket (Besley 1992: 102–21; see also Lockett 1934).

Chapter 10

HUMAN REMAINS

Human remains were first noted on the wreck by the Archaeological Diving Unit during their preliminary survey in 1992, and the iconic photograph of a carved wooden cherub taken at the time includes an ulna (Illus 118). Several exposed human bones were lifted during the subsequent recovery operation, and more were found during excavations between 1997 and 2003 (eg Illus 86, 128, 310). All were disarticulated and scattered among the deposit identified as the collapsed remains of the upper stern, and this has implications for the interpretation of site-formation processes at this part of the wreck (Chapter 4.2). At first it was assumed that the bones represented several individuals, but an examination conducted in 1999 by Professor Sue Black (Illus 311), showed that all derive from a single individual (Illus 312). Further finds since then have not altered this conclusion.

The only human casualties recorded in reports of the three shipwrecks off Duart Point in September 1653 were the 22 who perished aboard *Speedwell*. None is mentioned in association with the other two vessels wrecked, *Martha and Margaret* and *Swan*. As argued in Chapter 2.2, the latter seems to be the most probable candidate for the Duart Point wreck, so the evidence for an unrecorded fatality aboard this ship requires consideration. It raises the possibility that the wreck is not that of *Swan* but *Speedwell*, the only vessel on which casualties are positively stated to have occurred. However other evidence, including the royal associations of the Duart Point wreck and the origins of her ballast, militate strongly against such a conclusion. So too does the fact that only a single victim appears to have been involved. Had this indeed been the wreck of *Speedwell* the remains of some of the other 21 victims would surely have been identified.

There is something mysterious about the circumstances of this individual's death. Why was he below decks on a ship heading for disaster on a lee shore when every instinct should have brought him to the upper works, where the chances of survival and rescue would have been vastly greater? What was he doing in the stern area – possibly even in the great cabin – when he was (so far as we can judge) a common seaman? Might he even have been a prisoner under restraint? At any event the loss of a single and probably insignificant seaman, in the confusion of a catastrophic event, might well have passed un-noticed and unrecorded.

10.1 The human remains

Sue Black, May 2005

Skull (Illus 313–14)

DP99/022	Intact mandible with dentition
DP03/077	Fragment of left frontal bone
DP03/077	Fragment of left temporal bone
DP03/077	Fragment of left temporal bone
DP03/077	Fragment of right temporal bone

Illustration 310
Part of a human pelvis, as found on the wreck-site (DP 173954)

Illustration 311
Professor Sue Black studying the bones of Seaman Swan in the Granton Conservation Laboratory of National Museums Scotland in 1999 (DP 174691)

DP03/077	two fragments of right and left parietal bones
DP03/077	two fragments of right and left parietal bones
DP03/077	two fragments of right and left parietal bones
DP03/077	two fragments of occipital bone

Thorax (Illus 314)

DP99/033	Mesosternum
DP99/050	Right 1st rib
DP97/E003	Left 1st rib
DP92/045	Right possibly 4th rib
DP97/E002	Right 6th or 7th rib
DP92/180	Right 7th or 8th rib
DP02/025	Left 7th rib
DP92/013	Left 8th rib
DP99/015	Left 9th rib

Vertebral column (Illus 314)

DP99/024	2nd thoracic vertebra
DP99/014	4th thoracic vertebra
DP97/E001a	6th, 7th, or 8th thoracic vertebra
DP99/016	9th or 10th thoracic vertebra
DP99/024	11th or 12th thoracic vertebra
DP97/E001b	3rd lumbar vertebra
DP92/039	5th lumbar vertebra
DP00/057	Sacrum

Upper limb (Illus 314)

DP99/003	Right scapula
DP03/077	Right clavicle
DP00/060	Left clavicle
DP99/043	Left ulna
DP97/E004	Right 3rd metacarpal
DP02/025	Right 4th metacarpal
DP00/194	Left 5th metacarpal
DP02/025	Right 3rd proximal phalanx
DP00/037	Right 4th proximal phalanx

Lower limb (Illus 314)

DP97/E009	Right innominate
DP00/091	Left innominate
DP92/043	Left femur
DP00/120	Left tibia
DP92/279	Right fibula
DP92/064	Left fibula
DP99/034	Left calcaneus
DP00/130	Right talus
DP97/E006	Left 1st metatarsal
DP99/021	Left 2nd metatarsal
DP97/E005	Left 3rd metatarsal
DP99/026a	Left 4th metatarsal
DP99/026a	Left 5th metatarsal
DP99/034	Right 2nd metatarsal
DP99/026a	Left 1st proximal phalanx

Skull: mandible

The mandible (DP99/022) is intact, showing some post-mortem damage over the left condylar area, ramus and posterior aspect of the body (Illus 313–15). The remainder is well preserved, suggesting that the right side was buried deeper than the left, thereby preserving the surface. The bone is extremely robust and classically masculine in appearance although it is not very large. There are particularly well-developed sites of attachment for the masseter and medial pterygoid muscles which are involved in chewing. Mylohyoid, genioglossus and geniohyoid sites of attachment are also well developed.

Dentition

There has been post-mortem loss of most of the anterior teeth including both central and lateral incisors, both canines and the left 1st and 2nd premolars (Illus 315). These are single-rooted teeth and it is common for them to be absent from skeletonised remains. The remaining dentition therefore comprises all six molars and both right premolars. It can be said that all mandibular teeth were present and in occlusion, indicating an age at death in excess of 18–20 years. The molars show quite pronounced wear of the enamel with exposure to dentine apparent only on the first molars. Enamel polishing

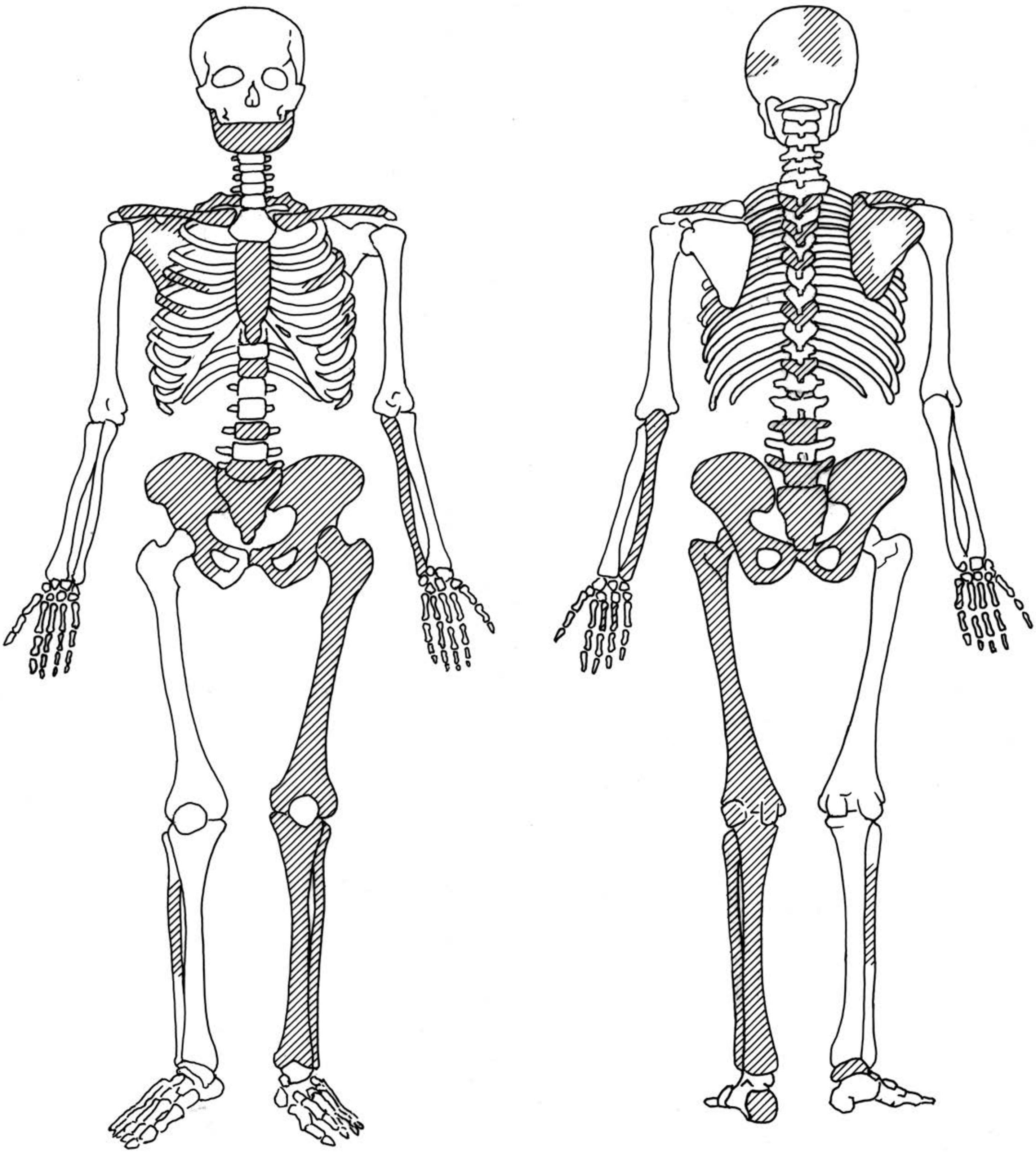


Illustration 312
Diagrammatic representation of the human bones found

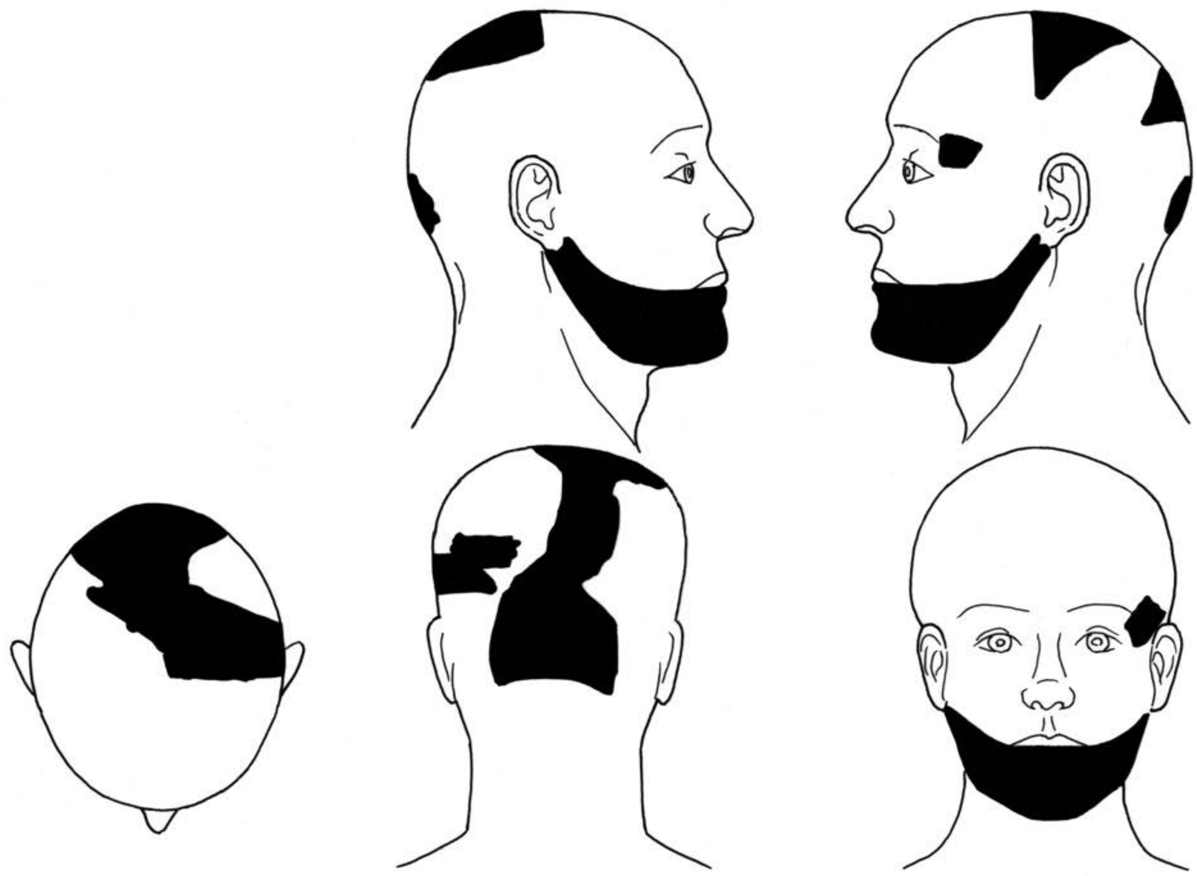


Illustration 313
Diagrammatic representation of the bones from the skull

Illustration 314
Diagrammatic representation of the bones from the rest of the body

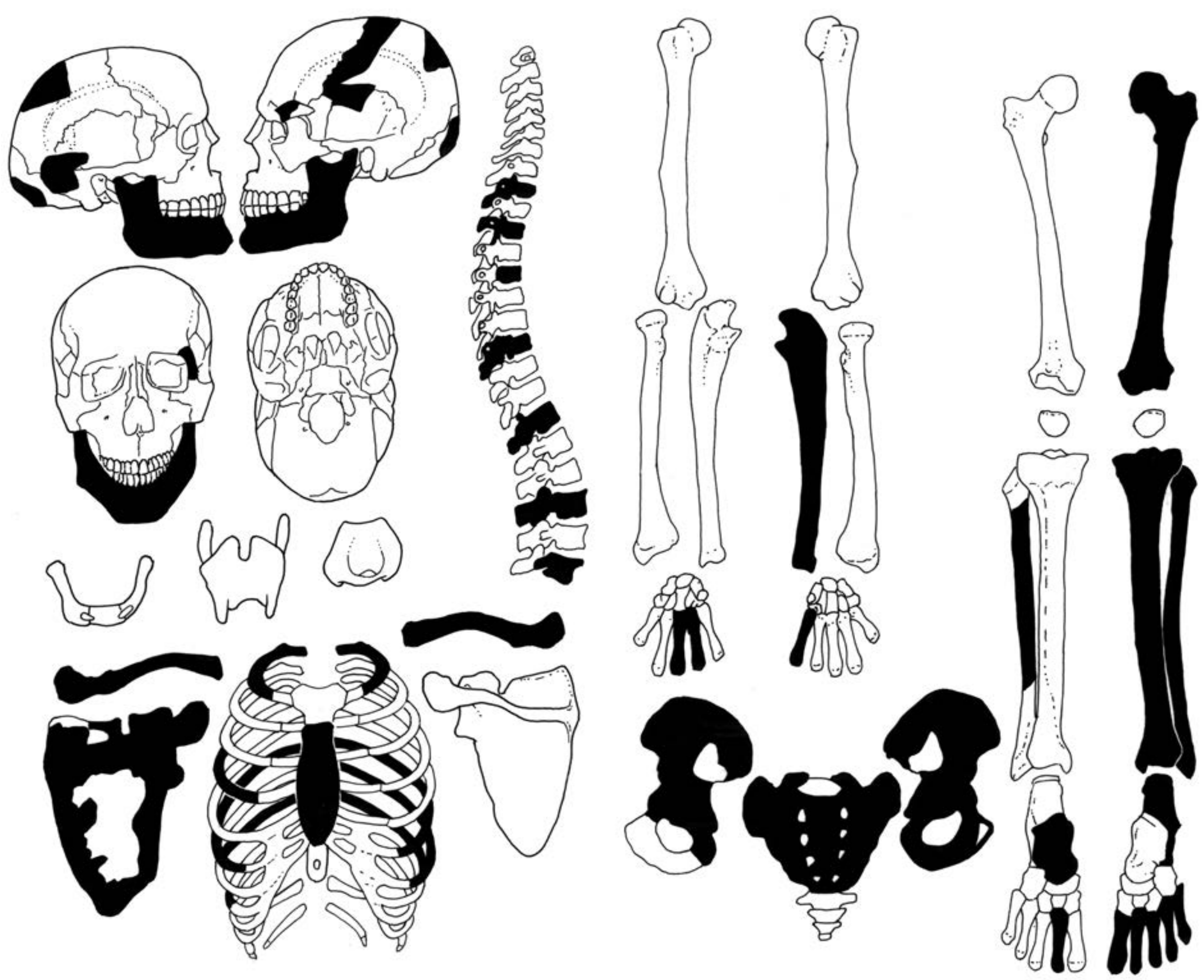


Illustration 315
Top: mandible and dentition as found. Bottom left: oblique view of mandible showing wear on teeth. Bottom right: mandible after removal of teeth for scientific analysis, exposing area of caries (DP 174146, DP 174064, DP 174063)

is present on all the molars. This pattern is consistent with an age at death younger than 25 years. The degree of wear is progressive from the 1st through to the 3rd molars and the pattern was symmetrical when the sides were compared. This indicates that all the maxilliary molars were present and in occlusion around the time of death.

A carious lesion is present on the distal surface of the right 2nd premolar and this can be seen in the dental radiograph (Black 2005: fig 2). There is a minimal build-up of calculus along the neck of each tooth and the alveolar bone looks to be in good health with a minimum amount of breakdown or porosity. The dentition suggests a robust adult male between 20 and 25 years old whose diet contained a heavy component of grit, probably stone-ground cereal. The distal root of the first left molar shows evidence of a granuloma which would cause no concern to the individual (Black 2005: fig 2). The 1st right premolar was removed, sectioned, and sent to Dr Wolfram Meier-Augenstein at Queens University, Belfast, for stable-isotope analysis. His results are presented below.

Skull: fragments

The 12 skull fragments (DP03/077), comprising only areas of the front, parietal, temporal and occipital bones, are illustrated in Illus 313. Three fragments could be bonded with confidence and formed the dorsal third of the right and left parietal bones (Illus 316). Two occipital fragments were also bonded. In summary the skull was relatively small and, from the presence

Illustration 316
Left: reconstructed skull fragments including the areas of the lambdoid and sagittal sutures. Right: conjoining skull fragments in the region of the occipital bone and lambdoid suture (DP 174062, DP 174065)

of an external occipital protuberance, was likely to be male. The open nature of some of the sutures, in conjunction with some evidence of endocranial closure, indicates a young adult. There was no evidence of pathology or trauma.

Thorax

(DP92/013, 045, 180; DP97/E002, 003; DP99/015, 033, 050; DP02/025)

Mesosternum

The mesosternum (DP99/033) is intact and shows not only completion of fusion between sternebra 1 and 2 but an absence of any residual lines. These have normally become obliterated by the age of 25 but the presence of sternochondral crevasses at the level of the 2nd and 3rd ribs indicates that age is most likely assessed as between 22 and 25. There is no evidence of either manubriosternal or xiphisternal fusion which corroborates age estimation to a limited extent. Radiography shows a mature mesosternum from a young adult (Black 2005: fig 5).

Ribs

Eight ribs were represented. While the first two in the sequence are readily identifiable, the fragmentary nature of the remaining six makes it difficult to establish their specific enumerations. However it is clear that four ribs from each side are present. All are adult, and show no evidence of epiphyseal activity, thereby indicating an age in excess of 22. Sternal ossification indicators of age indicated phase 2/3 activity which equates to an age at death of between 20 and 28.

The left 9th rib (DP99/015) displayed an absence of a tubercle for articulation with the transverse process of the 9th thoracic vertebra. This is a mirror of the picture portrayed in the possible 10th thoracic vertebra (DP99/016) where there was no corresponding facet on the transverse process. It is unlikely that this is a 10th rib as the head is not sufficiently horizontal, although the alteration in obliquity due to the higher positioning of the left ribs may account for this. These considerations suggest that in this individual the ribs on the left – certainly from the level of the 9th rib if not before – do not articulate with the transverse processes of the corresponding vertebrae. Little movement is possible at the costotransverse joint due to the tight binding nature of the ligaments, but it does allow slight rotational and gliding movements during respiration.

We can only guess as to the cause of this condition. It may have arisen due to a misalignment of the joint, probably during early development, or perhaps the congenital absence of a higher rib, or even intercostal fusion might have occurred. It is difficult to envisage the physical manifestation of such a condition and to appreciate whether there would have been any substantial alteration to thoracic stability, respiratory movements, and so on. In addition, this is a very broad rib for one occupying such a low position in the thoracic wall. In fact the supero-inferior depth of the midshaft region is significantly increased. This could be caused by the pull of the intercostal muscles that are being required to span a relatively wider intercostal space.

Vertebral column

(DP92/039; DP97/E001a, 001b; DP99/014, 016, 024; DP00/057)

Seven vertebrae are present, probably representing the 2nd, 4th, 6th, 9th and 12th thoracic and the 3rd and 5th lumbar. There is strong evidence to suggest that they belong to the same individual, although L5 is questionable. Although all the vertebrae have achieved adult status, the absence of the cortical shell on the ventral aspect of T2 (DP99/024) indicates recent maturity. Complete union of the vertebral epiphyses in the male occurs between 18 and 24 years. This therefore suggests that T2 is from an individual over 18 but probably under 25.

On the 4th thoracic vertebra (DP99/014) there is an unusual asymmetry with regard to the position of the articular facets for the tubercles of the ribs which begins at this vertebral level on the left side. The ribs on the left side of the body are carried slightly higher than those on the right. This can be deduced from the asymmetry on the inferior demi-facets for the head of the heads of the 7th ribs and this is mirrored by the position of the articular facets on the transverse processes for the tubercles of the ribs, being higher on the left.

For the 6th thoracic vertebra (DP99/E001a) there is some evidence of a slight vertebral endplate deformity on the right side of the superior surface. Recent research has indicated that such conditions are often the result of trauma at an age when the epiphyseal ring was still separate. The 9th/10th thoracic vertebra (DP99/016) also shows evidence of endplate deformities. While there is a possible site on the ventral aspect of the superior ring it is more obvious in the central area of the superior surface in a corresponding position. While these could be confused with Schmorl's nodes (herniation of the neucleus pulposus of the intervertebral disc) that on the inferior surface is more characteristic of a trauma-related endplate disorder.

As on the 4th thoracic vertebra, there is further evidence that the left ribs are carried higher than the right, primarily due to the position of the facets on the transverse processes, but also detectable in the facets on the lateral aspect of the vertebral bodies. In fact the tubercle for the 10th left rib does not appear to articulate at all with the vertebra, as there is no evidence of an articular facet on the transverse process.

As with all the previously described vertebrae, the 3rd lumbar vertebra (DP97/E001b) shows evidence of a well-defined endplate deformity (Illus 317). On the ring epiphyses

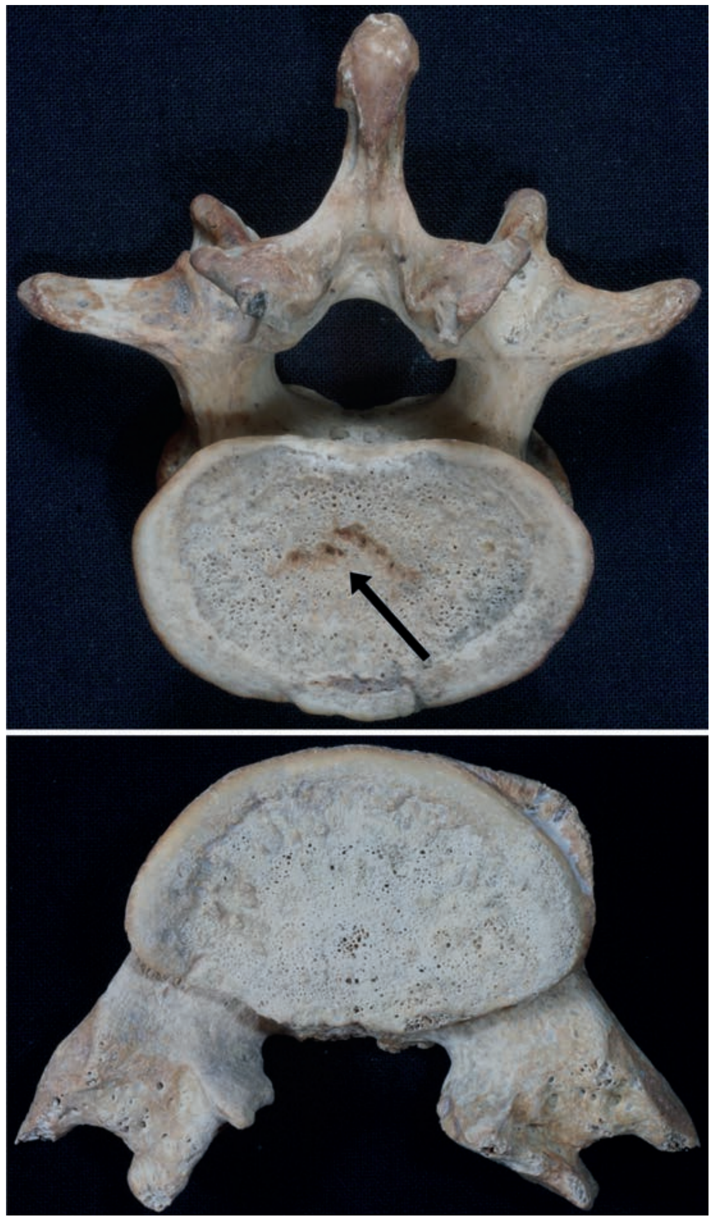


Illustration 317

Top: endplate deformity of the ventral aspect of the body of lumbar vertebra 3, with possible Schmorl's node in the middle of the body. Bottom: spondylolysis of lumbar vertebra 5. The posterior portion was not recovered (DP 174060, DP 174061) this has taken the form of an absence of the ring on the superior ventral aspect of the body, while on the inferior ring there is a discrete island of bone. This island also shows a build-up of bone along its ventral aspect, which could be indicative of a reaction to a previous trauma. The superior surface shows clear evidence of the vestiges of billowing, which would place an age-at-death estimate in agreement with the previous vertebrae. Schmorl's node is present.

The 5th lumbar vertebra (DP92/039) is damaged and does show some evidence of osteophytic development along the inferolateral aspect of the body. This may suggest that it is from an older individual, or it may be associated with the clinical condition present in this bone. The specimen shows a classic condition of spondylolysis, which is an ossification defect in the pars interarticularis portion of the vertebra (Illus 317). This results in the separation of the vertebra into two parts: a ventral body, pedicles and transverse and superior articular processes and a dorsal laminae, spinous process and inferior articular processes. In this specimen only the former is present, as the latter has not been recovered.

In adolescents and young adults this condition is rarely symptomatic, but with time the ligaments and muscles supporting this bipartite structure become strained and the ventral portion may slip forwards causing spondylolisthesis. The pain associated with spondylolysis and spondylolisthesis tends to be experienced as low back pain and stiffness, muscle spasms, sciatica or numbness. The condition is more common in males and can become symptomatic even in the young following strenuous activities. The incidence is 4–8% in a modern population. The cause of the condition is thought to be a defect in the cartilaginous anlage rather than the result of a traumatic incident, so there is likely to be a strong genetic component. Today, patients experiencing pain from this condition might be braced, and with bedrest and a cessation of strenuous activity the symptoms would subside. In more serious cases surgery might be advocated with L5–S1 arthrodesis. If this does indeed belong to the young adult represented by the previous vertebrae it is unlikely that he would have experienced any symptoms of the condition given his youth. However, with advancing years it is likely that he would have experienced pain and discomfort, and a modification of his lifestyle would have been the only option to relieve the symptoms, as no clinical alleviation would have been available. It is of course possible that the bone comes from a different individual who was somewhat older, but the fact that the skeletal collection includes no duplicates, and the general compatibility of the assemblage as a whole, suggests that this is unlikely. In any case the anterior vertebral margins are relatively sharp which suggests that even if this vertebra does belong to another individual, he was more likely to be in his 30s than in his 40s.

Illustration 318
The sacrum. The lines of fusion on the anterior aspect of the bone between S1 and S2 are clear, as is the patent line of non-fusion between S4 and S5 (DP 174055)

The sacrum (DP00/057) is complete although no coccygeal bones were retrieved (Illus 318). The bone is long and narrow with distinct male morphology including the extension of the sacro-iliac joint to the 3rd sacral vertebra. The bone articulates with the two innominates. Remnants of the S1/S2 junction indicate that the individual was younger than 33 and more likely to be around the mid-20s. The S2/S3 and S3/S4 junctions show completed fusion indicating an age of at least 23. Interestingly S4/S5 remains unfused but this is likely to be a developmental anomaly only. A slight articular disturbance is evident on the dorsolateral side of S1 and unusually small superior articular facets are present, confirming the spondylolysis diagnosis. The bone is not symmetrical but twisted, resulting in alae of a different length. This confirms the evidence of asymmetry located in the vertebrae and in the articulations of the ribs.

Upper limb

(DP97/E004; DP99/003, 043; DP00/037, 060, 194; DP02/025(2); DP03/077)

Right scapula

This (DP99/003) can be identified as an adult bone since the inferior angle has fused, as has the medial margin (Illus 319),

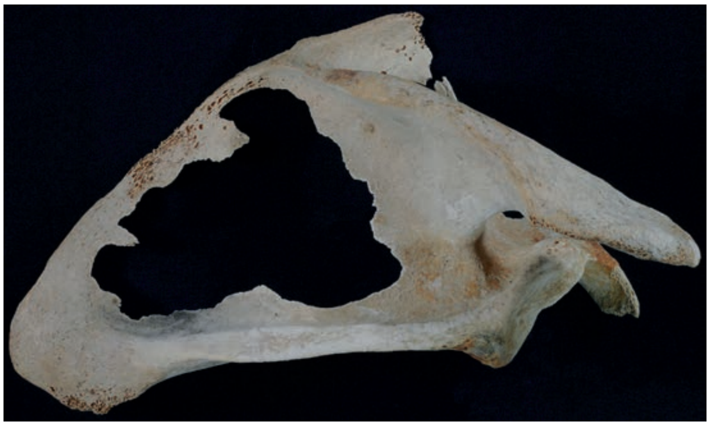


Illustration 319
The scapula was in a relatively poor state of preservation, but did show strong sites of muscle attachment (DP 174056)

which places the age at death in excess of 23. The thin areas of both the supra- and infrascapular regions have been lost due to erosion but the remainder of the bone is in relatively good condition. While the bone is not large, it is robust and shows some extremely well-defined regions of muscular attachment. In particular, the fossa running along the lateral margin of the subscapular fossa is very prominent. This is the site of attachment of the subscapularis muscle, which is a part of the rotator-cuff system of muscles and is responsible for medial rotation of the arm at the shoulder joint as well as being a stabilising influence on the joint. The remainder of the origin of this muscle cannot be examined, as the main body of the subscapular fossa is absent.

The site of attachment for the teres major muscle on the inferolateral aspect of the dorsal surface is also particularly well defined. Teres major is also a medial rotator of the humeral head. The well-developed crest that passes down the lateral border from the glenoid fossa represents the sites of attachment of the teres minor muscle (as with the subscapularis muscle, teres minor is a component of the rotator-cuff system that supports the head of the humerus in the shoulder joint). This is all indicative of an individual of relatively slight build who has particularly well-developed upper-limb musculature. There is evidence of a small impingement facet on the under-surface of the acromion. Unfortunately the head of the humerus has not been preserved, so we cannot predict the angle of the upper limb during this occupation to allow us to speculate on its origin.

Right clavicle

The clavicle (DP03/077) shows extensive sites of muscle attachment and an unusual degree of torsion. The site of attachment for the costoclavicular ligament displays a deep enthesopathy (Illus 320). The medial epiphysis has closed and

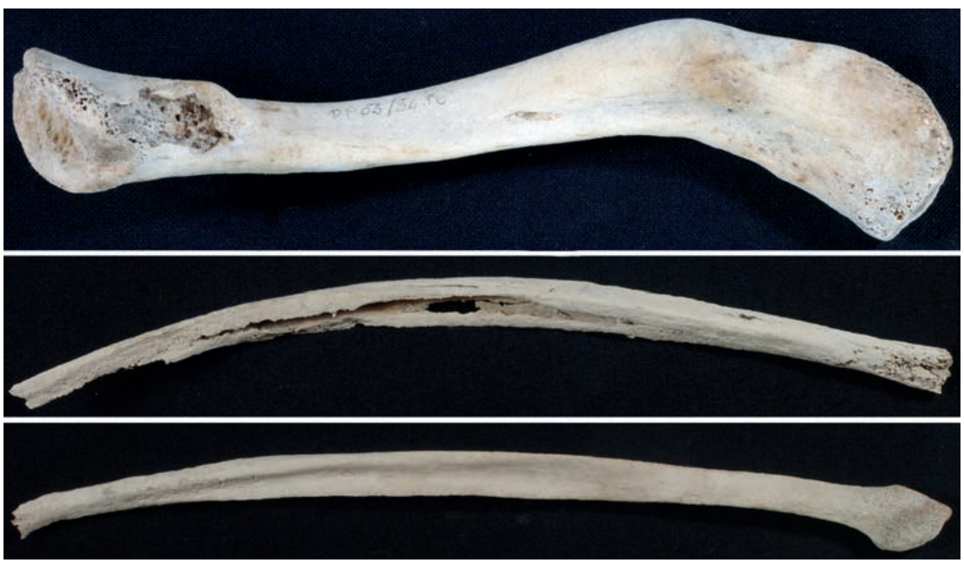


Illustration 320
Top: the clavicle shows strong sites of muscle attachment, and extensive cortical and medullary disruption at the site of attachment of the costoclavicular ligament. Centre: right fibula showing extensive post-mortem erosion. The bowing of the shaft seems somewhat accentuated because of the damage. Small circles were found imprinted on the cortex, presumably from the attachment of barnacles or similar creatures. Bottom: left fibula showing quite extensive bowing of the shaft. The interosseous border is well developed for sites of muscle attachment (DP 174057, DP 174058, DP 174059)

this tends to occur in the 20s. The left clavicle (DP00/060) mirrors everything seen in the right, indicating that the forces being placed through the clavicle as a result of strong muscle and ligament attachment are bilateral.

Left ulna

The bone (DP99/043) is intact and adult, as evidenced by epiphyseal closure, although a physeal indent is still visible on the olecranon process. The sites of attachment for the long flexors and extensors of the hand are particularly well developed, as is the site for the powerful forearm flexor, brachialis. Given the degree of robusticity it is most likely that the individual was male and the degree of muscle development suggests powerful arm and forearm musculature. A radiograph of the bone shows it to be normal with no evidence of growth-arrest lines to indicate serious episodes of childhood illness. Maximum length of the ulna was 253mm, which gives an estimated stature of *c* 1710mm ± 43mm (5ft 7in). It should be borne in mind that stature estimation based on the ulna has the highest standard deviation and is therefore the least reliable of all the long bones.

Metacarpals and phalanges

These were adult as evidenced by full epiphseal closure. They were small and relatively gracile but otherwise unremarkable.

Lower limb

(DP92/043, 064, 297; DP97/E005, 006, 009; DP99/021, 026a(3), 034(2); DP00/091, 120, 130; DP03/077)

Innominates

Right innominate (DP97/E009). The pubic bone is absent from this specimen (Illus 321). The bone is clearly adult, as the last vestiges of the iliac crest epiphysis have fused, indicating an age in excess of 23. The bone is male showing all the characteristic pelvic morphology of that sex, including greater sciatic notch appearance, shape of the iliac fossa and crest, and size of the acetabulum. Maximum acetabular diameter was recorded as 51.5mm which is small for a male but given the morphology of the innominate is not inconsistent with this attribution.

The sacro-iliac surface could not be used for age estimation as it was badly affected by post-mortem change. The acetabulum showed changes similar to those seen on the under-surface of the acromion consistent with an impingement facet. This suggests that the upward thrust of the femur has been sufficient to cause an irregularity on the articular surface of the acetabulum. While there is some post-mortem damage it is clear that there is a cortical disturbance on the dorsolateral rim of the acetabulum, possibly as a result of occupation-related movement or previous damage.

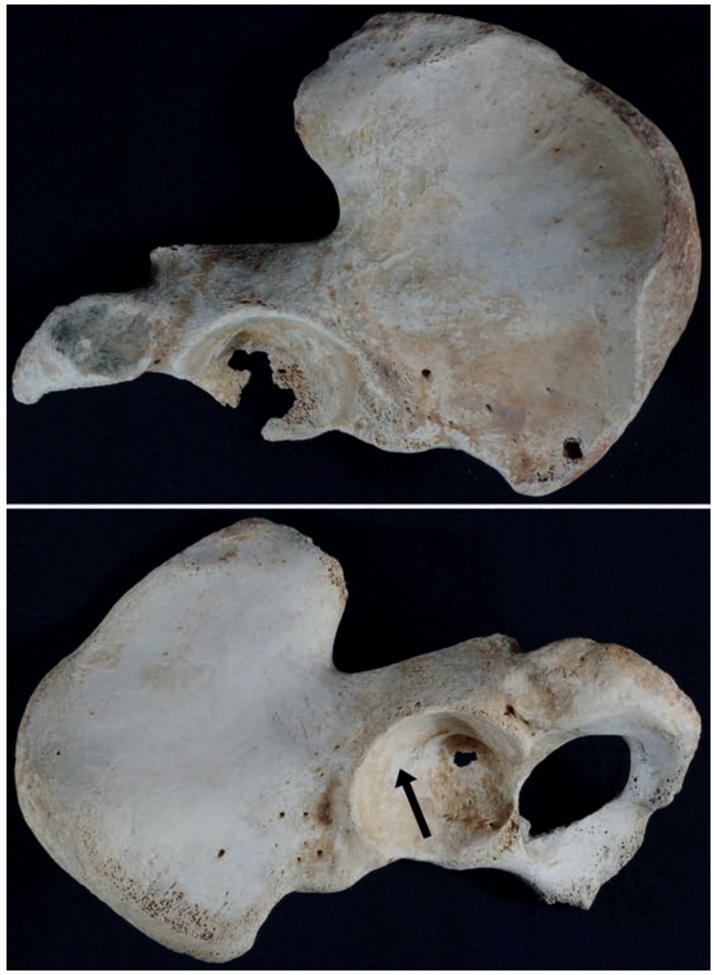


Illustration 321
Top: right innominate. The pubic bone is absent. The iliac crest is complete in terms of its fusion. Damage has occurred to the anterior aspect near the anterior superior iliac spine due to post-mortem damage where the bone has been pierced. Bottom: left innominate. The area of the impingement facet is indicated by an arrow (DP 174054, DP 174053)

The left innominate (DP00/091) was virtually intact (Illus 321). The epiphyses of the iliac crest were fused, suggesting an age at death in excess of 23. An impingement facet similar to that observed on the right innominate was located in the upper wall of the acetabulum. These impingement facets suggest a repeated upward translation of the femoral head to bring it into contact with the acetabulum. This condition is frequently seen in athletes whose sport involves landing on the lower limbs from a height, such as the high jump, long jump, and pole vault. Maximum acetabular diameter was 51.5mm, identical to that on the right side.

Long bones

The left femur (DP92/043) was neither particularly robust nor had particularly well-developed sites of muscular attachment.

However the site of the origin of the medial head of the gastrocnemius muscle in the popliteal fossa is moderately well developed. The maximum femoral-head diameter was 44.6mm which is clearly within the male range, and the maximum length is 442mm, which gives a calculated stature of 1680 ± 39mm (5ft 6in). The bone is adult as all sites of epiphyseal activity are closed. The head displays a slight impingement facet, superior and lateral to the fovea capitis, caused by an upwards displacement of the bone into its articular socket (see innominate above). A radiograph of the bone showed it to be normal with no evidence of growth-arrest lines to indicate serious episodes of childhood illness (Black 2005: fig 14).

The left tibia (DP00/120) is essentially complete and shows significant sites of muscle attachment. Metal deposits are present on the region of the medial epicondyle. The maximum length of the bone indicates a stature of *c* 1680 ± 34mm (5ft 6in), corresponding with the evidence of its associated femur. The proximal epicondylar breadth (70.5mm) and distal epicondylar breadth (48.5mm) are masculine but not robust. Tibial medial-lateral diameter at midshaft was 25.2mm, the tibial anteroposterior diameter at the nutrient foramen was 31.5mm and the mediolateral diameter at the same level was 25.5mm. These were all indicative, but not strongly, of male sex.

The right fibula (DP92/279) is in a particularly poor state of preservation (Illus 320). It represents only the central aspect of the shaft and shows extensive post-mortem damage to much of the cortex. Both proximal and distal extremities are absent. The bone is distinctly bowed in the midshaft area, which can be a strong indication of bone-deficit conditions such as rickets. Although this is generally considered to be a condition that arose during the Industrial Revolution, the symptoms have been noted on bones dating as far back as the Neolithic period. The condition arises through a deficiency in vitamin D, which manifests itself as an abnormal development of the bone precursor (cartilage). This irregular cartilage structure is then perpetuated when ossification of that structure begins. Therefore rickets is generally a disease of the young, which subsequently manifests itself in the adult as bowed long bones and is particularly prevalent in the lower limbs. It is of interest that in this individual there is no other evidence of rickets apart from the two fibulae, since it is unusual – though not impossible – for the fibulae but not the tibiae to be affected.

The left fibula (DP92/064) is represented by two parts: a shaft and distal extremity and a separate proximal extremity. The shaft shows a similar degree of bowing as seen in the bone above, so it is likely that they belong to the same individual (Illus 320). Although the bone is quite small it shows large sites of muscle attachment in the midshaft region. A radiograph of this bone shows no evidence of growth-arrest lines, again indicating no serious episodes of childhood illnesses.

Feet

The left foot is represented by a calcaneus, metatarsals 1–5 and the first proximal phalanx, while the right foot is represented by a talus and the 2nd metatarsal. The overall impression of the foot is that it would not have been particularly large.

The calcaneus (DP99/034) is intact and although not large it is robust. The peroneal trochlea on the lateral surface is particularly well developed with corresponding deep grooves for the peroneus longus and peronus brevis tendons. Full obliteration of the calcaneal epiphyseal line does not occur until between 18 and 20 years, indicating an age at death in excess of 20. All the metatarsals are adult as evidenced by fusion of the epiphyses. Apart from being small they are unremarkable.

10.2 Isotopic composition of human remains

Wolfram Meier-Augenstein, May 2005

Sections of one tooth (1st premolar) and of bone (femur and rib bone) were submitted to the Environmental Forensics and Human Health Laboratory for stable-isotope analysis.

Analysis

Trace-element isotope analysis

Subsamples of the above were sent to The Macaulay Institute (Aberdeen) for $^{87}Sr/^{86}Sr$ analysis (Table 10.1).

Light-element isotope analysis

Subsamples were prepared for ^{18}O-analysis of bone apatite using a modified protocol based on a published procedure (Stephan 2000) and precipitated Ag_3PO_4 was analysed for ^{18}O isotope composition by TC/EA-IRMS with the following results:

Femur CASS_2F = 16.7 ± 0.1‰ (vs V-SMOW)
Rib CASS_2R = 16.2 ± 0.2‰ (vs V-SMOW)

The samples were run in duplicate using a TC/EA (reactor temp 1400°C) coupled to a DeltaPlusXL isotope ratio mass

Table 10.1
Trace-element isotope analysis

Identifier	*$^{87}Sr/^{86}Sr$*	*%Sd Err*	*±2SE*
Femur Cass_1F Innerpart	0.709161	0.0018	0.000026
Femur Cass_1F Outerpart	0.709148	0.0016	0.000023
Rib Cass_1R	0.709142	0.0015	0.000021
Tooth Cass_1PM	0.709057	0.0016	0.000023

spectrometer and normalised to three standards: B1 (an in-house Ag_3PO_4, Alpha Aesar) and Tu1 and Tu2 (two Ag_3PO_4 standards from Dr T Vennemann, University of Lausanne) the 'true' values of which had been determined by fluorination methods at the University of Bradford.

Interpretation

It has to be stressed that this is probably the first time that archaeological human remains which have lain submerged in sea water for 350 years have been analysed for isotopic composition with a view to glean information on the geographic origin of a person (oxygen-isotope analysis was carried out on some teeth from the *Mary Rose* (Bell et al 2009). Due to the great potential for oxygen exchange between bone and sea-water as well as carbonate dissolved therein, and the unknown kinetics of these processes, great care must be taken when interpreting the results of ^{18}O isotope analysis of bone apatite. That said, in this particular case, the $\delta^{18}O$-values seem sound despite a distinct difference between rib and femur that, given the presumed age of this individual, seems to be the result of the aforementioned exchange processes rather than being caused by the different turnover rates of rib bone and femur.

Based on the ^{18}O from femur apatite (–16.7 ± 0.1‰) and Luz and Kolodny's correlation (1985) between ^{18}O of bone apatite and ^{18}O of drinking-water, the drinking-water consumed by this individual during his short life would have had a $\delta^{18}O$ value of –8.80‰ with a range of –8.67 to –8.93‰. In contrast, the same correlation yields a $\delta^{18}O$ value of –9.45‰ with a range of –9.19 to –9.71‰ for the $\delta^{18}O$ value obtained from the individual's rib bone.

There is no region in the United Kingdom with $\delta^{18}O$ values for precipitation or drinking-water of less than –9.00‰. However, there are two areas where $\delta^{18}O$ values for precipitation and drinking-water are less than –8.00‰ but greater than –9.00‰ (Illus 322).

However, the $\delta^{18}O$ values obtained from the rib bone are sufficiently close to those obtained from the femur to suggest that the difference as well as the more negative $\delta^{18}O$ value

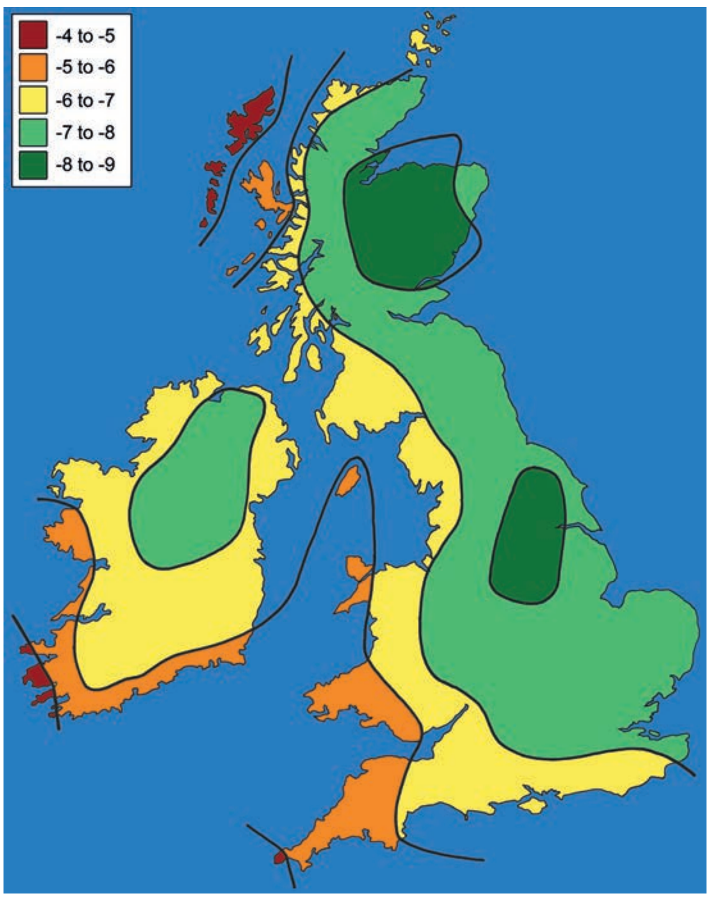


Illustration 322
Oxygen-isotope values for modern UK drinking-water (after a map kindly provided by NERC Isotope Geoscience Laboratory, 2004)

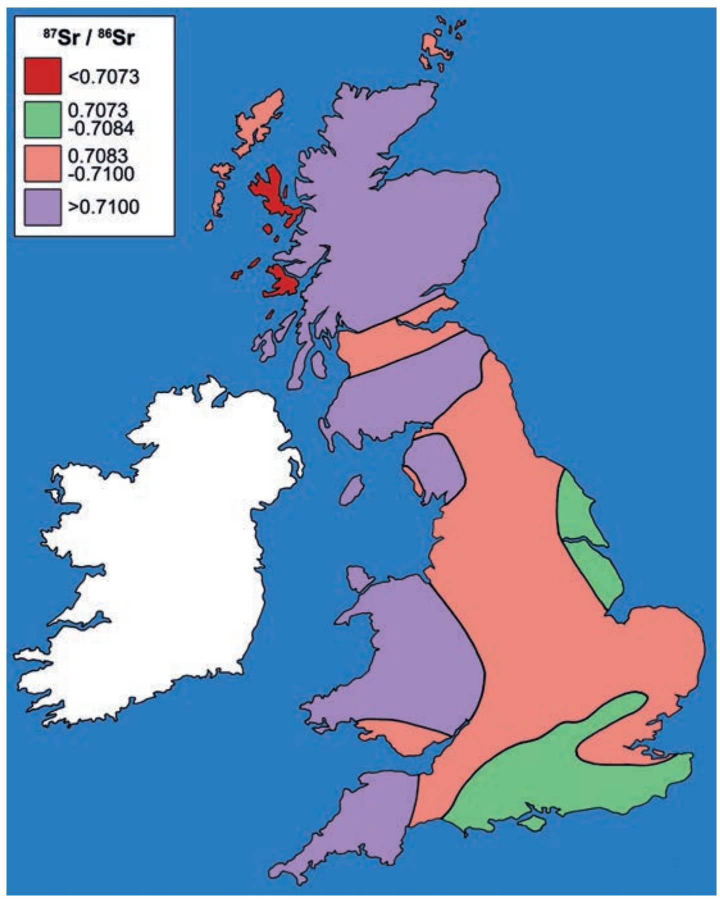


Illustration 323
Strontium-isotope values for modern UK drinking-water (after a map kindly provided by NERC Isotope Geoscience Laboratory, 2004)

could be caused by oxygen exchange with seawater, especially in conjunction with exchange via dissolved carbonate, since this type of exchange generally leads to a depletion in ^{18}O. Given the difference in thickness, density, and porosity between rib bone and femur, one could furthermore surmise the former to be more susceptible to this type of exchange than the latter. If, therefore, one used the lower end of the $\delta^{18}O$ value range for drinking-water gained from the femur as a geographical marker, this would put the individual's home either in an area enclosing York, Leeds, Doncaster, Sheffield and Nottingham, or in the Scottish Highlands, especially the northern part of Perthshire around Aberfeldy, Dunkeld, and Pitlochry, including parts of the Grampians such as Braemar and Ballater.

The above interpretation of the $\delta^{18}O$ values is supported by the findings of the strontium-isotope analysis, the results of which help to narrow down the Duart Point individual's geographic origins even further. The $^{87}Sr/^{86}Sr$ isotope ratios for all the sample materials fall in a relatively narrow range between 0.709057 and 709161. These values are consistent with the central part of the UK (Illus 323) and consistent with one of the two areas implicated by the ^{18}O-isotope analysis, namely Yorkshire. At the same time the observed range of strontium-isotope ratios rules out the Scottish Highlands, since the strontium-isotope stratigraphy here yields $^{87}Sr/^{86}Sr$ isotope ratio > 0.7110.

In summary, based on both ^{18}O and $^{87}Sr/^{86}Sr$ data from rib bone, femur, and 1st premolar it can be concluded that sufficient evidence exists to suggest that the individual concerned came from Yorkshire, specifically from an area circumscribed by Thirsk in the north, Sheffield in the south, York and Selby in the east, and Leeds and Bradford in the west.

10.3 Stable isotopic data analysis for rib and femur collagen

Peter Ditchfield, September 2012

The C/N ratios of 3.2 for both samples suggest that the collagen was in a good state of preservation. The values plotted (Illus 324) represent the mean of duplicate analysis. For the femur these are 11.11 per mil for $\delta^{15}N$ (AIR) and –19.91 per mil for $\delta^{13}C$ (V-PBD) and for the rib the values are 11.72 per mil for $\delta^{15}N$ (AIR) and –19.58 per mil for $\delta^{13}C$ (V-PBD), so there is

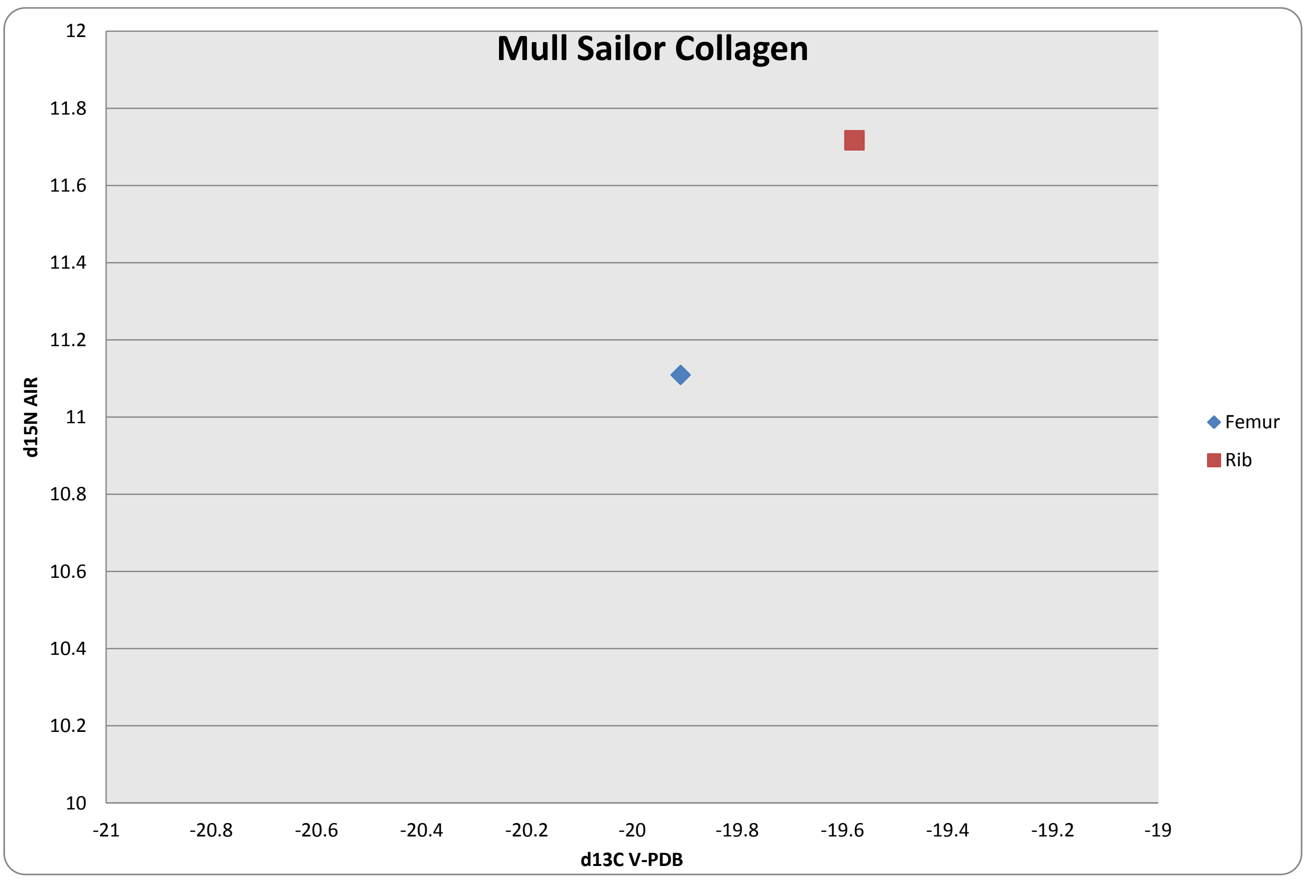


Illustration 324
Duart Point wreck sailor: rib and femur sampled in the first instance, given to JH for collagen extraction 07/06/12

a small difference between the femur and the rib. As this difference is somewhat larger than the difference between the values for the replicate analysis it may well be a real one.

In this case there is a shift towards less-depleted values of carbon and more-enriched values of nitrogen from femur to rib. As the rib collagen is likely to turn over more rapidly than that of the femur we might assume that the rib is more representative of later-life diet. The shift is quite small but nonetheless compatible with an increase in trophic position towards the end of the individual's life, possibly due to the incorporation of more marine resources in his diet with time.

Since the individual was quite young at the time of death, collagen was not sampled from the tooth as it would be unlikely to be different to that present in the femur. But given Dr Meier-Augenstein's findings based on the oxygen- and strontium-isotope analysis of the tooth enamel the shift seen in the bone collagen is compatible with a shift from an inland terrestrially dominated diet to one which incorporated some limited marine-protein resources such as might be included in shipboard rations. In this connection the presence of a substantial number of ling bones identified on the wreck may be significant (see Chapter 6.7). Nonetheless the protein component was still composed largely of terrestrially derived material, and this too is substantiated by finds from the wreck.

10.4 'Seaman Swan' in his contemporary world

Colin Martin

As excavators, recorders and specialist investigators, a number of people have come to feel a considerable affinity for the nameless individual who perished far from his home on 13 September 1653. Through the skill and dedication of Professor Sue Black and her colleagues we have come to know him not as a collection of bones but as a once-sentient person who lived in a world very different from ours. Their forensic wizardry, coupled with the archaeological investigation into the remains of his ship, have lifted a corner of the veil into that world, and what we have glimpsed has enlightened and enriched us in ways we could not have foreseen. It was a happy stroke of genius on Sue's part when, with respect and affection, she named this unknown young man 'Seaman Swan'. Over the years he has become a trusted informant and friendly presence as we have pursued our work among his bones and the remains of his ship.

Seaman Swan was born *c* 1630, probably on the eastern side of the Pennines between Thirsk and Sheffield, some distance from the coast. He was a slight, perhaps rather fragile child, though he suffered from no serious ailments apart from rickets. This condition is caused by vitamin D deficiency and lack of calcium, usually as a consequence of an inadequate early diet and dark living conditions. It is often associated with bad housing, poor hygiene, and breast-feeding by undernourished mothers. Rickets leads to a softening of the bones which characteristically causes bowed legs, a condition apparent in Seaman Swan's fibulae. It is not necessarily a disease of the poor – a generation earlier the sickly child who was to become Charles I suffered badly from it, fed inappropriately on curds and whey in the gloomy confines of Dunfermline Palace, in Fife (Keevil 1954: 409–10). But we may suppose that Seaman Swan spent his early years in poverty, perhaps in the dark hovels of a Yorkshire town such as Leeds or Sheffield, where industrial urbanisation was already stirring, or in York itself. It is less likely that he was a country boy, for in a rural environment he could have expected better access to the healthy food and sunlight that might have spared him the disease. Even so, that he survived at all in an age of high infant mortality suggests that there was an underlying resilience in his frail body. Evidence of rickets was also noted on skeletal material from *Mary Rose* (Stirland 2000: 88–9).

Around the time Seaman Swan was born, Charles I dissolved Parliament and attempted to rule without it for the next 11 years (1629–40), while his determination to establish an episcopal church in Scotland led to the so-called Bishops' Wars of 1639–40. These events probably meant little to the growing boy in Yorkshire, though he may have been aware that most of the area was in Royalist hands. However on 16 April 1642 Parliamentarians barred the gates of nearby Hull against the King, precipitating civil war. The Royalists remained dominant in Yorkshire until they were defeated by the Parliamentarians at Selby in April 1644 and at Marston Moor on 2 July, events of which young Master Swan would surely have been aware, even if they may not have affected him directly. The victors went on to capture York, and soon northern England was under their control.

By now our subject had reached adolescence and, although we cannot be certain, it is likely that around this time he went to sea. By the time of his death nine years later he had become an experienced sailor in his early 20s, following a skilled and physically strenuous calling which usually required entry in early adolescence. Whether from political conviction, or in hopes of bettering himself, or perhaps on a youthful whim, he left home and made for the coast – no doubt to the nearby Parliamentary naval base at Hull. His slight build and bowed legs may not have impressed the recruiting authorities, but he was wiry and agile and someone must have thought the navy might make something of him.

When he perished in the disaster off Duart Point on 13 September 1653 Seaman Swan was in his prime. Though his legs were bowed and rather weak his upper body had developed well, with strong shoulder and arm muscles, balanced on either side. This contrasts with the asymmetric muscle development which results from strenuous activities biased towards a master side – archery, for instance, or championship tennis (Stirland 2000: 123–30). A balanced muscular profile, on the other hand, is indicative of rhythmic, synchronised strenuous activity, such as weight-lifting or rowing. Like his fellow sailors, Seaman Swan would have been nurtured as a carefully programmed mobile power-source, able to apply co-ordinated motive energy through his muscles to the simple machinery which harnessed the wind and regulated the management of the ship – hauling on ropes, setting and adjusting spars and sails, heaving on oars, operating the whipstaff, manning the pumps and windlass, scrubbing the decks and working the guns. The routine performance of these duties would have developed the muscles and general fitness levels evidenced by Seaman Swan's anatomy, which also suggests that he had enjoyed an adequate and reasonably balanced diet, including meat, fish, and much stone-ground cereal as the extensive tooth-wear shows. This, it may be suggested, does not necessarily reflect humanity on the part of the Cromwellian authorities, but a practical realisation that seamen were engines of motive power essential to the working of the ship, and had to be kept in good condition.

That he was a topman who regularly worked aloft is indicated by the impingement facets caused by repeated upward thrusting of the femur onto the acetabular roof. It is still a practice on square-riggers, after working aloft, to slide down the mainstay or shrouds, dropping the last few feet onto the deck (Villiers 2000: pl 20). Working in the confined waters off western Scotland, Seaman Swan would probably have performed this action many times each day.

We may suppose that Seaman Swan was one of a party left on board the ship when her main company came ashore after anchoring in Duart Bay. What brought him to the stern-cabin area when she was cast adrift during the storm of 13 September 1653, and why he was still there when she struck Duart Point, we will never know. This anonymous casualty of a long-forgotten conflict has now been laid to rest in consecrated ground outside Duart Castle, overlooking the site of his wrecked ship.

Chapter 11

CONCLUSIONS

The nature of the wreck formation, its general cohesion, the survival of much of the lower hull, and the collapse of the upper hull to port, have informed reliable estimates of the dimensions, form, and displacement of the ship. This, viewed in conjunction with artefact distributions and other evidence, has enabled a three-masted rig and the internal layout of the vessel to be postulated with some confidence. An apparent lack of ordnance on the midships part of the main deck would be explained by the use of this space for rowing banks, an attribute documented for *Swan* and reinforced archaeologically by the identification of an oar-port lid. Since neither of the two merchant vessels lost with *Swan* in the 1653 incident would have carried oars this reinforces the already-strong evidence that the latter is the wreck off Duart Point, and for the purposes of the following discussion this identification is assumed.

A hypothetical reconstruction of the hull indicates a keel-length of 60ft, a maximum beam of 25ft, and a laden displacement of about 135 tons. The beam-length ratio of 1:2.4 is more appropriate to a warship (albeit a rather beamy one) than to a merchant vessel (Thrush 1991: 32). Her underwater lines indicate a blunt entry and a fine run reflecting the dictum 'head of cod, tail of mackerel' (Adams 2013: 115–16). The ship was probably built 'bottom-up' or 'frame-led' with perhaps three pre-erected frames faired by ribbands to control the alternating placement of floor-timbers, futtocks, and planking as the hull-structure progressed (Adams 2013: 130–1). This form of construction is believed to have originated in the Low Countries during the 15th century (Hocker 2004: 80–2), and was common in northern Europe during the 16th and 17th centuries.

The disposition of ordnance on the main deck is unusual. Two long pieces, identified as 5-pounder sakers, appear to have been mounted in the bow, pointing forwards. Paired broadside pieces of perhaps saker and minion calibre occupied the aft deck on either side. Finally, at least one and perhaps two minion drakes were placed astern, firing through the lower transom.

Though light, this armament would have been well-suited for operations against the castles and galleys of Scotland's western seaboard. The ship's two forward guns would be effective in the chase, and in combination with her rowing capability she would be a formidable pursuit-craft. Good sailing characteristics supplemented by oars would have allowed her to out-run larger and more heavily armed pursuers. The aft-pointing drakes would have countered attacks by small craft attempting to board from astern – her most vulnerable quarter. This capability would be augmented if the guns were loaded with case-shot of the kind identified on the wreck. Her modest broadside of two guns on each side would have sufficed to deal with most merchant ship adversaries in ship-to-ship encounters.

This armament, coupled with her shallow draught and oar-given manoeuvrability, would have given her a strong tactical advantage against static shore targets such as castles. How such an action might be fought is illustrated in a contemporary depiction of an attack by Elizabethan warships on a fortified headland at Smerwick Harbour in South-West Ireland in 1580 (Martin & Parker 1999: 68, fig 9). While the anchored fleet stands off in deeper water to maintain a long-range bombardment, smaller vessels take advantage of their shallow draught to run under sail towards the fort, firing their forward guns as they approach, before coming about at the last moment to present first their broadsides and then their stern guns at close range. This tactic could be repeated on a cyclical basis to maintain continuous fire.

The ship's upper stern contained a small but lavishly appointed cabin with panelled sides and door, cupboards, glazed windows, and quarter-galleries, indicative of an occupant of high status. The presence hereabouts of a London-made pocket-watch, a high-quality sword, and a top-of-the-range snaphaunce pistol by Charles II's dagmaker in Scotland, further emphasise this individual's status and wealth. A person of such eminence enjoying the isolated and relatively luxurious accommodation in the aft cabin can only have been *Swan's* captain, Edward Tarleton.

The captain's quarters would not have been the same aboard a merchant ship of comparable size. Recent investigations of trading vessels of similar date preserved almost intact in the deep Baltic show quite different arrangements to those postulated for *Swan*. For economic reasons merchant ships were designed to be operated by as small a crew as possible, and their rigs were simplified accordingly. The crews, moreover, were generally kin-based, with familial rather than systemic shipboard hierarchies. Such coherent social groups could live in close proximity without compromising authority, sleeping and performing bodily functions in a communal stern cabin, eating and relaxing in the warmth of an adjacent galley and fuel-store (Eriksson 2014: 104–12).

Internal spatial arrangements reflecting hierarchical divisions aboard a warship were radically different. The emphasis was not on economic operation, but on exacting maximum performance from a much more complex and efficient rig to gain tactical advantage and deploy strong offensive and defensive capabilities. Crews were consequently much larger, with a structured cadre of officers and specialists, and the large body of men required to work the ship, man the guns, and fight. Hierarchies were defined by systemically imposed ranks and duties, and these in turn defined rigidly controlled protocols of space and movement within the ship. There were zones for performing particular tasks, defined routeways for authorised movement between them, and space for eating, sleeping and excreting. The captain occupied what was in effect the 'driver's seat' in the stern cabin, while the rest of the zone abaft the mainmast was largely reserved for officers and key functionaries. Midships and forward areas were the preserve of the crew. This arrangement ensured that authority and supervision visibly emanated from the narrowing and upwardly sloping stern, from which the ship's executives could view, control, and dominate activity throughout the vessel (Eriksson 2014: 142–8). The evidence that the Duart Point wreck was organised in this way is strong, and further indicates that the vessel had been conceived from the outset as a warship.

To operate in all three of her potential configurations – sailing, rowing, and fighting – *Swan* would have required a crew of at least 94, comprising 54 oarsmen (at an estimated three per sweep), 30 seamen (the number she was credited with at Liverpool), and (say) ten executives and specialists, including the Captain, Master, Purser, Carpenter, Boatswain, Surgeon, Gunner, and their various mates. Most of the crew accommodation would have been on the main deck, where in the absence of guns and with the 18 sweeps hung on the upper-deck beams 65 6ft × 2ft (1.8m × 0.6m) sleeping spaces would have been available. Further accommodation could have been found on the aft part of the main deck, in the forecastle, and in the hold if this was not filled with cargo or provisions.

Thus organised, the ship could readily adapt to her specialist roles. As a sailing ship with a reasonable hold capacity she could transport goods and if necessary fight with a 30-strong crew, and in ballast was probably quite fast (hence her employment as a dispatch vessel). In an offensive capacity she could operate under oars and if necessary use the 54 oarsmen as soldiers who could fight from the ship or be deployed ashore. For localised operations she could carry additional troops in the hold. These capabilities might be enhanced, as evidence from the wreck has shown, by an ability to provision herself from local resources. For her size *Swan* was a powerful naval unit with a wide range of capabilities.

The origins of this versatile ship-type are to be found in the endemic piracy of the late 16th and early 17th centuries. Much of the maritime conflict between England, Spain and the fledgling Dutch republic was prosecuted by private ships operating, however loosely, under their respective states' authority. Though hostilities were usually motivated by religious divisions and economic rivalries, the motives of the participants were primarily predatory. From 1584 Catholic privateers operated out of Dunkirk, dominating the shipping lanes into and out of the English Channel, while the coastal waters around Britain were infested with Irish and Scottish privateers operating under various shades of legitimacy (Ohlmeyer 1989; 1990; Murdoch 2010). From further afield Moorish pirates of the North African coast, who had previously confined their attentions to shipping in the Mediterranean, broke loose into Atlantic waters to prey on ships and capture slaves along the coasts of Spain, France, the British Isles, and ultimately as far as Iceland (Jamieson 2012).

Paradoxically, the problem was exacerbated during the first two decades of the 17th century by the growth of state-owned and state-controlled European navies. An emphasis on size, powerful armaments and prestige led to increasingly large ships which could take their place in the disciplined formations of large-scale fleet actions. Such ships could secure dominance over the seaways they patrolled, but they could not protect humble merchant ships or fishing boats on the open ocean from small, nimble and well-armed predators. Nathaniel Butler, himself a reformed pirate from the glory days of Elizabethan privateering, compared the big sailing warships to 'a giant, strong and (if you will) invincible at close and grappling, but for all that so weak and impotent in his legs that any active and nimble dwarf, keeping out of reach, may affront and scorn them, may hurt and endanger him, without receiving the least harm and revenge from him' (Perrin 1929: 250).

In analysing the generally superior performance of small warships built in the Low Countries over their English counterparts, Butler considered the following factors relevant (Perrin 1929: 43–4): the ships are light, and carry little cargo or artillery; their underwater lines are good – long rake and good full bow; they have a fine run; they have narrow rudders; they are masted just right; the masts are properly stayed; and they are not over-rigged. Expanding on these factors, Butler continues:

> a fleet may and must receive these yere [desirable] and nimble sailers mixed amongst them, these ensuing particulars worthily held in special account: that they are ready at all hands to wait upon it, upon all occasions; that is in calms, or small store of wind, if they may be fitted with oars (as they may easily and conveniently be), they may be advantageously employed in all chases, and that upon occasions they may anchor near the shore, where the great ships cannot, and may be fitly used to fetch in all strange ships whatsoever (Perrin 1929: 250).

But in their attempts to replicate such ships, Butler asserts, the innate conservatism of English shipwrights had proved a hindrance. 'For the most part we build them so very strong, and consequently heavy; so full of timber and timbers; we building our ships for seventy years; they theirs for seven; we for stowage [load capacity], they for stirring [speed]' (Perrin 1929: 249).

Charles I's heavy battleships had proved powerless against the swift-sailing privateers operating from shallow-water Flemish ports during England's war with Spain between 1625 and 1630. In 1628 ten sail-and-oar pinnaces called the *Lion's Whelps* were built to counter them, but their over-heavy build and excessive armament compromised performance and they were not a success (Thrush 1991: 40–1). Like the Duart Point ship they had a three-masted rig and auxiliary oars, but their armament was immensely heavier. *Ninth Whelp's* guns, recorded at Waterford in July 1635, included two brass sakers, six iron demi-culverin drakes, four iron culverin drakes and four iron demi-culverin drakes (Thompson 1977; see also Howard 1979: 152). These 16 guns, if shotted to the full weight of their respective classes, would have thrown a total of 262lbs (118.8kg) against an estimated 34lbs (15.4kg) capability of the Duart ship's guns, a mere 14% of *Ninth Whelp*'s firepower.

It is difficult to see how the *Whelps*' ordnance, even if composed of lighter and shorter drakes, would not have filled all the available space on the main deck, including the waist, so it would have been necessary to dispose the sweeps among and between the guns. The number of oars mounted by the *Whelps* is nowhere explicit, although a summary contract for their building (TNA SP16/58) specifies a total of 320 32ft (9.75m) oars for all ten ships. The same document lists the total of masts and spars for all the *Whelps* which if divided by ten gives the correct complement for each ship, suggesting that the oars were similarly quantified and so there would have been 32 sweeps per vessel, or 16 on each side.

It is impossible to reconcile these numbers of guns and oars with the space available for them. Even if the main deck was entirely clear, and oar-ports provided at 4-ft intervals (the minimum distance required to accommodate the inboard stroke of the 3-man oar teams specified for the *Whelps*), only 15 ports per side are possible, and this presupposes that the decks were not encumbered with 16 pieces of ordnance, most of them mounted on the broadside. A further factor is the 96 oarsmen who would be required to man the 32 sweeps, plus seamen and supernumeraries, who cannot be reconciled with the 60-strong crew typically assigned to these ships (Thompson 1977). As with the unrealistic weight of ordnance, the evident desire to cram the *Whelps* with an unmanageable number of oars may be yet another example of wishful thinking outweighing reality on the part of the incompetent and ill-fated duke of Buckingham.

It is tempting to see the slightly later *Swan* as a similar but lighter and much more lightly armed and sensibly oared alternative, perhaps conceived in the knowledge of the *Whelps*' shortcomings, with a more realistic number, size, and distribution of guns which left adequate space to work them while leaving the waist free for the banks of oarsmen.

In 1637 a Flemish privateer called *Swan* (unrelated to the Duart ship), single-decked and fitted with oars, was captured. She served as a model for two English-built pinnaces, *Greyhound* (100 tons) and *Roebuck* (120 tons, 50 crew), though again a strengthened build compromised their performance. In 1637 Thomas Wentworth, Lord Deputy of Ireland, acquired a 160-ton Dutch-built ship which he equipped with oars in 1639, and was subsequently described as 'an extraordinary good sailer' (Thrush 1991: 42–3).

During the earlier part of the 17th century the naval policies of James VI/I on the western seaboard of Scotland, articulated and applied under the Statutes of Iona, sought to demolish clan-based naval power in the area and bring about the demise of the traditional sailing galley or *bírlinn*. But there was still a need for a locally deployed naval force under the control of magnates loyal to the crown. By this time Clan Campbell, through political guile and growing military strength, was close to achieving hegemony in the maritime west over its ancient rivals, the Macdonalds. In 1624 Clan Ian of Ardnamurchan (a branch of the Macdonalds), whose acts of piracy were notorious throughout the region, rebelled against the crown. The following year, on the orders of Scotland's Privy Council, a ship and pinnace were prepared and manned at Ayr to support Archibald Campbell, Lord Lorne (later the Marquess of Argyll), in executing a commission of fire and sword against them. The frigate was rated at 150 tons, and manned by 24 mariners and 24 soldiers; the pinnace at 50 tons had 12 soldiers and 12 mariners. John Osburne, son of the frigate's owner, commanded both vessels and was directed to 'pursue the rebels with all kind of rigour and hostility'. Clan Ian was ejected from Ardnamurchan (Gregory 1836: 410–11), and a Scottish and a Flemish ship which had been seized by Clan Ian were recovered (*RPCS*, ser 2 vol I: 19, 26; Gregory 1836: 405–12; Macinnes 2011: 69).

Other sporadic references record private naval activity by Argyll. In 1639 he purchased a frigate in Holland called *Lorne* (the title he had borne prior to his succession to the earldom), which he sold on in 1642 (Stevenson 1973: 128). Other references imply the existence of what was, in effect, a private navy on the western seaboard during the incumbency of the marquess. At the time of Alasdair MacColla's invasion of Ardnamurchan on behalf of the king in 1644 Argyll had three ships in service. They included *Swan* (which, as argued in Chapter 2.2, was very probably the Duart Point vessel) under Captain James Brown, *Antelope of Glasgow* commanded by Captain Richard Willoughby, and *Globe*, based at Dunollie (Campbell 2002: 217).

During Britain's complex civil wars – the so-called Wars of the Three Kingdoms (1639–51) Scotland was governed by a Committee of Estates dominated by the Covenanters. The leading Covenanter was the Marquess of Argyll who, though not a member of the Committee, had a profound influence over it rather in the manner of a king over his parliament. He was, in effect, commander-in-chief of its military and naval forces. On 24 October 1645 the Committee found it necessary to confirm that 'the frigate and the galley which have been kept in service on the west coast [should] continue to be entertained at public expense' (Stevenson 1982: 9). Shortly afterwards the Committee issued Letters of Marque to two ships and a galley of which a draft survives, with blanks for the names of the ships and their captains to be inserted:

> The ship called the [*blank*], of which [*blank*] is master, is employed by the estates for guarding the west coast and stopping supplies being sent to the enemy. The ship may encounter frigates and other vessels of these covenanted kingdoms; thereby the committee hereby warrants [*blank*] to provide the ship with men, victual, cannon, and other warlike equipment, for defence and to pursue such frigates and other vessels, goods, or whatever else belongs to the common enemy. [*blank*] has hereby full warrant, power, and commission to pursue, sink and destroy the common enemy, seizing their goods and making them lawful prizes. He shall receive orders from the marquess of Argyll, and shall be accountable for what he takes as others have been in this work. The commission is to last six months, and those employed by [*blank*] in this service shall be allowed as part of the present levy (Stevenson 1982: 42).

Though the names of these vessels are missing, it is quite likely that one of them was Argyll's *Swan*. If so, an intriguing question arises. The reconstruction of the Duart Point wreck's decorated stern (Illus 147) strongly suggests that the ship bore the Stewart royal arms, while the associated badge of the Heir Apparent indicates that the monarch concerned was Charles I, since Charles II did not have a direct male heir. If *Swan* was a private warship belonging to Argyll the link with the crown must be explained. Argyll's loyalties were complex. On the one hand he was a royalist and unionist, anxious to reinforce his territorial and political power within a greater Britain. On the other he was implacably opposed to Charles I's religious autocracy, especially the imposition of episcopacy and the Book of Common Prayer over Scotland's established Presbyterian church. As a leading Covenanter he had been in rebellion against the crown during the Bishops' Wars of 1639–40, but had reached an accommodation with the king and a year later, when Charles came to Edinburgh to concede virtually all the Covenanters had demanded, Argyll was created a marquess. This rapprochement – though suspicion and enmity remained on both sides – might well have resulted in the application of the royal arms to Argyll's frigate.

When and where this ship was built is not known, but it seems certain that she was strongly influenced by contemporary Dutch practice and the 'Dunkirk frigate' philosophy described above. Her close dimensional similarity to the 1628 *Lion's Whelps* is striking, though her lighter build and much lighter armament suggests that her design, if influenced by the *Whelps*, was modified in the knowledge of their shortcomings, which by *c* 1640 must have been glaringly evident.

Swan as reconstructed from her remains seems to have been designed specifically for the conditions of Scotland's western seaboard. In this respect she may perhaps be seen as a 'super-*bírlinn*', intended to meet the changing requirements of naval force in the area during the second quarter of the 17th century. As such, and by then in the service of the Commonwealth navy, she was well-suited to the 1653 campaign. Its aims were to establish forts on Orkney and Lewis, reduce the Mackenzie strongholds at Stornoway and Eilean Donan, invade Skye to neutralise the Macleods, and land troops and artillery on Mull to seize and occupy the Maclean stronghold of Duart. The ship may be categorised as a mobile gun-platform, troop-transport, bulk-carrier, reconnaissance craft, and fast dispatch boat, her capacity to operate in adverse winds or currents enhanced by auxiliary oar-power. Her broad bottom provided good cargo capacity and an ability to beach in remote locations. Grounded at low tide on any convenient shore she could load or unload without harbour facilities, like the smacks and puffers of later eras.

A parallel for Swan's unusual disposition of guns and oars (pp 155–6, Illus 214) is provided by the much larger 493-ton *Charles Galley* of 1676 (Endsor 2008). She is depicted in almost-photographic detail on a panel painted by Willem van de Velde the Younger for the cabin decoration of Charles II's yacht *Charlotte*, launched in 1677. Its accuracy is confirmed by van de Velde's graphite and wash portrait of the same ship (National Maritime Museum, Greenwich, PA17276). Though *Charles Galley* was nominally a 4th-rate with two gun-decks mounting a total of 32 pieces, 22 are shown on the upper deck. The remaining ten are disposed at either end of the lower deck, leaving the entire midships area clear for rowing banks, 20 on each side. Apart from an additional two forward-firing guns, reflecting her greater beam, *Charles Galley*'s lower gun-deck was arranged in just the same way as archaeological evidence suggests for *Swan*'s single gun-deck. It implies an intended predatory (or anti-predator) capability, and it is surely no coincidence that *Charles Galley* was designed to counter Barbary corsairs in the Mediterranean (Endsor 2008: 269).

These characteristics allowed her, when necessary, to sustain herself from local resources, just as a chief's progressions through his maritime dominions in earlier times depended on 'sorning' (see Chapter 1.1). Manifestations of predatory behaviour are seen in the evidence of the animal and fish bones, the hand-mill, the acquisition of Mackenzie-owned pewter, the high-quality Scottish pistol and the presence of a touchstone, with which the values of confiscated precious metals might quickly be assessed. Similar idiosyncrasies in material cultural assemblages have been applied to the recognition of sites associated with predation or piracy (Skowronek & Ewen 2006; Ewen & Skowronek 2016).

A vessel of this type could probably engage in such activities for sustained periods without shore-based support, being careened when necessary on any convenient beach. She would from time to time require more extensive overhauls, for which facilities existed at Dumbarton and Ayr. The bulk of her crew could no doubt have been obtained locally – seamen familiar with the operation of *bírlinns* would readily adapt to the tasks of working a three-masted rig, while they would have been bred to rowing and fighting. But operating the guns would have required more specialised training and experience, as would some of the executive functions on board, and these duties may have called for suitably qualified outsiders. Her captain in 1644, James Brown, was clearly not a Highlander, while her skipper at the time of her demise was a Liverpudlian, and at least one of his crew came from Yorkshire.

Ships and guns provided a means of transporting latent violence over distance, and of applying it with focused precision. It was as effective in the limited theatre of the Irish Sea and Scotland's Atlantic seaboard as it was on the global scale by which Europe's maritime nations were creating and controlling their world empires. Whatever *Swan*'s origins, her design and equipment appear to reflect an intention to project force and influence among the labyrinthine seaways of Scotland's politically unstable and frequently warring Highlands and Islands. In the mixed loyalties and partisan interests surrounding the Covenanting movement, the Bishops' Wars, the wider civil conflicts of the 1640s, the execution of Charles I, and the Cromwellian invasion of Scotland, *Swan* appears to have played significant roles for more than one side.

In conclusion, this project has drawn together a multiplicity of evidence from several sources and disciplines to create a three-dimensional hypothesis which reconstructs, from the deconstructed chaos of a wreck, the reality of a ship and her people as an organised entity within a sharply focused historical context.

Appendix 1

THE MOST SIGNIFICANT SHIPS MENTIONED FOR COMPARISONS

Name	***Built***	***Lost***	***Nationality***	***Warship***	***Merchant***	***Location***	***Chapters***	***Comparison***
Adelaar	1722	1728	Dutch		VOC	Barra, Outer Hebrides, Scotland	8	part of pocket-watch
Batavia	1628	1629	Dutch		VOC	Houtman Abrolhos, Western Australia	7, 8, 9	survival of tampions, iron corrosion, cartridge-box, case-shot, lead bullets, pewter bottle-top, Frechen stoneware
La Belle	1684	1686	French		45-ton barque longue, voyage of exploration	Matagorda Bay, Texas	5, 8	anchor-cable, lead bullets, powder-boxes
Dartmouth	1655	1690	British	5th-rate, 32 guns		Sound of Mull, Inner Hebrides, Scotland	1, 3–4	location, cycles of burial and exposure, construction
H L Hunley	1863	1864	American	submarine		Charleston, South Carolina, USA	4	corrosion and currents
Invincible	1744	1758	British	74-gun		Solent	6, 7, 9	pumps, cartridge-boxes, brush
Kennemerland		1664	Dutch		VOC	Out Skerries, Shetland, Scotland	9	pewter bottle-top, Frechen stoneware
Kronan	1668	1676	Swedish	124 guns		Öland, Baltic	5, 8, 9	cherub, compass-box lid, pewter bottle-top
Lastdrager	bought 1648	1653	Dutch		VOC	Yell, Shetland, Scotland	9	pewter bottle-top, Frechen stoneware
de Liefde	1698	1711	Dutch		VOC	Out Skerries, Shetland, Scotland	8, 9	sword hilt, pewter bottle-top
Lion's Whelps	from 1628		English	small (120-ton) warships with auxiliary oars			5, 7	rowing arrangements, use of drakes
London	1656	1665	English	3rd-rate		Thames Estuary, England	9	latchet shoe
Machault	1757	1760	French	32-gun frigate		Restigouche, Canada		pumps

Name	***Built***	***Lost***	***Nationality***	***Warship***	***Merchant***	***Location***	***Chapters***	***Comparison***
Mary Rose	1509	1545	English	700-ton			4, 5, 6, 7, 8, 9, 10	wreck-formation processes, gun-port lids, fish bones, parrel assembly, gun mounting, case-shot, compass-box and lid, chest and chest-handles, bobbins, brush, grindstone, wooden spoon, staved vessels, lantern parts, leather box/book cover
Mingary Castle wreck		1644?	Unknown			Mingary Castle, Ardnamurchan, Scotland	6, 9	copper-alloy kettle, Frechen stoneware
Pandora	1779	1791	British	frigate		Great Barrier Reef, Australia		pocket-watch
San Juan		1565	Basque		whaling	Red Bay, Labrador	8	binnacle
Santo Christo de Castello		1667					9	pewter bottle-top
Sovereign of the Seas	1637	1697	English	102 guns			4, 7	curved widow top, transom carvings, bronze drakes, gun carriages
Stinesminde		*c* 1640			merchant	N Jutland	8	windlass, binnacle
Susan Constant	1605		English		colonial merchantman		5	hull-shape, lowered floor of stern cabin, mizzenmast
La Trinidad Valencera		1588	Venetian	in Spanish Armada	grain-ship	Kinnagoe Bay, Donegal, Ireland	3, 9	lantern parts
Vasa	1628	1628	Swedish	yes		Stockholm harbour, Sweden	4, 5, 7, 8, 9	wreck-formation processes, quarter-gallery, curved window top, hawse-holes, transom carvings, gun-port lids, mizzenmast, gun mounting, cartridge-box, lead bullets, staved butter tub
Vergulde Draeck	bought 1652–3	1656	Dutch		VOC	Western Australia	6, 7, 8, 9	kettle, iron corrosion, powder-boxes, pewter bottle-top, Frechen stoneware
Yarmouth Roads		16th c				Solent	9	lantern parts
Zuytdorp	1701	1712	Dutch		VOC	Western Australia	7	survival of tampions, iron corrosion

GLOSSARY

Acanthus A decorative feature of spiny leaves

Aft Towards the stern end of a ship

Athwartships Across the hull

Ballast Heavy material (not cargo) placed low in the hold to improve the stability of a ship

Beakhead A projecting structure forward of the forecastle

Bilge That part of a ship's hull on which it would rest when grounded

Binnacle (or Bittakle) A wooden cupboard for housing the ship's compasses and other navigational equipment, set in front of the steersman

Bírlinn Generic Scots Gaelic term for a West Highland galley; specifically a one-masted vessel with 12–18 oars

Block A device for obtaining mechanical advantage, incorporating a pulley or sheave in a wooden shell, which rotates on a pin. The two sides of the shell are bound together or seized with a rope band called a strop, and to prevent this slipping the sides of the shell are grooved with scores. Blocks may contain single or multiple sheaves according to their function

Booge (also bouge or bilge) The widest part of a barrel stave and of the whole barrel

Bowsprit A pole projecting over the stem to carry a spritsail. It was also used to secure other elements of rigging

Bulkhead A partition, usually set athwartships

Butt-joint A simple joint between two planks, the squared ends of which butt together

Cable A thick rope made up of three strands of hawser-laid rope. Generally used for anchoring

Cable Tier A place in the hold where cables are coiled

Cames H-sectioned lead strips which hold together the small pieces of glass (quarries) in a leaded window

Cant The curved side-piece of a barrel-end (filling pieces between the cants are known as 'head-pieces')

Capsquare A hinged iron bar which locked the trunnions of a gun into its carriage

Capstan A mechanical arrangement which provided a pulling force on ropes. It consisted of a horizontal circular head with square holes around its edge into which bars could be inserted so that a team of men could rotate the device. Beneath was a perpendicular barrel around which was wound the rope (usually an anchor cable) to which pull is to be applied

Cat-Hole A round opening in the stern through which an anchor cable may be passed

Ceiling An internal lining of planks in the lower part of the vessel

Chain-Plate An iron strap bolted to a ship's side to which the shroud and deadeye assemblies are fastened

Chock An angular block of wood used to fill areas between timbers or to separate them

Claque The leather sealing element in a pump-valve

Costrel A personal drink container of wood or leather, usually slung on a strap or cord

Crank A vessel is said to be crank when her balance is unstable, causing her to heel excessively in a light breeze or when, for want of ballast, she is in danger of oversetting. See stiff

Crogan (pl *crogain*) – Scots Gaelic, vernacular hand-built pottery from western Scotland

Currach Gaelic *curach*, a type of boat consisting of animal skins stretched over a light wicker or lath framework. It has been used on the Atlantic seaboards of Ireland and Britain since antiquity

Dalriada An early historic kingdom in present-day Antrim which spread to the south-west Scottish Highlands about AD 500. 'Dalradian' (note spelling) is used by geologists to describe a rock-type in the region

Deck-Beam Transverse timber spanning the hull athwartships to support the deck and tie the sides together

Deadeye Flat tear-shaped piece of wood, pierced by three holes for thin ropes called lanyards. A groove round the outer edge allows a strop to be seized around it. Deadeyes are rigged in opposing pairs for tensioning and generally employed as blocks connecting the shrouds with the chain-plates

Deadwood Pieces of timber assembled on top of the keel, usually towards the extremities of the hull, to fill the narrowing and rising parts of a hull

Deadwood-Knee A knee placed within the deadwood to support the sternpost

Drake A short gun with a tapered chamber

Dunnage Packing of loose wood or other material to protect the hull and secure cargo in the hold

English Foot 0.305m

English Pint 569ml

Entry The hydrodynamic characteristics of a hull's submerged forward part

Euphroe A long piece of wood pierced by a line of holes to allow the rigging of a crowfoot, usually for attaching stays to a topmast

Floor-Timber A frame that crosses the keel and spans the bottom of a hull between the bilges

Forecastle The forward upper deck, below which the galley was situated (pronounced 'fokes'l')

Forelock A small iron wedge driven through a slot at the end of a bolt to secure it

Foremast The mast nearest the bow of a vessel

Forward (pronounced 'forrard') Towards the bow of a ship

Frame A transverse timber or assembly of timbers which describes the body-shape of a vessel, and to which planking and ceiling are fastened

Futtock (lit. 'foot hook') A frame-timber other than a floor- or top-timber. Sequenced 'first' 'second', etc

Girdling Additional planking fitted around the waterline to bulk out the beam. A corrective measure to stiffen a crank ship

Gudgeon Iron brace with eye, bolted onto the sternpost, in which the rudder pintles were hung

Gripe A curved piece linking the forward end of the keel to the rising stempost

Hawse-Holes Round ports at the bow and stern through which an anchor cable could pass

Hawser-Laid Rope A rope laid (wound) in three strands (cf cable)

Heir Apparent The Heir Apparent to the British throne can only be displaced from succession by his death. The Heir Presumptive is the next in line to succession subject to the reigning monarch not producing legitimate issue. Only the Heir Apparent can bear the coronet and ostrich-feathers badge

Home-Bored A gun barrel with a parallel bore from muzzle to breech

Inboard Towards the inner part of a vessel

Joiner's Dog A metal staple with wedge-shaped points used to pull tight and secure two pieces of wood. Often used to repair cracks

Keel The main longitudinal timber of a hull, to which the frames, deadwoods, and the stem- and stern-posts were attached

Keelson An internal longitudinal timber mounted on top of the frames along the centreline of the keel

Knee An angled timber used to reinforce the junction of two components, usually made from the crotch of a tree where two branches joined, or where a branch or root joined the trunk

Ledges Short transverse timbers associated with the structure supporting a deck

Limber-Boards Short lengths of loose ceiling-planks set on either side of the keelson, which can be removed to clear the limbers

Limber-Holes Longitudinal holes cut through the floor-timbers on either side of the keelson to allow water to flow towards the pump-well

Lymphad (Gaelic *long-fada*) Lit. 'long-ship', normally described as a galley with one mast and 18–20 oars (cf *bírlinn*)

Mainmast The central mast in a three-masted rig

Mast-Step The morticed timber into which the heel of a mast is stepped. Main- and foremast steps were generally bolted to the keelson, either longitudinally or transversely

Master-Frame The broadest frame in the hull, not necessarily in the mid-position

Moulded Dimension The measurement across a timber face to which a mould (curvature guide) would be laid, therefore generally at right-angles to the keel

Midships The central part of a ship

Mizzen Mast The aftermost mast in a three-masted rig

Minion A small muzzle-loading gun throwing an iron ball of *c* 4lbs

Mortice The housing cut for a tenon in a mortice-and-tenon joint

Muntin Interior vertical component of framed panelling

Nulling Ornamental grooves cut in decorative carving

Orlop The lowest deck of a ship

Outboard Towards or beyond the outer part of a ship

Palladian A neo-classical style of architecture associated with the Italian architect Andrea Palladio (1508–80)

Parrel An assembly of wooden rollers (trucks) and vertical ribs which reduced friction when raising or lowering the yard on a mast

Pintles A line of iron pins attached to the forward edge of a rudder which fitted into the gudgeons (eyes) strapped to the sternpost

Port The left-hand side of a ship looking forward

Pouch A board used to stabilise loose ballast and prevent it shooting sideways when the ship heels

Pound (avoirdupois) 0.454kg

Quarterdeck The upper deck aft of the mainmast

Quarter-Gallery A covered projection with windows on the stern quarter of the great cabin

Rabbet (lit. 'rebate') A groove made in a piece of timber so that the edge of another piece can fit into it

Rail Horizontal component of framed panelling

Rear-Chock Carriage A ship's gun-carriage with rotating trucks or wheels at the front and two fixed projections with flattened bottoms at the rear. These generated friction against the deck when the gun recoiled and so helped to restrain it

Ribband A flexible strip of wood used as a temporary guide to control the hull shape during construction by nailing it to the extremities and across one or more standing frames

Room-and-Space The distance from the moulded edge of one frame to the corresponding point on the adjoining one, usually measured at or near the keelson. That part occupied by the frame is called the room, while the open distance between it and the adjoining frame is the space

Run The narrowing underwater shape of a hull as it tapers towards the stern. A fine run ensures good hydrodynamic characteristics. cf 'entry'

Rung Heads (sometimes 'wrong heads') The head, or extremity, of a floor-timber

Rutter A set of instructions for route-finding at sea

Saker A muzzle-loading gun throwing an iron ball of approximately 5 pounds

Scarf (or Scarph) Joint An overlapping diagonal joint used to connect two longitudinally adjoining timbers or planks without increasing their thickness

Scots Pint Liquid measure of 1.696 litres or about three Imperial pints

Shallop A large oared boat, usually masted

Sheathing A thin outer covering of wood often under-laid with pitch and hair to protect a hull from marine life or fouling

Sided Dimension The measurement of a timber face which takes a curve, therefore generally fore-and-aft, parallel to the keel

Skeg The aft end of a keel

Sprue Spigot scar, where any excess metal left in the channel where molten metal was poured into a mould was cut off, but not flush with the main body of the moulded object

Starboard The right-hand side of a ship looking forward

Stempost The upwardly curving bow-timber rising from the forward end of the keel

Sterncastle The aft upper decks

Sternpost The timber rising from the aft end of the keel

Stiff A ship is said to be stiff when she is well-ballasted and stable, cf 'crank'

Stile Side component of framed panelling

Strake A continuous run of planks running from bow to stern

Tackle (pronounced 'taykel') An assembly of blocks and ropes, usually to facilitate lifting or pulling

Tapered Chamber A tapered reduction at the chamber end of a smooth-bored gun which effectively thickens and strengthens that part of the barrel where pressure stresses are greatest without increasing the outer circumference of the piece. In this way much weight is saved. This feature defines the 'drake' type of gun

Tenon The tongue of wood that fits into a mortice to make a mortice-and-tenon joint

Top-Timber The upper timber in a sequence of floors and futtocks which constitute a single frame

Transom A flat upper stern, often decorated

Transom-Beam A transverse timber associated with the framing of a transom

Treenail (also trenail, trunnel) A wooden dowel used to connect planks and timbers

Truck The solid wheel of a shipboard gun-carriage

Trunnions A pair of cylindrical pivots set on either side of a piece of artillery by which the gun is secured to its carriage. They are usually set just behind the centre of balance so that the gun rests lightly on its breech but is easily elevated or depressed

Tympanum The semi-circular element above a window or door

Wale A thick strake located along the side of a vessel

Waist The middle upper part of a ship, between the sterncastle and forecastle

Whipstaff A mechanical device for operating the rudder by attaching a pivoted lever to the end of a tiller

Windlass A machine consisting of a horizontally mounted drum with slots around its ends for removable levers, used to provide a pulling force on ropes. It is more compact but slower to operate and less powerful than a capstan

BIBLIOGRAPHY

Abbreviations

BAR	British Archaeological Reports
CBA	Council for British Archaeology
CSPD	*Calendar of State Papers: Domestic*
CSPS	*Calendar of State Papers: Scotland*
ECA	Edinburgh City Archives
HES	Historic Environment Scotland, the result of a merger between HS and RCAHMS
HMSO	Her Majesty's Stationery Office
HS	Historic Scotland (now Historic Environment Scotland)
NMS	National Museums Scotland
OED	*Oxford English Dictionary*
RCAHMS	Royal Commission on the Ancient & Historical Monuments of Scotland (now Historic Environment Scotland)
TNA	The National Archives, Kew

Manuscript Sources

Historic Environment Scotland, Edinburgh

ADU archive

Dr Colin and Dr Paula Martin Collection

Liverpool Record Office

Tarleton Papers, 920 TAR, photostat copies of the Tarleton family papers belonging to and in the care of Mrs H M Fagan, of Gerrard's Cross, Bucks; 6 volumes

The National Archives, Kew

ADM Admiralty Papers

SP State Papers

WO War Office

Worcester College, Oxford

msxxv f129r, William Clarke's shorthand notes, transcribed by Dr Frances Henderson, August 2005

Printed Primary Sources

Anderson, A O & Anderson, M O (transl & eds) 1961 *Adomnán's Life of Columba*. London & Edinburgh: Thomas Nelson.

Calendar of State Papers Domestic, *1652–53*, M A E Green (ed), 1878. London: HMSO.

Calendar of State Papers Domestic, *1653–54*, M A E Green (ed), 1879. London: HMSO.

Calendar of State Papers Domestic, *1654*, M A E Green (ed), 1880. London: HMSO.

Calendar of State Papers Domestic, *1655*, M A E Green (ed), 1881. London: HMSO.

Carey, H (ed) 1842 *Memorials of the Great Civil War in England from 1646 to 1652, edited from original letters in the Bodleian Library*, vol 1. London.

The Diary of John Evelyn, W Bray (ed) 1901, 2 vols. Washington & London: Walter Dunne.

'Diurnal of Occurences in Scotland', 1845, in J Maidment (ed) *The Spottiswoode Miscellany*. Edinburgh: Spottiswoode Society.

Firth, C H 1895, *Scotland and the Commonwealth: Letters and Papers Relating to the Military Government of Scotland from August 1651 to December 1653*. Edinburgh: Scottish History Society.

Letters & Papers, Henry VIII, J S Brewer (ed) 1867, vol 3, 1519–1523. London: HMSO.

Report on the Manuscripts of F W Leyborne-Popham of Littlecote, Wiltshire, 1899. Historical Manuscripts Commission: HMSO.

Mercurius Politicus: *comprising the summe of all intelligence, with the affairs, and designs now on foot, in the three nations of England, Ireland, and Scotland 1650–1660*. London.

Register of the Privy Council of Scotland 1877–1970, J Hill Burton (ed). Edinburgh: General Register House.

Thurloe State Papers: a Collection of the State Papers of John Thurloe, vol 1, 1638–1653, T Birch (ed) 1742, http://www.british-history.ac.uk/source.aspx?pubid=609&page=2&sort=1

Secondary Sources

Abbasi, H R, Bazdar, M & Halvaee, A 2007 'Effect of Phosphorous as an Alloying Element on the Microstructure and Mechanical Properties of Pearlitic Gray Cast Iron', *Materials Science and Engineering A* 444: 314–17.

Abbott, M 1989 *Green Woodwork: Working with Wood the Natural Way*. Lewes: Guild of Master Craftsmen.

Adams, J 2013 *A Maritime Archaeology of Ships*: *Innovation & Social Change in Medieval and Early-Modern Europe*. Oxford: Oxbow.

Adams, J & Rönnby, J 2013 'One of His Majesty's "Beste Kraffwells": the wreck of an early carvel-built ship at Franska Sternnana, Sweden', *International Journal of Nautical Archaeology* 42.1: 103–17.

Admiralty Chart 2390 1976. UK Hydrographic Office.

Admiralty Manual of Seamanship vol 1 1972 edn. London: HMSO.

Admiralty Manual of Seamanship vol 3 1964 edn. London: HMSO.

Adnams, J R 1974 'The *Dartmouth*, a British Frigate wrecked off Mull: an Interim Report', *International Journal of Nautical Archaeology* 3.2: 269–74.

Allsop, D & Foard, G 2008 'Case shot: an interim report on experimental firing and analysis to interpret early modern battlefield assemblages', in T Pollard & I Banks (eds) *Scorched Earth: Studies in the Archaeology of Conflict:* 111–46. Leiden: Brill.

Almgren, B (ed) 1975 *The Viking*. Gothenburg: Nordbok.

American Society for Metals 1983 *Metals Reference Book*. 2nd edn. Metals Park, Ohio.

Amman, J & Sachs, H 1973 *The Book of Trades (Ständebuch),* 1568 edn transl & ed. B Rifkin. New York: Society for the Promotion of Science & Scholarship.

Anderson, R C 1947 'Eighteenth-century books on shipbuilding', *Mariner's Mirror* 33: 218–25.

Asquith, S 1981, *New Model Army, 1645–60*. London: Osprey.

Baillie, G H 1929 *Watches: their history, decoration and mechanism*. London: Connoisseur's Library.

Baker, J & Brothwell, D 1980 *Animal Diseases in Archaeology*. London: Academic Press.

Barker, P 1977 *Techniques of Archaeological Excavation*. London: Batsford.

Barrett, J H 1997 'Fish Trade in North Orkney and Caithness: a Zooarchaeological Approach', *Antiquity* 71: 616–38.

Barrow, G 1981 *Kingship and Unity: Scotland 1000–1306*. London: Edward Arnold.

Bartlett, J 1970 'North Walls Excavation', *Kingston upon Hull Museums Bulletin* IV: 1–23.

Bascom, W 1976 *Deep Water, Ancient Ships: The Treasure Vault of the Mediterranean*. Newton Abbot: David & Charles.

Bass, G F 1966 *Archaeology Under Water*. London: Thames & Hudson.

Batchvarov, K N 2007 '*Dartmouth* Revisited', *International Journal of Nautical Archaeology* 36.2: 344–52.

Baugh, D 1965 *British Naval Administration in the Age of Walpole*. Princeton: Princeton University Press.

Bax, A & Martin, C J M 1974 '*De Liefde*: A Dutch East Indiaman lost on the Out Skerries, Shetland, in 1711', *International Journal of Nautical Archaeology* 3.1: 81–90.

Bell, L S, Lee-Thorp, J A & Elkerton, A 2009 'The sinking of the *Mary Rose* warship; a medieval mystery solved?', *Journal of Archaeological Science* 36: 166–73.

Besly, E 1992 'The English Civil War Mints at Truro and Exeter', *British Numismatic Journal* 62: 102–53.

Biggs, N & Withers, P 2000, *Lead Weights: the David Rogers Collection*. Llanfyllin, Powys: White House Publications.

Bingeman, J M 2010 *The First HMS* Invincible *(1747–58): her excavations (1980–1991)*. Oxford: Oxbow.

Binning, T 1676 *A Light to the Art of Gunnery*. London: John Darby.

Black, S 2005 Analysis of the skeletal remains associated with the 'Swan', Duart Point, Mull, unpublished report, Dr Colin and Dr Paula Martin Collection, HES.

Blackmore, H L 1976 *The Armouries of the Tower of London*. London: HMSO.

Boothroyd, G 1981 'The Birth of the Scottish Pistol', in D Caldwell (ed) *Scottish Weapons and Fortifications, 1100–1800*: 315–38. Edinburgh: John Donald.

Bound, M 1998 'A wreck off Alderney from the late Elizabethan period', in M Bound (ed) *Excavating Ships of War*: 64–83. Oswestry: Anthony Nelson.

Bowens, A (ed) 2009 *Underwater Archaeology: The NAS Guide to Principles and Practice*. Oxford: Blackwell.

Brinck, N 1996 'The Wreck at Terschelling', *Ordnance Society Newsletter* 34: 8–10.

Brinkhuizen, D C 1994, 'Some Notes on Fish Remains from the Late 16th Century Merchant Vessel *Scheurrak SO1*', in W Van Neer (ed) *Fish Exploitation in the Past: Proceedings of the 7th Meeting of the ICAZ Fish Remains Working Group*: 197–206. Tervuren: Musée Royale de l'Afrique Centrale.

Britten, F J 1904 *Old Clocks and Watches and their Makers*. 2nd edn. London: Batsford.

Bruseth, J E (ed) 2014 La Belle: *the Ship that changed History*. College Station TX: Texas A&M University Press.

Bruseth, J E & Turner, T S 2005, *From a Watery Grave: the Discovery and Excavation of La Salle's Shipwreck,* La Belle. College Station TX: Texas A&M University Press.

Burt, E 1754 *Letters from A Gentleman in the North of Scotland to His Friend in London*. 2 vols. London (facsimile edn 1974. Edinburgh: John Donald).

Butler, V L 1993 'Natural Versus Cultural Salmonid Remains: Origins of the Dalles Roadcut Bones, Columbia River, Oregon, USA', *Journal of Archaeological Science* 20: 1–24.

Caldwell, D 1991 'Tantallon Castle, East Lothian: a catalogue of the finds', *Proceedings of the Society of Antiquaries of Scotland* 121: 335–57.

Caldwell, D 2014 'The Lordship of the Isles: Identity Through Materiality', in R D Oram (ed) *The Lordship of the Isles*: 227–53. Leiden: Brill.

Cameron, J 1998 *James V: the Personal Rule, 1528–1542*. Edinburgh: Tuckwell Press.

Campbell, Alastair of Airds 2002 *A History of Clan Campbell, Vol 2: From Flodden to the Restoration*. Edinburgh: Edinburgh University Press.

Campbell, F C 2008 *Elements of Metallurgy and Engineering Alloys*. American Society of Metals International.

Capp, B 1989 *Cromwell's Navy: The Fleet and the English Revolution, 1648–1660*. Oxford: Oxford University Press.

Carlton, C 1992 *Going to the Wars: The Experience of the English Civil Wars, 1638–1651*. London: Routledge.

Carpenter, J & MacLeod, I D 1993 'Conservation of Corroded Iron Cannon and the Influence of Degradation on Treatment Times', *ICOM-Committee for Conservation, Preprints 10th Triennial Conference*, Vol. II, Washington: 759–66.

Carpenter, J, Pigott, L & Whitwell, H 1985 'A watch from HMS *Pandora*', *Antiquarian Horology* 15: 560–601.

Caruana, A 1994 *The History of English Sea Ordnance 1523–1875. Vol I: The Age of Evolution*. Rotherfield: Jean Boudriot Books.

Cederlund, C O 2006 Vasa *I: The Archaeology of a Swedish Warship of 1628*. Stockholm: National Maritime Museum of Sweden.

Chaplin, R E 1971 *The Study of Animal Bones from Archaeological Sites*. London: Academic Press.

Chapman, F H af 1768 *Architectura Navalis Mercatoria*. Translated facsimile edn 1971, London: Adlard Coles.

Cheape, H 1988 'Food and Liquid Containers in the Hebrides: a Window on the Iron Age', in A Fenton & J Myrdal (eds) *Food and Drink and Travelling Accessories: Essays in Honour of Gosta Berg*: 6–27. Edinburgh: John Donald.

Cipolla, C 1965 *Guns and Sails in the Early Phase of European Expansion, 1400–1700*. London: Collins.

Cochran, M D & Beaudry, M C 2006 'Material Culture Studies and Historical Archaeology', 191–204, in D Hicks & H Beaudry (eds) *The Cambridge Companion to Historical Archaeology*. Cambridge: Cambridge University Press.

Connor, R D, Simpson, A D C & Morrison-Low, A 2004, *Weights and Measures in Scotland: A European Perspective*. Edinburgh: National Museums Scotland.

Corbett, J S 1905 *Fighting Instructions: 1530–1816*. London: Navy Records Society 29.

Cotter, J L 1958 *Archaeological Excavations at Jamestown, Virginia*. National Parks Service Archaeological Research Series no 4, Washington.

Coy, J 2005 'Meat: the bone evidence', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose: 564–77. Portsmouth: Mary Rose Trust.

Crawford, B E 1987 *Scandinavian Scotland*. Leicester: Leicester University Press.

Crawforth-Hitchins, D 2005a 'Empty box for a coin scale', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose, 260–1. Portsmouth: Mary Rose Trust.

Crawforth-Hitchins, D 2005b 'Weights and Measuring Devices', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose, 330–4. Portsmouth: Mary Rose Trust.

Cronyn, J M 1990 *The Elements of Archaeological Conservation*. London: Routledge.

Crossley, D 1975 'Cannon Manufacture at Pippingford, Sussex: the excavation of two iron furnaces of *c* 1717', *Post-Medieval Archaeology* 9: 1–37.

Cunliffe, B, 2001, *Facing the Ocean: the Atlantic and Its Peoples, 8000 bc to ad 1500*. Oxford: Oxford University Press.

Dalgleish, G & Fotheringham, H S 2008 *Silver Made in Scotland*. Edinburgh: National Museums Scotland.

Davey, P J 1997, 'Clay Pipes', in M J Rains, D W Hall, F Moran & D Munro (eds) *Excavations in St Andrews 1980–89: a Decade of Archaeology in a Historic Scottish Burgh:* 94–9. Glenrothes: Tayside & Fife Archaeological Committee.

Davies, P S 2014 *Scottish Pewter 1600–1850.* Edinburgh: John Donald.

Davies, P, Dalgleish, G & Lamb, D 2012 'The Early Evolution of the Tappit Hen', *Proceedings of the Society of Antiquaries of Scotland* 141: 279–92.

Dekker, T 1608 *The Belman of London: bringing to light the most notorious villainies that are practised in the Kingdome*. London.

Dictionary of the Scots Language online, www.dsl.ac.uk.

Dodgshon, R A 1998 *From Chiefs to Landlords: Social and Economic Change in the Western Highlands and Islands, c 1493–1820*. Edinburgh: Edinburgh University Press.

Dow, F 1979 *Cromwellian Scotland*. Edinburgh: John Donald.

Driesch, A von den 1976 *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Harvard: Peabody Museum Bulletin No 1.

Dufty, A 1974 *European Swords and Daggers in the Tower of London*. London: HMSO.

Eames, 1961 'The King's Pinnace, the *Swan*, 1642–1645', *Mariner's Mirror* 47: 49–55.

Earwood, C 1991 'Two Early Historic Bog Butter Containers', *Proceedings of the Society of Antiquaries of Scotland* 121: 231–40.

Edwards, L J 1986 Tobacco Pipes, Pipemakers, and Tobacconists in Newcastle and Gateshead until *c* 1800: an archaeological study, unpublished MA dissertation, Durham University, http://etheses.dur.ac.uk/6882/.

Edwards, L J 1988 (P Davey ed) *The Archaeology of the Clay Tobacco Pipe. XI. Seventeenth and Eighteenth Century Tyneside Tobacco Pipe Makers and Tobacconists*. BAR British Series 192, Oxford.

Eldred, W 1646 *The Gunner's Glasse*. London.

Ellison, B & Harbottle, M 1983 'The excavation of a 17th-century Bastion in the Castle of Newcastle-upon-Tyne, 1976–81', *Archaeologica Aeliana*, 5th ser 11: 135–263.

Emeleus, C H 2005 *The Palaeogene Volcanic Districts of Scotland* (4th edn). Nottingham: British Geological Survey.

Endsor, R 2008 'The van de Velde Paintings for the Royal Yacht *Charlotte*, 1677', *Mariner's Mirror* 94.3: 264–75.

Endsor, R 2009 'The Rigging', in P Marsden (ed) Mary Rose: *Your Noblest Shippe: Anatomy of a Tudor Warship* (Archaeology of the *Mary Rose* Vol 2): 251–72. Portsmouth: Mary Rose Trust.

Eriksson, N 2014 *Urbanism Under Sail*. Sweden: Södertörn University.

Erwin, D & Picton, P 1987 *Guide to Inshore Marine Life*. London: Marine Conservation Society.

Every, R 2005 'Sewing', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose: 327–30. Portsmouth: Mary Rose Trust.

Ewen, C R & Skowronek, R (eds) 2016 *Pieces of Eight: More Archaeology of Piracy*. Gainesville: University Press of Florida.

Falconer, W 1780 *An Universal Dictionary of the Marine*. Facsimile of 4th edn 1970. Newton Abbot: David & Charles.

Fenton, A 1978 *The Northern Isles: Orkney and Shetland*. Edinburgh: John Donald.

Fenton, A 1999 'Peat Cutting in the Crombie Moss, Banffshire', *Review of Scottish Culture* 12: 124–7.

Fergusson, J 1951 *Argyll in the Forty-Five*. London: Faber & Faber.

Ffoulkes, C 1937 *The Gun-Founders of England*. Cambridge: Cambridge University Press.

Firth, C H 1926 'Sailors of the Civil War, the Commonwealth and Protectorate', *Mariner's Mirror* 12: 237–59.

Firth, C H 1992 *Cromwell's Army* (reprint of the 1st edn (1902) with a new introduction by John Adair). London: Greenhill Books.

Firth, C H & Davies, G 1940 *The Regimental History of Cromwell's Army*. 2 vols. Oxford: Oxford University Press.

Fisher, I 2004 'The Early Christian Period', in D Omand (ed) *The Argyll Book*: 71–84. Edinburgh: Birlinn.

Foard, G nd The Lead Bullets Recovered from The *Swan*, unpublished report, Dr Colin and Dr Paula Martin Collection, HES.

Foard, G 2012 *Battlefield Archaeology of the English Civil War*. BAR British Series 570, Oxford: Archaeopress.

Forsyth, H 2013 *London's Lost Jewels: The Cheapside Hoard*. London: Museum of London.

Foster, S M 1996 *Picts, Gaels and Scots*. London: Batsford.

Foster, W A & Higgs, K B 1973 'The *Kennemerland*, 1971: an Interim Report', *International Journal of Nautical Archaeology* 2.2: 291–300.

Fox, R & Barton, K J 1986 'Excavations at Oyster Street, Portsmouth, Hampshire, 1968–71', *Post-Medieval Archaeology* 20: 31–255.

Fraser, G MacDonald 1989 *The Steel Bonnets*. London: Harper Collins.

Freeth, T, Bitsakis, Y, Moussas, X, Seiradakis, J, Tsellikas, A, Mangou, H, Zafeiropoulou, M, Hadland, R, Bate, D, Ramsey, A, Allen, M, Crawley, A, Hockley, P, Malzbender, T, Gelb, D, Ambrisco, W & Edmunds, M 2006 'Decoding the ancient Greek astronomical calculator known as the Antikythera Mechanism', *Nature* 444 (30 Nov): 587–91.

Frey, J 1531 *Ein Neues Visier Büchlen*. Nürmberg.

Friel, I 1994 'The Carrack: The Advent of the Full Rigged Ship', in R Gardiner (ed) *Cogs, Caravels and Galleons: The Sailing Ship 1000–1650:* 77–90. London: Conway Maritime Press.

Fryer, K & Shelley, A 1997 'Excavation of a pit at 16 Tunsgate, Guildford, Surrey, 1991', *Post-Medieval Archaeology* 31: 139–230.

Furgol, E 2002 'The Civil Wars in Scotland', in J Kenyon & J Ohlmeyer (eds) *The Civil Wars: a Military History of England, Scotland, and Ireland 1638–1660:* 41–72. Oxford: Oxford University Press.

Gaimster, D 1997 *German Stoneware 1200–1900: Archaeology and Cultural History*. London: British Museum Press.

Gallagher, D B 1987 'Edinburgh Pipemakers in the 17th Century: the documentary evidence', in P Davey (ed) *The Archaeology of the Clay Tobacco Pipe X Scotland*: 3–13. Oxford: BAR British Series 178.

Gardiner, J 2005 'Grinding wheel and mount', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death aboard the* Mary Rose: 340–41. Portsmouth: Mary Rose Trust.

Gardiner, J & Cowham, M 'Timepieces', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death aboard the* Mary Rose: 162–70. Portsmouth: Mary Rose Trust.

Gardiner, R 2012 *The Sailing Frigate: A History in Ship Models*. Barnsley: Seaforth Publishing.

Gaskell, P 1996 *Morvern Transformed* (3rd edn). Colonsay: House of Lochar.

Gerrard, F (ed) 1949 *The Book of the Meat Trade*. 2 vols. London: Caxton Publishing.

Gheyn, J de 1608 *Wapenhandelinghe*. The Hague.

Gibbs, M 2006 'Cultural Site-Formation Processes in Maritime Archaeology: Disaster Response, Salvage and Muckelroy 30 Years On', *International Journal of Nautical Archaeology* 35.1: 4–19.

Gillen, C 2003 *Geology and Landscapes of Scotland*. Harpenden: Terra Publishing.

Glete, J 2000 *Warfare at Sea, 1500–1650: Maritime Conflicts and the Transformation of Europe*. London: Routledge.

Goodhand, S 1983 'Military Finds of the English Civil War', in B Ellison & M Harbottle 'The excavation of a 17th-century Bastion in the Castle of Newcastle-upon-Tyne, 1976–81', *Archaeologica Aeliana*, 5th ser 11: 202-07.

Goodlad, C A 1971 *Shetland Fishing Saga*. Lerwick: Shetland Times.

Gøthche, M 1994 'The Stinesminde Wreck of AD 1600, Denmark', in C Westerdahl (ed) *Crossroads in Ancient Shipbuilding:* 181–7. Oxford: Oxbow Monographs 40.

Grainger, J D 1997 *Cromwell Against the Scots*. Edinburgh: Tuckwell Press.

Grant, A 1982 'The use of tooth wear as a guide to the age of domestic ungulates', in B Wilson, C Grigson & S Payne (eds) *Ageing and Sexing Animal Bones from Archaeological Sites*: 55–71. Oxford: BAR British Series 109.

Grant, I F 1959 *The Macleods: The History of a Clan, 1200–1956*. London: Faber & Faber.

Grant, I F 1995 *Highland Folk Ways* (1st edn 1961). Edinburgh: Birlinn.

Green, J N 1977 *The A-VOC Jacht* Vergulde Draeck *wrecked Western Australia 1656*. Part I. Oxford: BAR International Series 36.

Green, J N 1989 *Retourschip* Batavia *wrecked Western Australia 1629: Excavation Report and Artefact Catalogue*. Oxford: BAR International Series 489.

Greenhill, B 1968 *The Merchant Schooners, Vols 1 & 2*. Newton Abbot: David & Charles.

Greenhill, B 1976 *Archaeology of the Boat*. London: Adam & Charles Black.

Gregory, D 1836 *History of the Western Highlands and Isles of Scotland*. Facsimile edn with introduction by M MacGregor 2008. Edinburgh: John Donald.

Gregory, D 1995 'Experiments into the Deterioration Characteristics of Materials on the Duart Point Wreck Site: an Interim Report', *International Journal of Nautical Archaeology* 24.1: 61–5.

Grenier, R, Bernier, M-A & Stevens, W 2007 *The Underwater Archaeology of Red Bay: Basque Shipbuilding and Whaling in the 16th Century. Vol IV, Rigging, Vessel Use, and Related Studies*. Ottawa: Parks Canada.

Groot, I de & Vortman, R 1980 *Maritime Prints by Dutch Masters*. London: Gordon Fraser Gallery.

Grueber, H A 1970 (1st edn 1899) *Handbook of the Coins of Great Britain and Ireland in the British Museum*. London: Spink & Son.

Guilmartin, J F 1974 *Gunpowder and Galleys*. Cambridge: Cambridge University Press.

Haldane, A R B 1973 *The Drove Roads of Scotland*. Newton Abbot: David & Charles.

Hall, B S 1997 *Weapons and Warfare in Renaissance Europe*. Baltimore & London: Johns Hopkins University Press.

Hamilton-Dyer, S 1995 'Fish in Tudor Naval Diet – with Reference to the *Mary Rose*', *Archaeofauna* 4: 27–32.

Hampshire & Wight Trust for Maritime Archaeology 2010 *Solent Marine Heritage Assets: Yarmouth Roads Report*, Microsoft Word - SMHA Yarmouth Roads Site Report 17_May_10_VM.doc.

Harding, D W 1997 'Forts, Duns, Brochs and Crannogs: Iron Age Settlements in Argyll', in G Ritchie (ed) *The Archaeology of Argyll*, 118–40. Edinburgh: Edinburgh University Press.

Harland, J 2010 'The Whipstaff', *Mariner's Mirror* 97.1: 103–26.

Harland, J F, Barrett, J H, Carrott, J, Dobney K & Jaques, D 2003 'The York System: An Integrated Zooarchaeological Database for Research and Teaching', *Internet Archaeology* 13: http://intarch.ac.uk/journal/issue13/harland_index.html.

Harrington, P 2004 *English Civil War Archaeology*. London: Batsford/ English Heritage.

Harris, H G 1977 *Collecting and Identifying Old Watches*. New York: Emerson Books.

Hart, V 2011 *Inigo Jones: The Architect of Kings*. Yale: Yale University Press.

Hayes-McCoy, G A 1937 *Scots Mercenary Forces in Ireland, 1565–1603*. Dublin: Burns, Oates & Washbourne.

Headland Archaeology 2003 The Swan – Assessment of Three Samples Collected from the Bilge of a 17th-Century Ship, unpublished report SPM03-5/08/03, Dr Colin and Dr Paula Martin Collection, HES.

Heywood, T 1637 *A true Description of His Majesties Royall Ship, built this yeare 1637, at Wooll-witch, etc*. London: Tho Jenner.

Hildred, A 1997 'The Material Culture of the *Mary Rose* (1545) as a Fighting Vessel: the uses of wood', in M Redknap (ed) A*rtefacts from Wrecks: dated assemblages from the Late Middle Ages to the Industrial Revolution*: 51–72. Oxford: Oxbow.

Hildred, A 2009 'The Fighting Ship', in P Marsden (ed) Mary Rose: *Your Noblest Shippe, Anatomy of a Tudor Warship:* 297–344. Portsmouth: Mary Rose Trust.

Hildred, A (ed) 2011 *Weapons of Warre: the armaments of the* Mary Rose. Portsmouth: Mary Rose Trust.

Hildyard, R 1989 'Bellarmines', *Antique Collecting* 24.4: 4–8.

Hocker, F M 2004 'Bottom-based Shipbuilding in Northwestern Europe', in F M Hocker & C A Ward (eds) *The Philosophy of Shipbuilding: Conceptual Approaches to the Study of Wooden Ships*: 65–93. College Station TX: Texas A&M University Press.

Hocker, F 2006 'The Physical Environment', in C O Cederlund (ed) Vasa *I: The Archaeology of a Swedish Warship of 1628:* 62–7. Stockholm: National Maritime Museum of Sweden.

Hocker, F 2011 Vasa*: a Swedish Warship*. Stockholm: Medstroms Bokforlag.

Hocker, F & Wendel, P 2006 'Site-Formation Processes', in C O Cederlund (ed) Vasa *I: The Archaeology of a Swedish Warship of 1628:* 146–70. Stockholm: National Maritime Museum of Sweden.

Hodgson, G, Smith, C & Jones, A 2011 'The mammal bone', in N Bogdan, G Hodgson, C Smith, A Jones, M Fraser, D Heppel, A Clark, A Jones, I Smart, R Longmore, R Cerón-Carrasco & D MacKay *The Perth High Street Archaeological Excavation 1975–77. Fascicule 4: Living and Working in a Scottish Medieval Burgh. Environmental Remains and Miscellaneous Finds*. Perth: Tayside & Fife Archaeological Committee.

Horsley, J E 1978 *Tools of the Maritime Trades*. Newton Abbot: David & Charles.

Horsmonden village web-site, http://www.horsmonden.co.uk/history/demi-culverin-drake-bermuda/.

Hoving, A J 2012 *Nicolaes Witsen and Shipbuilding in the Dutch Golden Age*. College Station TX: Texas A&M University Press.

Howard, F 1979 *Sailing Ships of War*. Greenwich: Conway Maritime Press.

Hurst, J G, Neal, D S & van Beuningen, H J 1986 *Pottery Produced and Traded in North-West Europe 1350–1650*. Rotterdam: Het Nederlandse Gebruiksvoorwerp.

Hustwick, I 2000 *The* George *of Port Seton*. Latheronwheel, Caithness: Whittles Publishing.

Hutchinson, G 1997 *Medieval Ships and Shipping*. London: Leicester University Press.

Ingleby Wood, L 1904 *Scottish Pewter-Ware and Pewterers*. Edinburgh: G A Morton.

Jacobsen, M, Blouin, V Y & Shirley, W 2013 'Does erosion corrosion account for intriguing damage to the hull of the Civil War submarine *H.L. Hunley*?', *Marine Technology Society Journal* 46.6: 38–48.

Jamieson, A G 2012 *Lords of the Sea: a History of the Barbary Corsairs*. Chicago: University of Chicago Press.

Jennings, S 1981 *Eighteen Centuries of Pottery from Norwich*. Norwich: East Anglian Archaeology Report No 13.

Johansson, B A (ed) 1985 *Regalskeppet* Kronan. Höganäs: Bra Böcker.

Johnson, S 1996 *A Journey to the Western Islands of Scotland*. Edinburgh: Canongate.

Jones, A K G 1982 'Bulk-Sieving and the Recovery of Fish Remains from Urban Archaeological Sites', in A R Hall & H Kenward (eds) *Environmental Archaeology in the Urban Context*: 79–85. London: CBA Research Report 43.

Keevil, J J 1954 'The illness of Charles, Duke of Albany from 1600 to 1612', *Journal of the History of Medicine* 9: 407–19.

Kelvin, M 1996, *The Scottish Pistol: Its history, manufacture, and design*. London: Cygnus Arts.

Kennedy, D E 1960 'Naval Captains of the English Civil War', *Mariner's Mirror* 46: 181–98.

Kilby, K 1977 *The Village Cooper*. Aylesbury: Shire Books.

Kirsch, P 1990 *The Galleon: the great ships of the Armada era*. London: Conway Maritime Press.

Kishlansky, M A 1979 *The Rise of the New Model Army*. Cambridge: Cambridge University Press.

Knecht, R J 2008 'The Duke of Argyll's Cannon', *History Scotland* 8.2: 21–9.

Konstam, R A 1988 '16th Century Naval Tactics', *International Journal of Nautical Archaeology* 17.1: 17–23.

Larn, R, McBride, P & Davis, R 1974 'The mid-17th Century Merchant Ship Found near Mullion Cove, Cornwall: Second Interim Report', *International Journal of Nautical Archaeology* 3.1: 67–79.

Laughton, L G Carr 1928 'Gunnery, Frigates, and Line of Battle', *Mariner's Mirror* 14.4: 339–63.

Lavery, B 1987 *The Arming and Fitting of English Ships of War, 1600–1815*. London: Conway Maritime Press.

Lavery, B 1988 *The Colonial Merchantman* Susan Constant, *1605*. London: Conway Maritime Press.

Legge, A J & Rowley-Conwy, P A 1988 *Star Carr Revisited*. London: Centre for Extra-Mural Studies, Birkbeck College, University of London.

Lenman, B 1995a *The Jacobite Clans of the Great Glen, 1650–1784*. Aberdeen: Scottish Cultural Press.

Lenman, B 1995b *The Jacobite Risings in Britain 1689–1746*. Aberdeen: Scottish Cultural Press.

Lewis, M 1961 *Armada Guns: A Comparative Study of English and Spanish Armaments*. London: Allen & Unwin.

L'Hour, M & Veyrat, E 1989 'A mid-15th-century clinker boat off the north coast of France, the Aber Wrac'h I wreck: A preliminary report', *International Journal of Nautical Archaeology* 18.4: 285–98.

Link, E A 1960 'Exploring the Drowned City of Port Royal', N*ational Geographic Magazine* 117.1: 151–83.

Lloyd, N 1925 *A History of English Brickwork*. London: H G Montgomery.

Lockett, R C 1934 'Notes on the Mints of Truro and Exeter under Charles II', *British Numismatic Journal* 22: 227–46.

Loewen, B 2007 'Casks from the 24M wreck', in R Grenier, M A Bernier & W Stevens (eds) *The Underwater Archaeology of Red Bay: Basque Shipbuilding and Whaling in the 16th Century*, Vol II: 5–46. Ottawa: Parks Canada.

Loomes, B 1981 *The Early Clockmakers of Great Britain*, vol 2. London: N A G Press.

Lowcock, M 1998 'The Pump', in P Wilkinson, M Lowcock & S Stell 'A 16th-century saltworks at Port Eynon, Gower', *Post-Medieval Archaeology* 32: 19–21.

Lucar, Cyprian 1588 *Tartaglia's Colloquies and Lucar Appendix*. London.

Luz, B & Kolodny, Y 1985 'Oxygen isotope variations in phosphate of biogenic apatites. IV. Mammal teeth and bones', *Earth and Planetary Science Letters* 75: 29–36.

Lyman, R L 1994 *Vertebrate Taphonomy*. Cambridge: Cambridge University Press.

Lynch, M 1992, *Scotland: A New History*. London: Vintage.

MacAulay, J 1996 *Bìrlinn: Longships of the Hebrides*. Knapwell, Cambridge: White Horse Press.

Macdougall, N 1989 *James IV*. Edinburgh: John Donald.

Macdougall, N 1991 '"The Greattest Scheip That Ewer Sallit in Ingland or France": James IV's *Great Michael'*, in N Macdougall (ed), *Scotland and War, ad 79–1918*. Edinburgh: Barnes & Noble.

McGrail, S 1987 *Ancient Boats in North-West Europe*. London: Longman.

McIan, R R & Logan, J 1983 *The Clans of the Scottish Highlands: the Costumes of the Clans* (reproduced from the original 1845 & 1847 volumes). London: Chancellor Press.

Macinnes, A I 2011 *The British Confederate: Archibald Campbell, Marquess of Argyll, 1607–1661*. Edinburgh: John Donald.

Macinnes, J 1976 'West Highland Sea Power in the Middle Ages', *Transactions of the Gaelic Society of Inverness* 48: 518–56.

McKay, M (ed) 1980 *The Reverend John Walker's Report on the Hebrides of 1764 and 1771*. Edinburgh: John Donald.

McKean, C 2001 *The Scottish Chateau*. Stroud: Sutton Publishing.

McKewan, C 2005 'General tools and equipment', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose*:* 348–56. Portsmouth: Mary Rose Trust.

Mackie, R L 1958 *King James IV of Scotland: A Brief Survey of his Life and Times*. Edinburgh: Oliver & Boyd.

McLaren, D & Hunter, F 2008 'New aspects of rotary querns in Scotland', *Proceedings of the Society of Antiquaries of Scotland* 138: 105–28.

Maclean-Bristol, N 2012 *Castor and Pollux*. Isle of Coll: Society of West Highland and Island Historical Research.

MacLeod, I D 1995 '*In Situ* Corrosion Studies on the Duart Point Wreck, 1994', *International Journal of Nautical Archaeology* 24.1: 53–9.

MacLeod, I D 2006 'Corrosion and conservation management of iron shipwrecks in Chuuk Lagoon', *Conservation and Management of Archaeological Sites* 7: 203–23.

Macleod, N 2002 (ed I Thornber) *Morvern: A Highland Parish*. Edinburgh: Birlinn.

McManus, J 2004 Sources of Ballast Material from the *Swan* Wreck, Duart Point, Mull, unpublished report, Dr Colin and Dr Paula Martin Collection, HES.

McNeill, G B & MacQueen, H L 1996 *Atlas of Scottish History to 1707*. Edinburgh: The Scottish Medievalists.

McWhannell, D C 2002 'The Galleys of Argyll', *Mariner's Mirror* 88.1: 14–32.

Manwaring, G E & Perrin, W G 1922 *The Life and Works of Sir Henry Mainwaring, Vol II*. London: Navy Records Society.

Marken, M W 1991 Ceramics carried by Spanish Ships from the 16th to the 18th Centuries with Specific Reference to Collections Recovered from Shipwrecks in the Caribbean Basin, Britain, and Bermuda, unpublished PhD thesis, University of St Andrews.

Marsden, P (ed) 2009 Mary Rose, *Your Noblest Shippe: Anatomy of a Tudor Warship* (Archaeology of the *Mary Rose* Vol 2). Portsmouth: Mary Rose Trust.

Martin, C J M 1978 'The *Dartmouth*, a British Frigate Wrecked off Mull, 1690. 5. The Ship', *International Journal of Nautical Archaeology* 7.1: 29–58.

Martin, C J M 1979 'Spanish Armada Pottery', *International Journal of Nautical Archaeology* 8.4: 279–302.

Martin, C J M 1983 'Archaeology in an Underwater Environment', in *Protection of the Underwater Heritage:* 15–76. Paris: UNESCO Technical Handbooks for Museums and Monuments 4.

Martin, C J M 1995 'The Cromwellian Shipwreck off Duart Point, Mull: an Interim Report', *International Journal of Nautical Archaeology* 24.1: 15–32.

Martin, C J M 1997 'Ships as Integrated Artefacts: the Archaeological Potential', in M Redknap (ed) *Artefacts from Wrecks: Dated Assemblages from the Late Middle Ages to the Industrial Revolution:* 1–13. Oxford: Oxbow.

Martin, C J M 1998 *Scotland's Historic Shipwrecks*. London: Batsford.

Martin, C J M 2004 'An Iron Bastard Minion Drake Extraordinary by John Browne from the Pinnace *Swan* (1641–53)', *International Journal of Nautical Archaeology* 33.1: 79–95.

Martin, C J M 2005 'The *Adelaar*, a Dutch East-Indiaman wrecked in 1728 off Barra, Outer Hebrides', *International Journal of Nautical Archaeology* 34.2: 179–210.

Martin, C J M 2009 '"Nowhere does the sea hold wider sway": Maritime Transport on Scotland's Western Seaboard', in K Veitch (ed) *Scottish Life and Society: a Compendium of Scottish Ethnology,* vol 8: *Transport and Communications in Scotland*: 137–67. Edinburgh: John Donald.

Martin, C J M 2011 'Wreck-Site Formation Processes', in A Catsambis, B Ford & D L Hamilton (eds) *The Oxford Handbook of Maritime Archaeology:* 47–67. New York: Oxford University Press.

Martin, C J M 2014 'A Maritime Dominion – Sea-Power and the Lordship', in R D Oram (ed) *The Lordship of the Isles*, 176–99. Leiden: Brill.

Martin, C J M & Martin, E A 2002 'An Underwater Photomosaic Technique Using Adobe Photoshop™', *International Journal of Nautical Archaeology* 31.1: 137–47.

Martin, C J M & Parker, N G 1999 *The Spanish Armada* (2nd edn). Manchester: Manchester University Press.

Matar, N 2014 *British Captives from the Mediterranean to the Atlantic*. Leiden: Brill.

Matz, E nd Vasa *Catalogue*. Stockholm: *Vasa* Museum.

Mayer, J 1852 'The Alleged Royal Visits to Liverpool', *Historic Society of Lancashire and Cheshire, Proceedings and Papers: Session IV. 1851–1855*. Liverpool.

Meddens, F M 2000 'The Pottery', in P Moore, 'Tilbury Fort: a Post-Medieval Fort and its Inhabitants', *Post-Medieval Archaeology* 34: 43–56.

Meehan, P, Buck, P & Lee, L 1996, 'The investigation and conservation of a 17th-century watch retrieved from the River Thames', *The Conservator* 20: 45–51.

Meier-Augenstein, W 2005 'Isotopic Composition of Archaeological Human Remains: "Seaman Swan"', in S Black Analysis of the skeletal remains associated with the 'Swan', Duart Point, Mull: 26–8, unpublished report, Dr Colin and Dr Paula Martin Collection, HES.

Meredith, J, Anderson, S, Egan, G, Higgins, D & Pattison, P 2008 'Excavations at Landguard Fort: an investigation of the 17th century defences', *Post-Medieval Archaeology* 42.2: 229–75.

Monson, W 1902 *Naval Tracts of Sir William Monson* (ed M Oppenheim), vols 1–2. London: Navy Records Society.

Monson, W 1903 *Naval Tracts of Sir William Monson* (ed M Oppenheim), vol 3. London: Navy Records Society.

Monson, W 1913 *Naval Tracts of Sir William Monson* (ed. M Oppenheim), vol 4. London: Navy Records Society.

Monson, W 1914 *Naval Tracts of Sir William Monson* (ed M Oppenheim), vol 5. London: Navy Records Society.

Moody, J D 1952 'Old Naval Gun-Carriages', *Mariner's Mirror* 38: 301–11.

Moorhouse, S 1970 'Finds from Basing House, Hampshire (*c* 1540–1645): Part 1', *Post-Medieval Archaeology* 4: 31–91.

Moorhouse, S 1971 'Finds from Basing House, Hampshire (*c* 1540–1645): Part II', *Post-Medieval Archaeology* 5: 35–76.

Muckelroy, K W 1978 *Maritime Archaeology*. Cambridge: Cambridge University Press.

Murdoch, S 2010 *The Terror of the Seas? Scottish Maritime Warfare 1513–1713*. Leiden: Brill.

Naish, G P B 1958 'Ships and Shipbuilding', in C Singer, E Holmyard, A Hall & T Williams *A History of Technology* vol 3: 471–500. Oxford: Oxford University Press.

Naish, G P B 1968 *The* Wasa*: her place in history*. London: HMSO.

Newton, E 1960 '17th Century Pottery Sites at Harlow, Essex', *Transaction of the Essex Archaeological Society 25*.3: 358–77.

Nicholson, R 1989 'The Fish Remains', in C O'Brian, L Bown, S Dixon, L Donel, L J Gidnet, J P Huntley, R Nicholson & P Walton 'Excavations at Newcastle Quayside: the Crown Court Site', *Archaeologia Aeliana* ser 5 no 17: 188–96.

Nicolaisen, W F H 1976 *Scottish Place-Names*. London: Harper Collins.

Nieke, M 2004 'Secular Society from the Iron Age to Dál Riata and the Kingdom of the Scots', in D Omand (ed) *The Argyll Book:* 60–70. Edinburgh: Birlinn.

Norton, R 1628 *The Gunner Shewing the Whole Practise of Artillery*. London: Humphrey Robinson.

Oertling, T J 1996 *Ships' Bilge Pumps: a History of their Development, 1500–1900*. College Station TX: Texas A&M University Press.

Ohlmeyer, J H 1989 'The Dunkirk of Ireland: Wexford privateers during the 1640s', *Journal of the Wexford Historical Society* 12: 23–49

Ohlmeyer, J H 1990 'Irish privateers during the civil war, 1642–50', *Mariner's Mirror* 76: 119–34.

Ohlmeyer, J H 2002 'The Civil Wars in Ireland', in J Kenyon & J Ohlmeyer (eds) *The Civil Wars: a Military History of England, Scotland, and Ireland 1638–1660*, 73–102. Oxford: Oxford University Press.

Oppenheim, M 1896 *A History of the Administration of the Royal Navy and of Merchant Shipping in relation to the Navy … 1509 to 1660*. 1988 reprint. Aldershot: Gower Publishing.

Oram, R D 2004 'The Lordship of the Isles, 1336–1545', in D Omand (ed) *The Argyll Book*: 123–39. Edinburgh: Birlinn.

O'Sullivan, J C 1969 'Wooden pumps', *Folk Life* 7: 101–16.

Oswald, A 1975 *Clay Pipes for the Archaeologist*. Oxford: BAR British Series 14.

Padfield, P 1973 *Guns at Sea*. London: H Evelyn.

Parks, R L & Barrett, J H 2004 *The Fish Bone from the Swan, a 17th-century shipwreck off Duart Point, Mull: 2000–2003 excavations*. Reports from the Centre for Human Ecology, University of York, 2004/08, http://www.york.ac.uk/inst/chumpal/CHPReps/chp2004–08.pdf.

Parsons, J E 1964 'The Archaeology of the Clay Tobacco Pipe in North East England', *Archaeologia Aeliana* 4th Series 42: 231–54.

Payne, S 1973 'Kill-off patterns in sheep and goats – the mandibles from Aşvan Kale', *Journal of Anatolian Studies* 23: 281–303.

Pearson, C 1972 'The Preservation of Iron Cannon after 200 Years in the Sea', *Studies in Conservation* 17: 91–110.

Pennant, T 1774 *A Tour of Scotland and voyage to the Hebrides, 1772*, 2 vols. Chester: John Monk.

Perdikaris, S 1999 'From Chiefly Provisioning to Commercial Fishery: Long-Term Economic Change in Arctic Norway', *World Archaeology* 30: 388–402.

Perrin, W G (ed) 1929 *Boteler's Dialogues*. London: Navy Records Society 65.

Platt, C & Coleman-Smith, R 1975 *Excavations in Medieval Southampton, 1953–1969. Vol 2. The Finds*. Leicester: Leicester University Press.

Preßlinger, H, Pilcher, B & MacLeod, I D 2012 'Werkstoffkundliche Untersuchungsergebnisse einer im 17. Jahrhundert aus Gusseisen gefertigten englischen Schiffskanone', *Berg-und Hüttenmäische Monatschefte* 157.5: 209–13.

Price, R & Muckelroy, K 1977 'The Kennemerland Site. The Third and Fourth Seasons 1974 and 1976. An Interim Report', *International Journal of Nautical Archaeology* 6.3: 187–218.

Puype, J P 1990 'Guns and their Handling at Sea in the 17th Century: a Dutch Point of View', *Journal of the Ordnance Society* 2: 11–23.

Ramsey, A T 2007, 'The latest techniques reveal the earliest technology – A new inspection of the Antikythera Mechanism', International Symposium on Digital Radiology and Computed Tomography, June 25–27 2007, Lyon, France: http://www.ndt.net/article/dir2007/papers/2.pdf.

Redknap, M & Besly, E 1997 '*Wreck de mer* and dispersed wreck-sites: the case of the A*nn Francis* 1583', in M Redknap (ed) *Artefacts from Wrecks: Dated Assemblages from the Late Middle Ages to the Industrial Revolution*: 191–207. Oxford: Oxbow.

Richards, M 2005 'Lighting Equipment', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose, 342–7. Portsmouth: Mary Rose Trust.

Richards, M with Every, R 2005 'Chests', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose, 387–97. Portsmouth: Mary Rose Trust.

Richards, M & Gardiner, J 'Books and Writing Equipment', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose: 127–33. Portsmouth: Mary Rose Trust.

Rixson, D 1998 *The West Highland Galley*. Edinburgh: Birlinn.

Roberts, K 1989 *Soldiers of the English Civil War. 1. Infantry*. London: Osprey Publishing.

Robinson, M S 1958 *The van de Velde Drawings. A Catalogue of Drawings in the National Maritime Museum*. Cambridge: Cambridge University Press.

Rodger, N A M 1996 'The Development of Broadside Gunnery', *Mariner's Mirror* 82: 301–24.

Rodger, N A M 1997 *The Safeguard of the Sea: A Naval History of Britain. Vol 1, 660–1649*. London: Harper Collins.

Rodger, N A M 2004 *The Command of the Ocean: A Naval History of Britain. Vol 2, 1649–1815*. London: Allen Lane.

Rodgers, B A, Richards, N & Lusardi, W R 2005 '"Ruling Theories Linger": Questioning the Identity of the Beaufort Inlet Shipwreck', *International Journal of Nautical Archaeology* 34.1: 24–37.

Rodriguez, J 2005 'Staved containers (casks)', in J Gardiner (ed) *Before the Mast: Life and Death Aboard the* Mary Rose: 409–21. Portsmouth: Mary Rose Trust.

Roth, R 1994, drawing, p.44, in Towes & McCree 'A Note on Drakes', *Journal of the Ordnance Society* 6: 39–46.

Royal Commission on the Ancient & Historical Monuments of Scotland 1980 *Argyll: an Inventory of the Monuments. Vol 3. Mull, Tiree, Coll & Northern Argyll*. Edinburgh: HMSO.

Salisbury, W (ed) 1958 'A Treatise on Shipbuilding *c* 1620, from a manuscript in the Admiralty Library', appendix in P Kirsch 1990 *The Galleon: the great ships of the Armada era*: 165–200. London: Conway Maritime Press.

Sanders, D 2010 'Knowing the Ropes: The Need to Record Ropes and Rigging on Wreck-Sites and Some Techniques for Doing So', *International Journal of Nautical Archaeology* 39.1: 2–26.

Schubert, H R 1957 *History of the British Iron and Steel Industry from c 450 bc to ad 1775*. London: Routledge & Kegan Paul.

Scott, B G, Brown, R R, Leacock, A G & Salter, C J 2008 *The Great Guns Like Thunder: The Cannon from the City of Derry*. Derry/Londonderry: Guildhall Press.

Scott-Giles, C W 1958 *Boutell's Heraldry*, revised edn. London: Frederick Warne.

Seller, J 1691 *The Sea-Gunner*. London.

Simmons, J J 1998 *Those Vulgar Tubes: External Sanitary Accommodations aboard European Ships of the Fifteenth through Seventeenth Centuries*. College Station TX & London: Chatham Publishing.

Simpson, W D 1931 'Edzell Castle', *Proceedings of the Society of Antiquaries of Scotland* 65: 115–73.

Singer, C, Holmyard, E, Hall, A & Williams, T 1956 *A History of Technology, Vol II: The Mediterranean Civilisations and the Middle Ages, c 700 bc –ad 1500*. Oxford: Oxford University Press.

Singer, C, Holmyard, E, Hall, A & Williams, T 1957 *A History of Technology, Vol III: From the Renaissance to the Industrial Revolution, c 1500–c 1800*. Oxford: Oxford University Press.

Sivlich, D M 1996 'Analyzing Musket Balls to Interpret a Revolutionary War Site', *Historical Archaeology* 30: 101–09.

Skoglund, F K 2002 The Coastal Defence in Scandinavia: the Role and Composition of the Military Organisation in the Viking and Early Middle Ages, unpublished M.Phil dissertation, University of St Andrews.

Skrowronek, R & Ewen, C R (eds) 2006 *X Marks the Spot: The Archaeology of Piracy*. Gainesville: University Press of Florida.

Smallman, R E & Bishop, R J 1999, *Modern Physical Metallurgy and Materials*. 6th edn. Oxford: Butterworth-Heinemann.

Smith, C 2003 Animal Bones from the 'Swan', Duart Point, Mull, unpublished report, SUAT Ltd, Perth, Dr Colin and Dr Paula Martin Collection, HES.

Smith, H D 1984 *Shetland Life and Trade 1550–1914*. Edinburgh: John Donald.

Smith, J 1627 *A Sea Grammar*. London.

Smith, J 1691 *Seamans Grammar & Dictionary*. London.

Smith, R D 2001 'A Carriage and Cast-Iron Cannon at Windsor Castle', *Journal of the Ordnance Society* 13: 25–38.

Steane, K 1987 'Bellarmine Capacities', *Post-Medieval Archaeology* 21: 257–8.

Steffey, J R 1994 *Wooden Shipbuilding and the Interpretation of Shipwrecks*. College Station TX: Texas A&M University Press.

Sténuit, R 1974 'Early Relics of the VOC Trade from Shetland: the Wreck of the Flute *Lastdrager* lost off Yell, 1653', *International Journal of Nautical Archaeology* 3.2: 213–56.

Stephan, E 2000 'Oxygen Isotope Analysis of Animal Bone Phosphate: Method Refinement, Influence of Consolidants, and Reconstruction of Palaeotemperatures for Holocene Sites', *Journal of Archaeological Science* 27.6: 523–35.

Stevenson, D 1973 *The Scottish Revolution 1637–1644*. Newton Abbot: David & Charles.

Stevenson, D 1982 *The Government of Scotland under the Covenanters 1637–1651*. Edinburgh: Scottish History Society.

Stevenson, D 2003 *Highland Warrior: Alasdair MacColla and the Civil Wars*. Edinburgh: Birlinn.

Stimson, A 2005 'The Navigation Instruments', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose: 267–81. Portsmouth: Mary Rose Trust.

Stirland, A J 2000 *Raising the Dead: The Skeleton Crew of Henry VIII's Great Ship, the* Mary Rose. Chichester: Wiley-Blackwell.

Stopford, P J 1953 *Cordage and Cables: Their Uses at Sea*. Glasgow: Brown Son & Ferguson.

Sutherland, W 1711 *The Shipbuilder's Assistant*. London.

Taylor, A B 1980 (ed I H Adams & G Fortune) *Alexander Lindsay: a Rutter of the Scottish Seas* circa *1560*. Greenwich Maritime Monographs & Reports 44.

Taylor, E G R 1956 *The Haven-Finding Art*. London: Hollis & Carter.

Thompson, E K 1977 'Whelps', *Mariner's Mirror* 63.2: 128.

Thrush, A 1991 'In Pursuit of the Frigate, 1603–40', *Historical Research* 64: 29–45.

Thwaite, A 1973 'The Chronology of the Bellarmine Jug', *Connoisseur* 182: 255–62.

Towes, R M & McCree, P 1994 'A Note on Drakes', *Journal of the Ordnance Society* 6: 39–46.

Troalen, L, Cox, D, Skinner, T, Ramsey, A & Bate, D 2010 'Three-Dimensional Computed Tomography X-Radiographic Investigation of a 17th Century Watch from the Wreck of the *Swan*, off Duart Point, Mull, Scotland', *International Journal of Nautical Archaeology* 39.1: 165–71.

Turner, N & Finlay, A 1971? *The Isle of Mull: a short guide to the island*. Printed by D J Clarke Ltd, Glasgow.

Unger, R W 1978 *Dutch Shipbuilding before 1800*. Amsterdam: van Gorcum.

Unstead, J F 1964 *The British Isles*. London: University of London Press.

Vale, D & Gargett, R H 2002 'Size Matters: 3-mm Sieves do not Increase Richness in a Fishbone Assemblage from Arrawarra I, an Aboriginal Shell Midden on the Mid-North Coast of New South Wales, Australia', *Journal of Archaeological Science* 29: 57–63.

Villiers, A 2000 *The Last of the Wind Ships*. London: Harvill Press.

Vlierman, K 1997 'The Ijsselmeerpolders: a "source book" for late medieval and early post-medieval wreck inventories', in M Redknap (ed) *Artefacts from Wrecks: Dated Assemblages from the Late Middle Ages to the Industrial Revolution:* 15–36. Oxford: Oxbow.

Vollan, O 1974 'Torskefiske', *Kulturhistorisk Leksikon for Nordisk Middelalder* 18: 506–09.

Ward, R 1639 *Animadversions of Warre*. London: Francis Eglesfield.

Waters, W 1955 'Bittacles and Binnacles', *Mariner's Mirror* 41: 198–208.

Waters, W 1958 *The Art of Navigation in England in Elizabethan and Early Stuart Times*. London: Hollis & Carter.

Watson, C B B (ed) 1929 *Roll of Edinburgh Burgesses and Guild-Brethren, 1406–1700*. Edinburgh: Scottish Record Society.

Webster, G 1969 *Romano-British Coarse Pottery: a Student's Guide*. London: CBA Research Report 6.

Weinstein, R 2005 'Eating and Drinking Vessels and Utensils', in J Gardiner with M J Allen (eds) *Before the Mast: Life and Death Aboard the* Mary Rose: 448–58. Portsmouth: Mary Rose Trust.

Wertime, T A 1962 *The Coming of the Age of Steel*. Chicago: University of Chicago Press.

Western Australian Museum, Maritime Archaeology databases, for *Zuytdorp* (1712), http://museum.wa.gov.au/maritime-archaeology-db/maritime-archaeology-databases

Wheeler, A 1978 *Key to the Fishes of Northern Europe*. London: Frederick Warne.

Whitelaw, C E 1977 *Scottish Arms Makers: a Biographical Dictionary of Makers of Firearms, Edged Weapons and Armour Working in Scotland from the 14th Century to 1870* (ed S Barter). London: Weidenfeld Military.

Willcock, J 1903 *The Great Marquess: Life and Times of Archibald, 8th Earl and 1st (and only) Marquess of Argyll (1607–1661)*. Edinburgh & London: Oliphant & Co.

Wilson, G 1988 'The Commonwealth Gun', *International Journal of Nautical Archaeology* 17.1: 87–99.

Wilthew, P 1994 XRF Analysis of a Watch from Duart Point, unpublished AR Report 94/16. National Museums Scotland.

Withers, W J & Munro, R W (eds) 1999 *A Description of the Western Islands of Scotland ca 1695 and a Late Voyage to St Kilda* by Martin Martin *and Description of the Western Islands of Scotland* by D Monro. Edinburgh: Birlinn.

Woolf, A 2004 'The Age of the Sea-Kings: 900–1300', in D Omand (ed) *The Argyll Book*: 94–109. Edinburgh: Birlinn.

Wu, Y S, Liu, D Y, Cao, B, Wang, F L, Wang, X Z, Fang, Z & Du, Z G 1998 'A Study of Electrochemical Behaviour of Various Thermal History Zones and Different Phase Structures on the Weldment for Low Alloy Steel in 16Mn in Nitrate Solution', *Acta Metallurgica Sinica (English Letters)* 11.4: 270–74.

Yokota Manufacturing Company of Japan 2011, https://www.aquadevice.com/english/01top_outline1.htm

INDEX

Page numbers in italic denote illustrations.

EXCAVATION PLAN

Grid in metres
Primary baseline A-B
Depth-datums C and D